ALCOHOL RESEARCH
Current Reviews

THE JOURNAL OF THE NATIONAL INSTITUTE ON ALCOHOL ABUSE AND ALCOHOLISM

Curated Collection
Recovery

Compiled June 2024

Curated Collection PDFs are updated by journal staff on a yearly basis. More recent articles for this Collection may be available on the *ARCR* website.

National Institute on Alcohol Abuse and Alcoholism

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

ALCOHOL RESEARCH
Current Reviews

Alcohol Res. 2021;41(1):10 ● https://doi.org/10.35946/arcr.v41.1.10

Published 29 July 2021

RECOVERY FROM AUD- FROM THE EDITORS

John F. Kelly[1,2] and Brett Hagman[3]

[1]Department of Psychiatry, Massachusetts General Hospital, Recovery Research Institute, Boston, Massachusetts

[2]Department of Psychiatry, Harvard Medical School, Boston, Massachusetts

[3]Division of Treatment and Recovery Research, National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health, Bethesda, Maryland.

In recent decades, the term "recovery" as it pertains to alcohol use disorder (AUD) and drug use disorders has taken on increasing cultural and scientific significance in the United States and around the world. Its growing prominence as a culturally recognized and, importantly, positively valenced organizing concept has occurred in large part in direct response to help counter the pervasive and intransigent stigma, discrimination, and general pessimism that so often surround alcohol misuse and AUD.[1-3] In addition, the term "recovery" often is used intentionally to describe improvements in functioning and quality of life that go beyond solely abstinence or disorder remission.[4,5] This broader construct stands in explicit contradistinction to the mere absence of alcohol use or AUD symptoms. As the cultural significance of recovery has developed and deepened, the scientific community has become interested in understanding its meaning, both as a dynamic, multidimensional biobehavioral process and as an outcome. Moreover, given the burden of disease, disability, mortality, and economic costs attributable to AUD, the discovery of factors that can help affected individuals to initiate and sustain long-term stable AUD recovery has become paramount. With all of these ends in mind, this topic series, "Recovery From Alcohol Use Disorder," reviews current understanding of AUD recovery from clinical, public health, and public policy perspectives.

Drawing on the expertise of renowned AUD researchers, this series provides an expansive review of what is currently known about recovery from AUD. From defining what "recovery" is to describing its epidemiology; its salubrious neurological, somatic, psychological, and behavioral effects; the services and therapeutic factors responsible for helping individuals initiate and sustain it; and the myriad pathways followed to achieve it—this series covers expansive terrain.

Defining what recovery actually is has been a goal of many organizations and stakeholder groups in recent years, including the National Institute on Alcohol Abuse and Alcoholism (NIAAA). This series begins with an in-depth look at defining recovery, examining the nuances and presumed components of the domain with important implications for clinical research and public health (Witkiewitz, Montes, Schwebel, et al., 2020).[6] Recovery prevalence also has been of great interest, including the extent to which individuals self-identify as "a person in recovery" (or not) and which demographic and clinical subgroups of individuals appear to have fewer or greater challenges on the path to recovery than others. Some of the reasons for these differences are detailed and explained along with the known

estimates of recovery prevalence in the United States (Tucker, Chandler, and Witkiewitz, 2020).[7] The positive neurophysiological, somatic, psychological, and behavioral effects of, and the milestones involved in, AUD recovery are of great interest to affected parties, as well as to the public and the clinical and research fields. These effects are covered in detail across domains of brain (Nixon and Lewis, 2020)[8] and other organ systems (Thomes, Rasineni, Saraswathi, et al., 2021).[9]

Several articles describe the therapeutic and dynamic mobilizers of recovery-related change across various clinical, nonclinical, and self-management pathways, including articles about the recovery journey (Davidson, Rowe, DiLeo, et al., 2021; Stout, 2021)[11,12] among individuals and their families (McCrady and Flanagan, 2021).[10] This section includes articles on long-term clinical in-person care (McKay, 2021),[13] pharmacology (Mason and Heyser, 2021),[14] and the growing array of community-based recovery support services, such as mutual help organizations (Zemore, Gilbert, Pinedo, et al., 2021),[15] as well as recovery housing, recovery coaching, recovery supports in education, and recovery community centers (Jason, Salomon-Amend, Guerrero, et al., 2021).[16] Demographic and clinical factors that have been shown to affect initiation and trajectories of recovery and related change are featured in depth with specific focus on sex (Holzhauer, Cucciare, and Epstein, 2020),[17] age (Finch, Jurinsky, and Anderson, 2020),[18] and race and ethnicity (Wagner and Baldwin, 2020).[19]

In sum, during the past 50 years since the birth of NIAAA, and strongly influenced by the voluminous research it has generated, the field has witnessed a number of evolutionary paradigm shifts in understanding and approach that have informed how best to address the endemic problems associated with alcohol misuse and AUD. This landmark topic series reflects yet another shift—one that recognizes the necessity of attending not only to clinical pathology through acute stabilization and short-term, professionally delivered services, but also to the need for additional resources to help individuals and their families build resilient, robust recovery and permit human flourishing over the long term.

Disclosures

Dr. Kelly has received funding from the National Institutes of Health (NIAAA, National Institute on Drug Abuse, National Institute of Mental Health), the Substance Abuse and Mental Health Services Administration, and the Veterans Health Administration to conduct research into the treatment of alcohol and drug use disorders, associated comorbidities, treatment response, and mechanisms of behavior change. Dr. Hagman is with the Division of Treatment and Recovery Research at NIAAA and reports no financial conflicts of interest.

Publisher's Note

Opinions expressed in contributed articles do not necessarily reflect the views of the National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health. The U.S. government does not endorse or favor any specific commercial product or commodity. Any trade or proprietary names appearing in *Alcohol Research: Current Reviews* are used only because they are considered essential in the context of the studies reported herein.

References

1. Kelly JF, Greene MC, Abry A. A U.S. national randomized study to guide how best to reduce stigma when describing drug-related impairment in practice and policy. *Addiction.* In press. https://doi.org/10.1111/add.15333.
2. Kelly JF, Saitz R, Wakeman SE. Language, substance use disorders, and policy: The need to reach consensus on an "addiction-ary." *Alcohol Treat Q.* 2016;34(1):116-123. https://doi.org/10.1080/07347324.2016.1113103.
3. Room R, Rehm J, Trotter II RT, et al. Cross-cultural views on stigma, valuation, parity, and societal values towards disability. In: Üstün TB, Chatterji S, Bickenbach JE, et al., eds. *Disability and Culture: Universalism and Diversity.* Seattle, WA: Hogrefe & Huber; 2001:247-291.
4. White WL. Addiction recovery: Its definition and conceptual boundaries. *J Subst Abuse Treat.* 2007;33(3):229-241. https://doi.org/10.1016/j.jsat.2007.04.015.
5. Kelly JF, Greene MC, Bergman BG. Beyond abstinence: Changes in indices of quality of life with time in recovery in a nationally representative sample of U.S. adults. *Alcohol Clin Exp Res.* 2018;42(4):770-780. https://doi.org/10.1111/acer.13604.
6. Witkiewitz K, Montes KS, Schwebel FJ, Tucker JA. What is recovery? *Alcohol Res.* 2020;40(3):01. https://doi.org/10.35946/arcr.v40.3.01.
7. Tucker JA, Chandler SD, Witkiewitz K. Epidemiology of recovery from alcohol use disorder. *Alcohol Res.* 2020;40(3):02. https://doi.org/10.35946/arcr.v40.3.02.
8. Nixon SJ, Lewis B. Brain structure and function in recovery. *Alcohol Res.* 2020;40(3):04. https://doi.org/10.35946/arcr.v40.3.04.
9. Thomes PG, Rasineni K, Saraswathi V, et al. Natural recovery by the liver and other organs after chronic alcohol use. *Alcohol Res.* 2021;41(1):05. https://doi.org/10.35946/arcr.v41.1.05.
10. McCrady BS, Flanagan JC. The role of the family in alcohol use disorder recovery for adults. *Alcohol Res.* 2021;41(1):06. https://doi.org/10.35946/arcr.v41.1.06.
11. Davidson L, Rowe M, DiLeo P, et al. Recovery-oriented systems of care: A perspective on the past, present, and future. *Alcohol Res.* 2021;41(1):09. https://doi.org/10.35946/arcr.v41.1.09.

12. Stout RL. Naturalistic research on recovery processes: Looking to the future. *Alcohol Res.* 2021;41(1):02. https://doi.org/10.35946/arcr.v41.1.02.
13. McKay JR. Impact of continuing care on recovery from substance use disorder. *Alcohol Res.* 2021;41(1):01. https://doi.org/10.35946/arcr.v41.1.01.
14. Mason BJ, Heyser CJ. Alcohol use disorder: The role of medication in recovery. *Alcohol Res.* 2021;41(1):07. https://doi.org/10.35946/arcr.v41.1.07.
15. Zemore SE, Gilbert PA, Pinedo M, et al. Racial/ethnic disparities in mutual help group participation for substance use problems. *Alcohol Res.* 2021;41(1):03.https://doi.org/10.35946/arcr.v41.1.03.
16. Jason LA, Salomon-Amend M, Guerrero M, et al. The emergence, role, and impact of recovery support services. *Alcohol Res.* 2021;41(1):04. https://doi.org/10.35946/arcr.v41.1.04.
17. Holzhauer CG, Cucciare M, Epstein EE. Sex and gender effects in recovery from alcohol use disorder. *Alcohol Res.* 2020;40(3):03. https://doi.org/10.35946/arcr.v40.3.03.
18. Finch AJ, Jurinsky J, Anderson BM. Recovery and youth: An integrative review. *Alcohol Res.* 2020;40(3):06. https://doi.org/10.35946/arcr.v40.3.06.
19. Wagner EF, Baldwin JA. Recovery in special emphasis populations. *Alcohol Res.* 2020;40(3):05. https://doi.org/10.35946/arcr.v40.3.05.

ALCOHOL RESEARCH
Current Reviews

Alcohol Res. 2021;41(1):09 ● https://doi.org/10.35946/arcr.v41.1.09

Published: 22 July 2021

Recovery-Oriented Systems of Care: A Perspective on the Past, Present, and Future

Larry Davidson,[1,2] Michael Rowe,[1] Paul DiLeo,[2,3] Chyrell Bellamy,[1,2] and Miriam Delphin-Rittmon[1,2]

[1]Program for Recovery and Community Health, Department of Psychiatry, Yale University School of Medicine, New Haven, Connecticut
[2]Connecticut Department of Mental Health and Addiction Services, Hartford, Connecticut
[3]Yale University School of Medicine, New Haven, Connecticut

This paper provides a perspective on the recent concept of recovery-oriented systems of care with respect to its origins in the past and its status in the present, prior to considering directions in which such systems might move in the future. Although influential in practice, this concept has yet to be evaluated empirically and has not been the object of a review. Recovery-oriented systems of care emerged from the efforts of persons with mental health and/or substance use disorders who advocated for services to go beyond the reduction of symptoms and substance use to promote a life in the community. Subsequent efforts were made to delineate the nature and principles of such services and those required of a system of such care. Coincident with the U.S. Substance Abuse and Mental Health Services Administration dropping reference to behavioral health in its revised definition of recovery, confusions and limitations began to emerge. Recovery appeared to refer more to a process of self-actualization for which an individual is responsible than to a process of healing from the effects of a behavioral health condition and associated stigma. In response, some systems are aiming to address social determinants of behavioral health conditions that transcend the scope of the individual and to develop a citizenship-oriented approach to promote community inclusion.

KEYWORDS: mental health recovery; substance use recovery; recovery-oriented care; behavioral health; recovering citizenship; recovery-oriented system of care; alcohol

This perspective focuses on the relatively recent topic of recovery-oriented systems of care; although influential in practice, this concept has yet to be evaluated empirically and thus cannot yet be the object of a review. In lieu of such evidence, this article offers one perspective on the origins of this concept and its present status prior to considering possible directions in which

such systems might move in the future. In the process, areas in which research is especially needed are highlighted to evaluate the utility of this concept in meeting its stated aim of moving behavioral health systems of care beyond an acute care model to better meet the needs of persons with prolonged mental illness and/or substance use disorder (SUD). Throughout this perspective, "substance use" refers to both alcohol use and other drug use.

This story begins with the decade between 2000 and 2010, which saw a flurry of activity at the federal level in the United States focused on defining what was then the relatively new concept of recovery in both mental health and substance use. Although other concepts of recovery may be as old as the treatment and study of mental health (e.g., Phillippe Pinel and moral treatment)[1] and SUD (e.g., 12-step tradition),[2] the term was given new meanings in the 1980s and 1990s through the consumer/survivor movement in mental health[3] and the new recovery advocacy movement in substance use.[4] These new definitions were then operationalized in terms of their implications for transforming mental health and SUD services to promote these new forms of recovery. At least two central arguments for the shift to recovery and recovery-oriented care were consistent across the mental health and substance use divide.

First, there was a growing recognition that although full ("clinical") recovery was possible following an acute episode of a mental or substance use disorder for some people, a more personal sense of recovery—involving a process of learning how to manage daily life in the presence of, or within the limitations imposed by, an ongoing disorder—was required and appropriate for others. Second, there was a parallel recognition that mental health and substance use services were primarily oriented to providing acute care that targeted, and hopefully lessened, signs and symptoms of mental disorder and substance use while paying considerably less attention to promoting functioning and living a full, meaningful life in the community of one's choice.

This perspective considers the implications of these two arguments for transforming mental health and substance use services under the broad vision of recovery-oriented systems of care, which has since been developed with support from the Substance Abuse and Mental Health Services Administration (SAMHSA). In addition to describing the initial steps taken during the 2000–2010 decade, this article considers the current status of additional efforts made between 2010 and 2020, prior to offering possible strategies to overcome some of the confusions and limitations that have been identified within the context of efforts to implement this ambitious vision. In the absence of empirical studies of this relatively new way of organizing behavioral health care, this perspective uses as a case study the evolution of mental health and substance use services in Connecticut, which was the first state in the country to envision and attempt to achieve a recovery-oriented system of care that both integrates mental health and substance use services and reorients them to promoting the new senses of recovery articulated by the recovery community itself.[5,6] Given that recovery-oriented systems of care emphasize prevention, health promotion, and outreach to, and inclusion of, persons with multiple conditions, no recovery-oriented system of care to date has specifically targeted persons solely with alcohol use disorder.

THE PAST: 2000–2010

The concept of recovery has been pushed to the forefront of behavioral health policy and practice in the United States (and elsewhere) over the last 3 decades largely through the advocacy efforts of people with behavioral health disorders rather than through advances in the effectiveness of new psychiatric medications or an accumulating body of research on clinical improvements or positive outcomes in the treatment of SUD.[7] Before it referred to innovations in practice,

recovery referred to the right of people with behavioral health conditions to "live, work, learn, and participate fully in the community."[8] Based most recently on the Americans with Disabilities Act of 1990[9]—but grounded in 30 years of consistent federal law preceding it (e.g., the Rehabilitation Act of 1973)[10]—this right cannot be made contingent on improvements in the person's clinical or functional status, nor can it be delayed indefinitely based on a system's lack of resources to support community tenure. Persons with behavioral health disorders have a right to live in the community alongside their peers and to participate in the treatment and rehabilitative interventions and make use of the community supports they need to manage their behavioral health conditions and pursue their own life goals. The challenge for a recovery-oriented system of care is to carry out this work in the most efficient and effective, and the least coercive and restrictive, manner possible, respecting the dignity and autonomy of clients while ensuring the safety and well-being of the broader community.

To guide these efforts, SAMHSA first held consensus development conferences separately for the mental health and substance use communities. The agency later brought them together around 2010 to come up with an integrated definition, reviewed below. It is worth citing the initial definitions, however, to get a sense of the direction in which SAMHSA was moving during the first decade of the 2000s. As defined by the 2004 National Consensus Statement on Mental Health Recovery, "Mental health recovery is a journey of healing and transformation enabling a person with a mental health problem to live a meaningful life in a community of his or her choice while striving to achieve his or her full potential."[11] "Recovery from alcohol and drug problems," on the other hand, was defined in a 2005 SAMHSA consensus statement as "a process of change through which an individual achieves abstinence and improved health, wellness, and quality of life."[12] These definitions can be seen for the most part as compatible, the only real difference being that one focuses on mental health problems and the other on alcohol and drug problems.

While it is clear from these definitions that this form of recovery is viewed as a process in which the person must be actively engaged, they hold implications for the nature of behavioral health treatment and supports as well. In other words, although a person needs to engage in their own recovery, making use of recovery-oriented services and supports can be one element of one's personal recovery efforts. This notion was first introduced in 2000, when Anthony published an important paper, "A recovery-oriented service system: Setting some system level standards."[13] This article laid out the argument for what standards should be used in evaluating treatments and community supports as to their recovery-orientation—that is, the degree to which the services and supports offered are aimed at promoting this new vision of recovery as the person's living a meaningful life, achieving one's full potential, and improving one's health and wellness in the presence of a behavioral health problem. Building on these efforts, in 2002 Connecticut became the first state behavioral health authority to adopt a commissioner's policy on promoting a recovery-oriented system of care. In this early stage, such a system was defined as one "that identifies and builds on each individual's assets, strengths, and areas of health and competence to support each person in achieving a sense of mastery over mental illness and/or SUD while regaining his or her life and a meaningful, constructive sense of membership in the broader community."[14]

Expanding upon these and similar efforts around the country, in 2010, SAMHSA came out with its own definition of a recovery-oriented system of care: "a coordinated network of community-based services and supports that is person-centered and builds on the strengths and resiliencies of individuals, families, and communities to achieve improved health, wellness, and quality of life for those with or

at risk for mental health and substance use problems."[15] SAMHSA's vision of a recovery-oriented system of care encompasses a menu of individualized, person-centered, and strength-based services within a self-defined network. This menu includes clinical services and alternative therapies (such as acupuncture and meditation) as well as recovery support services. Recovery support services include peer recovery coaching and other forms of peer support, peer-run programs, recovery community centers, employment and educational assistance, social and family support, childcare, care management, and housing support. It also provides individuals and families with more options with which to make informed decisions regarding their care; is designed to be accessible, welcoming, and easy to navigate; involves people in recovery, their families and allies, and the broader community to continually improve access to and quality of services; and supports the premise that there are many pathways to recovery.

Finally, recovery-oriented systems of care have been the focus of various technical assistance resources issued by SAMHSA, in which such systems are described as adhering to a list of principles and as serving specific functions.[15-18] But what does such a system actually look like? Based on the stages of change model first introduced into treatment of substance use, the overarching principle for design of this system and its various components is that people should be able to access effective and responsive services and supports regardless of where they are in the process of recovery from SUD, mental illness, or both combined. Realizing that substance use and mental health disorders frequently co-occur, this model further allows for a person to be in different stages with respect to each of the conditions they may have. Most importantly, being unaware of, or choosing not to accept having, a behavioral health condition is to be viewed as a point of departure for treatment, rehabilitation, and support efforts as opposed to being viewed as cause for discharge from care. Based also on the input of people who are in recovery, this model places central emphasis on the role of recovery support services, including services provided by peers, at each point along the continuum of care.

It could be argued that within a recovery-oriented system of care, all services should be supportive of recovery. The term "recovery support services" has been used, however, to refer more specifically to a subgroup of interventions—particularly those that focus on enhancing a person's abilities and resources, or recovery capital, to manage their own behavioral health condition(s) and/or to increase their participation in the community activities of their choice.[18,19] Importantly, these services and resources are to be offered to persons entering recovery prior to (as well as during and after) any expectations that they accept and benefit from active treatment rather than being reserved as rewards for doing so. People may need a basic amount of recovery capital to be able to make effective use of such treatments, whether medication or psychosocial. Finally, recovery support services are often provided by people who are in recovery themselves, but do not need to be exclusively so. Being a relatively recent development and given their central role in knitting such systems of care together, recovery support services will be an especially important topic for future research.

As shown in Figure 1, these services and supports also can be used during various stages of recovery and are conceptualized with a recovery management model, in which they assertively strive, according to White and Kelly, to "enhance early pre-recovery engagement, recovery initiation, long-term recovery maintenance, and the quality of personal/family life in long-term recovery."[20] The stages span from recovery priming (i.e., having experiences that prepare the person to make the decision to pursue recovery), to recovery initiation and stabilization, to recovery management and, finally, recovering one's full citizenship as a valued member of one's community. This model has been developed based on the arguments cited

in the introduction: that is, that many substance use disorders, like many mental illnesses, are prolonged rather than acute in nature, calling for services and supports to be offered to persons over longer periods of time and consistent with where they may be in recovery at the time. According to White and Kelly,[20] this model thus involves focused attention at several points along a continuum of care and across levels and components of the system that is managed by an overall integrated mental health and substance use authority (whether at the local, regional, or state level), including the following: (1) public education and prevention; (2) continuity of contact over a sustained period of time; (3) patient/family education and empowerment to promote self-management of the condition (including mobilization of family resources); (4) access to the latest advances in medication-assisted treatment; (5) access to peer-based recovery support groups and advocacy organizations; and (6) sustained monitoring (checkups), recovery coaching, and when needed, early re-intervention.

As can be seen in this figure, the continuum of care begins with public education, prevention, and mental health promotion. Then, for those who do not seek care on their own, assertive outreach and engagement efforts can take place anywhere—from the streets to faith communities, college campuses, and workplace settings—reaching out to people in distress or need wherever they might be found. At this point, recovery support services can be introduced to overcome barriers to access to care, to offer environments supportive of recovery, or to help to increase the person's recovery capital so that treatment, when accessed, can be fully effective. These kinds of recovery support should be available to persons in recovery throughout the remainder of their journey, either in different forms depending on the stage of change (e.g., case management until the person has established a firm foundation for recovery) or in a consistent form depending on the person's choice (e.g., 12-step group, recovery

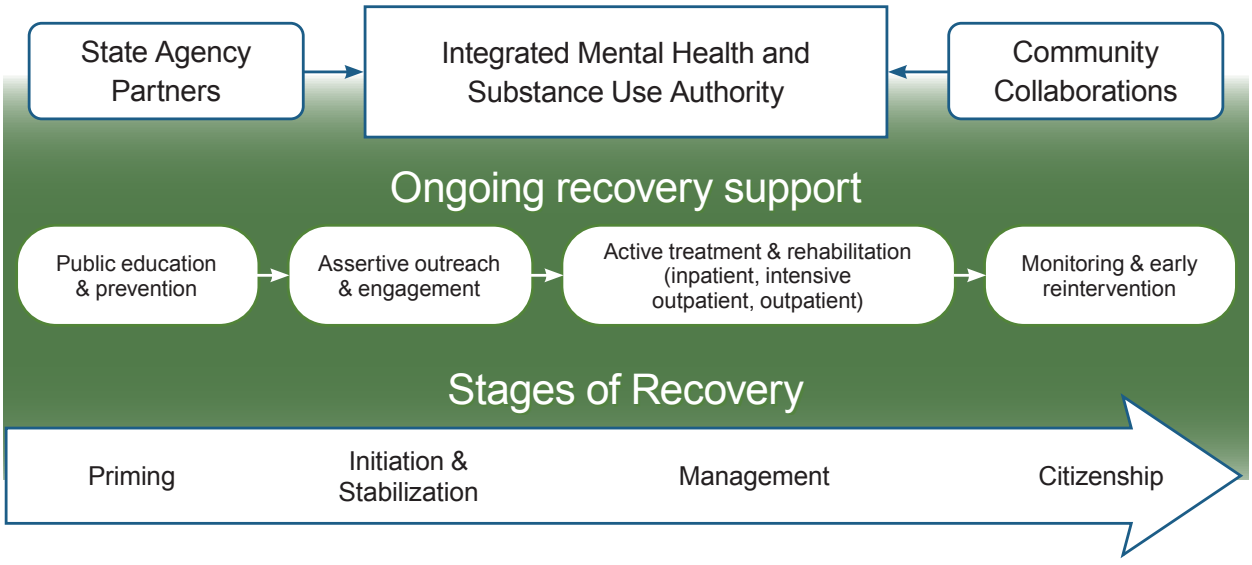

Figure 1 Recovery-oriented system of care. An integrated mental health and substance use authority provides care throughout the stages of recovery, beginning with public education, prevention, and mental health promotion. For those who do not seek care on their own, assertive outreach and engagement efforts provide outreach to people in distress or need, wherever they are. Active treatment and rehabilitation are supported with recovery support services, which helps to increase service engagement and effectiveness. Ongoing monitoring and early reintervention are provided as needed. State agencies and community collaborators act as partners to support the efforts of the integrated behavioral health authority.

community center). Following various forms of active treatment (e.g., detox/inpatient, intensive outpatient, outpatient), support is available for ongoing monitoring (e.g., wellness checkups) and early reintervention as needed. This continuum of care is developed in collaboration with a wide range of stakeholder partners, including education and faith community leaders, police and criminal justice representatives, business owners and other employers, family members and allies, and, perhaps most important, representatives of the recovery community itself.

THE PRESENT: 2010–2020

Such was the vision put forth beginning around 2000 as new meanings of recovery began to take hold, along with implications for transforming services, supports, and systems of care. And much progress has been made in the past 20 years in bringing this vision to life. Public education, including school-based efforts, have begun to address the roles of stigma and discrimination as barriers to access to care and to recovery, including the role of medications in the treatment of both mental illness and SUD. Inroads have been made into faith communities and onto college campuses to promote behavioral health and to increase access to needed services and supports. Increasing numbers of highly visible role models of recovery have disclosed their own struggles with mental illness and/or SUD and encouraged their followers and fans to know that help is available and how to ask for it. An expanding array of recovery support services are being offered and are beginning to be shown useful in increasing access to and the effectiveness of care.[21-24] So, other than continuing to follow this blueprint in building systems of recovery-oriented care, what remains to be done?

Unfortunately, over the last 10 years, confusion has arisen and limitations have been identified related to these notions of recovery and recovery-oriented care, threatening further progress toward a recovery orientation and with the potential, perhaps, to turn the clock backward. Although this confusion and these limitations do not stem directly from the more recent SAMHSA definition of recovery, they nonetheless seem to be best captured in the differences between the initial definitions cited above and the integrated version issued as a working definition in 2012. Hoping to integrate mental health and substance use services under a single umbrella, SAMHSA initiated another consensus development process in 2010 that involved representatives from both recovery communities and other stakeholders; this resulted in the following working definition of recovery from mental illness and/or SUD: Recovery is "a process of change through which individuals improve their health and wellness, live a self-directed life, and strive to reach their full potential."[25] Possibly due to pushback from some mental health and substance use recovery advocates who opposed the idea of behavioral health conditions being framed as disorders, what is conspicuously absent from this definition is what the person is recovering from. This definition appears to apply equally well to those without, as well as to those with, a mental illness or SUD. In this sense, the definition could apply equally well to everyone while saying nothing specific about anyone.

The advocates' point is well-taken and important, however. Persons with what has been described as mental illness or SUD are first and foremost, and most fundamentally, human beings just like everyone else. But if they remain human beings just like everyone else in all respects, then they lose their justification for laying claim to funding for behavioral health services and supports. If all that a person is doing is engaging in "a process of change" through which they are hoping to improve their "health and wellness, live a self-directed life, and strive to reach" their "full potential," then society has no obligation to provide them with different types of support or any more support than anyone else. In addition, this process is not only self-directed, but also appears to be entirely up to the individual. It appears to be their responsibility, and theirs only, to live their self-directed life as they wish. If they encounter difficulties in doing so, they are entirely responsible for managing these challenges, and they have no

fundamental right to claim any relief or intervention from anyone else.

How different this is from the framing of the Americans with Disabilities Act of 1990, which ushered in the recovery movement, in which mental illness and SUD were considered to be disabilities that entitled persons to request and receive reasonable accommodations and community supports necessary to live as full a life as desired alongside their peers without disabilities in the community of their choice.[26] That too was the result of considerable advocacy efforts. At least one major confusion and one major limitation have emerged from the shift from a disability model, in which services and supports are essential to ensuring persons' rights to community inclusion, to what may be called a self-actualization model, in which everyone could be recovering from something and so no one has a particular right to anything. This perspective addresses each of these in turn.

First, in the self-actualization model, there is the perception, or the implication, that recovery is the sole responsibility of the individual. Although people certainly play a central role in their own recovery, neither the person nor their recovery occurs in a vacuum and most often benefits from a supportive social context inclusive of accessible services and supports. Viewing recovery as solely the person's own responsibility delegitimizes the important roles that services and supports can play in lessening the suffering, burdens, and intrusions of the disorders and in promoting and enabling the degree of functioning required to lead a satisfying and meaningful life in one's community. Most often, such a confusion of viewing personal recovery as a personal responsibility has been used as justification for drawing arbitrary limits on the use of, or denying access entirely to, behavioral health services and supports to persons in need.[27] Either people claiming to be "in recovery" are considered too well to require care any longer or their ongoing challenges are viewed as requiring a different type of service than those provided based on medical necessity, thus garnering fewer resources. That is, if recovery is simply and solely an individual's journey to "reach their full potential," then "Good luck with that journey," the behavioral health system need only provide them with minimal, if any, support.

Second, understanding recovery as a personal journey for which the individual is largely responsible has the added byproduct of leading to a discounting of all those forces beyond the individual that are known to influence the onset, course, and outcomes of mental illness and SUD. These social determinants of mental illness and SUD include poverty, unstable housing, prolonged involuntary unemployment, social exclusion and isolation, and various forms of stigma and discrimination based on health status, gender, race and ethnicity, sexual orientation, religious and cultural orientation, and other markers of difference.[28-31] Understanding recovery as an individual's responsibility may draw attention away from the array of social conditions and collective resources needed for even the possibility of recovery (i.e., it is extremely difficult to recover without having a home, a family or friends, and an income). This use of recovery as a diversion of attention away from social, political, economic, and cultural factors has become such a serious concern among some earlier recovery proponents that articles have begun to appear with titles such as "Uses and Abuses of Recovery,"[32] and coalitions have begun to form to combat the political use of recovery as an excuse for preserving current inequities. One such coalition, Recovery in the Bin, clearly expresses this concern on its website as follows: "We recognise that the growing development of [mental health] 'Recovery' . . . has been corrupted by neoliberalism and capitalism is the crisis! Some of us will never feel 'Recovered' living under these intolerable inhumane social . . . and economic conditions, such as poor housing, poverty, stigma, racism, sexism, unreasonable work expectations, and countless other barriers."[33]

The confusion of personal recovery with (solely) personal responsibility appears to have limited the concept of recovery to an artificially decontextualized personal sphere that is somehow immune to the social determinants of mental health and substance use. If so, what might the future hold for still developing recovery-oriented systems of

care? Although research is still sorely needed on this topic, a case study of Connecticut's experience sheds some light on an answer to this question.

A POSSIBLE FUTURE

In Connecticut, in order to address and overcome these issues, this perspective found it necessary to incorporate an explicit focus on the array of social, economic, political, and cultural determinants of mental health and substance use and an emphasis on community inclusion and community life as a collective phenomenon into the state's recovery transformation work.[34-40] Doing so has required returning to the consumer/survivor and new recovery advocacy movements, which themselves are rooted, in part, in the civil rights movement of the 1950s and 1960s and the independent living and disability rights movement of the 1970s.[41] It was these movements, and the legislation inspired by them (e.g., the Rehabilitation Act of 1973, the Americans with Disabilities Act of 1990), that established the rights of persons with functionally disabling conditions (based on a medical assessment of functional impairment) to be provided not only with medical care for their health condition but also with the community supports needed to be able to live full and dignified lives in the communities of their choice. Were mental illness and SUD not recognized as legitimate health conditions, it is difficult to see how funding such supports could be justified. This may mean that some tensions between a state mental health and substance use authority and various advocacy communities are inevitable to some degree, although hopefully there remains much common ground to be found and put to good use.

In addition to returning to its roots in a disability rights paradigm,[7,28] this national shift in the direction of transformation is grounded in more than 20 years of research and scholarship related to the concept of "citizenship."[36,37] Although this concept has begun to gain traction in the mental health field over the last decade,[38-41] it is relatively new and less widely known than the concept of recovery. A rich and important topic for research in its own right, the concept of citizenship also has been especially effective as a counterbalance to the overemphasis on the individual nature of recovery discussed above. It is in this spirit—as drawing attention both to the social determinants of behavioral health and to the collective nature of community life—that the state of Connecticut's Department of Mental Health and Addiction Services has proposed a few modifications to the model of a recovery-oriented system of care under the rubric of "recovering citizenship."[42]

Rowe has defined citizenship in the technical sense as a person's strong connection to the rights, responsibilities, roles, resources, and relationships (the 5 Rs) that a democratic society makes available to its members through public and social institutions, the associational life of voluntary organizations such as faith communities and neighborhood organizations, and social networks and everyday social interactions. It also involves a sense of belonging in a person's own community that must be validated by others' recognition of their value as a member of society.[41] This concept thus builds on the aspect of "a life in the community" that has been core to the definition of personal recovery, spelling out concretely, and helpfully, what such a life is made up of in terms that are not limited to the individual. It recognizes that a person cannot effectively belong to a community unless they are treated as such by others, and that membership in a community comes with certain entitlements and obligations. To recover (or to develop for the first time) the sense of being a full citizen, the person must have certain rights (e.g., the right to community inclusion) and resources (e.g., a home, an income) and be able to take on certain roles and responsibilities (e.g., neighbor, voter) while having meaningful relationships with others that offer the person a sense of belonging. Once spelled out in this way, it becomes obvious how recovery involves more than an individual's own efforts. A person cannot will themselves to have a sense of belonging to a community; that sense must be conveyed by how others treat the person. Recovery happens in a social context, and that context matters a great deal.

What implications does this emphasis have for our recovery-oriented systems of care? In the model depicted in Figure 1, both state agencies and community collaborators must act as partners in expanding the scope of the behavioral health system to include the full community of people it serves. Although housing may have been recognized decades ago as an essential cornerstone of recovery, similar steps now need to be taken with respect to other components of community life including education, employment, finances, and social, leisure, and artistic pursuits. Along with partnering between the behavioral health authority and the state, county, or city departments that oversee these aspects of community life, inroads can be made into the voluntary sector, civic institutions (e.g., libraries), faith communities, and neighborhood organizations. Just as people with SUD and/or mental illness need to take steps in their own recovery that require courage and risk of failure, communities also need to take steps to welcome, include, and support those with behavioral health disorders. Systems of care oriented toward recovering citizenship recognize the importance of working collaboratively with an array of community leaders and institutions to cultivate opportunities for win-win strategies in which people with disabilities make valuable and valued contributions to their communities that benefit everyone. Giving back in this way has long been a core component of the 12-step tradition in substance use recovery. Forging pathways for people in recovery to have opportunities to do so can be a core component of behavioral health systems more broadly, and empirical studies will be needed to show the influence of this component on health outcomes.

CONCLUSION

Behavioral health conditions continue to be among the most poorly understood and most stigmatized conditions in the United States. As a result, persons affected by these conditions often face discrimination in how they are viewed and treated by others in numerous arenas, including where they will live, whether they will complete their education or be employed, and which opportunities they will have for participating in community life. To the degree to which the recovery movement remains rooted in a human rights movement, addressing and eliminating these forms of discrimination must be considered a pressing and ongoing priority for systems of care. Doing so is identified as a core function of recovery-oriented practice because little progress will be made either in system transformation or in the social inclusion of persons with behavioral health conditions until they are seen as full citizens of the society to which they belong, with all of the rights and responsibilities associated with membership.

As long as stigma and discrimination continue to exist, persons with behavioral health needs are discouraged from seeking care, but that is not all. They also are being denied the very resources and supports they need to enter into and sustain recovery, such as hope, a sense of meaning and purpose in life, a sense of agency and efficacy, a sense of self-worth, and confidence in their own ability to make good choices. Without these capacities, it becomes extremely difficult for people to voluntarily choose treatment or to take up and persist in the challenging work of recovery. And restoration of these capacities, as well as other forms of recovery capital, cannot be postponed until the person no longer shows any signs or symptoms of behavioral health difficulties.

In this respect, it is important to note that citizenship, including the right to social inclusion, is considered to be a foundation for recovery rather than to be viewed as one of its rewards.[43] The task of addressing stigma and discrimination comes first, rather than last, because all people have the right to be treated with dignity and respect, regardless of their behavioral health condition or status. In the past, many of the practices of the behavioral health system, as well as of society at large, conveyed the message that people were not welcome in the community as long as they were experiencing behavioral health difficulties. They might be accepted back once recovered (e.g., on release from residential treatment or the hospital),

but recovery was viewed as largely out of reach. It has been this combination of stigma and hopeless attitudes that has discouraged many people from seeking care and led others to believe that recovery was not possible for them. Organizations oriented toward recovering citizenship play a key role in shifting the culture both of the behavioral health system and of the broader society in the positive direction of embracing the reality of recovery and valuing the contributions that are made by the recovery community.

Disclosures

The authors have no competing financial interests to disclose.

Acknowledgments

This work was funded in part by the State of Connecticut Department of Mental Health and Addiction Services; however, this publication does not express the views of the Department of Mental Health and Addiction Services or the state of Connecticut. The views and opinions expressed are those of the authors.

Publisher's Note

Opinions expressed in contributed articles do not necessarily reflect the views of the National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health. The U.S. government does not endorse or favor any specific commercial product or commodity. Any trade or proprietary names appearing in *Alcohol Research: Current Reviews* are used only because they are considered essential in the context of the studies reported herein.

References

1. Davidson L, Rakfeldt J, Strauss JS. *The Roots of the Recovery Movement in Psychiatry: Lessons Learned*. London, UK: Wiley-Blackwell; 2010.
2. Davidson L, White W, Sells D, et al. Enabling or engaging? The role of recovery support services in addiction recovery. *Alcohol Treat Q*. 2010;28(4):391-416. https://doi.org/10.1080/07347324.2010.511057.
3. Chamberlin J. *On Our Own: Patient Controlled Alternatives to the Mental Health System*. New York, NY: McGraw Hill; 1978.
4. Davidson L, White W. The concept of recovery as an organizing principle for integrating mental health and addiction services. *J Behav Health Serv Res*. 2007;34(2):109-120. https://doi.org/10.1007/s11414-007-9053-7.
5. Davidson L, Tondora J, O'Connell MJ, et al. Creating a recovery-oriented system of behavioral health care: Moving from concept to reality. *Psychiatr Rehabil J*. 2007;31(1):23-31. https://doi.org/10.2975/31.1.2007.23.31.
6. Substance Abuse and Mental Health Services Administration (SAMHSA). *Guiding Principles and Elements of Recovery-Oriented Systems of Care: What Do We Know from the Research?* Rockville, MD: Center for Substance Abuse Treatment, SAMHSA; 2009.
7. Davidson, L. What happened to civil rights? *Psychiatr Rehab J*. 2006; 30(1):11-14. https://doi.org/10.2975/30.2006.11.14.
8. United States President's New Freedom Commission on Mental Health. *Achieving the Promise: Transforming Mental Health Care in America*. Rockville, MD: President's New Freedom Commission on Mental Health; 2003.
9. Americans With Disabilities Act of 1990, 42 U.S.C. § 12101 et seq. (1990). https://uscode.house.gov/view.xhtml?req=granuleid%3AUSC-prelim-title42-chapter126&edition=prelim.
10. Rehabilitation Act of 1973, 29 U.S.C. § 701 et seq. https://www.govinfo.gov/app/details/USCODE-2015-title29/USCODE-2015-title29-chap16-other-sec701.
11. SAMHSA. *National Consensus Statement on Mental Health Recovery*. Rockville, MD: Center for Mental Health Services, SAMHSA; 2004.
12. SAMHSA. *National Consensus Statement on Recovery*. Rockville, MD: Center for Substance Abuse Services, SAMHSA; 2005.
13. Anthony WA. A recovery-oriented service system: Setting some system-level standards. *Psychiatr Rehabil J*. 2000;23(4):159-168. https://doi.org/10.1037/h0095104.
14. Connecticut Department of Mental Health and Addiction Services. *Commissioner's Policy Statement No. 83: Promoting a Recovery-Oriented System of Care.* Hartford, CT: Connecticut Department of Mental Health and Addiction Services; 2002.
15. SAMHSA. *Recovery-Oriented System of Care (ROSC) Resource Guide.* Working draft. Rockville, MD: Center for Substance Abuse Treatment, SAMHSA; 2010.
16. Sheedy CK, Whitter M. *Guiding Principles and Elements of Recovery-Oriented Systems of Care: What Do We Know From the Research?* Rockville, MD: Center for Substance Abuse Treatment, SAMHSA; 2009.
17. Whitter M, Hillman DJ, Powers P. *Recovery-Oriented Systems of Care (ROSC) Resource Guide*. Rockville, MD: Center for Substance Abuse Treatment, SAMHSA; 2010.
18. Kaplan L. *The Role of Recovery Support Services in Recovery-Oriented Systems of Care*. Rockville, MD: Center for Substance Abuse Treatment, SAMHSA; 2008.
19. White WL. *Recovery Management and Recovery-Oriented Systems of Care: Scientific Rationale and Promising Practices*. Northeast Addiction Technology Transfer Center, Great Lakes Addiction Technology Transfer Center, and Philadelphia Department of Behavioral Health and Mental Retardation Services; 2008.
20. White WL, Kelly JF. Recovery management: What if we really believed that addiction was a chronic disorder? In: Kelly JF, White WL, eds. *Current Clinical Psychiatry. Addiction Recovery Management: Theory, Research and Practice*. New York: Humana Press; 2011:67-84. https://doi.org/10.1007/978-1-60327-960-4_5.
21. Laudet AB, Humphreys K. Promoting recovery in an evolving policy context: What do we know and what do we need to know about recovery support services? *J Subst Abuse Treat*. 2013;45(1):126-133. https://doi.org/10.1016/j.jsat.2013.01.009.
22. Bassuk EL, Hanson J, Greene RN, et al. Peer-delivered recovery support services for addictions in the United States: A systematic review. *J Subst Abuse Treat*. 2016;63:1-9.https://doi.org/10.1016/j.jsat.2016.01.003.
23. Reif S, Braude L, Lyman DR, et al. Peer recovery support for individuals with substance use disorders: Assessing the evidence. *Psychiatr Serv*. 2014;65(7):853-861. https://doi.org/10.1176/appi.ps.201400047.
24. White WL. *Peer-Based Addiction Recovery Support: History, Theory, Practice and Scientific Evaluation*. Great Lakes Addiction Technology Transfer Center and Philadelphia Department of Behavioral Health and Mental Retardation Services; 2009.

25. SAMHSA. SAMHSA's working definition of recovery. Rockville, MD: SAMHSA; 2012.
26. Davidson L. The recovery movement: Implications for mental health care and enabling people to participate fully in life. *Health Affairs*. 2016;35(6):1091-1097. https://doi.org/10.1377/hlthaff.2016.0153.
27. Braslow JT. The manufacture of recovery. *Annu Rev Clin Psychol*. 2013;9:781-809. https://doi.org/10.1146/annurev-clinpsy-050212-185642.
28. Davidson L. Is there a future for recovery? *World Association for Psychosocial Rehabilitation Bulletin*. 2018;42:10-13.
29. Compton MT, Shim RS. The social determinants of mental health. *Focus.* 2015;13:419-425. https://doi.org/10.1176/appi.focus.20150017.
30. Harper D, Speed E. Uncovering recovery: The resistible rise of recovery and resilience. In: Speed E, Moncrieff J, Rapley M, eds. *De-Medicalizing Misery, II: Society, Politics, and the Mental Health Industry*. London, UK: Palgrave MacMillan; 2014:40-57.
31. Morrow M. Recovery: Progressive paradigm or neoliberal smokescreen. In: LeFrançois BA, Menzies R, Reaume G, eds. *Mad Matters: A Critical Reader in Canadian Mad Studies*. Toronto: Canadian Scholars Press; 2013:323-333.
32. Slade M, Amering M, Farkas M, et al. Uses and abuses of recovery: Implementing recovery-oriented practices in mental health systems. *World Psychiatry*. 2014;13(1):12-20. https://doi.org/10.1002/wps.20084.
33. Recovery in the Bin. https://recoveryinthebin.org. Published February 2016. Accessed 2018.
34. Quinn N, Bromage B, Rowe M. Collective citizenship: From citizenship and mental health to citizenship and solidarity. *Soc Policy Admin*. 2019;1-14. https://doi.org/10.1111/spol.12551.
35. Fleischer DZ, Zames F. *The Disability Rights Movement: From Charity to Confrontation*. Philadelphia, PA: Temple University Press; 2001.
36. Rowe M. *Crossing the Border: Encounters Between Homeless People and Outreach Workers.* Berkeley, CA: University of California Press; 1999.
37. Rowe M. *Citizenship and Mental Health*. New York, NY: Oxford University Press; 2014.
38. Pelletier JF, Davidson L, Roelant JL. Citizenship and recovery for everyone: A global model of public mental health. *Int J Ment Health Promot*. 2009;11(4):45-53. https://doi.org/10.1080/14623730.2009.9721799.
39. Pelletier JF, Corbière M, Lecomte T, et al. Citizenship and recovery: Two intertwined concepts for civic-recovery. *BMC Psychiatry*. 2015;15(1):37. https://doi.org/10.1186/s12888-015-0420-2.
40. Eiroa-Orosa FJ, Rowe M. Taking the concept of citizenship in mental health across countries: Reflections on transferring principles and practice to different sociocultural contexts. *Front Psychol*. 2017;8:1020. https://doi.org/10.3389/fpsyg.2017.01020.
41. Rowe M, Ponce AN. How shall we promote citizenship and social participation? In: Goldman HH, Frank RG, Morrissey JP, eds. *Handbook of U.S. Mental Health Policy.* London, UK: Palgrave MacMillan; 2019:573-599.
42. Rowe M, Davidson L. Recovering citizenship. *Isr J Psychiatry Relat Sci*. 2016;53(1):14-20.
43. Davidson L, Tondora J, O'Connell MJ, et al. *A Practical Guide to Recovery-Oriented Practice: Tools for Transforming Mental Health Care.* New York, NY: Oxford University Press; 2009.

ALCOHOL RESEARCH
Current Reviews

Alcohol Res. 2021;41(1):07 ● https://doi.org/10.35946/arcr.v41.1.07

Published: 3 June 2021

Alcohol Use Disorder: The Role of Medication in Recovery

Barbara J. Mason and Charles J. Heyser

Pearson Center for Alcoholism and Addiction Research, Department of Molecular Medicine, Scripps Research Institute, La Jolla, California
Center for Human Development, University of California, San Diego, La Jolla, California

The misuse of alcohol in the United States continues to take a large toll on society, resulting in the deaths of about 88,000 Americans per year. Moreover, it is estimated that nearly 14.6 million Americans currently meet diagnostic criteria for current alcohol use disorder (AUD). However, very few individuals receive treatment, with an even smaller portion receiving medications approved by the U.S. Food and Drug Administration (FDA) for the treatment of AUD, despite scientifically rigorous evidence showing the benefits of combining medication approved for treating AUD with evidence-based behavioral therapy. These benefits include higher rates of abstinence and less risk of relapse to heavy drinking, with associated improvements in medical and mental health and in quality of life. This review provides an overview of FDA-approved medications and "off-label" drugs for the treatment of AUD. The article emphasizes that AUD medical advice and prescription recommendations should come from professionals with training in the treatment of AUD and that treatment plans should consider medication in conjunction with evidence-based behavioral therapy. Finally, this review notes the limited number of medications available and the continued need for the development of new pharmacotherapies to optimize AUD recovery goals.

KEY WORDS: disulfiram; acamprosate; naltrexone; gabapentin; medication-assisted treatments; alcohol use disorder; alcohol; drug therapy

INTRODUCTION

It is estimated that nearly 14.6 million Americans currently meet the diagnostic criteria for alcohol use disorder (AUD)[1] included in the *Diagnostic and Statistical Manual of Mental Disorders,* 5th edition (*DSM-5*),[2] and approximately 88,000 die from alcohol-related causes in the United States each year.[3] An older term, "alcohol dependence," is equivalent to the *DSM-5* criteria for AUD of moderate or greater severity.[4] This is the stage of AUD severity for which pharmacotherapy is generally indicated. Effective intervention can decrease drinking

and the likelihood of subsequent relapse, thereby significantly improving an individual's health and reducing the negative consequences of AUD that are most likely to burden society.[5]

This paper provides an overview of the medications for AUD that are currently available for use by the recovery community, as well as a brief introduction to potential medications under development. Throughout, this review emphasizes that (1) all AUD medical advice and prescription recommendations should come from professionals (or in consultation with professionals) who have specific training in the treatment of AUD; (2) physical examination and laboratory testing are recommended before treatment is initiated and may help with subsequent monitoring of treatment response and adverse events; (3) medications are not "stand-alone" treatments for AUD, but rather are an element in a comprehensive treatment plan; (4) clinical trial data show drinking outcomes and recovery are significantly better when behavioral interventions are combined with AUD medication rather than given without AUD medication; and (5) there is a critical need for research on potential modifiers of response—including potential differences in drug metabolism due to sex hormones, race or ethnicity, and pharmacogenetic and pharmacometabolomic markers—to identify individuals most likely to respond or have significant side effects to specific AUD pharmacotherapies. The U.S. Food and Drug Administration (FDA) uses drinking outcomes of abstinence from alcohol and/or cessation of heavy drinking (males, five or more drinks per day; females, four or more drinks per day) in determining its approval of a candidate drug. Additionally, measures of improved medical and mental health and of quality of life are associated with these operational measures of recovery but often are not reported in the clinical trial literature given the relatively short duration of clinical trials (generally 6 months or less). Given that FDA approval is associated with drinking-specific outcomes and that these outcomes have been linked to improvement in measures of medical and mental health and quality of life, there is reason to believe that by alleviating problems associated with AUD, the use of AUD medications may bestow other positive contributions to recovery.[6,7] The final section briefly reviews new pharmacological approaches and potential medications under development for the treatment of AUD.

CURRENT FDA-APPROVED MEDICATIONS TO TREAT AUD

To date, the FDA has approved three medications for the treatment of AUD. These alcohol-specific pharmacotherapies are the oral alcohol-aversive drug disulfiram (Antabuse), introduced more than half a century ago in 1951; the opioid antagonist naltrexone, approved in 1994 as an oral formulation (Revia) and in 2006 as a long-acting injectable formulation (Vivitrol); and the oral centrally acting taurine analog, acamprosate (Campral), approved in 2004. In other countries, the European Medicines Agency approved the opioid antagonist nalmefene (Selincro) in 2013 for the treatment of alcohol dependence throughout the United Kingdom and European Union. Nalmefene is similar to naltrexone, but it binds more potently to a broader range of opioid receptor subtypes. The FDA-approved medications act via widely different mechanisms but share some key features relevant to recovery and highlight the complex nature of AUD. More specifically, these medications are aimed at restoring normal functioning in alcohol-altered neurophysiological processes or act to blunt or punish the reinforcing properties of alcohol.

Treating AUD with a prescribed drug can appear counterintuitive or concerning to those aspiring to a drug-free recovery. Therefore, such overarching concerns must be addressed before delving into the details of a specific medication. All drugs (prescribed, herbal, and

over-the-counter) have a potential for harm. FDA has evaluated the drugs approved to treat AUD and found the safety profile to be acceptable, particularly given the potentially lethal harms of ineffectively treated AUD of moderate or greater severity. None of these prescribed medications are mood-altering, habit-forming, or addictive. They do not produce euphoria or other subjective experiences associated with misuse potential, nor do they have "street value" as do illicit drugs. None are "substitution" drugs for alcohol, as is methadone for heroin. Tolerance, or a need to increase the dose, does not develop with continued use, nor does rebound craving or drinking occur when medication is discontinued.

All AUD medical advice and prescription recommendations should come from professionals (or in consultation with professionals) who have specific training in the treatment of AUD. This training is critical because the efficacy of drug treatment may be influenced by an individual's unique characteristics, including comorbid conditions, severity and complexity of AUD, state of sobriety at the onset of treatment, medication adherence, any side effects, and motivation to recover from AUD. Treatment outcomes in a large acamprosate trial were significantly better in individuals motivated to a treatment goal of abstinence.[8] Therefore, a detailed understanding of these factors and available treatment options, obtained in partnership and communication with the individual, may optimize treatment selection and recovery. In addition, and perhaps more important, the time course for recovery is quite variable and subject to myriad environmental changes. Therefore, a trained professional is in the best position to respond to these changes in real time and adjust treatment accordingly.

People in recovery from AUD may need to take medications for other medical or psychiatric disorders, in conjunction with medication for AUD. Physician members of Alcoholics Anonymous (AA) have developed a thoughtful guide to the appropriate use of such non-AUD medications, with the aim of minimizing risk of their misuse and undermining recovery. Both treatment providers and persons in recovery can refer to and access the guide online (https://www.aa.org/pages/en_US/aa-member-medications-and-other-drugs). AA does not offer medical advice, but strongly recommends seeking out physicians who are experienced in the treatment of AUD. Persons in recovery are urged to communicate openly with their prescribing doctor if they skip doses or take extra medication, have a desire to take more medication, or experience side effects that make them feel worse, as well as to be sensitive to changes in their own behavior and mood when starting a new medication or when a dose is changed. Such reactions could signal an increased risk of drug misuse or relapse. AA stipulates that its members do not "play doctor"; all medical advice and prescriptions should come from a qualified provider.

EFFICACY CRITERIA FOR MEDICATIONS TO TREAT AUD

Comprehensive meta-analyses of randomized controlled trials of FDA-approved medications to treat AUD have shown a significant benefit on rates of abstinence and/or cessation of heavy drinking in studies that were typically 6 months in duration (see Table 1). It is critical to appreciate that those clinical trials included either the nonpharmacological treatment routinely provided for AUD in a given setting or protocol-specific behavioral treatments for all participants. Therefore, the medication (plus behavioral treatment) demonstrated a significant benefit over placebo (plus behavioral treatment) on drinking outcomes.

These rigorous, evidence-based findings have two important implications:

Table 1 Summary of Treatment Parameters for Medications Approved by the FDA for Alcohol Use Disorder

Parameter	Disulfiram* *(oral)*	Naltrexone* *(oral)*	Naltrexone* *(injectable)*	Acamprosate* *(oral)*
Primary evidence-based outcome	No drinking Double-blind trials, n.s.[25] Open-label trials, moderate effect size[25] Supervised administration trials, large effect size[25]	No heavy drinking NNT = 12[14] NNT = 8.6[15]	Heavy drinking days WMD = -4.6%[14]	No drinking NNT = 12[14] NNT = 7.5[15]
Median trial duration	6.5 months[25]	3 months[14]	6 months[20]	6 months[14]
Dosing	500 mg daily, Weeks 1-2; 250 mg daily thereafter	One 50 mg tablet, daily	One 380 mg injection, monthly	Two 333 mg tablets, 3x daily
Cost per month†	$48	$33	$1,308	$142
Abstinent baseline	≥ 12 hours (mandatory)‡	≈ 4 days[15]	7 days[20,‡]	≈ 6 days[15]
Medical contraindications‡	Use of metronidazole, paraldehyde, alcohol-containing preparations Severe myocardial disease or coronary occlusion Psychosis	Opioid dependence, withdrawal, or use Acute hepatitis or liver failure	Opioid dependence, withdrawal, or use within 7-10 days Acute hepatitis or liver failure	Severe renal impairment (creatinine clearance ≤ 30mL/min)
Adverse events	Neuritis, neuropathy‡ Hepatitis, hepatic failure‡ Psychosis‡ Drowsiness, fatigue‡ Impotence‡ Headache‡ Acne, allergic dermatitis‡ Metallic, garlic aftertaste‡	Dizziness NNH = 16[14] Nausea NNH = 9[14] Vomiting NNH = 24[14]	≥ 5% and 2x placebo‡ Vomiting, nausea Injection site reactions Muscle cramps Dizziness, syncope Somnolence, sedation Decreased appetite	Diarrhea 17% (placebo 10%)‡

*Review each drug's package insert for full prescribing information.

†Monthly cost estimates provided by local discount pharmacy (Costco) and are based on generic formulations when available.

‡Information derived from package inserts.

Note: FDA, U.S. Food and Drug Administration; NNH, a statistical estimate of the number needed to harm for the specified adverse event to occur in one individual; NNT, a statistical estimate of the number needed to treat to achieve the specified outcome in one individual; n.s., not significantly different than placebo; WMD, weighted mean difference.

1. Medications are not "stand-alone" treatments for AUD, but rather an element in a comprehensive treatment plan that includes behavioral therapy.
2. Drinking outcomes are significantly better when behavioral interventions are combined with AUD medication than when they are given without AUD medication.

Clinical trials of AUD medications typically incorporate a derivation of motivation enhancement or cognitive-behavioral treatment manuals developed for Project MATCH (https://pubs.niaaa.nih.gov/publications/projectmatch/matchintro.htm); the manual used in the multicenter U.S. acamprosate study is available at http://www.pearsoncenter.org/therapistmanual.

Given the incremental gains in recovery found when AUD medications are used in combination with behavioral treatment, recovery strategies should consider medications as an option in the treatment plan for AUD. For individuals with AUD, recovery historically has been viewed as a lifestyle of voluntary abstinence from alcohol and nonprescribed drugs.[9] In addition to complete abstinence, FDA has identified "no heavy drinking" as a clinically relevant outcome for assessing a drug's efficacy for AUD, given the relationship between alcohol-related harms and heavy drinking. Chronic heavy drinking is defined in women as routinely drinking more than three drinks per day or more than seven drinks per week, and in men as routinely drinking more than four drinks per day or more than 14 drinks per week.[10] These two FDA-recognized outcomes can be reported as the percentage of individuals having no drinks or no heavy drinking days over the course of treatment, which is typically 6 months in duration (see Table 1).

A third potential regulatory outcome for approval of a drug for treatment of AUD has recently been proposed. The proposed outcome involves a reduction of one or two in the World Health Organization (WHO) risk levels of alcohol use (measured in grams of alcohol consumed per day).[11] The European Medicines Agency used this outcome in its evaluation of nalmefene for the treatment of AUD.[12] Of note, unlike other oral AUD medications, nalmefene is not taken daily, but rather 2 hours prior to an anticipated heavy drinking situation. The 6-month duration of the majority of clinical trials for AUD may be too brief and the sample sizes too small to measure alcohol-related harms, such as driving under the influence or impaired quality of life. However, secondary analyses of larger data sets have shown that a reduction in WHO risk drinking levels is associated with significantly fewer alcohol-related consequences (e.g., less anxiety and depression, lower blood pressure and liver enzyme levels, improved quality of life).[6,7] Taken together, these findings suggest that the significant benefits of FDA-approved medications on reduced alcohol consumption also may have wide-ranging emotional and physical health benefits for individuals with AUD.

INTEGRATING MEDICATION INTO AN AUD TREATMENT PLAN

Given the scope of benefits associated with pharmacotherapy combined with evidence-based behavioral treatment for AUD, it is perplexing that a nationwide pharmacy survey suggests that fewer than 9% of eligible individuals have ever been provided with a prescription for a medication to treat AUD; psychiatrists provided the majority of these prescriptions.[13] Recent large-scale meta-analyses have reported that either acamprosate or naltrexone combined with counseling has superior efficacy for increasing rates of abstinence or of no heavy drinking relative to counseling administered in conjunction with placebo.[14,15] Recognizing the incremental gain typically achieved when medication is incorporated into the treatment plan, the American Psychiatric Association (APA) recently developed a practice guideline for the pharmacological treatment of individuals with AUD.[16] This guideline suggests that acamprosate or naltrexone be used in individuals with moderate to severe AUD who wish to cut down or quit drinking, who prefer medication or who have not

responded to nonpharmacological treatments, and who have no contraindications to the use of these medications. APA further suggests that disulfiram should not be selected as an initial treatment for AUD, given the physiological consequences of drinking in combination with this medication. In addition, this guideline recommends that antidepressant medications should not be used for the treatment of AUD, unless there is a comorbid disorder for which these treatments are indicated.[16] Furthermore, the medications approved to treat AUD are not treatments for alcohol withdrawal and should be initiated only following detoxification and/or after abstinence has been established. Acute withdrawal involves primarily symptoms of autonomic hyperactivity that may last up to 5 days, and although most cases (85%) do not require medication, severe alcohol withdrawal can be life-threatening if untreated.[17] Benzodiazepines are a standard treatment for clinically significant acute alcohol withdrawal symptoms, with the understanding that they are not an accepted treatment of AUD per se because of misuse potential.[16]

In its first report on alcohol, drugs, and health, the Office of the Surgeon General proposes a chronic care management approach to AUD that includes evidence-based behavioral and pharmacological treatments; social support services; and clinical monitoring of adverse events, medication adherence, and symptoms of relapse at every follow-up visit.[18] The report notes the importance of working collaboratively with the individual and their social support system; communicating the risks and benefits of each treatment option relative to the individual's recovery goals, drug costs, and dosing schedule; and ensuring that the individual comprehends this information. This again serves to highlight the importance of specific training in the treatment of AUD, given the need to explain complex information using clearly understood language. A written information sheet providing details about the prescribed medication can be taken home by the individual for future reference. It is recommended that the provider contact the individual a few days after an AUD medication is prescribed to address any concerns, to assess medication adherence and side effects, and to facilitate successful medication initiation.

SAFETY AND SIDE EFFECTS OF AUD MEDICATIONS

The well-being and safety of the individual is always the highest concern. Each AUD medication has a label or package insert that contains FDA-approved statements about the drug's indication (or purpose), dosing, side effects, and any warnings or contraindications. The label can be accessed by typing "[drug name] label" in an online search engine. Safety is optimized by heeding the recommended dose and the cautions and contraindications on the drug label. Ideally, the provider would have access to a complete and detailed medical history of the individual to optimize safety. Physical examination and laboratory testing are recommended before treatment is initiated and may help with subsequent monitoring of treatment response and adverse events. These lab tests could include alcohol breath/blood concentration, alcohol glucuronide testing, urine drug screen, liver function tests (i.e., gamma glutamyl transferase [GGT], alanine transaminase, aspartate transaminase), complete blood count, testing for vitamin deficiencies, renal function tests (standard panel for urea [blood urea nitrogen], electrolytes, and serum creatinine), and a pregnancy test for women of childbearing potential. Furthermore, measures of hepatic function and creatinine clearance may be critical in determining the choice of drug treatment. For example, baseline liver function tests may detect clinically significant hepatic impairment that would mitigate against treatment with disulfiram and naltrexone as well as severe impairment in creatinine clearance that would contraindicate the choice of acamprosate. A baseline urine drug screen may also be useful, as it may provide information about otherwise undisclosed drug use, including opioid use, which would rule out naltrexone treatment of AUD.

Individuals also should be assessed for any comorbid disorders, including depression and

other drug use disorders. Comorbid conditions may significantly influence AUD outcome if left untreated. Risk of suicide may be elevated in individuals with AUD, and it is recommended that the individual be screened and monitored for suicidality at baseline and throughout treatment to identify increased suicide risk that requires further intervention.

As with all medications, the FDA-approved pharmacotherapies for the treatment of AUD have common side effects (e.g., dizziness, nausea, diarrhea). Usually mild and associated with treatment initiation, these side effects resolve quickly. Individuals should be advised to avoid driving a car or operating heavy machinery until they are reasonably certain that the drug does not affect their ability to engage in such activities. Individuals should be given emergency phone numbers and instructed to call immediately if suicide ideation or depression develops, or if symptoms of acute hepatitis or liver failure emerge (in the case of naltrexone and disulfiram). As a precaution, it is highly recommended that individuals carry a card in their wallet listing all current medications in the event of a medical emergency. For example, anesthesia and pain management may need to be adjusted in individuals taking naltrexone. Furthermore, the presenting medical emergency may be the result of an interaction between alcohol and disulfiram.

Medication nonadherence will negatively impact treatment outcomes. Individuals can be instructed to bring the container for their oral medication to follow-up visits to be assessed for unused drug. Noncompliance can result from adverse side effects, inconvenience, the perception that the drug is no longer needed (i.e., "I feel fine"), and/or a return to drinking. It is therefore critical to understand the reason(s) for treatment noncompliance. First, treatment providers need to determine if adverse events (e.g., medication side effects) are undermining medication adherence, and intervene accordingly. In terms of convenience, long-acting injectable naltrexone was developed to offset the adherence problems noted with daily oral naltrexone dosing. Given that acamprosate has a dosing schedule of three times daily, it is recommended that patients keep their medication in a weekly pill organizer with day and time indicated for each dose. Patients are also advised to link commonly missed doses with an activity of daily living such as eating meals or brushing teeth as a reminder to take their medication at that time. Monitoring medication compliance is paramount to successful treatment outcomes.

MEDICATION INITIATION AND DURATION

The early days of abstinence are a period of heightened vulnerability for relapse and a critical time for healing neural processes associated with negative affect and impaired executive function.[19] Medications for AUD can have the greatest impact on reducing relapse risk when initiated immediately after a 4- to 7-day detoxification period.[15,20]

The patient's pattern of alcohol misuse should be established as a baseline, preferably using quantitative self-report and biochemical measures, against which treatment effects can be tracked. In addition, harmful effects of alcohol on the individual's health, functioning, and legal status should be documented and incorporated into a personalized treatment plan.

There is little scientific evidence to guide the optimal duration of pharmacological treatments of AUD. Decisions about treatment duration should reflect the individual's history of relapse, the severity of AUD at baseline, and the individual's clinical response and side effects to the medication. This should be discussed with the individual if they express a desire to discontinue treatment before a stable recovery has been achieved.

In situations where there is no response to treatment, the provider may consider switching to an alternative AUD medication. This decision is more difficult in situations where a partial response is observed. For example, an individual may have reduced their drinking by half from baseline, but continues to have episodes of heavy drinking. In these situations, the provider may consider the use of combined treatments on a case-by-case basis.

Some data lend support to the safety of acamprosate combined with naltrexone or disulfiram,[21-23] but efficacy data are insufficient to support a general recommendation for combined use as a first-line treatment approach to AUD.[16]

FDA-APPROVED MEDICATIONS FOR AUD

Disulfiram

In 1951 disulfiram (Antabuse; now in generic formulations) was the first drug approved for the treatment of AUD by the FDA. Pharmacologically, disulfiram inhibits the enzyme aldehyde dehydrogenase. Even small amounts of alcohol can cause acetaldehyde to quickly accumulate, resulting in a rapid onset of flushing, nausea, and vomiting. The resulting acute physical distress serves to reduce drinking and break the cycle of binge intoxication (see Figure 1). In severe reactions, there is the possibility of multiple cardiac and respiratory symptoms that could result in death. The intensity of the interaction varies across individuals but is generally proportional to the amounts of disulfiram and alcohol ingested and can last from 30 to 60 minutes to several hours, or as long as there is alcohol in the blood. Individuals should be instructed to abstain from alcohol for at least 12 hours before taking disulfiram and be advised that reactions with alcohol can occur up to 14 days after discontinuing disulfiram.

The therapeutic action of disulfiram is punitive, resulting in acute physical distress when taken with alcohol. Therefore, it should never be given to an individual in a state of alcohol intoxication or without their full knowledge. When taken as prescribed, disulfiram is typically well tolerated,[24] but more serious adverse events were found with disulfiram than with comparison treatments.[25] The psychological threat (fear) of the interaction between disulfiram and alcohol may be the primary mechanism of disulfiram's deterrent effect, as opposed to the drug's pharmacodynamic properties.[25] Therefore, consideration of disulfiram may be warranted only in individuals who have a clear goal of complete abstinence, are capable of understanding the risks of an interaction between alcohol and disulfiram, have not responded to acamprosate and naltrexone, and have no medical contraindications.[16] Given the drug's potential for hepatotoxicity, it is recommended that individuals taking disulfiram have bilirubin and liver function tests at baseline and 2 weeks, once a month for the next 6 months, and every 3 months thereafter. Medication nonadherence is a common problem with disulfiram,[26] and outcomes are optimized with supervised administration.[27]

Naltrexone

Naltrexone is a pure opioid receptor antagonist that the FDA approved first for opioid dependence (in 1984), and later for alcohol dependence (as an oral medication in 1994 and as a long-acting injectable in 2006). The therapeutic action of opioid receptor antagonism is to blunt the rewarding effects of alcohol. In our conceptual model (shown in Figure 1), blunting the rewarding effects of alcohol can reduce drinking and break the cycle of binge intoxication. Although side effects are generally mild (initial nausea, vomiting, and dizziness), a recent meta-analysis found a higher risk for discontinuation due to adverse events with naltrexone relative to placebo.[14] This meta-analysis, which included the results of 53 randomized controlled trials (involving 9,140 patients) of oral naltrexone (50 mg/d) for the treatment of AUD, showed that naltrexone significantly decreased the likelihood of a return to heavy drinking and, to a lesser extent, a return to any drinking.[14] This replicated the results from an earlier meta-analysis that reported a decreased risk of a return to heavy drinking and that also assessed moderators of naltrexone treatment response.[15] Maisel et al. (2013) found that 4 days of abstinence prior to beginning treatment significantly improved naltrexone treatment response and that having treatment goals other than abstinence was associated with a larger effect size on reducing heavy drinking than having the goal of complete abstinence.

Naltrexone, like disulfiram, is pharmacologically effective primarily while present in the system, but induces no long-term changes in the brain.

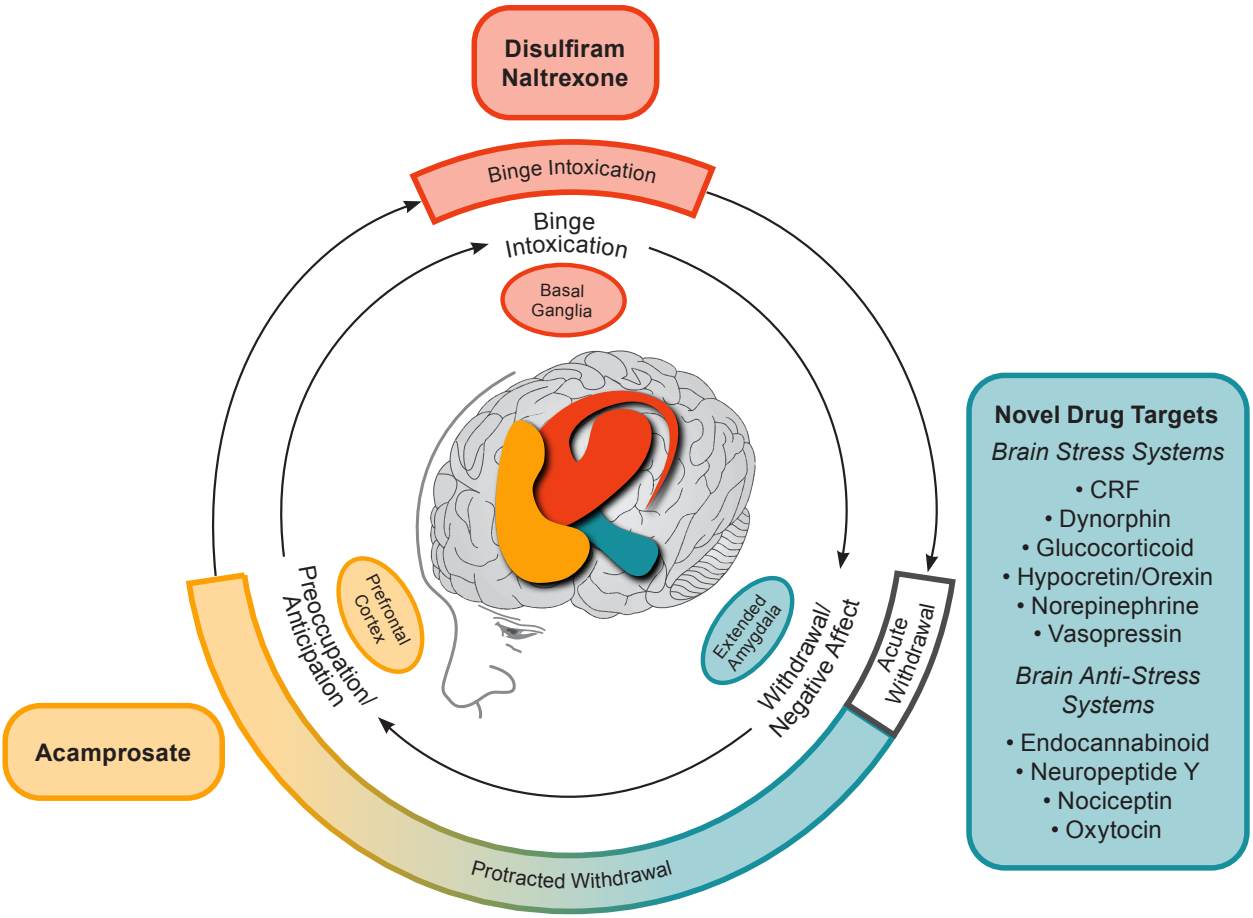

Figure 1 Conceptual framework for the effects of various medications on the three major stages of the alcohol addiction cycle and the clinical stages of alcohol use disorder (AUD). The outer ring relates to clinical stages of AUD. The inner ring relates to three stages of the addiction cycle. Acute withdrawal relates to physiological and emotional effects that are opposite to those of alcohol and includes activation of the extended amygdala brain stress systems. Acute withdrawal is a time-limited process (up to only 5 days in duration). Protracted withdrawal is characterized by continued hyperactivation of the brain stress systems. The overexpression of brain stress neuropeptides is hypothesized to mediate the anxiety, dysphoria, irritability, and sleep disturbances of post-acute (i.e., protracted) withdrawal that may persist for an indefinite duration. Protracted withdrawal/negative affect helps drive craving in the preoccupation/anticipation stage, for which acamprosate is the only available treatment. *Note*: CRF, corticotropin-releasing factor. Adapted by permission from Springer Nature: Nature Neuropsychopharmacology, 35(1):217-38, Neurocircuitry of addiction, George F. Koob and Nora D. Volkow, 2010.[31]

This is important in understanding the duration of treatment effects of naltrexone and disulfiram. For example, follow-up studies of patients in two 3-month naltrexone studies showed that treatment effects were no longer significant relative to placebo by 1 to 3 months posttreatment.[28,29] Pairing naltrexone with a form of cognitive behavior therapy focused on relapse prevention coping skills, therefore, may offer an optimal treatment strategy.[29]

Regarding route of administration, there have been no head-to-head comparisons of the efficacy of oral versus injectable naltrexone to date. A meta-analysis of drinking outcomes from 1,926 participants in two trials of different formulations of injectable naltrexone found no significant effects of treatment on return to any drinking or to heavy drinking, but did find a reduction in the number of heavy drinking days. The trial conducted in

support of FDA approval found a similar effect of naltrexone (Vivitrol) 380 mg per injection, but only in men and only in those with 7 days of abstinence prior to randomization.[20]

Any form of naltrexone treatment for AUD is contraindicated in individuals who have current physiologic dependence on opioids, who are in opioid withdrawal, who have used prescribed or illicit forms of opioids within the past 7 to 10 days, or who have a urine drug screen positive for opioids. This avoids unintended precipitation of opioid withdrawal through administration of an opioid antagonist. Of note, naltrexone can cause hepatocellular injury when used in higher than recommended doses and is contraindicated in individuals with acute hepatitis or liver failure.

Acamprosate

Acamprosate was developed in France in the 1980s and approved by FDA for the maintenance of abstinence in detoxified patients with alcohol dependence in 2004. The pharmacological action of acamprosate is complex. The chemical structure is similar to that of the endogenous amino acid homotaurine, which is a structural analog of the amino acid neurotransmitter gamma-aminobutyric acid (GABA) and the amino acid neuromodulator taurine. Repeated cycles of heavy drinking and withdrawal have been shown to dysregulate the balance between neuronal excitation (e.g., glutamatergic) and inhibition (e.g., GABAergic).[30] It has been hypothesized that this glutamatergic hyperactivity is associated with alcohol craving and the preoccupation/anticipation phase of protracted withdrawal—an effect that is ameliorated by acamprosate (see Figure 1).[31] Therefore, it suggested that the pharmacotherapeutic action of acamprosate in AUD works by restoring homeostasis in *N*-methyl-D-aspartate (NMDA)–mediated glutamatergic neurotransmission.[32,33] Acamprosate requires approximately 1 week to reach steady-state levels in the nervous system, and its effects on drinking behavior have been shown to persist in studies of up to 1 year after the treatment is completed, consistent with its role in restoring persisting homeostasis in brain glutamatergic activity.[33]

A meta-analyses of 27 randomized controlled trials of acamprosate (typically 6 to 12 months in duration) found that acamprosate was significantly more likely than placebo treatment to prevent a return to any drinking.[14] This finding replicates the results from an earlier meta-analysis that found a significantly higher rate of complete abstinence associated with acamprosate.[15] Detoxification or required abstinence prior to acamprosate administration was associated with increased efficacy.[15] A separate meta-analysis using individual records from more than 6,000 participants in 22 acamprosate studies found the medication to have a significant gain in the rate of complete abstinence and no heavy drinking over the study duration,[34] with no differences in the rate of discontinuation due to adverse events or severity or type of adverse event. Acamprosate was also associated with significantly higher rates of treatment completion and medication compliance than placebo. Posttreatment follow-up studies have shown the effects of acamprosate to be sustained for periods of up to 1 year after the last dose.[33] Acamprosate also has been reported to reverse alcohol-related insomnia and changes in sleep architecture.[35,36] This added benefit may improve treatment outcomes in individuals with comorbid psychiatric disorders characterized by sleep disturbance, such as post-traumatic stress disorder, anxiety, and depressive disorders.

Acamprosate is not metabolized by the liver and is not associated with hepatotoxicity. moreover, acamprosate does not interact with medications commonly prescribed for individuals with AUD, including disulfiram, antidepressants, anxiolytics, or hypnotics. pharmacokinetic studies found that coadministration with naltrexone increased the rate and extent of acamprosate absorption without compromising its tolerability.[22,23] As noted previously, acamprosate is taken three times a day, due to low bioavailability. This dosing schedule may be supported by placing a 1-week supply of medication in a commercially available pill organizer with day and time indicated for each dose.

Acamprosate is well tolerated with minimal side effects (e.g., mild to moderate diarrhea, typically at the start of treatment). The results of a meta-analysis found acamprosate to have no increase in the risk of withdrawal from treatment due to adverse events compared with placebo.[14]

"OFF-LABEL" MEDICATIONS TO TREAT AUD

Given that existing pharmacotherapies are underutilized and limited in scope, there is a continued need for the development of new medications to treat AUD safely and effectively. One avenue to discovery involves the repurposing of existing medications. This is the most expeditious route given that these drugs have FDA approval for use as treatments in other medical conditions and known safety profiles. However, once a drug is in generic formulations, there is little financial incentive for a pharmaceutical company to incur the cost of the additional research required for FDA approval of AUD as a new indication. Thus, the use of such drugs to treat AUD is considered "off label." Two generic drugs, topiramate and gabapentin (both originally developed as antiepileptic medications), have shown therapeutic potential for AUD and have been included in APA's practice guideline.[16] The guideline recommends the use of topiramate or gabapentin in individuals who have a goal of decreasing or quitting drinking and who are intolerant to or have not responded to acamprosate and naltrexone.[16] Co-occurring disorders, concomitant medications, side effect profiles, and contraindications for use are additional factors that may guide the selection of topiramate or gabapentin.

Topiramate

Topiramate (Topamax and generics) is currently approved by the FDA for the treatment of epilepsy and for the prophylaxis of migraine, and has been extensively studied for the treatment of AUD. A meta-analysis of randomized controlled trials of 3 months duration and target doses of 200 to 300 mg/d in outpatients with AUD found topiramate to be associated with fewer drinking days, fewer heavy drinking days, and fewer drinks per drinking day, compared with placebo.[14] Although promising, topiramate has a number of warnings and precautions. Safety monitoring recommends baseline and periodic measures of serum bicarbonate to detect treatment-emergent metabolic acidosis; baseline tests of renal function, as creatinine clearance of less than 70 mL/min requires a dose adjustment to half the starting and maintenance dose; and baseline tests of hepatic function, as topiramate plasma concentration is increased in hepatic impairment. In addition, it has been reported that individuals with AUD who were treated with topiramate had a higher risk of cognitive dysfunction, paresthesia, and taste abnormalities than did individuals treated with placebo. The cognitive dysfunction—including confusion; psychomotor slowing; attention, concentration, and memory impairment; and speech or language problems—was commonly associated with treatment discontinuation.[37] Individuals should be gradually withdrawn from topiramate to minimize the potential for seizures. An individual's current medications should be reviewed prior to considering topiramate, which interacts pharmacokinetically with some antiepileptic drugs, central nervous system depressants, oral contraceptives, metformin, lithium, and carbonic anhydrase inhibitors.

Gabapentin

Gabapentin (Neurontin and generics) is used "off label" for the treatment of AUD and is included in APA's practice guideline.[16] It is a synthetic GABA analog approved by FDA for the treatment of epilepsy and postherpetic neuralgia.[38] The authors hypothesize that gabapentin acts in AUD to break the cycle of negative affect given its effects on mood and sleep and on electrophysiological results showing that it acts like a corticotropin-releasing factor (CRF) receptor antagonist in the central nucleus of the amygdala (CeA)[38] (see Figure 1). A recent review found the efficacy of gabapentin for treatment of AUD supported by five of six single-site treatment studies reporting drinking

outcomes.[39] The efficacy of gabapentin has been reported to be dose dependent. More specifically, a 12-week trial of 0, 900, and 1,800 mg/d of gabapentin showed significant linear dose effects on rates of abstinence and absence of heavy drinking; number of drinks per week; number of drinking days per week; GGT; and standardized measures of craving, negative affect, and insomnia,[40] with the 1,800 mg/d dose associated with greatest efficacy. Similar to acamprosate, six of eight AUD studies reported a significant beneficial effect of gabapentin on alcohol-related sleep disturbance.[39] Moreover, gabapentin-related decreases in negative affect have been reported.[39] These clinical findings are consistent with basic research suggesting gabapentin may support recovery by restoring homeostasis (a stable equilibrium) in brain stress systems that become dysregulated in the protracted withdrawal/negative affect phase of AUD.[38] Research suggesting that gabapentin may be most effective in individuals with acute alcohol withdrawal symptoms was challenged because individuals with clinically significant acute alcohol withdrawal were systematically excluded from participation in this research.[41] Gabapentin should not be considered a standalone treatment for severe acute alcohol withdrawal because of its ineffectiveness in suppressing seizures related to alcohol withdrawal.[39] The APA practice guideline recommends the use of gabapentin for the treatment of AUD, not alcohol withdrawal.[16] Note that relative to other AUD medications, gabapentin shows unique evidence for treating the mood and sleep disturbance of the protracted withdrawal phase.

There are no contraindications to gabapentin, other than known hypersensitivity to the medication. Gabapentin is not metabolized in the liver and is eliminated from systemic circulation by renal excretion as unchanged drug. As such, a baseline test of creatinine clearance is indicated, with dose adjustments indicated in individuals with reduced renal function (creatinine clearance < 60 mL/min). Alcohol was not found to interact meaningfully with gabapentin in a pharmacokinetic/pharmacodynamic (PK/PD) study.[42] The lack of appreciable hepatic metabolism is a PK advantage of gabapentin, as chronic heavy drinking is often associated with liver injury. There were no reported safety concerns among the 655 individuals with AUD treated with gabapentin in clinical studies (≤ 1,800 mg/d), and any adverse events tended to be mild to moderate and to not differ from placebo.[39] These common adverse events included headache, insomnia, fatigue, muscle aches, and various gastrointestinal complaints at equivalent rates in both gabapentin- and placebo-treated outpatients with AUD. Taken together with patient experience for approved pain and epilepsy indications, gabapentin is considered to have a good safety and tolerability profile. As with any centrally active drug, individuals should be advised not to drive motor vehicles or operate heavy machinery until they have ascertained that the drug does not affect their performance.

Antiepileptic drugs, including gabapentin and topiramate, have been shown to increase the risk of suicidal thoughts or behavior in about one in 500 patients, irrespective of disorder. Further, abrupt withdrawal from gabapentin and topiramate can increase the risk of precipitated seizures and status epilepticus, and drug dose should be tapered gradually when discontinuing treatment. Reports of misuse of gabapentinoids, such as gabapentin and pregabalin, are increasingly documented in high-risk populations, notably among those who misuse opioids and prescription drugs. Gabapentin is not a controlled or scheduled substance. There was no evidence of tolerance to gabapentin dose or rebound with titration off drug, nor evidence of misuse potential, in studies of individuals with AUD. However, patients undergoing opioid withdrawal, those who misuse prescriptions recreationally, and prison populations may be at increased risk to misuse gabapentin, with self-administered doses often far exceeding the therapeutic range.[43,44] Hence, patients with risk histories should be monitored for potential gabapentinoid misuse or diversion.

Baclofen

Baclofen is a selective gamma-aminobutyric acid-B (GABA-B) receptor agonist; see de Beaurepaire et al., 2019, for review.[45] Baclofen has been used to

treat muscle spasticity, secondary to neurological conditions. It has been hypothesized that the pharmacotherapeutic action of baclofen in AUD may be to suppress the ventral tegmental area (VTA) dopamine system and blunt reinforcement, serving to reduce drinking and thereby breaking the cycle of binge intoxication (see Figure 1). Initial reports were positive in 39 male participants with AUD, showing that treatment with baclofen 30 mg/d increased the percentage of individuals who achieved and maintained abstinence as well as the number of abstinent days, and decreased the number of drinks per drinking day as well as anxiety levels.[46] However, these results have not been consistently observed in subsequent studies.[45] In addition, the use of baclofen remains controversial, in part because of uncertainty regarding dosing and efficacy, along with concerns about safety. Individuals should be told to avoid drinking while taking the drug as the sedative properties of both drugs may potentiate each other. Individuals should not drive motor vehicles or operate heavy machinery until they have ascertained that the drug does not affect their performance. Individuals also should be advised of the risk of overdose. Side effects range in severity, from nonsevere to more dangerous types, including seizures, respiratory depression with sleep apnea and potentially coma (in case of intoxication), severe mood disorders (mania or depression, with the risk of suicide), and mental confusion or delirium. Baclofen is mostly (~ 80%) eliminated from systemic circulation by renal excretion as unchanged drug. Therefore, baseline and repeated tests of renal function are recommended given that renal problems can lead to an accumulation of baclofen, which may result in mental confusion. Baclofen treatment should start and end slowly as there is a withdrawal syndrome associated with abrupt cessation of treatment; withdrawal symptoms may include confusion, agitation, seizures, and delirium and may be confused with alcohol withdrawal.[47] More research is needed to clarify the potential efficacy and safety of baclofen in AUD.

SEX DIFFERENCES IN AUD AND RESPONSE TO AUD PHARMACOTHERAPIES

To date, very few publications have examined sex differences in pharmacotherapies for AUD. This is surprising given that 5.6 million American women (~4%) met criteria for AUD in a recent survey by the Substance Abuse and Mental Health Services Administration.[48] Furthermore, it has been reported that women generally experience liver damage and other health problems after consuming less alcohol than men.[49,50] For example, among women, chronic consumption of more than two drinks per day is associated with increased risk of mortality, breast cancer, hypertension, stroke, and reproductive problems;[49] and binge drinking (e.g., consuming four or more drinks in a row) may incur increased risk of accident, rape, assault, and unprotected sex.[51] Given the significant disease burden of AUD in women, early intervention and effective treatment options are imperative.

There is a clear need for women to be represented in clinical trials of AUD, because sex may be associated with differential drug efficacy. The majority of clinical trials of disulfiram have been conducted primarily in men; women comprised less than 10% of all patients included in a recent meta-analysis.[25] A clear example of sex differences was reported in a pivotal multicenter trial for AUD where long-acting injectable naltrexone (Vivitrol) showed efficacy in men but not in women.[20] The reason for the sex difference in Vivitrol efficacy is not understood, as the pharmacokinetics of the drug do not differ between men and women. Additionally, oral naltrexone did not differ from placebo in the only trial exclusively studying women.[52]

Conversely, no sex differences were found in a sex-specific meta-analysis of individual records obtained from 1,317 women and 4,794 men who participated in 22 acamprosate clinical trials.[34] A significant effect of acamprosate relative to placebo on rates of abstinence and absence of heavy drinking was found in both men and women. The side effect and tolerability profile of acamprosate

was comparable to that of placebo and did not differ between women and men. Acamprosate was associated with significantly higher rates of treatment completion and medication compliance than placebo among both women and men.

Systematic evaluation of potential differences in drug metabolism due to race, ethnicity, or sex hormones, and of consequent effects on drug efficacy or safety, is essential for all medications to treat AUD, and clinical trials require adequate representation of women and individuals from diverse racial and ethnic backgrounds. An additional concern is that the prevalence of AUD is highest among women in the prime childbearing years (ages 18 to 29), with associated risk of fetal alcohol spectrum disorders.[53] Women with childbearing potential who do not use a reliable method of birth control or who are pregnant or lactating must be excluded from medication trials to avoid exposing the fetus or newborn to medication. There are no adequate and well-controlled studies of pharmacotherapies for AUD in pregnant women. Therefore, it is recommended that these medications not be used during pregnancy.

PHARMACOGENETIC AND PHARMACOMETABOLOMIC PREDICTORS OF RESPONSE

Pharmacogenetic and pharmacometabolomic predictors have the potential to inform clinical care by identifying individuals likely to respond to or have significant side effects to a specific medication, thereby personalizing AUD treatment. For example, a number of pharmacogenetic studies have focused on the moderating effects of a variant in the mu-opioid receptor gene OPRM1 on response to naltrexone. However, a comprehensive review of the literature concluded that inconsistent findings across studies and a lack of translation of findings from human laboratory studies to clinical trials do not yet support this application of pharmacogenetics in AUD clinical practice.[54]

Recent studies using pharmacometabolomics offer insights into optimizing acamprosate treatment. For example, elevated baseline serum glutamate was found to be a biomarker of response to acamprosate in alcohol-dependent patients,[55] with responders showing significantly higher baseline serum glutamate levels. Interestingly, this study reported that serum glutamate levels of responders were normalized after acamprosate treatment, whereas there was no significant glutamate change in nonresponders; this provides further support for the hypothesis that acamprosate works to restore homeostasis in the brain glutamate system. By developing such predictors, it may be possible to improve patient treatment matching and the overall success rate of acamprosate—and, to that end, any pharmacotherapy used in the treatment of AUD.

CONCLUDING REMARKS AND FUTURE DIRECTIONS

The recent surge in understanding of the neurocircuitry and neuropharmacological mechanisms that are involved in AUD have provided abundant targets for future medication development for treating AUD.[31] However, most previous work on medications has focused on blocking the rewarding effects of drugs in the binge intoxication stage of the AUD cycle. A clear role for drug targets in the protracted withdrawal phase is indicated by persisting negative emotional states that drive drinking relapse, such as anxiety, dysphoria, irritability, and insomnia (see Figure 1). To this end, medication development for AUD can benefit from the use of a framework for stages of the AUD cycle that is linked to neurocircuitry and that includes protracted withdrawal/negative affect.[56] Indeed, dysregulation in the brain reward and stress systems that results in the symptoms associated with the protracted withdrawal/negative affect and preoccupation/anticipation stages of the AUD cycle is a neglected focus for AUD drug development. Both repurposed drugs (e.g., gabapentin and mifepristone, a glucocorticoid receptor antagonist)[57] and new molecular entities (e.g., a vasopressin V1b receptor antagonist)[58] are all selective for restoring homeostasis in brain stress systems that drive symptoms of protracted withdrawal, and they show promise as emerging new treatments for AUD.

Medications can help restore normal brain functioning, reduce relapse risk, and decrease symptoms of protracted withdrawal (e.g., craving, mood, sleep disturbance), thereby facilitating better engagement in behavioral treatment. Behavioral therapies, in turn, enhance pharmacotherapy response by modifying attitudes and behaviors related to alcohol, increasing healthy life skills, and helping people to stay engaged in recovery.

The Alcohol Treatment Navigator website (https://alcoholtreatment.niaaa.nih.gov) was created by the National Institute on Alcohol Abuse and Alcoholism to assist individuals in locating clinicians who provide evidence-based behavioral and/or pharmacological treatments for AUD. Combining evidence-based pharmacological and behavioral treatments for AUD may increase the likelihood of individuals with AUD meeting their goals for recovery.

Acknowledgments

Appreciation is expressed to Sam Reed for his editorial assistance in the preparation of this article. Support for this project was provided by the Pearson Center for Alcoholism and Addiction Research and National Institute on Alcohol Abuse and Alcoholism grants P60AA06420 and U01AA025476.

Disclosures

There are no competing financial interests to disclose.

Publisher's Note

Opinions expressed in contributed articles do not necessarily reflect the views of the National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health. The U.S. government does not endorse or favor any specific commercial product or commodity. Any trade or proprietary names appearing in *Alcohol Research: Current Reviews* are used only because they are considered essential in the context of the studies reported herein.

References

1. Substance Abuse and Mental Health Services Administration (SAMHSA), Center for Behavioral Health Statistics and Quality. *Key Substance Use and Mental Health Indicators in the United States: Results From the 2016 National Survey on Drug Use and Health.* Rockville, MD: U.S. Department of Health and Human Services (HHS); 2017. https://store.samhsa.gov/product/Key-Substance-Use-and-Mental-Health-Indicators-in-the-United-States-/SMA17-5044.
2. American Psychiatric Association (APA). Diagnostic and Statistical Manual of Mental Disorders. 5th ed. Washington, DC: APA; 2013. https://doi.org/10.1176/appi.books.9780890425596.
3. National Center for Health Statistics. *Health, United States, 2015: With Special Feature on Racial and Ethnic Health Disparities.* Hyattsville, MD: HHS; 2016. https://www.cdc.gov/nchs/data/hus/hus15.pdf.
4. Compton WM, Dawson DA, Goldstein RB, et al. Crosswalk between DSM-IV dependence and DSM-5 substance use disorders for opioids, cannabis, cocaine and alcohol. *Drug Alcohol Depend.* 2013;132(1-2):387-390. https://doi.org/10.1016/j.drugalcdep.2013.02.036.
5. Baser O, Chalk M, Rawson R, et al. Alcohol dependence treatments: Comprehensive healthcare costs, utilization outcomes, and pharmacotherapy persistence. *Am J Manag Care.* 2011;17(suppl 8):S222-234.
6. Knox J, Wall M, Witkiewitz K, et al., for Alcohol Clinical Trials (ACTIVE) Workgroup. Reduction in non-abstinent World Health Organization (WHO) drinking risk levels and drug use disorders: 3-year follow-up results in the US general population. *Drug Alcohol Depend.* 2019;201:16-22. https://doi.org/10.1016/j.drugalcdep.2019.03.020.
7. Witkiewitz K, Kranzler HR, Hallgren KA, et al. Drinking risk level reductions associated with improvements in physical health and quality of life among individuals with alcohol use disorder. *Alcohol Clin Exp Res.* 2018;42(12): 2453-2465. https://doi.org/10.1111/acer.13897.
8. Mason BJ, Goodman AM, Chabac S, et al. Effect of oral acamprosate on abstinence in patients with alcohol dependence in a double-blind, placebo-controlled trial: The role of patient motivation. *J Psychiatr Res.* 2006;40(5):383-393. https://doi.org/10.1016/j.jpsychires.2006.02.002.
9. Betty Ford Institute Consensus Panel. What is recovery? A working definition from the Betty Ford Institute. *J Subst Abuse Treat.* 2007;33(3):221-228. https://doi.org/10.1016/j.jsat.2007.06.001.
10. National Institute on Alcohol Abuse and Alcoholism. *Rethinking Drinking: Alcohol and Your Health.* Washington, DC: U.S. Government Printing Office; 2010. Revised 2016: https://www.rethinkingdrinking.niaaa.nih.gov. .
11. World Health Organization. *International Guide for Monitoring Alcohol Consumption and Related Harm.* Geneva, Switzerland: WHO, Department of Mental Health and Substance Dependence, Noncommunicable Diseases and Mental Health Cluster; 2000. https://apps.who.int/iris/bitstream/handle/10665/66529/WHO_MSD_MSB_00.4.pdf.
12. European Medicines Agency. *Guideline on the Development of Medicinal Products for the Treatment of Alcohol Dependence.* London, United Kingdom: European Medicines Agency; 2010. https://www.ema.europa.eu/en/documents/scientific-guideline/guideline-development-medicinal-products-treatment-alcohol-dependence_en.pdf.
13. Mark TL, Kassed CA, Vandivort-Warren R, et al. Alcohol and opioid dependence medications: Prescription trends, overall and by physician specialty. *Drug Alcohol Depend.* 2009;99(1-3):345-349. http://dx.doi.org/10.1016/j.drugalcdep.2008.07.018.
14. Jonas DE, Amick HR, Feltner C, et al. Pharmacotherapy for adults with alcohol use disorders in outpatient settings: A systematic review and meta-analysis. *JAMA.* 2014;311(18):1889-1900. https://doi.org/10.1001/jama.2014.3628.
15. Maisel NC, Blodgett JC, Wilbourne PL, et al. Meta-analysis of naltrexone and acamprosate for treating alcohol use disorders: When are these medications most helpful? *Addiction.* 2013;108(2):275-293. https://doi.org/10.1111/j.1360-0443.2012.04054.x.

16. American Psychiatric Association. *Practice Guideline for the Pharmacological Treatment of Patients With Alcohol Use Disorder.* Washington, DC: APA; 2017. https://psychiatryonline.org/doi/pdf/10.1176/appi.books.9781615371969.
17. Sullivan JT, Sykora K, Schneiderman J, et al. Assessment of alcohol withdrawal: The revised clinical institute withdrawal assessment for alcohol scale (CIWA-Ar). *Br J Addict.* 1989;84(11):1353-1357. https://doi.org/10.1111/j.1360-0443.1989.tb00737.x.
18. SAMHSA. *Facing Addiction in America: The Surgeon General's Report on Alcohol, Drugs and Health.* Washington, DC: HHS, Office of the Surgeon General; 2016. https://addiction.surgeongeneral.gov/sites/default/files/surgeon-generals-report.pdf.
19. Sullivan EV. Why timing matters in alcohol use disorder recovery. *Am J Psychiatry.* 2020;177(11):1022-1024. https://doi.org/10.1176/appi.ajp.2020.20091323.
20. Garbutt JC, Kranzler HR, O'Malley SS, et al. Efficacy and tolerability of long-acting injectable naltrexone for alcohol dependence: A randomized controlled trial. *JAMA.* 2005;293(13):1617-1625. https://doi.org/10.1001/jama.293.13.1617.
21. Besson J, Aeby F, Kasas A, et al. Combined efficacy of acamprosate and disulfiram in the treatment of alcoholism: A controlled study. *Alcohol Clin Exp Res.* 1998;22(3):573-579. https://doi.org/10.1111/j.1530-0277.1998.tb04295.x.
22. Johnson BA, O'Malley SS, Ciraulo DA, et al. Dose-ranging kinetics and behavioral pharmacology of naltrexone and acamprosate, both alone and combined, in alcohol-dependent subjects. *J Clin Psychopharmacol.* 2003;23(3):281-293. https://doi.org/10.1097/01.jcp.0000084029.22282.bb.
23. Mason BJ, Goodman AM, Dixon RM, et al. A pharmacokinetic and pharmacodynamic drug interaction study of acamprosate and naltrexone. *Neuropsychopharmacology.* 2002;27(4):596-606. https://doi.org/10.1016/S0893-133X(02)00368-8.
24. Chick J. Safety issues concerning the use of disulfiram in treating alcohol dependence. *Drug Saf.* 1999;20(5):427-435. https://doi.org/10.2165/00002018-199920050-00003.
25. Skinner MD, Lahmek P, Pham H, et al. Disulfiram efficacy in the treatment of alcohol dependence: A meta-analysis. *PLoS One.* 2014;9(2):e87366. https://doi.org/10.1371/journal.pone.0087366.
26. Fuller RK, Branchey L, Brightwell DR, et al. Disulfiram treatment of alcoholism: A Veterans Administration cooperative study. *JAMA.* 1986;256(11):1449-1455. https://doi.org/10.1001/jama.1986.03380110055026.
27. Jørgensen CH, Pedersen B, Tønnesen H. The efficacy of disulfiram for the treatment of alcohol use disorder. *Alcohol Clin Exp Res.* 2011;35(10):1749-1758. https://doi.org/10.1111/j.1530-0277.2011.01523.x.
28. Anton RF, Moak DH, Latham PK, et al. Posttreatment results of combining naltrexone with cognitive-behavior therapy for the treatment of alcoholism. *J Clin Psychopharmacol.* 2001;21(1):72-77. https://doi.org/10.1097/00004714-200102000-00013.
29. O'Malley SS, Jaffe AJ, Chang G, et al. Naltrexone and coping skills therapy for alcohol dependence: A controlled study. *Arch Gen Psychiatry.* 1992;49(11):881-887. https://doi.org/10.1001/archpsyc.1992.01820110045007.
30. Boeijinga PH, Parot P, Soufflet L, et al. Pharmacodynamic effects of acamprosate on markers of cerebral function in alcohol-dependent subjects administered as pretreatment and during alcohol abstinence. *Neuropsychobiology.* 2004;50(1):71-77. https://doi.org/10.1159/000077944.
31. Koob GF, Volkow ND. Neurocircuitry of addiction. *Neuropsychopharmacology.* 2010;35(1):217-238. https://doi.org/10.1038/npp.2009.110.
32. Littleton JM. Acamprosate in alcohol dependence: Implications of a unique mechanism of action. *J Addict Med.* 2007;1(3):115-125. https://doi.org/10.1097/ADM.0b013e318156c26f.
33. Mason BJ, Heyser CJ. Acamprosate: A prototypic neuromodulator in the treatment of alcohol dependence. *CNS Neurol Disord Drug Targets.* 2010;9(1):23-32. https://doi.org/10.2174/187152710790966641.
34. Mason BJ, Lehert P. Acamprosate for alcohol dependence: A sex-specific meta-analysis based on individual patient data. *Alcohol Clin Exp Res.* 2012;36(3):497-508. https://doi.org/10.1111/j.1530-0277.2011.01616.x.
35. Staner L, Boeijinga P, Danel T, et al. Effects of acamprosate on sleep during alcohol withdrawal: A double-blind placebo-controlled polysomnographic study in alcohol-dependent subjects. *Alcohol Clin Exp Res.* 2006;30(9):1492-1499. https://doi.org/10.1111/j.1530-0277.2006.00180.x.
36. Perney P, Lehert P, Mason BJ. Sleep disturbance in alcoholism: Proposal of a simple measurement, and results from a 24-week randomized controlled study of alcohol-dependent patients assessing acamprosate efficacy. *Alcohol Alcohol.* 2012;47(2):133-139. https://doi.org/10.1093/alcalc/agr160.
37. Salinsky MC, Storzbach D, Spencer DC, et al. Effects of topiramate and gabapentin on cognitive abilities in healthy volunteers. *Neurology.* 2005;64(5):792-798. https://doi.org/10.1212/01.WNL.0000152877.08088.87.
38. Roberto M, Gilpin NW, O'Dell LE, et al. Cellular and behavioral interactions of gabapentin with alcohol dependence. *J Neurosci.* 2008;28(22):5762-5771. https://doi.org/10.1523/JNEUROSCI.0575-08.2008.
39. Mason BJ, Quello S, Shadan F. Gabapentin for the treatment of alcohol use disorder. *Expert Opin Investig Drugs.* 2018;27(1):113-124. https://doi.org/10.1080/13543784.2018.1417383.
40. Mason BJ, Quello S, Goodell V, et al. Gabapentin treatment for alcohol dependence: A randomized clinical trial. *JAMA Intern Med.* 2014;174(1):70-77. https://doi.org/10.1001/jamainternmed.2013.11950.
41. Kleinman RA, Ostacher MJ. Changed primary outcome between trial registration and publication. *JAMA Intern Med.* 2020;180(11):1550-1551. https://doi.org/10.1001/jamainternmed.2020.2183.
42. Bisaga A, Evans SM. The acute effects of gabapentin in combination with alcohol in heavy drinkers. *Drug Alcohol Depend.* 2006;83(1):25-32. https://doi.org/10.1016/j.drugalcdep.2005.10.008.
43. Chiappini S, Schifano F. A decade of gabapentinoid misuse: An analysis of the European Medicines Agency's 'suspected adverse drug reactions' database. *CNS Drugs.* 2016;30(7):647-654. https://doi.org/10.1007/s40263-016-0359-y.
44. Smith RV, Havens JR, Walsh SL. Gabapentin misuse, abuse and diversion: A systematic review. *Addiction.* 2016;111(7):1160-1174. https://doi.org/10.1111/add.13324.
45. de Beaurepaire R, Sinclair JMA, Heydtmann M, et al. The use of baclofen as a treatment for alcohol use disorder: A clinical practice perspective. *Front Psychiatry.* 2019;9:1-16. https://doi.org/10.3389/fpsyt.2018.00708.
46. Addolorato G, Caputo F, Capristo E, et al. Baclofen efficacy in reducing alcohol craving and intake: A preliminary double-blind randomized controlled study. *Alcohol Alcohol.* 2002;37(5):504-508. https://doi.org/10.1093/alcalc/37.5.504.

47. Rolland B, Jaillette E, Carton L, et al. Assessing alcohol versus baclofen withdrawal syndrome in patients treated with baclofen for alcohol use disorder. *J Clin Psychopharmacol.* 2014;34:153-156. https://doi.org/10.1097/JCP.0000000000000054.
48. SAMHSA, Center for Behavioral Health Statistics and Quality. *Behavioral Health Trends in the United States: Results From the 2014 National Survey on Drug Use and Health.* Rockville, MD: HHS; 2015. https://www.samhsa.gov/data/sites/default/files/NSDUH-FRR1-2014/NSDUH-FRR1-2014.pdf.
49. Bradley KA, Badrinath S, Bush K, et al. Medical risks for women who drink alcohol. *J Gen Intern Med.* 1998;13(9):627-639. https://doi.org/10.1046/j.1525-1497.1998.cr187.x.
50. Greenfield SF. Women and alcohol use disorders. *Harv Rev Psychiatry.* 2002;10(2):76-85. https://doi.org/10.1080/10673220216212. Erratum in: *Harv Rev Psychiatry.* 2002;10(4):254.
51. Wechsler H, Dowdall GW, Davenport A, et al. A gender-specific measure of binge drinking among college students. *Am J Public Health.* 1995;85(7):982-985. https://doi.org/10.2105/ajph.85.7.982.
52. O'Malley SS, Sinha R, Grilo CM, et al. Naltrexone and cognitive behavioral coping skills therapy for the treatment of alcohol drinking and eating disorder features in alcohol-dependent women: A randomized controlled trial. *Alcohol Clin Exp Res.* 2007;31(4):625-634. https://doi.org/10.1111/j.1530-0277.2007.00347.x.
53. Grant BF, Stinson FS, Dawson DA, et al. Prevalence and co-occurrence of substance use disorders and independent mood and anxiety disorders: Results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Arch Gen Psychiatry.* 2004;61(8):807-816. https://doi.org/10.1001/archpsyc.61.8.807.
54. Jones JD, Comer SD, Kranzler HR. The pharmacogenetics of alcohol use disorder. *Alcohol Clin Exp Res.* 2015;39(3):391-402. https://doi.org/10.1111/acer.12643.
55. Nam HW, Karpyak VM, Hinton DJ, et al. Elevated baseline serum glutamate as a pharmacometabolomic biomarker for acamprosate treatment outcome in alcohol-dependent subjects. *Transl Psychiatry.* 2015;5(8):e621. https://doi.org/10.1038/tp.2015.120.
56. Koob GF, Le Moal M. Drug abuse: Hedonic homeostatic dysregulation. *Science.* 1997;278(5335):52-58. https://doi.org/10.1126/science.278.5335.52.
57. Vendruscolo LF, Estey D, Goodell V, et al. Glucocorticoid receptor antagonism decreases alcohol seeking in alcohol-dependent individuals. *J Clin Invest.* 2015;125(8):3193-3197. https://doi.org/10.1172/JCI79828.
58. Ryan ML, Falk DE, Fertig JB, et al. A phase 2, double-blind, placebo-controlled randomized trial assessing the efficacy of ABT-436, a novel V1b receptor antagonist, for alcohol dependence. *Neuropsychopharmacology.* 2017;42(5):1012-1023. https://doi.org/10.1038/npp.2016.214.

ALCOHOL RESEARCH
Current Reviews

Alcohol Res. 2021;41(1):06 ● https://doi.org/10.35946/arcr.v41.1.06

Published online 6 May 2021

The Role of the Family in Alcohol Use Disorder Recovery for Adults

Barbara S. McCrady[1] and Julianne C. Flanagan[2,3]

[1]Department of Psychology and Center on Alcoholism, Substance Abuse, and Addictions, University of New Mexico, Albuquerque, New Mexico
[2]Department of Psychiatry and Behavioral Sciences, College of Medicine, Medical University of South Carolina, Charleston, South Carolina
[3]Ralph H. Johnson Veterans Affairs Medical Center, Charleston, South Carolina

Alcohol use disorder (AUD) and family functioning are inextricably bound, and families are impacted negatively by AUD, but families show substantial improvements with AUD recovery. Family members can successfully motivate a person with AUD to initiate changes in drinking or to seek AUD treatment. During recovery, family members can provide active support for recovery. Several couple- or family-involved treatments for AUD have been developed and tested in rigorous efficacy trials. Efficacious treatments based in family systems theory or cognitive behavioral approaches focus on the concerned family member alone, or they engage the couple or family as a unit in the treatment. However, most treatments have been studied in fairly homogeneous, heterosexual, White, non-Hispanic populations, limiting the potential generalizability of these treatments. Substantial gaps remain in our understanding of family processes associated with the initiation and maintenance of AUD recovery among adults. This review outlines the existing literature and describes opportunities for future research to address knowledge gaps in understanding the mechanisms by which these treatments are efficacious, use of family-based treatments with diverse populations, integration of pharmacotherapies with family-involved treatment, role of families in recovery-oriented systems of care, and how to improve treatment development and dissemination.

KEY WORDS: alcohol; adult; alcohol treatment; couples; family therapy; recovery

It is almost axiomatic that alcohol use disorder (AUD) and the family are inextricably bound. AUD harms individual family members and the functioning of the family as a whole, and family members' actions may exacerbate problematic drinking. Conversely, families play a key role in recovery from AUD, and recovery has a positive impact on family members and family functioning. Scientific research to understand the interrelationships between drinking and family functioning began in the early 1900s, and treatment models that address both drinking and family functioning have been developed and tested for close to 75 years. This article reviews the conceptual and empirical literature on the impact of AUD on families, the role of the family in recovery from AUD, the role of family-involved treatment in fostering recovery, and issues related to specific populations. The review concludes with suggested future directions for research. When discussing families, we are using the term broadly to refer to a broad range of kinship relationships. When discussing couples, we are referring to couples in intimate relationships regardless of marital or co-habiting status, and using the term "partner" to refer to either individual in the intimate relationship. However, where research findings apply to a more limited group (e.g., spouse versus partner) we use the correct term to delimit the population studied. Given the limitations of current research findings, we are referring to different-sex couples unless otherwise specified.

THE IMPACT OF AUD ON FAMILIES

AUD affects the functioning of families: Family members take on additional household and childcare responsibilities, social events are disrupted, and families may experience significant financial difficulties.[1] Individual members of these families suffer as well. Spouses and children of adults with AUD or other substance use disorder (SUD). experience psychological distress as well as health and behavioral problems. For example, women with a male partner who has AUD and is actively drinking reported elevated levels of depression, anxiety and psychosomatic complaints, and disruptions to work and social/leisure activities, and they utilize more health care resources.[2-4] Similarly, children who have a parent with AUD experience a variety of psychological, behavioral, and school problems.[5,6]

Research also has demonstrated a reciprocal relationship between drinking, AUD, and the quality of intimate relationships. For example, longitudinal studies of engaged different-sex couples have found that the husband's drinking prior to marriage is a strong predictor of the wife's drinking a year into marriage,[7] that the female partner's drinking influences the male partner's drinking in the next year,[8] and that relationship distress and AUD are strongly related.[9] A recent meta-analysis of 17 studies (N = 10,553 couples) focused on different-sex couples found that partners influence one another's drinking, although the magnitude of effects was modest. The extent to which women influenced men's drinking ($\beta = .19$) was slightly greater than the extent to which men influenced women's drinking ($\beta = .12$).[8] Results from clinical and nonclinical samples also reveal a close association between heavy drinking and the perpetration of intimate partner violence.[10] Couples with at least one partner with AUD have high rates of intimate partner violence, regardless of the sex of the partner with AUD,[11] and drinking is common during episodes of interpersonal violence.[12] Most typically, interpersonal violence is bidirectional in these couples.

Orford and his colleagues have proposed that the functioning of family members of those with AUD is best understood within a stress-strain-coping-support (SSCS) framework.[13] The SSCS model assumes that living with a family member with AUD is a stressful circumstance, putting family members at risk of a variety of psychological and physical health problems. Within this model, families are seen as engaging in a variety of behaviors to cope with this chronic stressor, some of which are more effective in helping families to cope with and to influence the drinker's behavior, and others that are less effective. The SSCS framework has informed much of contemporary research on AUD and the family.

THE ROLE OF THE FAMILY IN RECOVERY FROM AUD

There are strong connections between family functioning and drinking outcomes. Family behaviors can contribute to changes in drinking, and, conversely, changes in drinking can contribute to more positive family functioning. For example, in early studies, Moos and colleagues examined the longitudinal course of functioning in families of men receiving treatment for AUD. At 2-year follow-up, they compared family functioning for men who were in recovery to men who had relapsed. Wives of men in recovery, compared to wives of men who relapsed, drank less, were less depressed and anxious, had fewer negative life events, and had higher family incomes.[14] Similarly, the children of the men in recovery showed fewer symptoms of emotional distress.[15] As a whole, families of men in recovery had greater family cohesion, greater expressiveness, a higher orientation toward recreational activities, and greater agreement in how they viewed the overall environment of their families, compared to families of men who had relapsed.[16] These studies highlight the positive impact of recovery on families.

Families may play a key role in fostering the initiation of recovery. Although popular literature and 12-step mutual help groups for families, such as Al-Anon (https://al-anon.org/), emphasize detachment for family members and empirically supported interventions for families, such as Community Reinforcement and Family Training (CRAFT),[17] it has been found that family behavior can increase the probability that an individual will seek help for AUD.[18] Key family behaviors that support the initiation of change include ignoring behaviors associated with using alcohol or drugs, reinforcing positive or desirable behaviors related to sobriety or help-seeking, allowing the drinker to experience the naturally occurring negative consequences of drinking, and making specific and positive requests for changes in behavior related to drinking, such as reducing consumption or seeking help.[17]

Families and other members of the social network of persons with AUD also play an important role in supporting successful changes in drinking.[19] Although the scientific literature is limited on specific family behaviors that facilitate and support successful recovery from AUD, there is evidence that active partner coping predicts positive outcomes. Specific types of active partner coping that support successful change include (a) decreasing negative or controlling behaviors that serve as antecedents to drinking; (b) increasing supportive and problem-solving communication; (c) reinforcing positive behavior change by the partner with an alcohol problem; (d) increasing shared positive activities; and (e) reducing family member drinking behavior to support changes in the drinking of the person with AUD.[20]

Families also may make recovery more difficult. For example, individuals with AUD perceive relationship problems as significant relapse precipitants,[21] and believing that one's partner also has AUD predicts poorer drinking outcomes compared to individuals who did not believe that their partners have AUD.[22] Specific family behaviors associated with relapse include negative attitudes, emotional responding, and low levels of distress tolerance.[19]

THE ROLE OF FAMILY-INVOLVED TREATMENT IN FOSTERING RECOVERY

Knowledge of the impact of AUD on families has led to the development of family-engaged treatments. Considerable research has focused on the development and testing of these family-engaged treatments to foster recovery from AUD. These treatments have focused on the role of the family in the initiation of help seeking, initiation of change, and maintenance of long-term change. The following sections describe and review treatments for affected family members in their own right, and as a way to help effect change in the identified individual with AUD. This is then followed by a review of the array of interventions influenced by cognitive behavioral therapy (CBT) and family systems models. Table 1 provides a summary of key elements in each of the treatments reviewed.

Table 1 Family Interventions for AUD

Intervention	Number of Sessions	Target Population	Key Interventions
5-Step Method[23]	Variable/ as needed	Family members	Explore sources of stress/strain Provide psychoeducation Identify ways of coping Identify social supports Address other family needs
Community Reinforcement and Family Training (CRAFT)[17]	12 or more	Family members	Decrease behaviors protecting from negative consequences Increase self-care Increase positive responses to changes in drinking Enhance self-care Protect from domestic violence Enhance communication skills
A Relational Intervention Sequence for Engagement (ARISE)[24]	3 or more	Family members	Level 1: telephone coaching to invite person with AUD to a meeting Level 2: face-to-face coaching with family Level 3: coaching family to set limits and consequences
Significant Other engagement in Motivational Interviewing (SOMI)[26]	1	Couples	Single session of motivational interviewing Partner skills to enhance motivation to change drinking Partner skills to support drinking reductions
Alcohol Behavioral Couple Therapy (ABCT)[20]	12 (weekly)	Couples	Cognitive behavioral therapy interventions to change drinking Partner skills to support change Partner skills to decrease antecedents to drinking Couple skills to manage drinking situations Enhance positive couple interactions Enhance couple communication skills
Behavioral Couples Therapy (BCT)[31]	12–20 (weekly)	Couples	Implement daily recovery contract Enhance positive couple interactions Enhance couple communication skills
Brief Family-Involved Treatment (B-FIT)[41]	3 (weekly)	Family member and person with AUD	Increase positive interactions Implement recovery contract Enhance family communication skills
Brief Strategic Family Therapy (BSFT)[43]	12–16 (weekly)	Whole families	Influence maladaptive family interactions, alliances, and boundaries Decrease scapegoating
Multidimensional Family Therapy (MDFT)[44]	40–48 (twice weekly for 5 to 6 months)	Whole families	Develop multiple therapeutic alliances Restructure family functioning
Multisystemic Therapy (MST)[45]	Approximately 20	Whole families; youth involved with juvenile justice system	Individual treatment Family intervention School-based intervention Peer-based intervention Community-based intervention

Treatments for Affected Family Members

The 5-Step Method, a systematic intervention based on the SSCS model, is designed to help families cope more effectively with the AUD of a family member. The focus of the intervention is on the families in their own right, rather than on the relationship between family behaviors and outcomes for the person with AUD. The 5-Step Method helps families explore sources of stress and strain in their lives, provides psychoeducation about the SSCS model, helps them identify effective ways of coping with these sources of stress, assists them in identifying sources of social support for themselves, and assists with other needs that family members might have. The 5-Step Method has been tested with families in primary care as well as specialty care settings, with results supporting the effectiveness of the approach in reducing family-related harm in terms of both physical and psychological symptoms.[23]

Two treatments focus on providing family members with skills to help a family member to seek AUD treatment. CRAFT helps concerned family members to change contingencies for drinking by decreasing behaviors that protect the drinker from naturally occurring consequences of drinking, increasing positive family responses to changes in drinking, learning self-care and protection from intimate partner violence, and learning how to communicate positive requests for change and/or help seeking.[17] Compared to Al-Anon, CRAFT results in significantly greater rates of help seeking, and comparable rates of improvement in family members' depression and anxiety. The ARISE method (A Relational Intervention Sequence for Engagement) provides a series of steps that family members may use to encourage their loved one to seek treatment; ARISE also is effective in encouraging persons with AUD to seek treatment.[24] In addition to treatments for the affected family member alone, there are several treatment models and approaches that involve both the affected family members and the individual with AUD. Treatments with strong empirical support have drawn largely from cognitive behavioral and family systems concepts; the following sections review these approaches.

Cognitive Behavioral Approaches

Cognitive behavioral therapy (CBT) approaches view alcohol use as a learned behavior, cued by environmental stimuli and maintained by the positive consequences of alcohol use. Family-engaged CBT approaches view family behaviors as potential cues for drinking, as providing positive consequences of drinking, and as having the potential to provide positive consequences for changes in drinking behavior.

Adding partner-assisted components to individual treatment might involve partners assisting the person with AUD with accurate self-monitoring of alcohol intake and contributing to functional analysis of drinking patterns to help identify high-risk situations in which craving and alcohol consumption are likely to present a challenge. Psychoeducation is also common to help the partner more clearly understand the treatment needs and program of recovery for the person with AUD. Partner involvement might provide additional benefits such as helping the partner without AUD to develop new skills to reinforce changes in drinking and minimize behaviors that might contribute to maladaptive couple and family interactions. One recent study exemplifying this approach found support for integrating romantic partners into individual motivational interviewing interventions to improve individual AUD outcomes.[25,26]

Several manual-guided conjoint couple therapies incorporate cognitive behavioral techniques that have proven useful in individual treatments along with couple-focused interventions. One such modality with strong empirical support for both men and women with AUD is Alcohol Behavioral Couple Therapy (ABCT).[20] ABCT is a 12-week, cognitive behavioral treatment that has demonstrated efficacy in reducing alcohol consumption, enhancing relationship functioning, and improving partners' skills to facilitate reductions in drinking.[27] Core components of ABCT include (a) CBT interventions to help the person with AUD change his or her drinking,

(b) psychoeducation for the intimate partner to learn how to support changes in the behavior of their partner with AUD and to decrease behaviors that might serve as triggers for drinking, (c) interventions to teach the couple how to deal more effectively with drinking situations and drinking urges, (d) behavioral couple therapy interventions to increase positive interactions and improve communication skills, and (e) couple-focused relapse prevention. Figure 1 summarizes the hypothesized mechanisms by which ABCT impacts drinking outcomes. Recent ABCT literature indicates a strong association between partner participation in treatment and AUD outcomes. Reductions in drinking have been associated with increases in partner coping, conflict resolution skills, relationship satisfaction, and support behaviors.[28] Greater relationship quality before treatment predicted abstinence and alcohol consumption posttreatment.[29] Greater relationship satisfaction also is associated with fewer drinking urges and greater reduction in drinking urges during ABCT.[30] One notable strength of ABCT is that it results in positive outcomes for couples presenting with poor relationship functioning and high levels of psychiatric comorbidity, and it is equipped to treat couples in which one or both partners have AUD.[27]

A second well-researched approach to couple-involved therapy is behavioral couples therapy (BCT) for AUD and other SUD.[31] BCT is a 12- to 20-session intervention that lasts 3 to 6 months. The core components of BCT include (a) a daily "recovery contract" to encourage abstinence from substance use, (b) interventions to increase positive couple behaviors, and (c) training in behavioral communication skills. Participants with SUD also complete weekly urine drug screens, and progress is monitored in a calendar-assisted approach (similar to the Timeline Follow-Back procedure).[32]

Like ABCT, BCT is suitable to implement alongside 12-step groups such as Alcoholics Anonymous (https://aa.org/) and individual AUD treatments. Data from randomized controlled trials suggest that BCT has excellent feasibility, participant acceptability, and efficacy.[33,34,35]

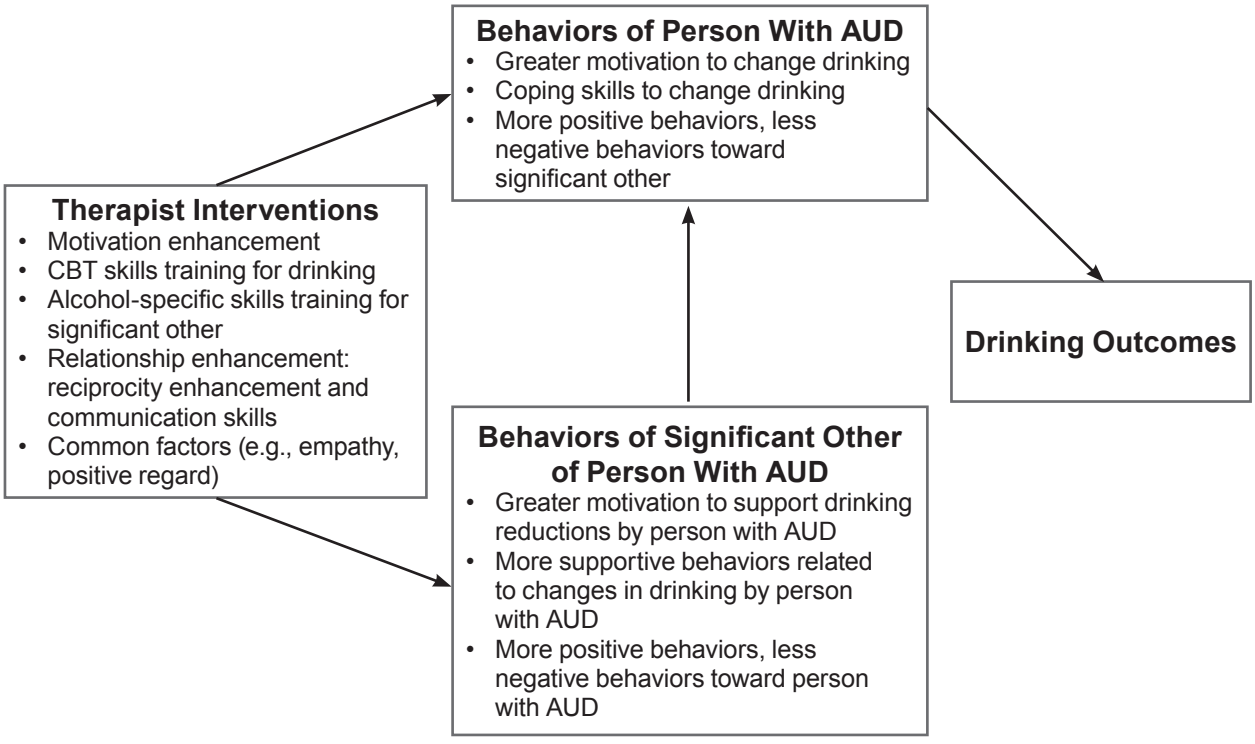

Figure 1 Hypothesized mechanisms of change in Alcohol Behavioral Couple Therapy. *Note:* AUD, alcohol use disorder; CBT, cognitive behavioral therapy.

BCT also has the ability to reduce maladaptive couple conflict behaviors such as intimate partner violence[36] and has been tested for use among military veterans with positive outcomes[37] and with couples in which both partners have AUD.[38] However, findings from one recent trial indicate that a group adaptation to BCT to treat multiple couples simultaneously did not perform as well as when couples were treated separately.[39]

Brief family-involved treatment (B-FIT) is a three-session intervention that aims to improve family functioning, increase family-related incentives associated with reduced alcohol consumption, and implement proven techniques for family treatment of AUD to achieve and maintain long-term abstinence.[40] Specifically, B-FIT incorporates adaptations such as (a) involving any concerned family member rather than romantic partners only, (b) implementation within a patient's multifaceted program of recovery, (c) targeting the key components of ABCT in an accelerated manner, and (d) leveraging behavioral contracting techniques to increase treatment efficiency.[41] B-FIT was recently examined in a pilot randomized controlled trial ($N = 35$ couples) with promising outcomes.[42]

Family Systems Approaches

Treatment models based in family systems theory assume that the actions of individual family members affect all other members of the family, and that families have typical and repetitive ways of interacting that maintain dysfunctional behavior patterns of the family as a whole and of individuals within the family. Thus, these models focus on change in the structure and functioning of the family to effect change in dysfunctional behaviors, such as alcohol or drug use, in individual family members. Three major approaches in family systems therapy have evidence supporting their efficacy and should be noted, although most of the controlled trials of these treatments have been conducted primarily with adolescents with AUD or other SUD.

Brief strategic family therapy (BSFT) combines interventions from structural and strategic family therapies and assumes that substance use as well as other behavioral problems are symptoms of family dysfunction. Thus, the treatment focuses on influencing maladaptive patterns of family interaction, alliances, boundaries, and scapegoating of individual family members. Data reported from multiple studies support that BSFT is efficacious in decreasing adolescent substance use a year after treatment, that changes in family functioning mediate the relationship between BSFT and outcomes, and that parents receiving BSFT also decreased their drinking after treatment.[43]

Multidimensional family therapy (MDFT) views adolescent problems as multidimensional and addresses factors on multiple levels (i.e., individual, family, environment) that may be contributing to the adolescent's problem behaviors. The treatment involves establishing multiple relationships between the therapist and the adolescent, family, and other systems, and it uses a range of interventions to restructure family and individual functioning. Data suggest that MDFT is more effective than comparison treatments,[43] although it is more costly to deliver. However, when the associated costs of delinquency are considered, the cost-effectiveness of MDFT is comparable to cognitive behavioral interventions.[44]

Multisystemic therapy (MST), developed as a family intervention for youth involved with the juvenile justice system, intervenes in multiple systems, including the individual, family, school, peer, and community. The primary focus of MST has been on antisocial behaviors, but data also suggest that, compared to community treatment as usual, MST leads to positive substance use outcomes.[43] Combined with interventions to strengthen families with parental AUD and child maltreatment, MST has been found to decrease child negative symptoms, parental substance abuse, and instances of child maltreatment.[45]

Summary of Family-Involved Treatments

Efficacious treatments drawn from cognitive behavioral and family systems theories have been developed both for family members alone and for

family members together with the individual with AUD. Most controlled trials of these treatments have compared either the family-involved treatment to treatment without the family member, or variations on the specific treatment (e.g., ABCT with or without involvement in Alcoholics Anonymous). Thus, the research literature to date does not provide guidance to clinicians about selecting a treatment from among those with empirical support.

SPECIFIC POPULATIONS

A great deal has been learned to date regarding efficacious family and couple treatment models. However, the empirical literature is also clear that AUD is a condition characterized by a great deal of heterogeneity in etiology, course, and factors influencing treatment outcomes. The following section describes treatment considerations for populations that might require tailored treatment considerations and adaptations to optimize outcomes.

Military and Veteran Families

Rates of hazardous and harmful alcohol use and AUD are high among active duty military and veteran populations. Compared to age- and sex-matched civilian samples, both women and men in active duty and veteran populations consume alcohol more frequently and heavily as well as incur a nearly fivefold greater risk for experiencing harmful alcohol-related health outcomes and developing AUD. Toward the goal of improving the health of the U.S. armed forces, their partners, and their families, emerging research has examined existing or adapted behavioral treatment approaches to determine their appropriateness in military and veteran populations, including couple therapy and treatment for families of veterans with AUD. For example, one recent open-label trial examined an adaptation of ABCT for returning military veterans ($N = 44$ couples).[46] This study utilized a 15-session format and incorporated relevant topics for combat veterans, including intimate partner violence, depression, post-traumatic stress disorder (PTSD), and traumatic brain injury, which are all known to co-occur at high rates with heavy drinking and to affect military populations disproportionately. Similarly, BCT has demonstrated efficacy among veterans with AUD and co-occurring PTSD. More recently, a novel integrated approach that combines BCT with Cognitive Behavioral Couples Therapy for PTSD (Couple Treatment for AUD and PTSD) has shown promise in a preliminary open-label pilot study ($N = 13$ couples).[37] Given that military culture places heavy emphasis on marriage and family, this population is ripe with opportunities to advance dyadic alcohol research to better understand how veteran and active duty families cope with and encourage recovery from AUD, and how the family as a whole changes as the person with AUD recovers. In addition, more attention is needed to address the unique challenges to implementing dyadic treatment in active duty and veteran treatment settings (e.g., frequent relocations, extended deployments).

Women

Women with AUD experience different challenges than men with AUD in general and particularly in terms of intimate relationships. Data from longitudinal research suggest that husbands' drinking patterns prior to marriage strongly predict women's drinking in the first year of marriage, and male partners of women with AUD are more likely than wives of men with AUD to have AUD as well.[47] Women with AUD see relationship problems and the male partner's drinking as important antecedents to relapse, and they use alcohol to cope with relationship problems. Male partners of women with AUD tend to avoid confrontation as a way to cope with the woman's drinking.[48]

The efficacy of ABCT and BCT has been tested with women with AUD and their male partners.[47,49,50] In all three studies, ABCT or BCT led to better alcohol use outcomes for the women compared to the control condition. McCrady and colleagues also found that women who entered treatment with higher levels of relationship distress and women who presented with another clinical and personality disorders had greater improvements in drinking with BCT than individual therapy.[47]

However, if given the choice, women with AUD prefer individual rather than conjoint therapy, citing as reasons their desire to work on individual problems, their perception of a lack of support from their partner, and logistical challenges to attending treatment together.[51]

Racial and Ethnic Minority Populations

Race and ethnicity play a significant role in family and couple relationship structure and functioning for many persons with AUD, thereby influencing the complex role of the family in AUD treatment seeking and recovery trajectories. To develop the knowledge base regarding the mechanisms by which race and ethnicity influence AUD recovery in families, dyadic AUD research must improve diversity within samples and must focus on treatment development adaptations for specific diverse populations. The existing literature demonstrates that substantial differences exist in alcohol consumption patterns, etiology, and risk factors associated with developing AUD as well as treatment engagement and outcomes in different racial and ethnic groups.[52] Racially and ethnically diverse minority populations are persistently underrepresented as participants in randomized controlled trials focused on alcohol use. AUD research on families and couples faces a similar constraint that currently limits the generalizability of current findings.

Cultural constructs and institutional marginalization are likely to impact AUD recovery among racial and ethnic minority groups in varying ways. Furthermore, the complex intersectionality of various cultural and institutional factors is likely to influence drinking and recovery. Among other factors, gender roles, socioeconomic status, health care access, employment status, immigration status, involvement with the criminal justice system, religion, and language barriers are likely to manifest in separate but overlapping ways among families who belong to racial and ethnic minority groups.[53,54] Some research suggests that acculturation and "traditional" family structures more often identified in non-White, non-Hispanic families might prevent the onset of AUD and facilitate effective treatment seeking and change in racial and ethnic minority groups.[52,55] Conversely, stigma and cultural beliefs related to AUD and help seeking, as well as couple and family therapy specifically, might negatively influence AUD recovery processes for some members of racial and ethnic minority groups. However, these mechanisms have not been well tested in the context of couple or family treatment for AUD.

Socioeconomic Status

Socioeconomic status (SES) is defined by many variables, including educational access and level, occupational status, housing access, neighborhood factors, and income.[56] Although AUD occurs among individuals and families from all socioeconomic backgrounds, the direct association between socioeconomic status, AUD, and alcohol-related harms is complex.[57] However, research indicates that families with lower SES (based on factors such as income and educational level) might incur increased negative physical and mental health sequelae of AUD, encounter barriers to accessing treatment, and confront more barriers to successful treatment outcomes, compared to families with higher SES.[53,54,57,58] Minimal research has been conducted regarding socioeconomic barriers to accessing couple therapy for AUD specifically; thus, research is necessary to identify potential socioeconomic disparities and pathways to mitigating them. One study of access to general couple therapy was conducted among couples living in neighborhoods with at least 30% of households below the poverty threshold. Results showed that when couples in this sample obtained access to treatment, they utilized couple therapy services and derived positive gains.[59] Thus, research is needed to better understand AUD recovery among families with different socioeconomic advantages or disadvantages. Studies investigating effective methods to increase access to low-cost treatment options—including those with technological adaptations to increase treatment availability—are warranted. Leveraging existing study data and using qualitative data collection techniques to identify barriers and methods to overcoming barriers are also needed.

Sexual and Gender Minority Populations

Individuals identifying as sexual and gender minorities are more likely to consume alcohol and have higher rates of AUD than individuals identifying as heterosexual.[60] Some accruing research suggests connections between alcohol use, AUD, and relationship functioning in this population. For example, in same-sex male couples, poorer relationship functioning appears related to higher rates of alcohol problems;[60] in same-sex female couples, higher levels of verbal aggression and physical violence are associated with higher levels of alcohol use;[61] and differences in alcohol use in same-sex female couples are associated with poorer relationship functioning (e.g., poor conflict resolution, poor satisfaction).[62] However, research on intimate or family relationships and recovery in sexual minority groups is very limited. One qualitative study of gay men in recovery examined familial and other social network influences on recovery.[63] Family and other social network factors cited as important to their recovery included acceptance of their sexual orientation and a sense of social connectedness. Conversely, although the men indicated that they continued to look to their families for support, many continued to experience family rejection of their sexual orientation and perceived this as a stressor that made recovery more difficult.

Engaging Communities in AUD Treatment

A crucial shift emerging in the AUD treatment community is the recognition that treatment approaches need to be adapted to accommodate families from diverse backgrounds, rather than expecting individuals and families to adapt to current treatment methods. To achieve this goal, research is needed on how to modify current approaches to reduce pervasive barriers to identification of AUD, how to develop evidence-supported approaches to treatment access and engagement relevant to diverse populations, and how to include diverse communities in the scientific process (as both participants and investigators). Increasing partnerships between research and AUD provider teams with health systems and community representatives serving racial and ethnic minority families, families with limited economic resources, and sexual minority populations might reveal pathways to achieve this goal. Community-based participatory research is an approach that provides one framework for developing research through true community partnerships.[64]

FUTURE DIRECTIONS FOR RESEARCH

During the past several decades, the empirical literature has expanded significantly to develop a critical foundation of knowledge and advance the implementation of family and couples-based approaches to AUD treatment. This section reviews promising areas for future research to further advance the state of the science in this area and to inform clinical best practices to optimize the AUD recovery process by incorporating family members.

Understanding Couple and Family Support in Recovery

Data are limited on the role of couple and family support in AUD recovery processes outside of treatment; most of our knowledge to date has come from clinical trials of specific couple- or family-involved treatments or from studies using patients in treatment programs. A related question that warrants attention in the literature is learning about the circumstances under which partners and family members are well suited versus possibly inappropriate for conjoint therapies. Clinical guidelines for couple therapy for AUD suggest that conjoint therapy should not be attempted for couples with intimate partner violence that has resulted in physical harm or fear of retaliation or for couples in which one partner is planning to leave the relationship.[20] Gaining a clearer understanding of the specific couple and family behaviors that support or are detrimental in AUD recovery, as well as the mechanisms by which these behaviors influence

AUD recovery, is crucial to improve alcohol prevention and treatment efforts. For example, studies examining family-specific interactive behaviors that increase or mitigate known precipitants to drinking and relapse risk, such as heightened craving, are warranted. Similarly, this literature can be improved by examining thoughts, behaviors, and emotions that acutely predict both positive and negative AUD treatment outcomes, including those that occur within and between treatment sessions.

Exploring Partner and Family Integration in Recovery-Oriented Systems of Care

Although the majority of the current review has focused on manual-guided and single-episode treatment approaches, it is widely recognized that more integrated and sustainable resources often are warranted to initiate and maintain AUD recovery across populations. During the last two decades, research focused on recovery-oriented systems of care (ROSC) has demonstrated positive findings.[65-69] ROSC is defined as "networks of organizations, agencies, and community members that coordinate a wide spectrum of services to prevent, intervene in, and treat substance use problems and disorder."[65] Identifying pathways to integrate partners and family members, where appropriate, into ROSC models holds promise, but has not been investigated thoroughly. Future research directed at examining facilitators and barriers—at the patient, provider, and system levels—to inviting family members into AUD treatment under this model is necessary. For example, some individuals engaged in ROSC might be facing obstacles such as homelessness or incarceration that might make it more challenging to identify and engage a supportive peer, partner, or family member. Under these circumstances, an adjunctive approach to developing or strengthening nonfamilial social support relationships could be explored. It also is possible that improved training in existing couple and family theory and treatment modalities could facilitate greater accessibility and treatment outcomes.

Role of Partners and Family in AUD Resilience

The existing literature can be improved by developing a better understanding of couple- and family-level factors promoting AUD resilience, with a particular focus on individuals, couples, and families who choose to change their drinking behaviors without engaging formal treatment resources. Recent literature has begun to expand the knowledge base regarding individual-level behavioral and neurobiological factors associated with greater likelihood of sustained recovery. However, less research has focused on the specific roles of partner and family members in changing drinking behaviors, neurobiological functioning associated with recovery-related cognitions and behaviors, and recovery when formal treatments are not engaged.[70-72] Extending this area of the literature might be particularly useful for diverse populations with disproportionate risk for developing AUD or disparities and barriers to accessing formal or traditional AUD treatment resources.[73,74]

Specific Populations

Couples and families from diverse backgrounds differ in their values, the structure and functioning of the families, gender roles within these relationships, how family members influence and support each other, and the role of alcohol use and AUD in the family. Although awareness of diversity in family functioning among different racial and ethnic groups, socioeconomically challenged populations, sexual and gender minorities, and veteran populations is increasing, the specific associations between alcohol use, AUD, family functioning, and AUD recovery have not been studied. Future research needs to focus on developing a more nuanced understanding of family structure and function around AUD in diverse populations to develop effective family-engaged treatments and dissemination of knowledge of effective practices to support recovery for these populations.

Expanding Couple and Family Treatment for AUD

Technology

One new direction for dyadic AUD treatment is the integration of existing and emerging modalities with electronic and technologically based adaptations (e.g., smartphone/online access, e-health [electronic health], m-health [mobile health]). Such adaptations hold promise to facilitate treatment access and engagement, enable accuracy in assessment, reduce participant burden, and streamline delivery of treatment content.

Among individual participants, technology-assisted and fully technology-based interventions are rapidly proliferating in the alcohol field. Technology-based approaches have proven utility to inform novel treatment development efforts, and they focus existing interventions on key components that are most likely to yield significant impacts on alcohol-related cognitions and behavior. Studies conducted among individuals consistently find that technology-assisted modalities are highly feasible and acceptable among participants. They show promise to increase participant access, engagement, and outcomes; to improve reach and cost-effectiveness; and ultimately to provide a viable AUD treatment option for individuals in a variety of populations.[75,76] An emerging body of literature is examining technology-based, e-health, or mobile interventions for couples with AUD. Findings from the limited emerging literature on technology-based couple interventions are encouraging. For example, one recent study tested a mobile support system to facilitate family communication among families affected by AUD ($N = 9$).[77] Another study examined the feasibility and acceptability of a novel, four-session, web-based AUD intervention for military and veteran couples ($N = 12$) with promising outcomes.[78] As remote telehealth (e.g., using telephone and/or videoconferencing) approaches are evolving in the AUD treatment field, an emerging literature suggests that telehealth implementation of couple and family therapy is also feasible and acceptable.[79] Recent research on a brief, in-person, home-based couple intervention found positive results for enhancing accessibility and efficacy.[80] Creating a home-based family telehealth intervention model of recovery has the potential to improve treatment access for individuals in AUD recovery and their partners and families.

A recently completed Small Business Innovation Research Phase 1 development project created a novel e-health intervention for families to reduce driving while intoxicated (DWI) and DWI recidivism.[81] The intervention, B-SMART, was designed to help reduce risk for DWI reoffending by leveraging environmental support (e.g., family support) known to reinforce and thus increase the likelihood of alcohol abstinence and simultaneously reduce harmful drinking outcomes. Participants ($N = 32$) were family members of individuals with a recent DWI arrest and an interlocking ignition device installed on their vehicle, who rated the useability of the smartphone app. A Small Business Technology Transfer Phase 2 grant is underway to develop additional intervention modules and to conduct a randomized trial of the efficacy of the intervention.[82] Overall, a great deal more research is needed to adapt existing dyadic AUD treatment modalities to incorporate technology such as mobile or online assessment monitoring, telehealth sessions, or self-guided online interventions.

Pharmacological treatment of AUD for couples and families

Combining pharmacological interventions with evidence-based behavioral treatments has the potential to optimize and sustain AUD treatment outcomes.[83-85] However, few studies have examined the role of pharmacological interventions in trials of conjoint or family treatments for AUD. Research aimed at examining the role of medication utilization and compliance in dyadic and family modalities is needed. More specifically, medication-enhanced psychotherapy for AUD, in which medications and behavioral interventions are designed to work synergistically within or between sessions, is a promising new direction for couples. As new medications for AUD are being developed specifically with the goal of

targeting brain stress and social reward systems (e.g., intervening in the withdrawal/negative affect and preoccupation/anticipation stages of AUD), medications to simultaneously maximize AUD outcomes and enhance relationship functioning could optimize AUD and relationship functioning outcomes among couples.[86-91] One such medication, intranasal oxytocin, is currently being examined among couples with AUD for that purpose.[92] Phase II trials of 3,4-methylenedioxymethamphetamine (MDMA) also are being conducted for a variety of psychiatric conditions, including among couples, and could hold promise to augment dyadic intervention for AUD.[93]

Neurobiological underpinnings of AUD

Current AUD research has a heavy emphasis on understanding the neurobiological and behavioral underpinnings of AUD and interactions between them. Such approaches have proven utility in novel treatment development efforts. However, advanced neurobiological measures and techniques, which have proven useful in treatment development efforts with individuals, have not yet been applied to couples. For example, clinically relevant AUD biomarkers are rarely examined in epidemiological or treatment research with couples. Similarly, although functional magnetic resonance neuroimaging is widely used in laboratory and treatment research in the alcohol field, there is a scarcity of literature examining resting state or task-related neural functioning in romantic couples. Some novel directions include hyperscanning, in which two participants are scanned simultaneously in response to shared stimuli, and adapting imaging paradigms to address relational behaviors relevant to AUD.[94,95] Preliminary evidence from a small sample of couples with relationship distress and substance misuse suggests that intimate partner violence in the relationship might exacerbate neural stress responses associated with couple conflict cues.[96] When applied to either mechanistic or treatment development efforts, this emerging line of literature might help to develop neural prognostic and diagnostic indicators of positive AUD treatment outcomes, risk for AUD relapse, and short- and long-term correlates of AUD relapse risk.

Another area of potential for future research is applying the existing literature on dyadic physiological and neuroendocrine co-regulation to the alcohol field, an effort that has begun but needs to be extended. Data collected from samples of couples experiencing relationship distress and who enrolled in treatment trials for problems other than AUD indicate that discordant dyadic autonomic dysregulation is associated with acute and more severe couple conflict,[97] whereas synchrony in autonomic functioning is indicative of constructive couple therapy processes such as working alliance and improved health outcomes.[98] As biofeedback intervention approaches continue to evolve in the AUD field, these emerging data can help to inform the development and refinement of remote and in-person dyadic biofeedback to support recovery efforts among families affected by AUD.

Involvement of partners and family members in AUD therapies in the context of co-occurring mental health conditions

Identifying pathways to successfully treat AUD and co-occurring conditions among individual participants remains an area of intense scientific inquiry. However, far less attention has been dedicated to understanding how partners and family members might contribute to adjunct or conjoint therapies. One preliminary pilot study found promising feasibility and acceptability outcomes when examining a novel integrated approach that combines BCT with Cognitive Behavioral Couples Therapy[99] for PTSD ($N = 13$ couples).[37] Research also suggests that ABCT is more efficacious than individual CBT for women with AUD and co-occurring clinical and personality disorders.[47] A great deal more research is needed to identify dyadic pathways to treating AUD and commonly co-occurring conditions such as PTSD and depression.

Dissemination and implementation

Despite the abundance of rigorously conducted studies and findings supporting the efficacy of

dyadic AUD treatment, evidence-based couple and family therapies are rarely applied in frontline treatment settings. Literature identifying barriers to provider uptake and patient utilization is also limited. The scant data available suggest that a lack of familiarity with modalities such as BCT among treatment providers and administrators of treatment clinics are among the most commonly cited challenges.[100] Additional challenges include (a) logistical and time-related barriers to scheduling sessions with both members of a couple; (b) a lack of clarity regarding insurance reimbursements available for couple therapies (and whether reimbursements are greater than for individual sessions); (c) lack of formal training in couples therapies for AUD; and (d) perceived increase in the difficulty of implementing dyadic treatment compared to treating individuals with AUD.[100] As a result, dissemination and implementation efforts are needed to identify more clearly provider and administrative barriers to uptake across various treatment settings (e.g., community clinics, Veterans Affairs clinics, academically affiliated clinics), to develop accessible provider education models, and ultimately to develop a more robust and diverse pipeline of capable and confident providers.

The majority of individuals with AUD who change successfully do so on their own, without any formal treatment.[101] As knowledge accrues about the most effective ways for families to motivate persons with AUD to change and to support change efforts, models to disseminate this knowledge in provider training programs and outside of treatment settings are needed. Community-based studies of these dissemination efforts also are needed to advance provider education and training efforts and to promote utilization of the full scope of couple and family treatments for AUD that are both available and efficacious.

Mechanisms of Treatment Response

Although efficacious couple and family treatments for AUD have been developed and tested, knowledge regarding behavioral mechanisms of action underlying treatment response largely remains untested. It is possible that both individual and relational mechanisms specific to family and couple interactions might facilitate improved treatment outcomes, maintenance of recovery programs and sobriety, and long-term health. Thus, studies examining the mechanisms of action underlying effective couple and family treatments for AUD—as well as secondary analyses of extant data sets and studies combining data sets from multiple randomized controlled trials—are warranted. One avenue to addressing this gap in the literature is the use of observational coding schemes to examine within-session behaviors indicative of treatment response. A recent study examined the association between pronoun utilization (i.e., "I" versus "we") within ABCT sessions and found that greater "we" language utilization was associated with greater alcohol abstinence at end of treatment and follow-up.[102] Recent analyses based on coding of within-session language in ABCT sessions have found that contemptuousness by individuals with AUD toward their partners predicts poorer drinking outcomes[103] and that within an ABCT treatment session there is a complex interaction among client and partner change language and positive and negative relationship behaviors.[104] This line of research can be expanded to further improve our understanding of within-session behaviors relevant to AUD recovery among couples and families, given that several reliable and valid observational coding systems (i.e., the Rapid Marital Interaction Coding System [RMICS]; System for Coding Couple Interaction in Therapy–Alcohol [SCCIT-A]) have been developed and are widely used among couples in laboratory settings.

One specific mechanistic aspect of this literature that has not been thoroughly explored is the role of specific conflict behaviors and dyadic processes (both adaptive and maladaptive) in influencing alcohol craving as well as risk for lapse and relapse in AUD. The daily process and micro-longitudinal research designs and methods that have proven essential to understand some individual and dyadic mechanisms linking alcohol with couple conflict behaviors, such as intimate partner violence, have not been extended to nonviolent dyadic processes and recovery-related cognitions

and behaviors. This literature could be advanced through innovative intersections of multi-method approaches that link laboratory, neurobiological, and naturalistic data, such as incorporating traditional clinical trial designs with micro-longitudinal and remote assessment methods. Such data might be used to inform novel and accessible adjunct interventions and tailored treatment modifications to insulate people with AUD and their families from high-risk situations.

Leveraging Representative Samples

Future large-scale and multisite studies examining nationally representative samples (such as the National Epidemiologic Survey on Alcohol and Related Conditions [NESARC] data set,[105] etiological processes (such as the Adolescent Brain Cognitive Development study [ABCD]),[106] and treatment development (such as the Combined Pharmacotherapies and Behavioral Interventions for Alcohol Dependence [COMBINE study])[107] have the ability to leverage rich infrastructures and diverse resources, often in a longitudinal fashion, to measure dyadic and family functioning using reliable and valid measures. To date, measurement of partner- and family-related variables has been limited in existing efforts. Increased collaboration between investigators and treatment providers with dyadic and family expertise pertaining to AUD is warranted in future integrated and large-scale efforts. As brief and empirically sound measurement approaches become more widely available, such collaborative efforts have the potential to reduce existing silos between fields of expertise within the AUD research community and ultimately to provide critical new information to drive the AUD field forward.

SUMMARY AND CONCLUSIONS

The existing literature suggests that families play a key role in motivating persons with AUD to recognize the need to change, providing support for change, and supporting long-term recovery and that AUD recovery is good for families. Most of our current knowledge, however, has come from studies of relatively small clinical samples or from treatment studies. The lack of community-based research, multisite randomized controlled trials, research on integration of partners and family members in recovery-oriented systems of care, conduct of AUD treatment-specific meta-analyses, and the exclusion of couple- and family-level variables in large-scale longitudinal studies of the onset and course of AUD remain important areas for future research. Similarly, the lack of research on the role of the family in AUD recovery in diverse populations is a major gap in the current literature.

The existing literature from treatment studies suggests that integrating partners and family members into AUD treatment is a highly effective way to maximize positive treatment outcomes and to facilitate long-term AUD recovery and health of individuals with AUD and their families. Several manual-guided approaches have proven efficacy, but efforts to improve provider education and increase uptake of evidence-supported couple- and family-based AUD treatment modalities are needed to improve access and maximize the reach of available interventions. Challenges also might emerge if social relationships are persistently strained, if it is not safe or appropriate to include partners and family members in these modalities, or if individuals with an alcohol problem are navigating additional challenges such as incarceration or homelessness that are likely to influence day-to-day social contact and implementation of currently available modalities. There is an abundance of new opportunities to integrate emerging novel scientific methods—such as multimodal, multidisciplinary assessment and intervention approaches—into research focused on couples and families with a family member with AUD. The literature also is clear that improved access to AUD treatments among diverse populations is needed. It is crucial to improve synergy between existing alcohol research and the treatment community as well as the vast population of individuals in need of AUD treatment and their partners and families. Progress toward meeting these goals can be facilitated through increased collaboration with community partners

to develop culturally informed modifications to research inclusion, AUD assessment, and intervention. Increased collaboration between investigators, administrators, and clinical providers to maximize existing federal funding investments in couple and family AUD treatment and recovery processes also holds potential to reduce treatment barriers and improve long-term outcomes for couples and families.

Acknowledgments

This manuscript is the result of work supported, in part, by the National Institute on Alcohol Abuse and Alcoholism (K23AA023845).

Disclosures

Dr. McCrady is the author of a therapist manual and a client workbook on Alcohol Behavioral Couple Therapy, a treatment that is discussed briefly in this paper. She receives royalties from the sale of these publications and also receives payments for workshops to train practitioners in the use of Alcohol Behavioral Couple Therapy. Dr. McCrady's research on Alcohol Behavioral Couple Therapy and the B-FIT treatment discussed in this paper has been supported by grants from NIAAA. Dr. Flanagan is Principal Investigator of an NIAAA-sponsored grant using the Alcohol Behavioral Couple Therapy treatment manual. There are no other competing financial interests or other conflicts of interest to declare.

Publisher's Note

Opinions expressed in contributed articles do not necessarily reflect the views of the National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health. The U.S. government does not endorse or favor any specific commercial product or commodity. Any trade or proprietary names appearing in *Alcohol Research: Current Reviews* are used only because they are considered essential in the context of the studies reported herein.

References

1. Burton R, Kane G, Mason J, et al. *The Range and Magnitude of Alcohol's Harm to Others: A Report Delivered to the Five Nations Health Improvement Network.* London: Public Health England; 2019.
2. Stanley S. Interpersonal violence in alcohol complicated marital relationships (A study from India). *J Fam Violence.* 2008;23:767-776. https://doi.org/10.1007/s10896-008-9202-7.
3. Tempier R, Boyer R, Lambert J, et al. Psychological distress among female spouses of male at-risk drinkers. *Alcohol.* 2006;40(1):41-49. https://doi.org/10.1016/j.alcohol.2006.09.032.
4. Ray GT, Mertens JR, Weisner C. Family members of people with alcohol or drug dependence: Health problems and medical cost compared to family members of people with diabetes and asthma. *Addiction.* 2009;104(2):203-214. https://doi.org/10.1111/j.1360-0443.2008.02447.x.
5. Grekin ER, Brennan PA, Hammen C. Parental alcohol use disorders and child delinquency: The mediating effects of executive functioning and chronic family stress. *J Stud Alcohol Drugs.* 2005;66(1):14-22. https://doi.org/10.15288/jsa.2005.66.14.
6. Chen Y, Weitzman ER. Depressive symptoms, DSM-IV alcohol abuse and their comorbidity among children of problem drinkers in a national survey: Effects of parent and child gender and parent recovery status. *J Stud Alcohol.* 2005;66(1):66-73. https://doi.org/10.15288/jsa.2005.66.66.
7. Leonard KE, Mudar P. Peer and partner drinking and the transition to marriage: A longitudinal examination of selection and influence processes. *Psychol Addict Behav.* 2003;17(2):115-125. https://doi.org/10.1037/0893-164x.17.2.115.
8. Muyingo L, Smith MM, Sherry SB, et al. Relationships on the rocks: A meta-analysis of romantic partner effects on alcohol use. *Psychol Addict Behav.* 2020;34(6):629-640. https://doi.org/10.1037/adb0000578.
9. Whisman MA. Marital distress and DSM-IV psychiatric disorders in a population-based national survey. *J Abnorm Psychol.* 2007;116(3):638-643. https://doi.org/10.1037/0021-843x.116.3.638.
10. Smith PH, Homish GG, Leonard KE, et al. Intimate partner violence and specific substance use disorders: Findings from the National Epidemiologic Survey on Alcohol and Related Conditions. *Psychol Addict Behav.* 2012;26(2):236-245. https://doi.org/10.1037/a0024855.
11. Drapkin ML, McCrady BS, Swingle J, et al. Exploring bidirectional couple violence in a clinical sample of female alcoholics. *J Stud Alcohol.* 2005;66(2):213-219. https://doi.org/10.15288/jsa.2005.66.213.
12. Caetano R, Schafer J, Cunradi CB. Alcohol-related intimate partner violence among white, black, and Hispanic couples in the United States. *Alcohol Res Health.* 2001;25(1):58-65. https://doi.org/10.4324/9781315264905-11.
13. Orford J, Copello A, Velleman R, et al. Family members affected by a close relative's addiction: The stress-strain-coping-support model. *Drugs (Abingdon Engl).* 2010;17(suppl 1):36-43. https://doi.org/10.3109/09687637.2010.514801.
14. Moos RH, Finney JW, Gamble W. The process of recovery from alcoholism. II. Comparing spouses of alcoholic patients and matched community controls. *J Stud Alcohol.* 1982;43(9):888-909. https://doi.org/10.15288/jsa.1982.43.888.
15. Moos RH, Billings AG. Children of alcoholics during the recovery process: Alcoholic and matched control families. *Addict Behav.* 1982;7(2):155-163. https://doi.org/10.1016/0306-4603(82)90040-5.
16. Moos RH, Moos BS. The process of recovery from alcoholism. III. Comparing functioning in families of alcoholics and matched control families. *J Stud Alcohol.* 1984;45(2):111-118. https://doi.org/10.15288/jsa.1984.45.111.
17. Meyers RJ, Wolfe BI. *Get Your Loved One Sober. Alternatives to Nagging, Pleading, and Threatening.* Center City, MN: Hazelden; 2004.
18. Bischof G, Iwen J, Freyer-Adam J, et al. Efficacy of the Community Reinforcement and Family Training for concerned significant others of treatment-refusing individuals with alcohol dependence: A randomized controlled trial. *Drug Alcohol Depend.* 2016;163:179-185. https://doi.org/10.1016/j.drugalcdep.2016.04.015.
19. Atadokht A, Hajloo N, Karimi M, et al. The role of family expressed emotion and perceived social support in predicting addiction relapse. *Int J High Risk Behav Addict.* 2015;4(1):e21250. https://doi.org/10.5812/ijhrba.21250.
20. McCrady BS, Epstein EE. *Overcoming Alcohol Problems: A Couples-Focused Program: Therapist Guide.* New York, NY: Oxford University Press; 2009.
21. Maisto SA, McKay JR, O'Farrell TJ. Relapse precipitants and behavioral marital therapy. *Addict Behav.* 1995;20(3):383-393. https://doi.org/10.1016/0306-4603(94)00079-e.

22. Tracy SW, Kelly JF, Moos RH. The influence of partner status, relationship quality and relationship stability on outcomes following intensive substance-use disorder treatment. *J Stud Alcohol.* 2005;66(4):497-505. https://doi.org/10.15288/jsa.2005.66.497.
23. Copello A, Templeton L, Orford J, et al. The 5-Step Method: Principles and practice. *Drugs (Abingdon Engl).* 2010;17(suppl 1):86-99. https://doi.org/10.3109/09687637.2010.515186.
24. Landau J, Garrett J. Invitational Intervention: The ARISE Model for engaging reluctant alcohol and other drug abusers in treatment. *Alcohol Treat Q.* 2008;26(1-2):147-168. https://doi.org/10.1300/J020v26n01_08.
25. Apodaca TR, Magill M, Longabaugh R, et al. Effect of a significant other on client change talk in motivational interviewing. *J Consult Clin Psychol.* 2013;81(1):35-46. https://doi.org/10.1037/a0030881.
26. Magill M, Mastroleo NR, Apodaca TR, et al. Motivational interviewing with significant other participation: Assessing therapeutic alliance and patient satisfaction and engagement. *J Subst Abuse Treat.* 2010;39(4):391-398. https://doi.org/10.1016/j.jsat.2010.07.006.
27. McCrady BS, Epstein EE, Cook S, et al. A randomized trial of individual and couple behavioral alcohol treatment for women. *J Consult Clin Psychol.* 2009;77(2):243-256. https://doi.org/10.1037/a0014686.
28. McCrady BS, Hayaki J, Epstein EE, et al. Testing hypothesized predictors of change in conjoint behavioral alcoholism treatment for men. *Alcohol Clin Exp Res.* 2002;26(4):463-470.
29. Graff FS, Morgan TJ, Epstein EE, et al. Engagement and retention in outpatient alcoholism treatment for women. *Am J Addict.* 2009;18(4):277-288.
30. Owens MD, Hallgren KA, Ladd BO, et al. Associations between relationship satisfaction and drinking urges for women in alcohol behavioral couples and individual therapy. *Alcohol Treat Q.* 2013;31(4):415-430. https://doi.org/10.1080/07347324.2013.831668.
31. O'Farrell TJ, Fals-Stewart W. *Behavioral Couples Therapy for Alcoholism and Drug Abuse.* New York, NY: Guilford Press; 2013.
32. Sobell LC, Sobell MB. Timeline follow-back: A technique for assessing self-reported alcohol consumption. In: Litten RZ, Allen JP, eds. *Measuring Alcohol Consumption: Psychosocial and Biochemical Methods.* Totowa, NJ: Humana Press; 1992:41-72. https://doi.org/10.1007/978-1-4612-0357-5_3.
33. Powers MB, Vedel E, Emmelkamp PG. Behavioral couples therapy (BCT) for alcohol and drug use disorders: A meta-analysis. *Clin Psychol Rev.* 2008;28(6):952-962. https://doi.org/10.1016/j.cpr.2008.02.002.
34. Schmit MK, Schmit EL, Lenz AS, et al. Meta-analysis of behavioral couples therapy for increasing abstinence from substance use and relationship adjustment. *Counseling Outcome Research and Evaluation.* 2020:1-15. https://doi.org/10.1080/21501378.2020.1796481.
35. O'Farrell TJ, Schreiner A, Schumm JA, et al. Do outcomes after behavioral couples therapy differ based on the gender of the alcohol use disorder patient? *Addict Behav.* 2016;54:46-51. https://doi.org/10.1016/j.addbeh.2015.12.005.
36. O'Farrell TJ, Schein AZ. Behavioral couples therapy for alcoholism and drug abuse. *J Fam Psychother.* 2011;22(3):193-215. https://doi.org/10.1080/08975353.2011.602615.
37. Schumm JA, Monson CM, O'Farrell TJ, et al. Couple treatment for alcohol use disorder and post-traumatic stress disorder: Pilot results from U.S. military veterans and their partners. *J Trauma Stress.* 2015;28(3):247-252.
38. Schumm JA, O'Farrell TJ, Andreas JB. Behavioral couples therapy when both partners have a current alcohol use disorder. *Alcohol Treat Q.* 2012;30(4):407-421. https://doi.org/10.1080/07347324.2012.718963.
39. O'Farrell TJ, Schumm JA, Dunlap LJ, et al. A randomized clinical trial of group versus standard behavioral couples therapy plus individually based treatment for patients with alcohol dependence. *J Consult Clin Psychol.* 2016;84(6):497-510. https://doi.org/10.1037/ccp0000089.
40. McCrady BS. *B-FIT: Brief Family-Involved Treatment. Therapist Manual.* Unpublished; 2017.
41. McCrady BS, Wilson A, Fink BC, et al. A consumer's eye view of family-involved alcohol treatment. *Alcohol Treat Q.* 2018;37(1):43-59.
42. NIH Research Portfolio Online Reporting Tools (*RePORT*). McCrady BS, University of New Mexico. Developing a brief family-involved treatment for alcohol use disorders. https://projectreporter.nih.gov/project_info_description.cfm?aid=9252980&icde=53144049&ddparam=&ddvalue=&ddsub=&cr=1&csb=default&cs=ASC&pball= https://doi.org/10.1080/07347324.2018.1482245.
43. McCrady BS, Owens MD, Brovko JM. Couples and family treatment methods. In: McCrady BS, Epstein EE, eds. *Addictions: A Comprehensive Guidebook.* 2nd ed. New York, NY: Oxford University Press; 2013:454-481.
44. Goorden M, van der Schee E, Hendriks VM, et al. Cost-effectiveness of multidimensional family therapy compared to cognitive behavioral therapy for adolescents with a cannabis use disorder: Data from a randomized controlled trial. *Drug Alcohol Depend.* 2016;162:154-161. https://doi.org/10.1016/j.drugalcdep.2016.03.004.
45. Schaeffer CM, Swenson CC, Tuerk EH, et al. Comprehensive treatment for co-occurring child maltreatment and parental substance abuse: Outcomes from a 24-month pilot study of the MST-Building Strong Families program. *Child Abuse Negl.* 2013;37(8):596-607. https://doi.org/10.1016/j.chiabu.2013.04.004.
46. NIH Research Portfolio Online Reporting Tools (*RePORT*). Epstein EE. Adapting alcohol behavioral couple therapy for service members in post-deployment. https://reporter.nih.gov/search/CcE-Vraf0Uagq54wkWI9Qw/project-details/9085190
47. McCrady BS, Epstein EE, Cook S, et al. A randomized trial of individual and couple behavioral alcohol treatment for women. *J Consult Clin Psychol.* 2009;77(2):243-256. https://doi.org/10.1037/a0014686.
48. Green KE, Pugh LA, McCrady BS, et al. Unique aspects of female-primary alcoholic relationships. *Addict Disord Their Treat.* 2008;7(3):169-176. https://doi.org/10.1097/adt.0b013e31814c3f94.
49. Schumm JA, O'Farrell TJ, Kahler CW, et al. A randomized clinical trial of behavioral couples therapy versus individually based treatment for women with alcohol dependence. *J Consult Clin Psychol.* 2014;82(6):993-1004. https://doi.org/10.1037/a0037497.
50. O'Farrell TJ, Schumm JA, Murphy MM, et al. A randomized clinical trial of behavioral couples therapy versus individually-based treatment for drug-abusing women. *J Consult Clin Psychol.* 2017;85(4):309-322. https://doi.org/10.1037/ccp0000185.
51. McCrady BS, Epstein EE, Cook S, et al. What do women want? Alcohol treatment choices, treatment entry and retention. *Psychol Addict Behav.* 2011;25(3):521-529. https://doi.org/10.1037/a0024037.

52. Vaeth P, Wang-Schweig M, Caetano R. Drinking, alcohol use disorder, and treatment access and utilization among U.S. racial/ethnic groups. *Alcohol Clin Exp Res.* 2017;41(1):6-19. https://doi.org/10.1111/acer.13285.
53. Zemore SE, Karriker-Jaffe KJ, Keithly S, et al. Racial prejudice and unfair treatment: Interactive effects with poverty and foreign nativity on problem drinking. *J Stud Alcohol Drugs.* 2011;72(3):361-370. https://doi.org/10.15288/jsad.2011.72.361.
54. Mulia N, Zemore SE. Social adversity, stress, and alcohol problems: Are racial/ethnic minorities and the poor more vulnerable? *J Stud Alcohol Drugs.* 2012;73(4):570-580. https://doi.org/10.15288/jsad.2012.73.570.
55. Galvan FH, Caetano R. Alcohol use and related problems among ethnic minorities in the United States. *Alcohol Res Health.* 2003;27(1):87-94.
56. Diemer MA, Mistry RS, Wadsworth ME, et al. Best practices in conceptualizing and measuring social class in psychological research. *Anal Soc Issues Public Policy.* 2013;13(1):77-113. https://doi.org/10.1111/asap.12001.
57. Collins SE. Associations between socioeconomic factors and alcohol outcomes. *Alcohol Res.* 2016;38(1):8394.
58. Katikireddi SV, Whitley E, Lewsey J, et al. Socioeconomic status as an effect modifier of alcohol consumption and harm: Analysis of linked cohort data. *Lancet Public Health.* 2017;2(6):e267-e276. https://doi.org/10.1016/s2468-2667(17)30078-6.
59. Williamson HC, Karney BR, Bradbury TN. Barriers and facilitators of relationship help-seeking among low-income couples. *J Fam Psychol.* 2019;33(2):234-239. https://doi.org/10.1037/fam0000485.
60. Starks TJ, Robes G, Bosco SC, et al. Relationship functioning and substance use in same-sex male couples. *Drug Alcohol Depend*. 2019;201:101-108. https://doi.org/10.1016/j.drugalcdep.2019.04.009.
61. Lewis RJ, Milletich RJ, Kelley ML, et al. Minority stress, substance use, and intimate partner violence among sexual minority women. *Aggress Violent Behav.* 2012;17:247-256. https://doi.org/10.1016/j.avb.2012.02.004.
62. Kelley ML, Lewis RJ, Mason TB. Discrepant alcohol use, intimate partner violence, and relationship adjustment among lesbian women and their same-sex intimate partners. *J Fam Violence.* 2015;30:977-986. https://doi.org/10.1007/s10896-015-9743-5.
63. del Pino HE, Moore MR, Dacus J, et al. Stigma and family relationships of middle-aged gay men in recovery. *J Gay Lesbian Soc Serv.* 2016;28(1):1-19. https://doi.org/10.1080/10538720.2016.1124350.
64. Wallerstein N, Duran B, Oetzel J, et al. *Community-Based Participatory Research for Health: Advancing Social and Health Equity.* 3rd ed. San Francisco, CA: Jossey-Bass; 2018.
65. Sheedy CK, Whitter M. Guiding principles and elements of recovery-oriented systems of care: What do we know from the research? *J Drug Addict Educ Erad.* 2013;9(4).
66. Scott CK, Dennis ML, Foss MA. Utilizing recovery management checkups to shorten the cycle of relapse, treatment reentry, and recovery. *Drug Alcohol Depend.* 2005;78(3):325-338. https://doi.org/10.1016/j.drugalcdep.2004.12.005.
67. Padwa H, Urada D, Gauthier P, et al. Organizing publicly funded substance use disorder treatment in the United States: Moving toward a service system approach. *J Subst Abuse Treat.* 2016;69:9-18. https://doi.org/10.1016/j.jsat.2016.06.010.
68. Humphreys K, Lembke A. Recovery-oriented policy and care systems in the UK and USA. *Drug Alcohol Rev.* 2014;33(1):13-18.
69. Laudet AB, White WL. What are your priorities right now? Identifying service needs across recovery stages to inform service development. *J Subst Abuse Treat.* 2010;38(1):51-59. https://doi.org/10.1016/j.jsat.2009.06.003.
70. Charlet K, Rosenthal A, Lohoff FW, et al. Imaging resilience and recovery in alcohol dependence. *Addiction.* 2018;113(10):1933-1950.
71. Kelly JF, Bergman B, Hoeppner BB, et al. Prevalence and pathways of recovery from drug and alcohol problems in the United States population: Implications for practice, research, and policy. *Drug Alcohol Depend.* 2017;181:162-169. https://doi.org/10.1016/j.drugalcdep.2017.09.028.
72. Best D, Beckwith M, Haslam C, et al. Overcoming alcohol and other drug addiction as a process of social identity transition: The social identity model of recovery (SIMOR). *Addict Res Theory.* 2016;24(2):111-123. https://doi.org/10.3109/16066359.2015.1075980.
73. Talley AE, Gilbert PA, Mitchell J, et al. Addressing gaps on risk and resilience factors for alcohol use outcomes in sexual and gender minority populations. *Drug Alcohol Rev.* 2016;35(4):484-493. https://doi.org/10.1111/dar.12387.
74. Bartone PT, Hystad SW, Eid J, et al. Psychological hardiness and coping style as risk/resilience factors for alcohol abuse. *Mil Med.* 2012;177(5):517-524. https://doi.org/10.7205/milmed-d-11-00200.
75. Fowler LA, Holt SL, Joshi D. Mobile technology-based interventions for adult users of alcohol: A systematic review of the literature. *Addict Behav.* 2016;62:25-34. https://doi.org/10.1016/j.addbeh.2016.06.008.
76. Kiluk BD, Ray LA, Walthers J, et al. Technology-delivered cognitive-behavioral interventions for alcohol use: A meta-analysis. *Alcohol Clin Exp Res.* 2019;43(11):2285-2295. https://doi.org/10.1111/acer.14189.
77. You C, Chuang Y, Lin H, et al. SoberComm: Using mobile phones to facilitate inter-family communication with alcohol-dependent patients. *Proc ACM Interact Mob Wearable Ubiquitous Technol.* 2019;3(3):1-31. https://www.doi.org/10.1145/3351277.
78. Osilla KC, Pedersen ER, Tolpadi A, et al. The feasibility of a web intervention for military and veteran spouses concerned about their partner's alcohol misuse. *J Behav Health Serv Res.* 2018;45(1):57-73. https://doi.org/10.1007/s11414-016-9546-3.
79. Doss BD, Feinberg LK, Rothman K, et al. Using technology to enhance and expand interventions for couples and families: Conceptual and methodological considerations. *J Fam Psychol.* 2017;31(8):983-993. https://doi.org/10.1037/fam0000349.
80. Lenger KA, Roberson P, Amer Z, et al. Your place or mine?: Examining the accessibility and efficacy of a brief, home-based, couple intervention. *J Fam Psychol.* 2020;34(4):496-502. https://doi.org/10.1037/fam0000622.
81. NIH Research Portfolio Online Reporting Tools (*RePORT*). Woodall WG. Smartphone help for DWI offenders and their families: A B-SMART app. https://projectreporter.nih.gov/project_info_description.cfm?aid=8715345&icde=53145218&ddparam=&ddvalue=&ddsub=&cr=1&csb=default&cs=ASC&pball=.
82. NIH Research Portfolio Online Reporting Tools (*RePORT*). Woodall WG. Smartphone help for DWI offenders and their families: A B-SMART app. ttps://projectreporter.nih.gov/project_info_description.cfm?aid=9784712&icde=53145223&ddparam=&ddvalue=&ddsub=&cr=1&csb=default&cs=ASC&pball=.

83. Anton RF, O'Malley SS, Ciraulo DA, et al. Combined pharmacotherapies and behavioral interventions for alcohol dependence: The COMBINE study: A randomized controlled trial. *JAMA.* 2006;295(17):2003-2017. https://doi.org/10.1001/jama.295.17.2003.
84. Balldin J, Berglund M, Borg S, et al. A 6-month controlled naltrexone study: Combined effect with cognitive behavioral therapy in outpatient treatment of alcohol dependence. *Alcohol Clin Exp Res.* 2003;27(7):1142-1149. https://doi.org/10.1097/01.alc.0000075548.83053.a9.
85. Donovan DM, Anton RF, Miller WR, et al. Combined pharmacotherapies and behavioral interventions for alcohol dependence (The COMBINE Study): Examination of posttreatment drinking outcomes. *J Stud Alcohol Drugs*. 2008;69(1):5-13. https://doi.org/10.15288/jsad.2008.69.5.
86. Koob GF. A role for brain stress systems in addiction. *Neuron.* 2008;59(1):11-34. https://doi.org/10.1016/j.neuron.2008.06.012.
87. Berglund M, Thelander S, Salaspuro M, et al. Treatment of alcohol abuse: An evidence-based review. *Alcohol Clin Exp Res.* 2003;27(10):1645-1656. https://doi.org/10.1097/01.alc.0000090144.99832.19.
88. Chick J, Lehert P, Landron F. Does acamprosate improve reduction of drinking as well as aiding abstinence? *J Psychopharmacol.* 2003;17(4):397-402. https://doi.org/10.1177/0269881103174017.
89. Maisel NC, Blodgett JC, Wilbourne PL, et al. Meta-analysis of naltrexone and acamprosate for treating alcohol use disorders: When are these medications most helpful? *Addiction.* 2013;108(2):275-293. https://doi.org/10.1111/j.1360-0443.2012.04054.x.
90. Jonas DE, Amick HR, Feltner C, et al. Pharmacotherapy for adults with alcohol use disorders in outpatient settings: A systematic review and meta-analysis. *JAMA.* 2014;311(18):1889-1900. https://doi.org/10.1001/jama.2014.3628.
91. Mason BJ. Emerging pharmacotherapies for alcohol use disorder. *Neuropharmacology.* 2017;122:244-253. https://doi.org/10.1016/j.neuropharm.2017.04.032.
92. NIH Research Portfolio Online Reporting Tools (*RePORT*). Flanagan JC. Oxytocin to enhance alcohol behavioral couple therapy. https://reporter.nih.gov/project-details/9961452.
93. Yazar-Klosinski BB, Mithoefer MC. Potential psychiatric uses for MDMA. *Clin Pharmacol Ther.* 2017;101(2):194-196. https://doi.org/10.1002/cpt.565.
94. Pan Y, Cheng X, Zhang Z, et al. Cooperation in lovers: An fNIRS-based hyperscanning study. *Hum Brain Mapp.* 2017;38(2):831-841. https://doi.org/10.1002/hbm.23421.
95. Flanagan JC, Joseph JE, Nietert PJ, et al. Design of a randomized controlled trial examining the efficacy of oxytocin to enhance alcohol behavioral couple therapy. *Contemp Clin Trials.* 2019;82:1-8. https://doi.org/10.1016/j.cct.2019.05.002.
96. Flanagan JC, Yonce S, Calhoun CD, et al. Preliminary development of a neuroimaging paradigm to examine neural correlates of relationship conflict. *Psychiatry Res Neuroimaging.* 2019;283:125-134. https://doi.org/10.1016/j.pscychresns.2018.12.009.
97. Cribbet MR, Smith TW, Uchino BN, et al. Autonomic influences on heart rate during marital conflict: Associations with high frequency heart rate variability and cardiac pre-ejection period. *Biol Psychol.* 2020;151:107847. https://doi.org/10.1016/j.biopsycho.2020.107847.
98. Tourunen A, Kykyri VL, Seikkula J, et al. Sympathetic nervous system synchrony: An exploratory study of its relationship with the therapeutic alliance and outcome in couple therapy. *Psychotherapy.* 2020;57(2):160-173. https://doi.org/10.1037/pst0000198.
99. Monson CM, Fredman SJ. *Cognitive-Behavioral Conjoint Therapy for Posttraumatic Stress Disorder: Therapist's Manual.* New York, NY: Guilford Press; 2012.
100. Schonbrun YC, Stuart GL, Wetle T, et al. Mental health experts' perspectives on barriers to dissemination of couples treatment for alcohol use disorders. *Psychol Serv*. 2012;9(1):64-73. https://doi.org/10.1037/a0026694.
101. Spinelli C, Thyer BA. Is recovery from alcoholism without treatment possible? A review of the literature. *Alcohol Treat Q.* 2017;35(4):426-444. https://doi.org/10.1080/07347324.2017.1355219.
102. Hallgren KA, McCrady BS. We-language and sustained reductions in drinking in couple-based treatment for alcohol use disorders. *Fam Process.* 2016;55(1):62-78. https://doi.org/10.1111/famp.12150.
103. McCrady BS, Tonigan JS, Ladd BO, et al. Alcohol Behavioral Couple Therapy: In-session behavior, active ingredients and mechanisms of behavior change. *J Subst Abuse Treat.* 2019;99:139-148. https://doi.org/10.1016/j.jsat.2019.01.018.
104. Fokas KF, Houck JM, McCrady BS. Inside Alcohol Behavioral Couple Therapy (ABCT): In-session speech trajectories and drinking outcomes. *J Subst Abuse Treat.* 2020;118:108122. https://doi.org/10.1016/j.jsat.2020.108122.
105. Hasin DS, Grant BF. The National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) Waves 1 and 2: Review and summary of findings. *Soc Psychiatry Psychiatr Epidemiol.* 2015;50(11):1609-1640. https://doi.org/10.1007/s00127-015-1088-0.
106. Volkow ND, Koob GF, Croyle RT, et al. The conception of the ABCD study: From substance use to a broad NIH collaboration. *Dev Cogn Neurosci.* 2018;32:4-7. https://doi.org/10.1016/j.dcn.2017.10.002.
107. Pettinati HM, Anton RF, Willenbring ML. The COMBINE Study: An overview of the largest pharmacotherapy study to date for treating alcohol dependence. *Psychiatry (Edgmont).* 2006;3(10):36-39.

ALCOHOL RESEARCH
Current Reviews

Alcohol Res. 2021;41(1):05 ● https://doi.org/10.35946/arcr.v41.1.05

Published: 8 April 2021

Natural Recovery by the Liver and Other Organs after Chronic Alcohol Use

Paul G. Thomes,[1,2] Karuna Rasineni,[1,2] Viswanathan Saraswathi,[2,3] Kusum K. Kharbanda,[1,2] Dahn L. Clemens,[4,5] Sarah A. Sweeney,[1,2] Jacy L. Kubik,[1,2] Terrence M. Donohue, Jr.,[1,2] and Carol A. Casey[1,2]

[1]Department of Internal Medicine, Section of Gastroenterology, University of Nebraska Medical Center, Omaha, Nebraska
[2]Research Service, U.S. Department of Veterans Affairs Nebraska-Western Iowa Health Care System, Omaha, Nebraska
[3]Department of Internal Medicine, Section of Diabetes, Endocrinology, and Metabolism, University of Nebraska Medical Center, Omaha, Nebraska
[4]Department of Internal Medicine, Section of Cardiovascular Medicine, University of Nebraska Medical Center, Omaha, Nebraska
[5]Fred & Pamela Buffet Cancer Center, University of Nebraska Medical Center, Omaha, Nebraska

Chronic, heavy alcohol consumption disrupts normal organ function and causes structural damage in virtually every tissue of the body. Current diagnostic terminology states that a person who drinks alcohol excessively has alcohol use disorder. The liver is especially susceptible to alcohol-induced damage. This review summarizes and describes the effects of chronic alcohol use not only on the liver, but also on other selected organs and systems affected by continual heavy drinking—including the gastrointestinal tract, pancreas, heart, and bone. Most significantly, the recovery process after cessation of alcohol consumption (abstinence) is explored. Depending on the organ and whether there is relapse, functional recovery is possible. Even after years of heavy alcohol use, the liver has a remarkable regenerative capacity and, following alcohol removal, can recover a significant portion of its original mass and function. Other organs show recovery after abstinence as well. Data on studies of both heavy alcohol use among humans and animal models of chronic ethanol feeding are discussed. This review describes how (or whether) each organ/tissue metabolizes ethanol, as metabolism influences the organ's degree of injury. Damage sustained by the organ/tissue is reviewed, and evidence for recovery during abstinence is presented.

KEY WORDS: alcohol use disorder; alcohol-associated liver disease; alcohol abstinence; alcohol cessation; alcohol; alcoholic pancreatitis; alcoholic cardiomyopathy

INTRODUCTION

A vast body of evidence from human studies and animal research clearly indicates that chronic, heavy alcohol consumption causes structural damage and/or disrupts normal organ function in virtually every tissue of the body. In heavy consumers of alcohol, the liver is especially susceptible to alcohol-induced injury.[1,2] Additionally, several other organs—including the gastrointestinal (GI) tract, pancreas, heart, and bone—exhibit impaired function after chronic ethanol use.[3]

As the largest internal organ and the first to see blood-borne nutrients, toxins, and xenobiotics absorbed from the GI tract, the liver is especially vulnerable to alcohol-induced damage. The liver plays a key role in the body's metabolic regulation and is a "frontline" organ that rapidly metabolizes (i.e., chemically converts or oxidizes) alcohol to less harmful substances. However, acetaldehyde, the first metabolite generated by alcohol oxidation is actually more toxic than alcohol, but acetaldehyde is rapidly converted to acetate for use in other biochemical reactions in the body.[3] Thus, although the liver has the capacity to eliminate toxic substances, continual excessive alcohol consumption can seriously damage the liver and other organs. Recent studies report that alcohol-associated liver disease (ALD) is one of the leading preventable causes of illness and death from liver disease in the United States and the world.[4]

After drinking stops, damaged organs may regain partial function or even heal completely, depending on the extent of organ damage and whether there is relapse (i.e., resumption of drinking). Organ damage due to heavy drinking is greatest in the liver, in part because the liver has higher levels of enzymes that catalyze the metabolism of acetaldehyde from alcohol. Acetaldehyde is more toxic than ethanol because it is highly reactive and binds to biomolecules (e.g., proteins, lipids, nucleic acids) and disrupts their function.[3,5] However, even after years of chronic alcohol use, the liver has remarkable regenerative capacity and, after sustained cessation of drinking, can recover a significant amount of its original mass.[6]

This review examines injury to selected organs and tissues from chronic alcohol use and their "natural recovery" after drinking ceases. Data have been obtained from both human studies and studies with experimental animal models of alcohol administration. The main points of emphasis will be how ethanol, the active ingredient and principal component in alcoholic beverages, affects the liver, GI tract, pancreas, heart, and bone. This review describes how (or whether) each organ/tissue metabolizes ethanol, as this property is closely related to the organ's degree of injury. The damage sustained by the organ/tissue is then described, and the evidence for natural recovery after drinking cessation is reviewed. It is important to emphasize that "natural recovery" is that which is unaided by external agents that directly enhance healing of the damaged organ or tissue. In the case of the liver, such agents include drugs or other compounds that suppress inflammation or dietary or medicinal compounds (e.g., betaine, caffeine, aspirin), which alleviate tissue damage by enhancing protective pathways, thereby preventing further damage. Throughout the article, "alcohol" and "ethanol" are used interchangeably, given that they have the same meaning.

LIVER

Alcohol Metabolism in the Liver

In humans (and other animals, such as rodents), the liver is the primary site of alcohol metabolism. The same two enzymes catalyze ethanol oxidation in both species. The major, most catalytically efficient enzyme is alcohol dehydrogenase (ADH), which catalyzes the formation of acetaldehyde from alcohol. The other enzyme, cytochrome P450 2E1 (CYP2E1), is catalytically less efficient than ADH, but it increases in both content and activity severalfold after continual alcohol exposure.[3] This increase, called "induction," further accelerates alcohol conversion to acetaldehyde, which is rapidly detoxified by its conversion to acetate by the enzyme aldehyde dehydrogenase (ALDH).[3,7] Many laboratories utilize rodent models to examine ALD to elucidate the mechanisms responsible for such injury. As in humans, fatty liver (steatosis) is the earliest pathophysiological change that occurs in rodent livers after chronic alcohol administration.

In rodent models, with continued drinking, hepatic steatosis can worsen to further injury such as alcoholic steatohepatitis (ASH). Fibrosis and cirrhosis occur when nutrients such as choline and/or methionine are deleted from the diet, when an endotoxin is simultaneously administered to increase injury, or after continual intragastric infusion of high levels of alcohol in liquid diets.[8] Other studies have administered alcohol to nonhuman primates (baboons) to induce liver fibrosis.[9] However, most laboratories utilize rodent models, which are more manageable and can be used in greater numbers than nonhuman primates.

Liver Injury and Recovery After Chronic Alcohol Use in Humans

Fatty liver (steatosis), characterized by an accumulation of lipids in hepatocytes, is one of the earliest pathological changes in the progression of ALD. More than 90% of people who drink heavily consume up to 60 grams or more of ethyl alcohol per day. Most of these individuals develop fatty liver.[2] Once the liver becomes steatotic, it is more prone to damage by inflammatory mediators (tumor necrosis factor, endotoxin) and/or toxic agents, leading to progression to ASH, fibrosis, and eventually cirrhosis and, in some cases, hepatocellular carcinoma. Even though virtually all heavy-alcohol consumers develop fatty liver, only about 20% to 40% of such people develop steatohepatitis, and a subset of these latter individuals develop the more advanced stages of ASH, cirrhosis, and hepatocellular carcinoma.[10] Progression to further injury depends on the genetic constitution of individuals, their lifestyle (diet and exercise), and their exposure to viral infections, all of which contribute to disease progression and severity.[11] The actual mechanisms involved in ALD development are complex and multifactorial, including gut and other tissue dysfunctions that influence liver pathology. Other parts of this review describe such dysfunctions in greater detail. Abstinence from alcohol is considered the most effective therapeutic strategy to recover from ALD, and there is clear evidence that abstinence can improve outcomes at nearly all stages of this disease.[6]

Diagnosis and recovery from ALD steatosis

Excessive use of alcohol (≥ 60g/day) for more than 2 weeks results in development of fatty liver (steatosis), characterized by deposition of fat in more than 5% of hepatocytes resulting in mostly macrovesicular steatosis (large intrahepatocyte lipid droplets) with or without minimal inflammation. Steatosis is mostly asymptomatic, although some people feel weakness, nausea, and pain in the right upper quadrant. Mild elevations in serum alanine transaminase (ALT), aspartate transaminase (AST), and gamma glutamyl transferase (GGT) are seen in patients with ALD. After abstinence from alcohol for 2 to 3 weeks, hepatic steatosis completely resolves and liver biopsies appear normal when examined by electron microscopy.[12] Similarly, Mehta et al. reported that 1 month of abstinence from alcohol by heavy-alcohol consumers (average consumption ~258 g/week) reduced serum ALT, AST, GGT, and carbohydrate-deficient transferrin to baseline (abstinence) levels.[13] In addition, insulin resistance, systolic and diastolic blood pressure, and serum cholesterol levels were also reduced with abstinence from alcohol. These changes were attained without significant lifestyle adjustments such as changes in diet or increased exercise, indicating that abstinence was the major factor in recovery.[14]

Alcoholic steatohepatitis

With continued excessive drinking, about 20% to 40% of heavy-alcohol consumers with steatosis develop alcoholic steatohepatitis (ASH), characterized by fatty liver, inflammation with accumulation of neutrophils, ballooning degeneration of hepatocytes with or without Mallory-Denk bodies, and pericentral and perisinusoidal fibrosis. The severity of ASH can range from mild to severe and is superimposed on chronic liver disease. Severity of ASH can be assessed by the model for end-stage liver disease (MELD). A MELD score greater than 20 has been proposed as defining severe ASH with approximately 20% mortality.[1] Steatohepatitis symptoms include reduced appetite, nausea and vomiting, abdominal pain, fatigue, and weakness. People with severe alcoholic hepatitis exhibit

jaundice (yellowing of the skin), dark urine, kidney failure, and confusion. ASH is diagnosed by a serum AST:ALT ratio greater than 1.5:1 with absolute ALT and AST numbers not exceeding 400 international units per liter, increased GGT, serum bilirubin greater than 3 mg/dl, and documented heavy alcohol use until 8 weeks prior to seeking help.[15] Ultrasound and magnetic resonance analyses are additionally used to confirm ASH. Currently, hepatologists recommend liver biopsies for diagnosis of ASH, as one-third of patients who are asymptomatic can show advanced fibrosis histologically.[10] As for steatosis, the major therapy recommended for mild ASH and severe ASH with systemic inflammatory response syndrome is abstinence from alcohol consumption. This provides the best long-term outcome for survival and recovery. Indeed, Kirpich et al. (2017) reported that after 2 weeks of abstinence, patients who presented with inflammation and increased serum endotoxin showed improvement, as indicated by decreased serum AST, ALT, and cytokeratin 18 (a sensitive marker of liver injury), as well as lower levels of tumor necrosis factor alpha and endotoxin.[16] In other articles in this topic series, information is given on pharmacological therapy, in addition to cognitive behavioral therapy, which is known to be key to preventing relapses during abstinence; both of these therapies show increased recovery from ALD.[6] In addition, nutritional supplementation is beneficial for recovery from ALD.[10]

Fibrosis and cirrhosis

Repeated episodes of ASH are accompanied by hepatic fibrosis and characterized by ballooned and dying hepatocytes and abnormal deposition of extracellular matrix around these cells. The stage/intensity of fibrosis (F0–F4) can be evaluated histologically and, in some cases, on the basis of liver stiffness, which is determined by transient elastography (FibroScan).[17] When overexposed to alcohol, the liver loses its efficiency, and inflammatory damage produces scar tissue and fatty deposits in the organ. Normal liver parenchymal cells are replaced by regenerative nodules surrounded by fibrotic (scar) tissue. If enough scar tissue develops, the liver loses function in those scarred areas. Decompensated liver cirrhosis occurs when the liver can no longer properly perform its functions because of excessive scar tissue. Symptoms include fatigue, spider angioma (radiating blood vessels beneath the skin), palmar erythema (reddening of the palms), and jaundice (yellowing of the skin). These patients also have an increased risk of developing hepatocellular carcinoma, with a lifetime risk of about 3% to 10% and an annual risk of about 1%. The American College of Gastroenterology recommends that patients with alcohol-associated cirrhosis undergo screening with ultrasound examination every 6 months.[18] At this stage, abstinence from alcohol improves survival rates.[6,14,19]

Liver Injury and Recovery After Alcohol Administration in Animals

Researchers have studied molecular mechanisms of ALD and recovery from ALD in several animal models, most notably in rats and mice, using a wide variety of experimental conditions and various genetic backgrounds. As noted previously, both rats and mice develop fatty liver after alcohol administration, but progression to fibrosis or cirrhosis occurs only with manipulation of the diet and/or injection of an agent such as endotoxin or low-dose carbon tetrachloride to enhance a fibrotic response. This review summarizes cellular mechanisms that contribute to resolution of liver injury in alcohol-fed rats subjected to alcohol cessation. All studies described here used a similar model to investigate effects of alcohol and its cessation: Rats fed control or alcohol-containing Lieber-DeCarli liquid diets for 1 to 6 weeks showed typical serum alcohol concentrations of 200 to 300 mg/dl.[20-22] Subsequently, randomly chosen alcohol-fed rats were weaned from the alcohol diet.[21-23]

Receptor-mediated endocytosis

Work from Casey and others has identified alcohol-induced defects in protein trafficking and organelle function, both of which recover upon alcohol cessation.[21,24] The latter studies focused on the asialoglycoprotein receptor, a hepatocyte-specific

receptor, which exhibits decreased function after even 1 week of alcohol administration.[21] The authors identified impaired binding, internalization, and degradation of several ligands internalized by receptor-mediated endocytosis. In all cases, recovery to control levels of receptor-mediated endocytosis by the asialoglycoprotein receptor was partially restored after 2 to 3 days of refeeding with the control diet, and function was fully restored after 7 days of refeeding. These findings suggest that the detrimental effects of alcohol on protein trafficking pathways occur rather rapidly (1 to 5 weeks) and that complete recovery is obtained within 7 days after cessation of alcohol consumption.

Golgi apparatus organization

Another study reported that alcohol cessation normalizes alcohol-induced Golgi apparatus disorganization in the liver.[25] These findings further support the notion that alcohol cessation reverses alcohol-induced trafficking defects. Here, chronic alcohol administration caused de-dimerization of the large Golgi matrix protein giantin in rat hepatocytes, leading to Golgi apparatus disassembly. Alcohol cessation and refeeding with the control diet for 10 days restored the compact, native structure of the Golgi apparatus.

Mg^{2+} levels

In another study, Torres et al. reported that 3 weeks of alcohol administration to rats impairs hepatocytes' ability to increase the level of magnesium ion (Mg^{2+}) in the extracellular compartment. Ten days after alcohol cessation, Mg^{2+} homeostasis was restored.[23]

Steatosis

Additionally, resolution of alcohol-induced fatty liver after alcohol cessation has been reported. Here, alcohol feeding increases hepatic triglycerides, confirmed by microscopic analyses of liver sections, which clearly show lipid droplet accumulation associated with elevated levels of ADH, CYP2E1, and lipid peroxides, as well as higher levels of serum AST, ALT. and nonesterified fatty acids (NEFA, or free fatty acids).[22] After alcohol removal and refeeding with the control diet, there was normalization of serum NEFA and ALT levels with a significant (but not complete) reduction of hepatic triglycerides. The latter reduction was associated with normalization of ADH and CYP2E1 to control levels. Additionally, there was concomitant reduction of hepatic lipid peroxides, indicating lower levels of oxidants.[22] These findings reveal that alcohol cessation attenuates generation of oxidants to alleviate hepatocyte damage, as confirmed by normalization of ALT levels.

NEFA levels

It is well established that impaired liver function affects other organs, and vice versa. For example, high serum NEFA levels in alcohol-fed rats arise from alcohol-induced lipolysis in adipose tissue, generating serum NEFA levels that exacerbate hepatic fat accumulation. This occurs because hepatocytes rapidly take up circulating NEFA,[22] which, upon their entry into hepatocytes, are esterified with glycerol to form triglycerides. Notably, alcohol removal and refeeding with the control diet normalize serum NEFA levels, indicating that alcohol cessation slows the hepatic uptake of circulating fatty acids and attenuates adipose lipolysis to alleviate alcohol-induced steatosis in the liver. Also noteworthy is that alcohol cessation enhances hepatic fatty acid oxidation.

Hepatic autophagy

Alcohol cessation also resolves impaired hepatic autophagy, a key intracellular catabolic pathway that breaks down lipid droplets and other obsolete organelles. Chronic feeding of alcohol reduces the nuclear localization of transcription factor EB,[22] which coordinates lysosome biogenesis with autophagy. Additionally, chronic alcohol feeding downregulates the activity of lysosomal acid lipase, causing intrahepatic lipid accumulation. Cessation of alcohol restores nuclear transcription factor EB levels to normal, thereby reactivating hepatic autophagy and the normal turnover of lipid droplets.[22]

Alcohol cessation and recovery following intragastric alcohol administration

Yin et al. (1988) examined recovery in rats subjected to intragastric alcohol feeding, during which rodents are given continual intragastric infusion of an alcohol diet through an inserted cannula.[26] Liver damage in these animals is typically greater than in animals given oral feeding of alcohol ad lib. Alcohol removal for 2 weeks nearly normalized all liver functions in rats previously subjected to 6 weeks of intragastric alcohol administration.[26]

The foregoing findings indicate that several cellular mechanisms collectively contribute to resolution of steatosis and liver injury following alcohol cessation. First, since alcohol cessation would terminate ethanol metabolism, oxidant generation would be greatly decreased. Second, cessation normalizes circulating NEFA, their uptake by liver cells, and their reesterification into triglycerides. Third, alcohol cessation reactivates hepatic autophagy by restoring nuclear transcription factor EB levels, allowing resumption of lipid droplet degradation and organelle turnover. Interestingly, although alcohol cessation alleviates fat accumulation, it does not completely reverse fatty liver, probably because the amount of residual fat in livers of alcohol-fed rats overwhelms the degradation/oxidative systems. The latter findings indicate a longer recovery period is necessary to reverse fatty liver completely in alcohol-withdrawn rats.

GI TRACT AND ALCOHOL

Alcohol Metabolism in the GI Tract

As the principal site of alcohol absorption, the GI tract plays a particularly significant role in mediating the toxic effects of alcohol on the liver and other organs. GI metabolism of alcohol is significant as it affects the systemic availability of alcohol while it locally generates acetaldehyde. GI mucosal ADH catalyzes alcohol oxidation, especially in the oropharynx and esophagus where ADH class IV activity is relatively high, and it likely contributes to local toxicity because of the acetaldehyde it produces.[27]

Before alcohol reaches the liver, the stomach lining is the principal site of "first pass" metabolism of the ingested alcohol.[27] Various isoforms of gastric ADH oxidize a significant percentage of ingested alcohol before it enters the portal circulation. The total first-pass metabolism of alcohol was calculated to be in the range of 7% to 9% and is influenced by many factors including gastric emptying.[28] Besides ADH, the other major enzymes that catalyze alcohol oxidation, CYP2E1 and catalase, are present in GI mucosal cells. Similar to liver, GI CYP2E1 content also increases after chronic alcohol administration. GI tract microflora, including bacteria and yeast, possess ADH activity and metabolize alcohol to produce acetaldehyde, but they also are capable of generating alcohol during fermentation.[27] Other factors such as motility, absorption, dilution by GI secretions, and rediffusion of alcohol all influence alcohol clearance from the GI tract. In addition, gender, age, genetics, and gastric morphology modulate gastric ADH activity. ADH levels are significantly lower in younger women compared with age-matched men. This difference probably accounts for greater alcohol-induced liver toxicity in women.[27]

GI Injury and Recovery After Alcohol Exposure in Humans

Alcohol consumption interferes with the function of all parts of the GI tract. These malfunctions are due to the local production and systemic levels of acetaldehyde. Chronic alcohol use also damages and erodes the upper GI mucosa, which encounter undiluted alcoholic beverages, causing hemorrhagic lesions and increasing the risk of cancer development. Alcohol also impairs the muscles surrounding the stomach, small intestine, and large intestine. This affects motility, which, while delaying gastric emptying, shortens transit time in the small intestine, causing diarrhea. Essentially, alcohol inhibits absorption of a variety of nutrients by the small intestine and contributes to malnourishment commonly seen in patients with alcohol use disorder (AUD).[29]

Intestinal barrier disruption

Most relevant, chronic alcohol use disrupts the tightly regulated gut barrier function. This barrier consists of a system of highly specialized, intercellular, multiprotein junctional complexes known as tight junctions. These are located at the apical (luminal) ends of intestinal epithelial cells. Studies reveal that alcohol metabolism in the gut disrupts tight junction structural integrity. The consequent loss of the mucosal barrier allows paracellular translocation of pathogenic molecules—including cell wall components from gram-positive and gram-negative bacteria and fungi—into the general circulation, allowing direct access to the liver via the portal vein. Once inside the liver, these microbial components can activate resident macrophages (Kupffer cells) to initiate a necroinflammatory cascade. Alcohol compromises tight junction integrity by the following molecular mechanisms: generating reactive oxygen species, upregulating production of specific micro-RNAs, and disrupting both the epithelial cell methionine metabolic pathway and the intestinal circadian rhythm.[29]

In addition to the physical barrier, there are immunological and chemical barriers on the luminal surface of the GI tract. The chemical barriers secreted by the epithelial/immune cells include secretory immunoglobulin A, mucins, and antimicrobial peptides, all of which are altered by alcohol metabolism**.**

Alterations in the microbiota

A symbiotic balance between proinflammatory and commensal bacteria allows only trace amounts of luminal antigens to penetrate the intestinal barrier and enter the portal vein and systemic circulation. However, chronic alcohol administration alters the balance among intestinal microbiota. This is characterized by both quantitative and qualitative changes, including suppression of many commensal probiotic bacteria, vital for bile acid metabolism and for the generation of short- and long-chain fatty acids necessary for maintaining gut health and liver homeostasis.[30]

Recovery after abstinence

Recent studies have shown that a 3-week abstinence following the removal of alcohol induces a complete recovery of gut barrier function in subjects with AUD who presented with high intestinal permeability.[31] Similar results were shown by other laboratories that reported a decrease in endotoxemia following the removal of alcohol.[16] However, 3-week abstinence produces only an incomplete recovery of the gut microbiota,[31] indicating that alcohol consumption has a more long-lasting effect on gut dysbiosis, even after more than 1 month of abstinence.[32] A 3-week abstinence also increases bacterial populations known to be beneficial, which leads to a decrease in potential toxins and an increase in beneficial microbial metabolites.[31]

GI Injury and Recovery After Alcohol Exposure in Animals

Most studies conducted to date using animal models have examined whether external agents—such as antibiotics, probiotics, prebiotics, synbiotics, betaine, zinc, indole-3-acetic acid, and long- and short-chain fatty acids—prevent or reverse alcohol-induced changes in the gut and prevent liver damage. Only one animal study has shown that sobering for 24 hours after 4 weeks of alcohol feeding partially restored intestinal barrier function, but such cessation did not reduce the inflammatory response in the colon.[33]

PANCREAS

Alcohol Metabolism in the Pancreas

Although the pancreas expresses both ADH and CYP2E1, its capacity for oxidative alcohol metabolism is significantly lower than that of the liver.[34] However, the pancreas has a high capacity for nonoxidative alcohol metabolism, which is catalyzed by fatty acid ethyl ester (FAEE) synthases. These enzymes generate FAEE by condensing alcohol with a fatty acid (e.g., oleic acid). FAEE can bind to and accumulate in mitochondria to impair cell function in the pancreas and the heart,[35] which is also rich in FAEE synthases.

Pancreatic Injury and Repair After Chronic Alcohol Use in Humans

The association between alcohol consumption and pancreatic diseases has been recognized for more than 100 years. The pancreas contains two functionally distinct compartments: As an endocrine gland, the pancreas secretes insulin and glucagon, the hormones that govern glycemia. As an exocrine gland, the pancreas produces zymogen precursors of digestive enzymes used for food breakdown in the gut. Both compartments can suffer consequences of chronic alcohol use.

Pancreatitis

Chronic alcohol use is commonly associated with pancreatitis, a necroinflammatory disease of the exocrine pancreas that is classified as either acute or chronic. Although the association between chronic alcohol use and pancreatitis has long been recognized, the mechanism or mechanisms by which chronic alcohol use predisposes the pancreas to disease are not entirely understood. Despite this association, chronic alcohol use alone is not sufficient to trigger a clinical event, such as development of acute pancreatitis.[36] Heavy drinking is believed to sensitize the pancreas to injury, whereas other factors trigger necroinflammation.

In developed countries, chronic alcohol use is the second most common factor associated with acute pancreatitis.[37] In up to 20% of the cases, there are severe clinical complications of pancreatitis with mortalities of up to 10%.[37]

In contrast, in the Western world, chronic alcohol use is the major etiological factor in chronic pancreatitis, accounting for approximately 70% of reported cases. Alcohol-induced chronic pancreatitis is thought to have an early stage associated with recurrent attacks of alcohol-induced acute pancreatitis and a late stage characterized by steatorrhea, diabetes, fibrotic scarring, and pancreatic calcification. In many cases, it appears that alcohol-induced acute pancreatitis progresses to chronic pancreatitis. This progression is generally associated with frequent, severe, and acute attacks that are common among chronic alcohol users. Little is known regarding the effects of alcohol in humans after pancreatic damage. Because chronic pancreatitis is commonly associated with recurrent attacks of acute pancreatitis, it appears that continued alcohol consumption impairs proper pancreatic repair. In support of this, one study investigated pancreatic dysfunction associated with alcohol-induced chronic pancreatitis and demonstrated that pancreatic function deteriorated more slowly in patients who quit drinking compared with those who continued heavy drinking. These findings indicate that the functional deterioration of the pancreas associated with alcohol-induced chronic pancreatitis continues even after drinking ceases, although this occurs to a lesser degree than in those who continue to chronically use alcohol.[38] A long-term, population-based study demonstrated that progression from acute to chronic pancreatitis is most common among chronic alcohol users. These findings indicate that alcohol consumption delays the normal repair process following acute pancreatitis and it may enhance the progression from acute to chronic pancreatitis. Although more work must be done to determine how alcohol affects repair of the pancreas, it appears that cessation of chronic alcohol use slows progression of alcohol-induced chronic pancreatitis.

Pancreatic Injury and Repair After Alcohol Exposure in Animals

The structural and functional regeneration of the pancreas after acute injury is supported by studies of experimentally induced pancreatitis in rodents.[39] One of the main characteristics of alcohol-induced chronic pancreatitis is the aberrant repair of injury that results in fibrotic scarring. Given the close association between chronic alcohol use and chronic pancreatitis, it is reasonable that chronic alcohol consumption adversely affects pancreatic repair. Using the Lieber-DeCarli pair-feeding model of alcohol administration in rats, one group reported that chronic alcohol feeding for 2 to 8 weeks significantly decreased the amylase content of the pancreas after cerulein-induced pancreatitis, indicating that alcohol consumption impaired functional pancreatic regeneration. This treatment did not affect total protein, DNA, or RNA content

of the pancreas. Although no histological evaluation was performed, and amylase production declined, these authors concluded that alcohol consumption does not affect pancreatic regeneration.[40] In contrast, Pap et al. reported that intragastric alcohol feeding for 2 months slowed the restoration of pancreatic weight and enzyme content in rats with surgically induced pancreatic injury.[41] During this period, alcohol-fed animals developed chronic calcifying pancreatitis. Cessation of alcohol feeding resulted in structural and functional recovery of the pancreas. These results indicate that inhibition of pancreatic regeneration by alcohol is necessary to maintain the state of chronic pancreatitis. Cholecystokinin is a crucial peptide hormone in pancreatic regeneration. Alcohol feeding reduces cholecystokinin release and prevents pancreas regeneration after partial pancreatectomy.[42] Additionally, using a model of virally induced pancreatitis, it was demonstrated that alcohol administration to mice delays pancreas repair.[43] Together, these studies indicate that alcohol delays the structural repair and functional restitution of pancreatic tissue in animal models of alcoholic pancreatitis. Most studies indicate that cessation of alcohol consumption by rodents restores pancreatic structure and function.

HEART

Alcohol Metabolism in the Heart

Cardiac tissue expresses both major alcohol-metabolizing enzymes: ADH and CYP2E1.[44] There are reports that both enzymes may influence alcohol-induced myocardial damage by converting alcohol to acetaldehyde. However, the heart also has a rich content of FAEE synthases, suggesting that nonoxidative alcohol metabolism prevails in this organ.

Cardiac Injury and Recovery After Alcohol Exposure in Humans

Alcohol-induced dilated cardiomyopathy is an important manifestation of chronic alcohol use. Chronic AUD is accompanied by a high incidence of cardiac morbidity and mortality due to development of alcoholic cardiomyopathy. Cardiomyopathy can be seen by ventricle dilation, along with a reduced ventricular wall thickness and some contractile dysfunction. Alcohol/acetaldehyde toxicity along with mitochondrial production of reactive oxygen species is one theory proposed for alcohol-induced cardiac injury. Indeed, acetaldehyde can directly impair cardiac contractile function, disrupt cardiac excitation-contraction coupling, and promote oxidative damage and lipid peroxidation. Some resulting effects are oxidative injury, apoptosis, impaired myofilament Ca^{2+} sensitivity, impaired protein synthesis, and altered fatty acid extraction and deposition, along with changes in protein catabolism.[45] The removal of alcohol is associated with the reduction or disappearance of myocardial damage and the improvement of function.[46] A study on cardiovascular changes during different phases following the removal of alcohol found that heart rate, systolic blood pressure, and diastolic blood pressure were higher in the early stage of alcohol cessation. These cardiovascular parameters returned to baseline levels after 1 month of abstinence.[47] Other cardiac effects of chronic alcohol exposure are cardiac arrhythmias (irregular heartbeat), tachycardia (fast heartbeat), and other cardiovascular disease. These cardiovascular parameters also returned to baseline levels after 1 month of abstinence.[47] There is no evidence for reversal of cardiac fibrosis in humans with alcoholic cardiomyopathy. However, cessation of alcohol consumption can result in significant improvement in left ventricular function.[48,49] In a case study, Mahmoud et al. showed that a patient who exhibited signs of alcoholic cardiomyopathy demonstrated severe global left ventricular systolic dysfunction with an ejection fraction of 20%.[50] Moreover, the end-systolic dimension was 4.1 cm and the end-diastolic dimension was 5.0 cm. However, after 1 month of alcohol abstinence, this patient was asymptomatic, with a higher ejection fraction of 62%. The patient's end-systolic dimension was 3.3 cm, and the end-diastolic dimension was 4.8 cm.[50] Cardiac arrhythmias may explain cases of sudden death in patients with AUD who are abstinent.

The QTc interval (a measure of heart rate) is frequently prolonged during alcohol cessation syndrome and tends to become normal over time.[51] The frequency and nature of arrhythmias, as well as some irregularities of their time-course due to alcohol cessation terms were studied in subjects with chronic AUD. Sinus tachycardia, abnormal excitation, and conduction were more frequently observed in the acute (early) period of alcohol cessation. In most cases, these symptoms ceased within 2 weeks after cessation.[52]

Cardiac Injury and Recovery After Alcohol Exposure in Animals

Alcoholic cardiomyopathy is a specific heart muscle disease caused by chronic alcohol intake and has been studied in animal models. Chronic alcohol intake tends to increase left ventricular mass and dilatation that leads to heart failure in a rat model of alcohol administration. In one study, the authors postulated that alcohol intake activates the pro-renin receptor and contributes to cardiac remodeling and damage.[53] They examined the relationship between the pro-renin receptor and alcoholic cardiomyopathy and found that alcohol intake increases myocardial fibrosis, myocardial oxidative stress, and inflammation response like that seen in humans. Studies examining recovery of cardiac function in animal models have not been described.

BONE

Alcohol Metabolism in Bone

It is not clear whether bone tissue itself metabolizes alcohol by oxidative metabolism (i.e., ADH and CYP2E1 catalysis) or by esterification with fatty acids. Current evidence supports that alcohol alone is the causative agent that delays bone growth and repair.

Bone Injury and Repair After Alcohol Exposure in Humans

Osteopenia

Continued heavy alcohol use decreases bone density. The pathogenesis of osteopenia in AUD remains unclear, and many alcohol-related abnormalities have been proposed to explain bone loss.[54] A direct inhibitory effect of alcohol on osteoblast function was suggested by in vivo and in vitro studies. The rapid increase in serum bone Gla protein (BGP) concentrations following alcohol cessation suggests that low serum BGP concentrations in heavy-alcohol users may result from a direct toxic effect of alcohol on osteoblast function and/or numbers.[54] The role of alcohol as a risk factor for osteopenia was studied in subjects with AUD who did not have liver cirrhosis. The data show that chronic alcohol ingestion induces osteopenia regardless of whether liver cirrhosis is present, and that some relationship can be expected between the amount and duration of alcohol consumption and the degree of bone loss. Low serum levels of BGP in drinkers are reversible upon alcohol cessation, suggesting that reduction of osteoblast activity is likely the main factor responsible for alcohol-associated bone disease.[55] Alcohol not only promotes bone loss but also impairs bone formation. Plasma concentrations of osteocalcin, a marker of bone formation, were measured in human male heavy drinkers before and after 3 weeks of alcohol cessation and compared with nondrinking men. Plasma osteocalcin levels in heavy-alcohol-using subjects were significantly lower than in controls. After 21 days of cessation, plasma osteocalcin levels were significantly higher than on the day of admission and were equal to those of controls, who did not have AUD. The results support the notion that the decrease of plasma osteocalcin with chronic alcohol use is reversible within 3 weeks following alcohol removal.[56]

Bone turnover

The biochemical markers for bone formation (osteocalcin, bone-specific alkaline phosphatase, and procollagen type 1 carboxy-terminal peptide) and resorption (c-terminal telopeptide and urine deoxypyridinoline) were studied in men who were heavy-alcohol users and in abstainers with more than 5 years of abstinence. The results were compared with male controls. The findings

suggest that there is an imbalance between bone formation and bone resorption among heavy-alcohol users that results in rapid bone loss. Although most directions tended to normalize shortly following the removal of alcohol, biochemical data suggest that there may still be persistently high bone turnover after more than 5 years of abstinence.[57]

Although most studies suggest that alcohol induces bone loss, epidemiological studies indicate that higher bone mass is associated with moderate alcohol consumption in postmenopausal women. Therefore, a study investigated the hypothesis that moderate alcohol intake attenuates bone turnover after menopause. This study showed that abstinence from alcohol results in increased markers of bone turnover, whereas resumption of drinking reduces bone turnover markers. These results suggest that the inhibitory effect of alcohol on bone turnover attenuates the detrimental skeletal consequences of excessive bone turnover associated with menopause.[58] Taken together, these studies indicate that alcohol has a direct effect on bone formation and resorption and that these effects are reduced during abstinence.

Bone Injury and Repair After Alcohol Exposure in Animals

Animal (rodent) studies report that the adverse effects of alcohol on bones are limited not only to bone formation and resorption, but that chronic alcohol administration also impairs the healing capacity of fractured bone in rodents.[59] In vitro studies report that proliferation of alcohol-exposed osteoblasts (precursor bone cells) is impaired and that such treatment enhances oxidant stress by increasing intracellular superoxide, which inhibits osteoblast proliferation.[60,61] Recent in vivo studies suggest that oxidant stress inhibits bone repair, as fracture healing is restored in alcohol-fed rats treated with the antioxidant, *N*-acetylcysteine.[62] Given the latter findings, it is reasonable to postulate that alcohol cessation may fully restore osteogenesis in bone.

SUMMARY

Continual heavy alcohol consumption damages multiple organs/systems. This review focused on damage and recovery in five of those tissues in humans and experimental rodents. The greatest degree of alcohol-induced injury occurs in the liver and GI tract, as both these organs/systems are the first to encounter high concentrations of imbibed alcohol. The liver and GI tract are well equipped to oxidatively metabolize alcohol. However, alcohol oxidation comes at a cost, as it generates acetaldehyde, which is capable of forming toxic acetaldehyde-macromolecular adducts as well as free radicals that oxidize lipids and form reactive lipid peroxides. Thus, the continual metabolic generation of these intermediates eventually disrupts homeostasis, causing cell death, inflammation, and the eventual breakdown of organ integrity.

In the pancreas and heart, alcohol is minimally oxidized. Instead, most of it is esterified with fatty acids, forming FAEE. These molecules bind to mitochondria and disrupt the generation of energy that is normally reserved for pancreatic secretion or myocardial contraction. Although it is not clear whether oxidative or nonoxidative alcohol metabolism actually occurs in bone tissue, it is clear that alcohol exposure to osteoblasts inhibits their proliferation by causing oxidant stress. Also, structural weakening of bone and delays in fracture healing are clearly evident after chronic alcohol consumption by rodents.

Despite alcohol-induced damage to these tissues, abstinence, in its simplest form, brings about either complete or partial recovery, but the extent of such recovery depends on the extent of the damage, as shown in Figure 1. For example, it is unlikely that abstinence would be effective in a case of decompensated cirrhosis, but resolution of cirrhosis which involves a portion of the liver (i.e., compensated cirrhosis) is more likely. Thus, the examples provided in this review highlight the value of intrinsic regenerative processes that maintain organ function.

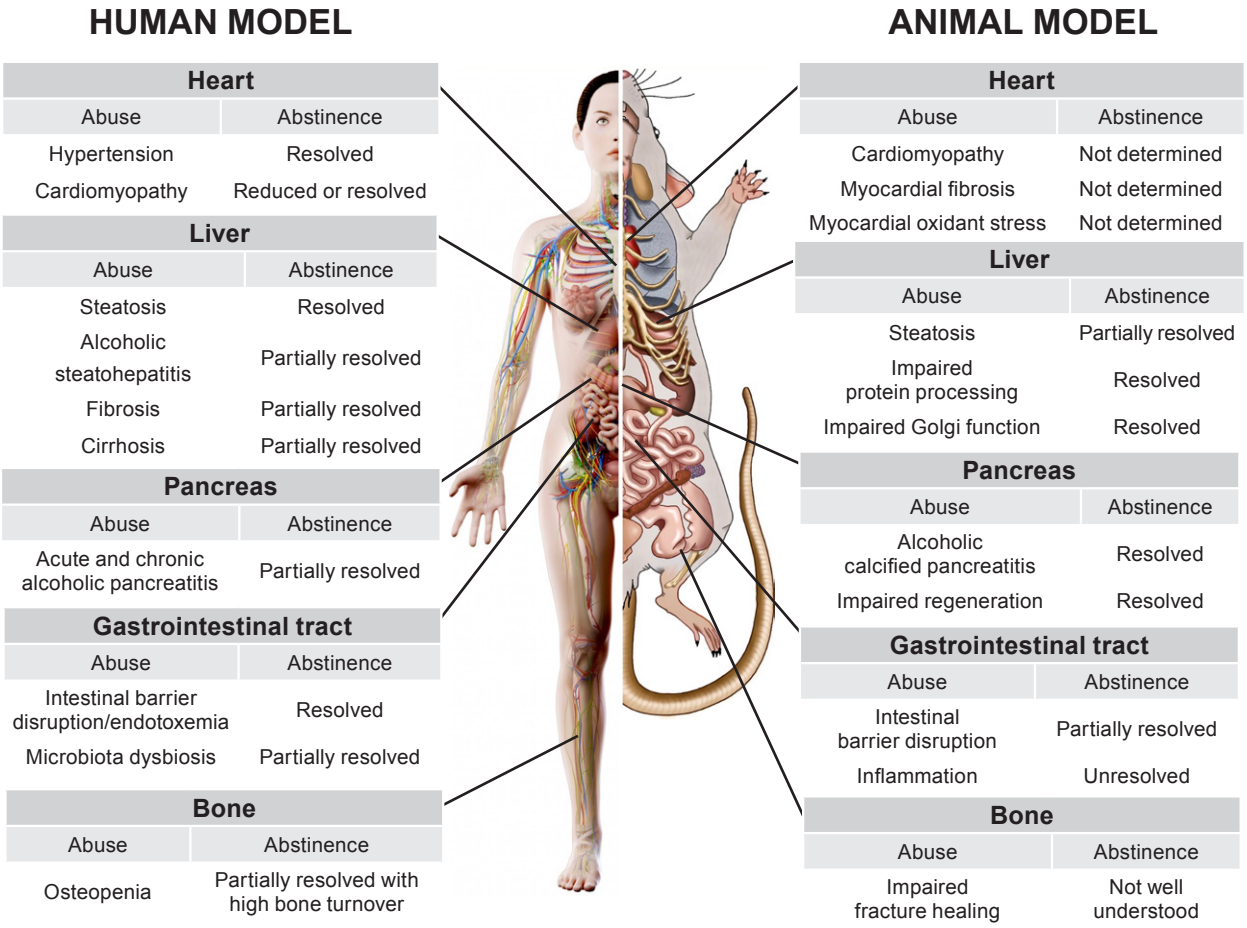

Figure 1 Schematic diagram of the effects of chronic alcohol use and abstinence in humans and rodents on various organs and systems, including the heart, liver, gastrointestinal tract, pancreas, and bone. Each row describes a consequence of chronic alcohol use, whether it is resolved by abstinence, and, if so, to what degree**.** Adapted with permission from SciePro/stock.adobe.com (human) and Science Photo Library, London (rodent).

Finally, more basic research is needed to clearly evaluate whether abstinence that follows chronic alcohol consumption completely or partially restores the full integrity of the affected organs. To date, the results appear promising that cessation of alcohol consumption indeed allows partial or full recovery, depending on the parameter being measured. It is also worth noting that alcohol-induced pathology in animals (usually rodents) does not fully reflect the extent of injury incurred by human heavy drinkers. However, the use of other feeding models, such as intragastric feeding and the acute-on-chronic feeding model have yielded valuable information on liver damage in animals that consume similar amounts of alcohol and have similar drinking patterns as humans with AUD.

FINAL REMARKS

The focus of this review has been on organ recovery after cessation of chronic alcohol use. Abstaining from alcohol by a person with AUD is not a trivial matter. A recent review by Asrani et al. gives important details on the scope of the global burden of alcohol-associated disease;[63] although its principal focus is ALD, it applies to all the alcohol-induced disorders described here. Presently, the problems of alcohol-related morbidity (suffering from AUD) and mortality (death from AUD) are rising worldwide. Their reductions will require multifaceted solutions that focus on early identification of problem drinking and interventions at the population level (e.g., increased taxation of

beverages; youth education) and at the patient level (e.g., early diagnosis of organ injury; counseling by an addiction specialist). Although none of the aforementioned examples, by themselves, are considered innovative, their combined use represents a new approach, especially when they make use of technological advances, including smartphone technology and telehealth. The team approach to treatment is important because, although a physician can diagnose and treat organ injury, an addiction specialist or mental health professional also must be part of the treatment plan to prevent patient relapse. These measures, along with public reeducation about social stigmas related to alcohol addiction, will likely reverse the rising trends toward heavy drinking.

Acknowledgments

This review is the result of work supported with resources and the use of the facilities at the Omaha Veterans Affairs Medical Center. The original research cited in this review was supported by Merit Review grants BX004171 and BX004053 from the U.S. Department of Veterans Affairs, Office of Research and Development (Biomedical Laboratory Research and Development); BX004853, Research Career Scientist Award from the U.S. Department of Veterans Affairs; and National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health grants AA020735, AA027367, AA024254, and AA026723.

Financial Disclosures

The authors declare no competing financial or nonfinancial interests.

Publisher's Note

Opinions expressed in contributed articles do not necessarily reflect the views of the National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health. The U.S. government does not endorse or favor any specific commercial product or commodity. Any trade or proprietary names appearing in *Alcohol Research: Current Reviews* are used only because they are considered essential in the context of the studies reported herein.

References

1. Singal AK, Anand BS. Recent trends in the epidemiology of alcoholic liver disease. *Clin Liver Dis (Hoboken)*. 2013;2(2):53-56. https://doi.org/10.1002/cld.168.
2. Wong T, Dang K, Ladhani S, et al. Prevalence of alcoholic fatty liver disease among adults in the United States, 2001-2016. *JAMA*. 2019;321(17):1723-1725. https://doi.org/10.1001/jama.2019.2276.
3. Cederbaum AI. Alcohol metabolism. *Clin Liver Dis*. 2012;16(4):667-685. https://doi.org/10.1016/j.cld.2012.08.002.
4. Mellinger JL. Epidemiology of alcohol use and alcoholic liver disease. *Clin Liver Dis (Hoboken)*. 2019;13(5):136-139. https://doi.org/10.1002/cld.806.
5. Teschke R. Alcoholic liver disease: Alcohol metabolism, cascade of molecular mechanisms, cellular targets, and clinical aspects. *Biomedicines*. 2018;6(4). https://doi.org/10.3390/biomedicines6040106.
6. Leggio L, Lee MR. Treatment of alcohol use disorder in patients with alcoholic liver disease. *Am J Med.* 2017;130(2):124-134. https://doi.org/10.1016/j.amjmed.2016.10.004.
7. Zakhari S. Overview: How is alcohol metabolized by the body? *Alcohol Res Health*. 2006;29(4):245-254.
8. Nanji AA, French SW. Animal models of alcoholic liver disease—Focus on the intragastric feeding model. *Alcohol Res Health*. 2003;27(4):325-330.
9. Mak KM, Leo MA, Lieber CS. Alcoholic liver injury in baboons: Transformation of lipocytes to transitional cells. *Gastroenterology.* 1984;87(1):188-200.
10. Singal AK, Bataller R, Ahn J, et al. ACG clinical guideline: Alcoholic liver disease. *Am J Gastroenterol.* 2018;113(2):175-194. https://doi.org/10.1038/ajg.2017.469.
11. Miller AM, Horiguchi N, Jeong WI, et al. Molecular mechanisms of alcoholic liver disease: Innate immunity and cytokines. *Alcohol Clin Exp Res*. 2011;35(5):787-793. https://doi.org/10.1111/j.1530-0277.2010.01399.x.
12. Lane BP, Lieber CS. Ultrastructural alterations in human hepatocytes following ingestion of ethanol with adequate diets. *Am J Pathol.* 1966;49(4):593-603.
13. Mehta G, Macdonald S, Cronberg A, et al. Short-term abstinence from alcohol and changes in cardiovascular risk factors, liver function tests and cancer-related growth factors: A prospective observational study. *BMJ Open*. 2018;8(5):e020673. http://dx.doi.org/10.1136/bmjopen-2017-020673.
14. Lackner C, Spindelboeck W, Haybaeck J, et al. Histological parameters and alcohol abstinence determine long-term prognosis in patients with alcoholic liver disease. *J Hepatol.* 2017;66(3):610-618. https://doi.org/10.1016/j.jhep.2016.11.011.
15. Crabb DW, Bataller R, Chalasani NP, et al. Standard definitions and common data elements for clinical trials in patients with alcoholic hepatitis: Recommendation from the NIAAA Alcoholic Hepatitis Consortia. *Gastroenterology.* 2016;150(4):785-790. https://doi.org/10.1053/j.gastro.2016.02.042.
16. Kirpich IA, McClain CJ, Vatsalya V, et al. Liver injury and endotoxemia in male and female alcohol-dependent individuals admitted to an alcohol treatment program. *Alcohol Clin Exp Res*. 2017;41(4):747-757. http://doi.org/10.1111/acer.13346.
17. Salavrakos M, Piessevaux H, Komuta M, et al. Fibroscan reliably rules out advanced liver fibrosis and significant portal hypertension in alcoholic patients. *J Clin Gastroenterol.* 2019;53(10):772-778. https://doi.org/10.1097/MCG.0000000000001119.
18. O'Leary JG, Greenberg CS, Patton HM, et al. AGA Clinical Practice Update: Coagulation in cirrhosis. *Gastroenterology.* 2019;157(1):34-43 e31. https://doi.org/10.1053/j.gastro.2019.03.070.
19. Seitz HK, Bataller R, Cortez-Pinto H, et al. Alcoholic liver disease. *Nat Rev Dis Primers*. 2018;4(1):16. https://doi.org/10.1038/s41572-018-0014-7.
20. Rasineni K, McVicker BL, Tuma DJ, et al. Rab GTPases associate with isolated lipid droplets (LDs) and show altered content after ethanol administration: Potential role in alcohol-impaired LD metabolism. *Alcohol Clin Exp Res.* 2014;38(2):327-335. https://doi.org/10.1111/acer.12271.

21. Casey CA, Kragskow SL, Sorrell MF, et al. Ethanol-induced impairments in receptor-mediated endocytosis of asialoorosomucoid in isolated rat hepatocytes: Time course of impairments and recovery after ethanol withdrawal. *Alcohol Clin Exp Res.* 1989;13(2):258-263. https://doi.org/10.1111/j.1530-0277.1989.tb00323.x.
22. Thomes PG, Rasineni K, Yang L, et al. Ethanol withdrawal mitigates fatty liver by normalizing lipid catabolism. *Am J Physiol Gastrointest Liver Physiol.* 2019;316(4):G509-G518. https://doi.org/10.1152/ajpgi.00376.2018.
23. Torres LM, Cefaratti C, Berti-Mattera L, et al. Delayed restoration of Mg^{2+} content and transport in liver cells following ethanol withdrawal. *Am J Physiol Gastrointest Liver Physiol.* 2009;297(4):G621-G631. https://doi.org/10.1152/ajpgi.90652.2008.
24. Tuma DJ, Mailliard ME, Casey CA, Volentine GD, Sorrell MF. Ethanol-induced alterations of plasma membrane assembly in the liver. *Biochim Biophys Acta.* 1986;856(3):571-577. https://doi.org/10.1016/0005-2736(86)90149-5.
25. Casey CA, Thomes P, Manca S, et al. Giantin is required for post-alcohol recovery of Golgi in liver cells. *Biomolecules.* 2018;8(4):150. https://doi.org/10.3390/biom8040150.
26. Yin M, Ikejima K, Arteel GE, et al. Glycine accelerates recovery from alcohol-induced liver injury. *J Pharmacol Exp Ther.* 1998;286(2):1014-1019.
27. Elamin EE, Masclee AA, Dekker J, et al. Ethanol metabolism and its effects on the intestinal epithelial barrier. *Nutr Rev.* 2013;71(7):483-499. https://doi.org/10.1111/nure.12027.
28. Oneta CM, Simanowski UA, Martinez M, et al. First pass metabolism of ethanol is strikingly influenced by the speed of gastric emptying. *Gut.* 1998;43(5):612-619. http://dx.doi.org/10.1136/gut.43.5.612.
29. Purohit V, Bode JC, Bode C, et al. Alcohol, intestinal bacterial growth, intestinal permeability to endotoxin, and medical consequences: Summary of a symposium. *Alcohol.* 2008;42(5):349-361. https://doi.org/10.1016/j.alcohol.2008.03.131.
30. Hartmann P, Seebauer CT, Schnabl B. Alcoholic liver disease: The gut microbiome and liver cross talk. *Alcohol Clin Exp Res.* 2015;39(5):763-775. https://doi.org/10.1111/acer.12704.
31. Leclercq S, Matamoros S, Cani PD, et al. Intestinal permeability, gut-bacterial dysbiosis, and behavioral markers of alcohol-dependence severity. *Proc Natl Acad Sci U S A.* 2014;111(42):E4485-E4493. https://doi.org/10.1073/pnas.1415174111.
32. Mutlu EA, Gillevet PM, Rangwala H, et al. Colonic microbiome is altered in alcoholism. *Am J Physiol Gastrointest Liver Physiol.* 2012;302(9):G966-G978. https://doi.org/10.1152/ajpgi.00380.2011.
33. Shukla PK, Meena AS, Manda B, et al. *Lactobacillus plantarum* prevents and mitigates alcohol-induced disruption of colonic epithelial tight junctions, endotoxemia, and liver damage by an EGF receptor-dependent mechanism. *FASEB J.* 2018;32(11):6274-6292. https://doi.org/10.1096/fj.201800351R.
34. Haber PS, Apte MV, Applegate TL, et al. Metabolism of ethanol by rat pancreatic acinar cells. *J Lab Clin Med.* 1998;132(4):294-302. https://doi.org/10.1016/S0022-2143(98)90042-7.
35. Beckemeier ME, Bora PS. Fatty acid ethyl esters: Potentially toxic products of myocardial ethanol metabolism. *J Mol Cell Cardiol.* 1998;30(11):2487-2494. https://doi.org/10.1006/jmcc.1998.0812.
36. Apte MV, Pirola RC, Wilson JS. Mechanisms of alcoholic pancreatitis. *J Gastroenterol Hepatol.* 2010;25(12):1816-1826. https://doi.org/10.1111/j.1440-1746.2010.06445.x.
37. Wang GJ, Gao CF, Wei D, et al.. Acute pancreatitis: Etiology and common pathogenesis. *World J Gastroenterol.* 2009;15(12):1427-1430. https://doi.org/10.3748/wjg.15.1427.
38. Gullo L, Barbara L, Labò G. Effect of cessation of alcohol use on the course of pancreatic dysfunction in alcoholic pancreatitis. *Gastroenterology.* 1988;95(4):1063-1068. https://doi.org/10.1016/0016-5085(88)90184-9.
39. Desai BM, Oliver-Krasinski J, De Leon DD, et al. Preexisting pancreatic acinar cells contribute to acinar cell, but not islet beta cell, regeneration. *J Clin Invest.* 2007;117(4):971-977. https://doi.org/10.1172/JCI29988.
40. Rydzewska G, Jurkowska G, Wroblewski E, et al. Pancreatic regeneration after chronic ethanol feeding in rats. *J Physiol Pharmacol.* 1999;50(2):227-241.
41. Pap A, Boros L. Alcohol-induced chronic pancreatitis in rats after temporary occlusion of biliopancreatic ducts with Ethibloc. *Pancreas.* 1989;4(2):249-255. https://doi.org/10.1097/00006676-198904000-00015.
42. Pap A, Boros L, Hajnal F. Essential role of cholecystokinin in pancreatic regeneration after 60% distal resection in rats. *Pancreas.* 1991;6(4):412-418. https://doi.org/10.1097/00006676-199107000-00007.
43. Schneider KJ, Scheer M, Suhr M, et al. Ethanol administration impairs pancreatic repair after injury. *Pancreas.* 2012;41(8):1272-1279. https://doi.org/10.1097/MPA.0b013e31824bde37.
44. Hung CL, Chang SC, Chang SH, et al. Genetic polymorphisms of alcohol metabolizing enzymes and alcohol consumption are associated with asymptomatic cardiac remodeling and subclinical systolic dysfunction in large community-dwelling Asians. *Alcohol Alcohol.* 2017;52(6):638-646. https://doi.org/10.1093/alcalc/agx049.
45. Ren J, Wold LE. Mechanisms of alcoholic heart disease. *Ther Adv Cardiovasc Dis.* 2008;2(6):497-506. https://doi.org/10.1177/1753944708095137.
46. Ballester M, Martí V, Carrío I, et al. Spectrum of alcohol-induced myocardial damage detected by indium-111-labeled monoclonal antimyosin antibodies. *J Am Coll Cardiol.* 1997;29(1):160-167.
47. Kähkänen S, Zvartau E, Lipsanen J, et al. Effects of alcohol withdrawal on cardiovascular system. *Prog Neuropsychopharmacol Biol Psychiatry.* 2011;35(2):550-553. https://doi.org/10.1016/j.pnpbp.2010.12.015.
48. Renault A, Mansourati J, Genet L, et al. Cardiomyopathies dilatées en insuffisance cardiaque sévère chez des éthyliques chroniques: Évolution clinique après sevrage complet [Dilated cardiomyopathies in severe cardiac failure in chronic alcoholics: Clinical course after complete withdrawal]. *Rev Med Interne.* 1993;14(10):942. https://doi.org/10.1016/S0248-8663(05)80064-5.
49. Estruch R, Fernandez-Sola J, Mont L, et al. [Reversibility of alcoholic myocardiopathy with abstinence: Presentation of 2 cases]. *Med Clin (Barc).* 1989;92(2):69-71.
50. Mahmoud S, Beauchesne LM, Davis DR, et al. Acute reversible left ventricular dysfunction secondary to alcohol. *Can J Cardiol.* 2007;23(6):475-477. https://doi.org/10.1016/s0828-282x(08)70561-0.
51. Otero-Antón E, González-Quintela A, Saborido J, et al. Prolongation of the QTc interval during alcohol withdrawal syndrome. *Acta Cardiol.* 1997;52(3):285-294.
52. Lukoshiaviciute AI, Stasiukinene VR. Narusheniia serdechnogo ritma i provodimosti u bol'nykh khronicheskim alkogolizmom [Disorders of heart rhythm and conduction in patients with chronic alcoholism]. *Kardiologiia.* 1989;29(11):111-113.

53. Cao X, Yu S, Wang Y, et al. Effects of the (pro)renin receptor on cardiac remodeling and function in a rat alcoholic cardiomyopathy model via the PRR-ERK1/2-NOX4 pathway. *Oxid Med Cell Longev.* 2019;2019:4546975. https://doi.org/10.1155/2019/4546975.
54. Pepersack T, Fuss M, Otero J, et al. Longitudinal study of bone metabolism after ethanol withdrawal in alcoholic patients. *J Bone Miner Res.* 1992;7(4):383-387. https://doi.org/10.1002/jbmr.5650070405.
55. Gonzalez-Calvín JL, Garcia-Sanchez A, Bellot V, et al. Mineral metabolism, osteoblastic function and bone mass in chronic alcoholism. *Alcohol Alcohol.* 1993;28(5):571-579.
56. Jaouhari J, Schiele F, Pirollet P, et al. Concentration and hydroxyapatite binding capacity of plasma osteocalcin in chronic alcoholic men: Effect of a three-week withdrawal therapy. *Bone Miner.* 1993;21(3):171-178. https://doi.org/10.1016/S0169-6009(08)80228-0.
57. Nyquist F, Ljunghall S, Berglund M, et al. Biochemical markers of bone metabolism after short and long time ethanol withdrawal in alcoholics. *Bone.* 1996;19(1):51-54. https://doi.org/10.1016/8756-3282(96)00110-X.
58. Marrone JA, Maddalozzo GF, Branscum AJ, et al. Moderate alcohol intake lowers biochemical markers of bone turnover in postmenopausal women. *Menopause.* 2012;19(9):974-979.
59. Chakkalakal DA, Novak JR, Fritz ED, et al. Inhibition of bone repair in a rat model for chronic and excessive alcohol consumption. *Alcohol.* 2005;36(3):201-214. https://doi.org/10.1016/j.alcohol.2005.08.001.
60. Mercer KE, Sims CR, Yang CS, et al. Loss of functional NADPH oxidase 2 protects against alcohol-induced bone resorption in female p47phox$^{-/-}$ mice. *Alcohol Clin Exp Res.* 2014;38(3):672-682. https://doi.org/10.1111/acer.12305.
61. Chen JR, Lazarenko OP, Shankar K, et al. Inhibition of NADPH oxidases prevents chronic ethanol-induced bone loss in female rats. *J Pharmacol Exp Ther.* 2011;336(3):734-742. https://doi.org/10.1124/jpet.110.175091.
62. Duryee MJ, Dusad A, Hunter CD, et al. N-acetyl cysteine treatment restores early phase fracture healing in ethanol-fed rats. *Alcohol Clin Exp Res.* 2018;42(7):1206-1216. https://doi.org/10.1111/acer.13765.
63. Asrani SK, Mellinger J, Arab JP, et al. Reducing the global burden of alcohol-associated liver disease: A blueprint for action. *Hepatology.* 2020. https://doi.org/10.1002/hep.31583.

ALCOHOL RESEARCH
Current Reviews

Alcohol Res. 2021;41(1):04 ● https://doi.org/10.35946/arcr.v41.1.04

Published: 25 March 2021

The Emergence, Role, and Impact of Recovery Support Services

Leonard A. Jason, Meghan Salomon-Amend, Mayra Guerrero, Ted Bobak, Jack O'Brien, and Arturo Soto-Nevarez

Center for Community Research, DePaul University, Chicago, Illinois

Various community recovery support services help sustain positive behavior change for individuals with alcohol and drug use disorders. This article reviews the rationale, origins, emergence, prevalence, and empirical research on a variety of recovery support services in U.S. communities that may influence the likelihood of sustained recovery. The community recovery support services reviewed include recovery high schools, collegiate recovery programs, recovery homes, recovery coaches, and recovery community centers. Many individuals are not provided with the types of environmental supports needed to solidify and support their recovery, so there is a need for more research on who may be best suited for these services as well as when, why, and how they confer benefit.

KEY WORDS: recovery high schools; collegiate recovery programs; recovery homes; recovery coaches; recovery community centers; alcohol

Across the different developmental stages of the life course, alcohol and other drugs play an influential role in health, functioning, disease, disability, and premature mortality. A number of different approaches have emerged during the past 60 years to address areas impacted by alcohol and drug use, including formal professional treatment services, but also—in recognition of the need for ongoing support following acute care stabilization—a variety of recovery support services. This article reviews several recovery support services, including recovery high schools, collegiate recovery programs, recovery homes, recovery coaches, and recovery community centers. The article examines the role and implications of recovery support services across diverse subpopulations of individuals with alcohol or drug use disorders and related problems. It begins with a review of the prevalence rates and unmet needs for services across the life span for those with alcohol and drug use disorders.

According to recent national estimates, 17% of adolescents report using illicit drugs, and 5% engage in binge drinking.[1] Additionally, 24% of full-time college students ages 18 to 22 report using illicit drugs, and 16% and 11% meet the diagnostic criteria for a drug use disorder or alcohol use disorder (AUD), respectively.[2] At any given time, an estimated 4% of the college student population

is in recovery from substance use disorder (SUD), including AUD.[3] Students in recovery face many challenges when pursuing higher education, including exposure both to the high availability of alcohol or other drugs and to peers using substances on college campuses. These risk factors are further compounded by difficulties commonly experienced by students, including transitional stress and academic challenges, which can increase their susceptibility to engage in alcohol and drug use. Additionally, students who attend college full-time are more likely to consume considerable amounts of alcohol compared to their peers who are either not attending college or who are enrolled in college part-time.[4] Many youth in high school and college settings are exposed to environments that encourage drug use experimentation, and few recovery programs are available and accessible.

Although 8% to 9% of the adult U.S. population has an alcohol or drug use problem at any given time, only 2% of the population seek and receive treatment each year for these disorders (about 3.8 million individuals),[5] and even individuals who successfully complete treatment have high relapse rates. Posttreatment, individuals often live in communities that do not provide environmental recovery programs. However, there is an emerging network of recovery high schools, collegiate recovery programs, recovery housing, recovery coaches, and recovery community centers throughout the United States. This article's goal is to engage in an integrative review that summarizes past literature to provide a comprehensive understanding of the rationale, origins, emergence, prevalence, and research associated with these recovery support services. The articles mentioned below were the result of MEDLINE, Google Scholar, and PsycINFO searches that included the following terms: recovery high schools, collegiate recovery programs, recovery housing, recovery coaches, and recovery community centers.

RECOVERY HIGH SCHOOLS

Beginning in the late 1970s, recovery high schools (RHS) were established to serve youth recovering from drug use disorders.[6] Currently, there are more than 35 RHS across the United States. Most of these schools have licensed counselors and staff to provide recovery support. Students are usually required to attend outside support groups, such as 12-step programs. According to Finch and colleagues, the enrollment range in RHS is between six and 50 students, with one to five teachers.[6] Some RHS have independent physical structures and organizations, whereas others share space with public high schools. In addition, some RHS support students' transition back to traditional high schools, whereas others retain students until graduation. The lack of steady referrals to RHS can pose challenges to remaining financially viable.

Tanner-Smith and colleagues explored the characteristics of students who attend RHS.[7] In comparison to national samples, they found that students from RHS were significantly older, were more likely to be female and White, and reported higher levels of social support. In addition, RHS students were more likely to have family histories of drug use and mental health problems. Their parents also tended to have higher socioeconomic status than the general population. Compared to local non-RHS samples, students from RHS had higher rates of illicit drug use and drug use treatment episodes and fewer problems with illegal activities and arrests. In addition, students from RHS were more likely to suffer from other types of mental illness and to seek treatment alongside their drug use. Treatment centers appear to provide the majority of referrals, followed by family and self-referrals.

A few studies have evaluated the experiences and outcomes of those provided RHS. For example, Finch reported that the structure of RHS helped students maintain sobriety by separating them from traditional high school students, providing support groups comprising peers undergoing recovery, and making available staff with expertise in drug use recovery.[8] In addition, students mentioned that RHS led to increases in abstinence self-efficacy. Karakos found that RHS staff felt that students received emotional support and information on peer-to-peer recovery, and that RHS students gained new social network members who replaced those who engaged in drug use.[9] The small school sizes led to strong bonds as well as increased accountability because

relapse was harder to hide. However, RHS staff also reported that students experienced peer pressure to engage in alcohol and drug use and risky behavior during social outings. In addition, staff had to help students navigate boundaries around sharing information about their sobriety on social media.

In one of the few outcome studies, Finch et al. compared alcohol and drug use and educational outcomes between students in RHS and those attending other high schools.[7] They found that students attending RHS were more likely to be abstinent from alcohol and drugs and less likely to be absent from school than students in other high schools, but there were no significant differences in academic performance and mental health outcomes.

Oser et al. noted that youth of color often lack access to treatment prior to enrolling in RHS.[10] Glaude et al. found high rates of drug use among Hispanic youth, yet they lack access to interventions tailored for them.[11] RHS that include culturally specific elements may represent a promising setting for this population; however, additional research is warranted to determine the effectiveness of RHS among Hispanic youth.

COLLEGIATE RECOVERY PROGRAMS

In response to the challenges students in recovery face, collegiate recovery programs (CRPs) have formed on college campuses nationwide to help students manage their recovery while completing their education. CRPs provide students with a network of peers in recovery and with institutional support in the form of services and academic guidance. The first CRP was developed in 1977 at Brown University, and there are now 138 active programs throughout the United States.[12] Predominantly peer-run and informed by a 12-step abstinence framework, CRPs provide counseling services, recreational activities, life skills workshops, and both academic and financial support.[13] Some provide drug-free housing on campus and typically do not have limitations on duration of stay.

There is neither an accreditation process nor a single CRP model. However, the Association of Recovery in Higher Education and Texas Tech University's Center for Addiction and Recovery have developed guidelines for programming and implementation (https://www.depts.ttu.edu/hs/csa/replication.php). Given that these guidelines are not mandatory, CRPs differ in the way services are provided, their cost to students, and their eligibility criteria (e.g., length of abstinence, verification of abstinence). Some CRPs implement contracts that delineate behaviors to which members are expected to adhere.

Data from a national survey of 29 CRPs revealed that 57% of students are male, and 91% of students identify as White.[14] These demographic characteristics may reflect inequitable access across diverse populations to treatment and to 4-year universities. The average age of participants was 26 years, making this group older than the average college student. The majority of the students surveyed reported drug use disorder as their primary problem and AUD as their second. Additionally, 83% of students reported having received treatment for alcohol and/or drug use prior to enrolling in the program.

To date, no national studies have evaluated the effectiveness of CRPs, but smaller-scale studies and site-specific reports show promising recovery and educational outcomes. These positive outcomes include low relapse rates, grade-point averages (GPA) above the school average, high graduation rates, and perceived usefulness by members. A survey consisting of 29 CRPs reported that annual relapse rates ranged from 0% to 25%, with an average of 8%.[14] Additionally, only 5% of students reported using alcohol or drugs in the past month. These relapse rates are much lower compared to the first-year posttreatment relapse rates among youth.[13] Students who participate in CRPs have higher GPAs and higher retention and graduation rates compared to national averages for the general student population.[3]

As an example, the Texas Tech University program found a semester relapse rate of 4% to 8% among participants. In addition to lower relapse rates, CRP participants at Texas Tech had a 70% graduation rate, surpassing the graduation rate of the general student population at the university.[15]

Follow-up studies on CRP alumni have found that benefits extended beyond graduation.[16] Current findings also have implications for the recruitment of students in recovery into colleges and universities. In one study, 34% of participants surveyed expressed they would not be in college were it not for a CRP and 20% indicated that they would not have enrolled at their institution if a CRP had not been available.[17]

RECOVERY HOMES

Recovery homes (RHs) are community-style residences open to individuals maintaining a sober lifestyle. Residents of these homes are often individuals who have undergone and exited a drug rehabilitation program or incarceration and who have entered into an RH of their own volition or by court order. All residents must avoid drugs or alcohol while living in RHs. Typically, these homes are single-sex, and residents are expected to find employment and engage in external programs—such as Alcoholics Anonymous (AA), Narcotics Anonymous, or Cocaine Anonymous—that promote their commitment to sobriety. These homes afford residents with supportive social networks of individuals also living a sober lifestyle.

RHs manifest varying intensities of structure and support for their residents, and are classified into four levels of support.[18] Level I homes are self-run and do not include any external professional services. Level II homes often include a resident who is paid to oversee and maintain the home and to coordinate peer groups and services for residents. Level III homes often have staff present in the home who might provide clinical services and administrators who coordinate other services. Level IV homes are usually state-licensed and, as such, have licensed clinical services, are connected to state-funded services, and may be housed within a larger state-level institution.

The Washington Temperance Society started the earliest known RH in the United States in 1841.[19] In the middle half of the 20th century, RHs expanded across the country—fostered by religious groups, state governments, and private institutions—often branching into distinct systems. For example, more than 500 houses in the Sober Living Network in Southern California are closely associated with AA. It is unclear how many RHs exist, but recent estimates suggest there may be more than 17,500 such houses in the United States.[20]

The most well-known organizations that oversee RHs are the National Alliance for Recovery Residences and the Oxford House network; of these, the latter has been more well studied. Oxford Houses are self-governed homes within the Level I designation. Responsibilities of maintaining the home, establishing and enforcing house rules, and paying rent are distributed among residents. Research on Oxford Houses suggests that residents who remain in the houses for a minimum of 6 months are significantly less likely to relapse than are those who are not provided this housing or who stay for less than 6 months.[21] The collective and individual responsibility necessary to live at an Oxford House may motivate individuals to stay sober and provides each resident with motivated housemates who support sobriety.

Longitudinal findings from Level II homes have found that engagement in 12-step groups is the single best predictor of positive long-term outcomes for residents.[22] When paid staff or counselors are present in the RH, as in Level III homes, residents can access psychiatric treatment and receive a structured and formalized recovery plan. Residents in these RHs, compared to individuals who enter exclusively clinical programs, have longer durations of stay and better sobriety and criminology outcomes, all at a significantly lower cost.[23]

Level IV RHs frequently house individuals who have been court-mandated to enter into a recovery program. These systems usually exist within larger institutions, are run by staff, and are known as residential therapeutic communities. Martin et al. found that, 5 years after exiting a Level IV therapeutic community, individuals who had resided in community-based therapeutic communities had lower rates of drug use and re-arrest than did those who had been in prison-based therapeutic communities, and both samples had

better outcomes than individuals in the study who received no treatment.[24]

RECOVERY COACHES

A multitude of community-based self-help groups use a mentorship-style model for recovery (e.g., sponsorship in AA). These services are provided free of cost and are typically peer-driven. The more experienced members tend to "sponsor" the newcomers,[25] sharing their lived experiences with recovery and providing social support and access to recovery resources. Similar peer-driven recovery models are beginning to utilize recovery coaches (RCs). The first articles on RCs appeared between 1994 and 1998, coinciding with the beginning of the Recovery Community Services Program, which was instrumental in recognizing the role of peer-to-peer support services as a means of delivering treatment for drug use disorders.[26] The reference term "recovery coach" has been evolving, from "patient navigator" to "peer recovery specialist." Typically, RCs are peers who share their experiences of drug use and recovery with newer members and provide resources designed to build their mentees' problem-solving abilities.[27,28]

RCs, who are typically in recovery themselves, are trained to provide supportive services (i.e., psychological, social, emotional, spiritual, employment, financial) to those who struggle with a substance use disorder. Employed through a variety of community groups (e.g., community centers, religious organizations), RCs generally work full- or part-time hours and are typically required to have completed high school and have earned a formal training certificate.[27] Sharing past lived experiences with SUD and recovery cultivates trust from newcomers (who may be apprehensive about asking for help), which has been shown to increase motivation toward changing problematic behavioral patterns.[28] Overall, RCs model recovery values of honesty and open-mindedness, a capacity for introspection, problem-solving abilities, the construction of a recovery-based identity, as well as a recovery-supportive social network.[29]

A number of factors can distinguish an AA sponsor from an RC; for example, sponsors typically work within the framework of their respective 12-step fellowship, whereas RCs offer a larger range of services and resources that fall outside of the expertise of an AA sponsor.[30] In contrast to RCs, "recovery allies" provide the same services—that is, supporting behavior change, relationship building, harm reduction, and systems navigation[28]—but lack the "lived experience" component of an RC.[27]

Several studies have found supplemental advantages of utilizing an RC to provide recovery-specific social support. Ryan et al. found that, compared to receiving services as usual, the addition of an appointed RC significantly increased the likelihood for achieving a stable reunification for families.[31] VanDeMark et al. found that 54% of participants endorsed RCs as helpful in creating feelings of being part of a community.[32] Reif et al. found that RCs are effective across four domains: (1) improved relationships with providers and social supports, (2) increased treatment retention, (3) increased satisfaction with the overall treatment experience, and (4) reduced rates of relapse.[33]

RECOVERY COMMUNITY CENTERS

Recovery community centers (RCCs) provide a variety of services such as recovery coaching, space for 12-step meetings, employment opportunities, and educational linkages. They are often located in central areas within cities and towns, with services being provided by peer volunteers and recovery professionals.[34] RCCs do not subscribe or endorse just one ideology or pathway to recovery, but rather embrace all recovery approaches.[35] Alcohol and drug use are reduced by providing personal, social, and environmental resources and by being flexible to multiple recovery strategies.[36]

Unfortunately, there have been few investigations of RCCs.[37,38] In one of the few comprehensive investigations, Kelly et al. studied 32 RCCs across the northeastern United States.[39] Services included social/recreational activities, mutual help, recovery

coaching, employment help, education assistance, overdose reversal training, and medication-assisted treatment support. The RCCs studied were in operation for an average of 8.5 years, with considerable variability in how many clients were served each month, ranging from a dozen to more than 2,000. Most were state-funded with yearly budgets ranging from $17,000 to $760,000. Locations were primarily in urban or suburban areas with easy accessibility. The neighborhoods and buildings were rated as moderate to good in attractiveness and quality. Most but not all directors and staff were in recovery themselves.

Kelly et al. also interviewed more than 300 clients attending these RCCs.[40] With an average age of 41, about 50% of participants were female, 79% were White, 49% had a high school or lower education, and 45% had a household income of less than $10,000 over the past year. Their primary substance of use was opioids or alcohol, and 49% reported a lifetime psychiatric diagnosis. The investigators found that the RCCs were associated with increased recovery capital (the sum of personal and social resources that facilitate the process of recovery), and that recovery capital and social support were related to improvements in psychological distress, self-esteem, and quality of life.

DISCUSSION

This article reviews various recovery support services available in the United States throughout the life span—from adolescence through adulthood. The support services reviewed include recovery high schools, collegiate recovery programs, recovery housing, recovery coaches, and recovery community centers. These types of programs are of particular importance given that alcohol and drug use disorders are chronic conditions marked by cycles of recovery, relapse, and repeated treatment.[41] Too often, these conditions have been treated without any attention to community factors that can contribute to abstinence or relapse. These disorders should be treated like any other chronic condition, with long-term care and treatment. Effectively treating alcohol and drug use disorders requires a paradigm shift away from pathological models of recovery and toward a multidimensional recovery health framework that encompasses the environmental context.

As noted in this article, attention is increasingly focused on supportive recovery networks, along with housing and job opportunities for social reintegration. These environmental factors highlight the importance of recovery capital.[42] The personal component of recovery capital includes endowments such as self-efficacy, knowledge, personal health, education, hope, employment, financial assets, and transport. The social/environmental component can be further subdivided into a social branch (supportive, pro-recovery relationships with family and significant others, peer mentors, and recovery and support groups), and a community branch (treatment resources and support services, social acceptance and lack of stigma, continuum of care resources, and non-SUD support services for mental and physical health).

RHS have the potential to provide a protective environment to promote and maintain recovery for adolescent youth. Students of diverse backgrounds may benefit from access to these schools. Unfortunately, the scarcity of outcome studies makes it difficult to understand the outcomes for youth attending these settings. In addition, it is still unclear if proximity to drug-using students increases the risk of relapse. Future research should examine students' social networks to assess both positive and negative effects of attending these alternative schools. There is also a need to better understand how to increase program sustainability of these schools.

CRPs seem to help students successfully manage their recovery while they complete their education in college and university settings, environments that are often not conducive for recovery. The lack of uniformity across CRPs limits understanding of the available findings. Further research is needed to evaluate the effectiveness of CRPs in determining which services generate the best outcomes and which pre-program enrollment characteristics (e.g., length

of sobriety) can optimize student outcomes. There is also a need to investigate barriers to program implementation and to understand how to improve access and delivery of CRP resources to students. More research on post-program outcomes is needed to determine the long-term effects of participation in CRPs. Furthermore, whether CRPs can be as successful for individuals from diverse racial, ethnic, gender, and socioeconomic backgrounds needs to be examined.

In regard to recovery homes, individuals who stay in an RH for at least 6 months appear to have better long-term outcomes than those who do not stay as long. However, self-selection is at work here as a potential bias, given that the outcome might be different if people were randomly assigned to receive differing lengths of stay. There is a need to identify the location and availability of recovery houses across different regions of the United States. In addition, information about whether these homes have openings for prospective residents should be made available to the public. There is also a need to better understand the underlying processes that might account for a successful or unsuccessful stay in recovery housing; this would help determine which aspects of these homes and living communities are related to long-term sobriety. Finally, oversight of RHs by organizations such as Oxford House or by state regulatory agencies could curb the potential exploitation of residents in poorly managed houses.

RCs appear to be a helpful part of the recovery support environment, but there is a need to determine their unique contributions to outcomes. Regarding RCs and other types of recovery support services, developing a commonly agreed upon set of outcome measures in studies could advance the research in this area.[43] This could occur with oversight committees to encourage agreements from critical stakeholder groups (e.g., outreach workers, hospitals, outpatient clinics, inpatient treatment centers, RHs).

Findings from RCCs suggest that they may facilitate the acquisition of recovery capital and enhance functioning and quality of life. It appears that individuals with few resources make use of these accessible RCCs, which may increase social support, employment, housing, and other recovery capital. Given the spread of these RCCs over the past few years, more information is needed about the costs and benefits of these innovative settings, which may play an important factor in reducing relapse.

There are a number of limitations of the studies reviewed in this article. For example, there is an overemphasis on "smaller-scale" studies and "site-specific reports," which can be biased in favor of the particular modality and/or site being evaluated. For example, among residents of RHs, engagement in 12-step groups was the single best predictor of positive outcomes, but these types of outcomes could be biased by the self-selection of individual clients into 12-step engagement and may not indicate any additional benefit of the housing. Thus, it is important to sort out the effects of the particular intervention under review from the effects of ancillary services received in the setting. In addition, there are very few longitudinal studies evaluating recovery support services. Additional studies are needed to assess whether short-term sobriety gains and other observed outcomes are maintained over time. It is still unclear what mechanisms are involved in how recovery support services may help reduce relapse risk and foster stabilization and recovery; it is likely that this occurs by increasing recovery capital, but this is an area where more research is needed. Lastly, most of the studies reviewed had a predominantly White sample, thus warranting an examination of whether these recovery support services can help diverse racial or ethnic populations initiate and maintain long-term recovery.

Alcohol and drug use treatment programs have begun providing briefer formal programs followed by "aftercare," which is sometimes a referral to AA or Narcotics Anonymous and an expectation to refrain from alcohol and drug use. Following release from a few weeks of acute treatment, follow-up stays in supportive, cohesive posttreatment settings encourage personal transformation and have been shown to reduce relapse rates.[44] Environmental factors

may be key contributors to long-term abstinence. Unfortunately, many youth and adults are not provided the types of environmental supports needed to solidify and support their recovery. There is a need to better understand possible improvements in long-term recovery outcomes for those provided these types of supports, as well as to gain information regarding their accessibility, availability, and affordability.[45] There is also a need for more research in general across the spectrum of these services as well as additional research on the types of individuals for whom particular recovery support services may be most helpful, the most effective timing for introducing these services during the recovery change process, and how these services confer benefits.

Acknowledgments

The authors appreciate the financial support from the National Institute on Alcohol Abuse and Alcoholism (grant number AA022763). The assistance from members of the Oxford House organization—and, in particular, Paul Molloy, Kathleen Gibson, Alex Snowden, Casey Longan, and Howard Wilkins—is acknowledged. The authors also appreciate the help of colleagues, including Ed Stevens, John Light, Mike Stoolmiller, and Nathan Doogan.

Financial Disclosures

The authors declare no competing financial or nonfinancial interests.

Publisher's Note

Opinions expressed in contributed articles do not necessarily reflect the views of the National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health. The U.S. government does not endorse or favor any specific commercial product or commodity. Any trade or proprietary names appearing in *Alcohol Research: Current Reviews* are used only because they are considered essential in the context of the studies reported herein.

References

1. Substance Abuse and Mental Health Services Administration (SAMHSA), Center for Behavioral Health Statistics and Quality. *Key Substance Use and Mental Health Indicators in the United States: Results From the 2018 National Survey on Drug Use and Health.* Rockville, MD: U.S. Department of Health and Human Services (HHS); 2019. https://www.samhsa.gov/data.
2. SAMHSA. *Results From the 2018 National Survey on Drug Use and Health: Detailed Tables.* Rockville, MD: HHS; 2018. https://www.samhsa.gov/data/sites/default/files/cbhsq-reports/NSDUHDetailedTabs2018R2/NSDUHDetailedTabs2018.pdf.
3. Ashford RD, Brown AM, Eisenhart E, et al. What we know about students in recovery: Meta-synthesis of collegiate recovery programs, 2000-2017. *Addict Res Theory.* 2018;26(5):405-413. https://doi.org/10.1080/16066359.2018.1425399.
4. SAMHSA. *Treatment Episode Data Set (TEDS): 2014. Discharges From Substance Abuse Treatment Services.* BHSIS Series S-94, HHS Publication No. (SMA) 17-5040. Rockville, MD: HHS; 2017. https://wwwdasis.samhsa.gov/dasis2/teds_pubs/2014_teds_rpt_d.pdf.
5. SAMHSA. *Results From the 2011 National Survey on Drug Use and Health: Summary of National Findings.* Rockville, MD: HHS; 2011. https://www.samhsa.gov/data/sites/default/files/Revised2k11NSDUHSummNatFindings/Revised2k11NSDUHSummNatFindings/NSDUHresults2011.htm#Ch7.
6. Finch AJ, Moberg DP, Krupp AL. Continuing care in high schools: A descriptive study of recovery high school programs. *J Child Adolesc Subst Abuse.* 2014;23(2):116-129. https://doi.org/10.1080/1067828X.2012.751269.
7. Tanner-Smith EE, Finch AJ, Hennessy EA, et al. Who attends recovery high schools after substance use treatment? A descriptive analysis of school aged youth. *J Subst Abuse Treat.* 2018;89:20-27. https://doi.org/10.1016/j.jsat.2018.03.003.
8. Finch AJ. Authentic voices: Stories from recovery school students. *J Groups Addict Recover.* 2008;2(2-4):16-37. https://doi.org/10.1080/15560350802080779.
9. Karakos HL. Positive peer support or negative peer influence? The role of peers among adolescents in recovery high schools. *Peabody J Educ.* 2014;89(2):214-228. https://doi.org/10.1080/0161956X.2014.897094.
10. Oser R, Karakos HL, Hennessy EA. Disparities in youth access to substance abuse treatment and recovery services: How one recovery school initiative is helping students "change tracks." *J Groups Addict Recover.* 2016;11(4):267-281. https://doi.org/10.1080/1556035X.2016.1211056.
11. Glaude M, Torres LR. Hispanic perspectives on recovery high schools: If we build them, will they come? *J Groups Addict Recover.* 2016;11(4):240-249. https://doi.org/10.1080/1556035X.2016.1211058.
12. Association of Recovery in Higher Education (ARHE). *Collegiate recovery programs.* ARHE website. 2019. https://collegiaterecovery.org/crps-crcs.
13. Laudet A, Harris K, Kimball T, et al. Collegiate recovery communities programs: What do we know and what do we need to know? *J Soc Work Pract Addict.* 2014;14(1):84-100. https://doi.org/10.1080/1533256X.2014.872015.
14. Laudet AB, Harris K, Kimball T, et al. Characteristics of students participating in collegiate recovery programs: A national survey. *J Subst Abuse Treat.* 2015;51:38-46. https://doi.org/10.1016/j.jsat.2014.11.004.
15. Bugbee BA, Caldeira KM, Soong AM, et al. *Collegiate Recovery Programs: A Win-Win Proposition for Students and Colleges.* College Park, MD: Center on Young Adult Health and Development; 2016. https://doi.org/10.13140/RG.2.2.21549.08160.
16. Brown AM, Ashford RD, Figley N, et al. Alumni characteristics of collegiate recovery programs: A national survey. *Alcohol Treat Q.* 2019;37(2):149-162. https://doi.org/10.1080/07347324.2018.1437374.
17. Laudet AB, Harris K, Kimball T, et al. In college and in recovery: Reasons for joining a Collegiate Recovery Program. *J Am Coll Health.* 2016;64(3):238-246. https://doi.org/10.1080/07448481.2015.1117464.
18. Jason LA, Mericle AA, Polcin DL, et al. The role of recovery residences in promoting long-term addiction recovery. *Am J Community Psychol.* 2013;52(3-4):406-411. https://doi.org/10.1007/s10464-013-9602-6.

19. National Association of Recovery Residences. *A Primer on Recovery Residences: Frequently Asked Questions.* September 20, 2012. https://narronline.org/wp-content/uploads/2014/06/Primer-on-Recovery-Residences-09-20-2012a.pdf.
20. Jason LA, Wiedbusch E, Bobak T, et al. Estimating the number of substance use disorder recovery homes in the United States. *Alcohol Treat Q.* 2020;38(4):506-514. https://doi.org/10.1080/07347324.2020.1760756.
21. Jason LA, Davis MI, Ferrari JR. The need for substance abuse after-care: Longitudinal analysis of Oxford House. *Addict Behav.* 2007;32(4):803-818. https://doi.org/10.1016/j.addbeh.2006.06.014.
22. Polcin DL, Korcha RA, Bond J, et al. Sober living houses for alcohol and drug dependence: 18-month outcomes. *J Subst Abuse Treat.* 2010;38(4):356-365. https://doi.org/10.1016/j.jsat.2010.02.003.
23. Borkman TJ, Kaskutas LA, Room J, et al. An historical and developmental analysis of social model programs. *J Subst Abuse Treat.* 1998;15(1):7-17. https://doi.org/10.1016/S0740-5472(97)00244-4.
24. Martin SS, Butzin CA, Inciardi JA. Assessment of a multistage therapeutic community for drug-involved offenders. *J Psychoactive Drugs.* 1995;27(1):109-116. https://doi.org/10.1080/02791072.1995.10471679.
25. Stevens EB, Jason LA. Evaluating Alcoholics Anonymous sponsor attributes using conjoint analysis. *Addict Behav.* 2015;51:12-17. https://doi.org/10.1016/j.addbeh.2015.06.043.
26. Kaplan L, Nugent C, Baker M, et al. Introduction: The recovery community services program. *Alcohol Treat Q.* 2010;28(3):244-255. https://doi.org/10.1080/07347324.2010.488522.
27. Eddie D, Hoffman L, Vilsaint C, et al. Lived experience in new models of care for substance use disorder: A systematic review of peer recovery support services and recovery coaching. *Front Psychol.* 2019;10:1052. https://doi.org/10.3389/fpsyg.2019.01052.
28. Jack HE, Oller D, Kelly J, et al. Asking how our patients understand addiction. *Am J Med.* 2018;132(3):269271. https://doi.org/10.1016/j.amjmed.2018.09.007.
29. White W. Executive summary. Peer-based addiction recovery support: History, theory, practice, and scientific evaluation. *Counselor.* 2009;10(5):54-59.
30. SAMHSA. *What Are Peer Recovery Support Services?* Rockville, MD: HHS; 2009. https://store.samhsa.gov/system/files/sma09-4454.pdf.
31. Ryan JP, Victor BG, Moore A, et al. Recovery coaches and the stability of reunification for substance abusing families in child welfare. *Child Youth Serv Rev.* 2016;70:357-363. https://doi.org/10.1016/j.childyouth.2016.10.002.
32. VanDeMark NR, Burrell NR, LaMendola WF, et al. An exploratory study of engagement in a technology-supported substance abuse intervention. *Subst Abuse Treat Prev Policy.* 2010;5:10. https://doi.org/10.1186/1747-597X-5-10.
33. Reif S, Braude L, Lyman DR, et al. Peer recovery support for individuals with substance use disorders: Assessing the evidence. *Psychiatr Serv.* 2014;65(7):853861. https://doi.org/10.1176/appi.ps.201400047.
34. Cousins SJ, Antonini VP, Rawson RA. Utilization, measurement, and funding of recovery supports and services. *J Psychoactive Drugs*. 2012;44(4):325-333. https://doi.org/10.1080/02791072.2012.718924.
35. Valentine P. Peer-based recovery support services within a recovery community organization: The CCAR experience. In: Kelly JF, White WL, eds. *Addiction Recovery Management: Theory, Research and Practice.* New York, NY: Springer; 2011:259-279.
36. Kelly JF, White WL. Broadening the base of addiction mutual help organizations. *J Groups Addict Recover.* 2012;7(2-4):82-101. https://doi.org/10.1080/1556035X.2012.705646.
37. Armitage EV, Lyons H, Moore TL. Recovery Association Project (RAP), Portland, Oregon. *Alcohol Treat Q.* 2010;28(3):339357. https://doi.org/10.1080/07347324.2010.488539.
38. Mericle AA, Miles J, Cacciola J, et al. Adherence to the social model approach in Philadelphia recovery homes. *Int J Self Help Self Care.* 2014;8:259-275. https://doi.org/10.2190/SH.8.2.g.
39. Kelly JF, Stout RL, Jason LA, et al. One-stop shopping for recovery: An investigation of participant characteristics and benefits derived from U.S. recovery community centers. *Alcohol Clin Exp Res.* 2020;44(3):711-721. https://doi.org/10.1111/acer.14281.
40. Kelly JF, Fallah-Sohy N, Vilsaint C, et al. New kid on the block: An investigation of the physical, operational, personnel, and service characteristics of recovery community centers in the United States. *J Subst Abuse Treat.* 2020;111:1-10. https://doi.org/10.1016/J.JSAT.2019.12.009.
41. Dennis M, Scott CK. Managing addiction as a chronic condition. *Addict Sci Clin Pract.* 2007;4(1):45-55.
42. Best D, Laudet A. *The Potential of Recovery Capital.* London: RSA; 2010.
43. London K, McCaffrey M, McDowell L, et al. *Recovery Coaches in Opioid Use Disorder Care: Report and Estimator Tools.* Worcester, MA: Commonwealth Medicine Publications; 2019. https://escholarship.umassmed.edu/commed_pubs/227.
44. Schaefer JA, Cronkite RC, Hu KU. Differential relationships between continuity of care practices, engagement in continuing care, and abstinence among subgroups of patients with substance use and psychiatric disorders. *J Stud Alcohol Drugs.* 2011;72(4):611-621. https://doi.org/10.15288/jsad.2011.72.611.
45. Kelly JF, White WL, eds. *Addiction Recovery Management: Theory, Research, and Practice.* Totowa, NJ: Humana Press; 2011.

ALCOHOL RESEARCH
Current Reviews

Alcohol Res. 2021;41(1):03 ● https://doi.org/10.35946/arcr.v41.1.03

Published: 11 March 2021

Racial/Ethnic Disparities in Mutual Help Group Participation for Substance Use Problems

Sarah E. Zemore,[1] Paul A. Gilbert,[2] Miguel Pinedo,[3] Shiori Tsutsumi,[4] Briana McGeough,[5] and Daniel L. Dickerson[6]

[1]Alcohol Research Group, Emeryville, California
[2]Department of Community and Behavioral Health, University of Iowa, Iowa City, Iowa
[3]Center for Health and Social Policy, College of Education-Kinesiology and Health Education, University of Texas, Austin, Texas
[4]School of Environment and Society, Department of Social and Human Sciences, Tokyo Institute of Technology, Tokyo, Japan
[5]Cofrin Logan Center for Addiction Research and Treatment, School of Social Welfare, University of Kansas, Lawrence, Kansas
[6]Integrated Substance Abuse Programs, University of California, Los Angeles, California

Mutual help groups are a ubiquitous component of the substance abuse treatment system in the United States, showing demonstrated effectiveness as a treatment adjunct; so, it is paramount to understand whether they are as appealing to, and as effective for, racial or ethnic minority groups as they are for Whites. Nonetheless, no known comprehensive reviews have examined whether there are racial/ethnic disparities in mutual help group participation. Accordingly, this study comprehensively reviewed the U.S. literature on racial/ethnic disparities in mutual help participation among adults and adolescents with substance use disorder treatment need. The study identified 19 articles comparing mutual help participation across specific racial/ethnic minority groups and Whites, including eight national epidemiological studies and 11 treatment/community studies. Most compared Latinx and/or Black adults to White adults, and all but two analyzed 12-step participation, with others examining "self-help" attendance. Across studies, racial/ethnic comparisons yielded mostly null (*N* = 17) and mixed (*N* = 9) effects, though some findings were consistent with a racial/ethnic disparity (*N* = 6) or minority advantage (*N* = 3). Findings were weakly suggestive of disparities for Latinx populations (especially immigrants, women, and adolescents) as well as for Black women and adolescents. Overall, data were sparse, inconsistent, and dated, highlighting the need for additional studies in this area.

KEY WORDS: race/ethnicity; African American; Hispanic; Native American; mutual help; self-help; alcohol

INTRODUCTION

Racial/ethnic minority groups comprise a large proportion of the U.S. population and evidence a substantial need for treatment of substance use disorder (SUD). Analysis of the most recent, reliable data available—the 2018 National Survey on Drug Use and Health (NSDUH)[1]—found that the prevalence of past-year SUD among those age 12 and older was higher among some racial/ethnic minority groups than Whites. Compared to Whites (with a prevalence rate of 7.7%), the prevalence of past-year SUD was 31% higher among American Indians or Alaska Natives (10.1%), 21% higher among Native Hawaiians or Other Pacific Islanders (9.3%), and 16% higher among multiracial U.S. residents (8.9%). The prevalence rate for Whites was similar to those for Hispanic or Latino populations (7.1%) and Black or African American populations (6.9%). Prevalence among Asians was low overall (4.8%), though other studies suggest that substance use problems may be elevated in some ethnic subgroups (e.g., Koreans) and in Asian American young adults.[2-4] Parallel patterns emerged for alcohol and illicit drug use disorders, revealing elevated rates among American Indians or Alaska Natives, Native Hawaiians or Other Pacific Islanders, and multiracial respondents in both cases.

Participation in mutual help groups (also known as self-help groups), including 12-step groups such as Alcoholics Anonymous (AA), is an integral and nearly ubiquitous component of the U.S. SUD treatment system[5-7] and a typical constituent of mandated treatment.[8] Moreover, 12-step participation—in conjunction with specialty SUD treatment (i.e., formal SUD treatment, such as that delivered in outpatient or residential treatment programs)—is also highly effective in treating SUD for typical treatment populations overall.[9-14] Indeed, 12-step facilitation (TSF) interventions, which are designed to enhance involvement by (for example) explaining 12-step principles and culture, have repeatedly, if not universally, achieved better substance use outcomes than both usual treatment alone and gold standard treatments, such as cognitive behavioral therapy.[15] Emerging studies also have examined, and found support for, the effectiveness of abstinence-based, secular mutual help alternatives to the 12-step approach.[16-18] For instance, one recent study compared the effectiveness of 12-step groups and several abstinence-based alternatives—namely, Women for Sobriety, Self-Management and Recovery Training (SMART Recovery), and LifeRing Secular Recovery (LifeRing)—among current attendees with alcohol use disorder (AUD) over 1 year. Results indicated equally strong relationships between higher involvement and better substance use outcomes regardless of mutual help group choice and, unexpectedly, higher group cohesion and satisfaction in Women for Sobriety, SMART Recovery, and LifeRing versus 12-step groups.[17,18]

Together, the prevalence and effectiveness of mutual help groups highlight a critical need to understand the nature and extent of racial/ethnic disparities in mutual help group participation for substance use problems. Given that mutual help groups are a key resource for supporting recovery, any racial/ethnic disparity in mutual help participation connotes a potential health disadvantage for racial/ethnic minority groups that is worthy of investigation.[19] Investigation of disparities in mutual help group participation is particularly valuable because there are reasons to believe that racial/ethnic minority groups (and especially immigrants) experience unique barriers to mutual help participation (e.g., racial/ethnic discrimination) as well as more barriers to help-seeking generally, described below. Accordingly, the present study offers a comprehensive review of empirical research on racial/ethnic disparities in mutual help group participation, addressing research on individuals with alcohol and/or drug problems. Although others have summarized the literature on racial/ethnic disparities related to mutual help groups,[10,20,21] this study is the first known comprehensive review. Attention is focused predominantly on racial/ethnic disparities related to 12-step groups (and especially AA) because these groups have been the dominant focus of existing literature; however, the review also discusses alternatives to 12-step groups. Results will inform attempts to maximize SUD treatment effectiveness among racial/ethnic minority groups as well as future research aiming to understand

recovery and pathways for recovery among racial/ethnic minority populations.

UNIQUE BARRIERS TO PARTICIPATION IN MUTUAL HELP GROUPS

Several qualitative studies on the experiences of racial/ethnic minority individuals in 12-step groups/AA have concluded that these individuals may face unique barriers to full mutual help group participation and benefit. For example, Jilek-Aall suggested that AA can be off-putting to American Indians because attending AA may be equated with rejection of one's Indian identity and culture; because AA's worldview and practices (e.g., focus on confession-like speeches and Christian religiosity) are not consistent with those of American Indians; and because of miscommunication, barriers to trust, and discrimination by Whites.[22,23] Venner and colleagues' more recent, qualitative study likewise concluded that American Indians may avoid AA because they see it as "for White men," because aspects of the program are not consistent with their beliefs and preferences, and because they feel scrutinized in AA.[24] For some of the same reasons, others have argued that mainstream AA can be a poor fit for Black[25-27] and Latinx[28] people with substance use problems.

This literature broadly illuminates three distinct mechanisms that may create discomfort for racial/ethnic minority individuals in the context of mutual help groups. Racial/ethnic minority individuals may (a) perceive that their people and culture are not well represented within a given mutual help group's founding, history, membership, and/or leadership, generating concern and mistrust; (b) perceive that a given mutual help group's philosophy, values, and practices run counter to those of their own culture; and (c) experience challenging, current social contexts within a given mutual help group, such as heightened scrutiny, prejudice, and discrimination. These barriers could influence racial/ethnic minority individuals to avoid meetings and/or to participate in circumscribed ways that limit the benefits of participation, such as avoiding talking, avoiding sensitive disclosures, and failing to seek a 12-step sponsor. Although not a focus of the above studies, language barriers also could diminish or preclude participation for racial/ethnic minority groups, especially recent immigrants and those with low acculturation to U.S. society.

Counter to these arguments, some evidence suggests that such differences can be at least partially overcome. In principle, 12-step groups are open to adaptation,[29,30] and they have proliferated (in sometimes adapted form) in many countries throughout the world, suggesting the potential for wide if not universal appeal.[31] Furthermore, 12-step groups have been culturally adapted specifically for American Indian and Alaska Native,[22,23,32,33] Black,[26,27] and Latinx[28,34,35] populations. For American Indians and Alaska Natives, the Medicine Wheel and 12 Steps program blends Native American traditional teachings with the 12 Steps of Alcoholics Anonymous to provide culture-specific recovery assistance for Native Americans.[32] In this program, each step may be worded differently from its AA wording, and the steps are presented in a circle rather than as a straight-line listing to ensure cultural appropriateness. Also, this program states that being "in recovery" requires a further journey to wellness by going beyond "clean and sober," by pursuing a journey of healing and balance—mentally, physically, emotionally, and spiritually. This highlights that racial/ethnic minority individuals may have distinct concepts of recovery that should (and can) be addressed in cultural adaption.

Nonetheless, appropriately adapted meetings may not be available and accessible to all racial/ethnic minority groups and subgroups. For example, Asian Americans may face especially serious barriers to 12-step participation given the prohibitions common to many Asian cultures against publicly acknowledging addiction[36,37] and given the heterogeneous composition and small number of Asian Americans in the United States, which may inhibit the growth of culturally adapted meetings. Racial/ethnic minority individuals living outside of major metropolitan areas or ethnic enclaves also may be at a disadvantage, due to their restricted access to culturally adapted meetings;[29] and recent immigrants and others low on acculturation may

struggle with cultural mismatch regardless of the availability of culturally adapted meetings, as adapted meetings in the United States still may fail to adequately reflect their cultures of origin.[28]

GENERAL BARRIERS TO HELP SEEKING

Quantitative and qualitative studies also suggest that racial/ethnic minority groups face greater barriers to seeking help for SUD more generally, which likewise could influence mutual help group participation and benefits. Multiple studies conducted with U.S. national samples have reported lower rates of specialty SUD treatment utilization among Latinx (vs. White) individuals with SUD,[38-44] with studies suggesting particularly limited utilization among foreign-born and Spanish-speaking Latinx subgroups.[45-47] National studies in the United States also have reported disparities in specialty SUD treatment utilization among Asian Americans (vs. Whites)[4,48] and lower SUD treatment retention among both Black and Latinx (vs. White) individuals.[49,50] These studies provide compelling evidence of racial/ethnic disparities in treatment utilization and retention because they used nationally representative samples, restricted analysis to those with an SUD, and often controlled for problem severity.

A parallel evidence base has addressed general barriers to seeking help for an SUD, focusing mostly on Latinx and Black populations.[42,47,51-55] Studies (most addressing multiple barriers simultaneously) have described increased barriers facing Latinx and Black populations in several categories, including logistic barriers (e.g., difficulties with finding treatment, paying/qualifying for treatment, obtaining transportation, handling family and work responsibilities), attitudinal barriers (e.g., lack of perceived treatment need, lack of perceived treatment effectiveness), social and legal barriers (e.g., lack of social support/pressure for treatment seeking, stigma, concerns about deportation, concerns about retaining child custody), and cultural barriers (e.g., lack of culturally adapted treatments, lack of racial/ethnic minority group representation among clients and staff).

Although parallel studies have not been conducted to explore barriers to mutual help group participation per se, many of the above barriers could plausibly affect mutual help group participation. Logistic barriers may be especially salient for recent immigrants and economically disadvantaged groups. For example, recent immigrants and impoverished members of racial/ethnic minority groups may face particular challenges in locating appropriate meetings, obtaining transportation to meetings, and handling competing responsibilities. That said, impacts of certain logistic and legal barriers to help seeking in general terms may be somewhat mitigated when considering mutual help group participation specifically. This is because 12-step meetings are widely available (i.e., located in accessible community settings), free, and independent of governmental institutions.

A last point worthy of attention is that disparities in treatment utilization and retention among Latinx, Black, and Asian populations may themselves constitute barriers to mutual help group participation among affected groups because specialty treatment constitutes a major route to mutual help group involvement (and especially 12-step involvement). Referral to meetings by treatment staff is perhaps the predominant route to 12-step participation, so those who do not attend (or attend less) treatment may be less likely to participate in 12-step groups. Toward this point, 32% of respondents to the 2014 AA Membership Survey reported direct referral from a treatment facility, and 59% reported receiving some treatment/counseling related to their drinking before coming to AA; among the latter, 74% said this experience played an important part in directing them to AA.[8] Referral to 12-step by medical and mental health professionals is also common,[8] which may similarly disadvantage Latinx and Black individuals because they are less likely than Whites to regularly access primary care and mental health care.[56-59]

The discussion above paints a complex picture of the potential for racial/ethnic disparities related

to mutual help groups. It suggests that, although any racial/ethnic minority individual could experience multiple barriers to mutual help group participation, mitigating factors may alter the impacts of these barriers. In lieu of study hypotheses, this review therefore offers two questions:

1. What is the extent and nature of quantitative research on racial/ethnic disparities in mutual help group participation?
2. Do existing studies suggest racial/ethnic disparities in mutual help group participation, and for whom?

In addressing the second question, the review initially examines national studies and treatment/community studies separately, given their differences in rigor and sampling strategies. However, in view of the limited evidence base, results from both study types are synthesized to formulate overarching conclusions.

METHODS

Approach and Search Strategy

The current review employed a narrative review strategy strengthened by incorporation of key aspects of systematic reviews, including systematic search procedures and study coding. To locate relevant publications, PubMed and PsycINFO were searched using the following search terms and combinations thereof: mutual help, self-help, mutual aid, Alcoholics Anonymous, Narcotics Anonymous, Cocaine Anonymous, Marijuana Anonymous, 12-step, twelve-step, SMART Recovery, LifeRing, Women for Sobriety, alcohol, substance, drug, Black, African American, Latino, Hispanic, Asian American, American Indian, Native American, Alaska Native, race, and ethnicity. Reference lists of relevant articles and related-citation links also were examined.

Focal Variables and Study Inclusion and Exclusion Criteria

This review examined associations between racial/ethnic self-identification (the independent variable) and mutual help participation (the outcome), defined as meeting attendance and/or participation in key activities. The review included only original, quantitative articles describing the results of U.S. studies; published in English-language, peer-reviewed journals; and analyzing the presence or extent of mutual help participation across two or more specific racial/ethnic groups with SUD treatment need—as indicated by the presence of an alcohol problem and/or drug use/a drug problem. The review included studies on both adults and adolescents, using no publication date restrictions. Studies were excluded from review if they (1) analyzed only one racial/ethnic group; (2) compared Whites to a combined sample of racial/ethnic minority groups; (3) omitted statistical tests of racial/ethnic differences in mutual help group participation or data sufficient for such tests; or (4) presented results for subsamples of racial/ethnic minority groups where data for the larger racial/ethnic populations were published elsewhere.

Analysis and Summary of Findings

Where statistical comparisons were not provided, this review's lead author conducted bivariate comparisons (i.e., Pearson chi-square tests) using raw, published data. Study characteristics and relevant results were summarized in two descriptive tables. A third table was used to summarize the main results for each racial/ethnic subgroup separately. This table coded results for racial/ethnic comparisons across all mutual help participation outcomes for a given study, but relative only to a specific racial/ethnic group (e.g., coding results for Latinx-White comparisons on all study measures of mutual help group participation at all time points). Results were coded as null, mixed, entirely consistent with lower minority-group participation (a disparity), or entirely consistent with higher minority-group participation (a minority advantage); results were coded as "mixed" when they differed across outcomes, data sources, and/or subgroups (e.g., genders). Marginally significant results (i.e., $.05 < p < .10$) were coded as significant, not null, for this purpose.

RESULTS

National, Epidemiological, Cross-Sectional Studies

Table 1 presents the characteristics and key results of identified national epidemiological studies examining racial/ethnic differences in mutual help group participation; all were cross-sectional ($N = 8$ studies).[38-42,60-62] Data sources were the 1995–2010 National Alcohol Survey (NAS) series, the 1991–1992 National Longitudinal Alcohol Epidemiologic Survey (NLAES), the 2001–2002 and 2004–2005 National Epidemiologic Surveys on Alcohol and Related Conditions (NESARC), and the 2001–2013 NSDUH series, yielding six unique data sets. No studies addressed adults over the past decade. As shown in Table 1, key racial/ethnic subgroups were relatively large (all $N > 100$), excepting those for Asian American/Native Hawaiian/Pacific Islander ($N = 99$) and Native Hawaiian/Pacific Islander ($N = 68$) groups. All but two studies targeted Latinx and/or Black populations, and only one targeted adolescents. All but two studies[40,42] aggregated across nativity and gender when examining racial/ethnic differences. However, all studies including Latinx respondents, excepting the NLAES, reported providing Spanish-language interviews, allowing participation of those not fluent in English. Half targeted those with AUD only, with the others targeting other drug use disorders also or exclusively. All eight studies analyzed AA/12-step or "self-help" attendance and were limited to a measure of any versus no attendance, most using a lifetime time frame. Five conducted multivariate analyses.

Results were quite mixed, with three studies providing at least some evidence of disparities (i.e., Cummings et al., 2011;[39] Mancini et al., 2015;[40] Zemore et al., 2014[42]); three showing at least some evidence of a minority advantage (i.e., Chartier et al., 2011;[38] Perron et al., 2009;[61] Wu et al., 2016[62]); and two reporting entirely null results (i.e., Schmidt et al., 2007;[41] Kaskutas et al., 2008[60]) for racial/ethnic differences in mutual help group participation. (See also Table 3.)

Treatment and Community Studies

Table 2 presents the characteristics and key results of identified treatment- and community-based studies examining racial/ethnic differences in mutual help group participation ($N = 11$ studies).[29,63-72] Studies represent 10 unique data sources, many dated—especially for Latinx-White and Black-White comparisons. Seven of the 11 reported total *samples* of less than 100 for key racial/ethnic subgroups. All but two studies targeted Latinx and/or Black populations exclusively, and all but one targeted adults. All 11 studies aggregated across nativity and gender groups for analysis, and no studies sampling Latinx respondents reported the use of Spanish-language interviews. Five targeted individuals seeking alcohol-related services (the remainder studying populations seeking SUD services), and all studied AA/12-step participation. Contrasting with the epidemiological studies, most (six) captured level of (vs. any/no) participation, at least in addition to any/no participation, and several examined activity participation as well as attendance at meetings. Most (eight) conducted only bivariate analyses or analyses controlling for treatment condition or time alone.

Results were again mixed, with three studies providing at least some evidence of disparities (i.e., Arroyo et al., 1998;[65] Tonigan et al., 1998;[66] Tonigan, 2003[69]); three showing at least some evidence of one or more minority advantages (i.e., Humphreys et al., 1991;[63] Kingree et al., 1997;[64] Tonigan et al., 2013[72]), one reporting countervailing results (i.e., Kaskutas et al., 1999[67]), and four reporting entirely null results (i.e., Humphreys and Woods, 1993;[29] Hillhouse and Fiorentine, 2001;[68] Goebert and Nishimura, 2011;[70] Krentzman et al., 2012[71]). (See also Table 3.)

Overall Summary of Results

Table 3 summarizes the findings of Tables 1 and 2 separately for comparisons involving Latinx; Black; American Indian or Alaska Native; Asian American, Native Hawaiian, or Other Pacific Islander; and multiracial respondents. As noted in the Methods, this summary table simultaneously codes results for comparisons across all mutual

Table 1 National, Epidemiological, Cross-Sectional Studies of Racial/Ethnic Differences in Mutual Help Group Participation ($N = 8$)

Authors	Analytic Sample (All Mixed-Gender)	Data Source	Use of Spanish Interviews	Mutual Help Group Participation Outcome	Analysis	Results
Schmidt et al., 2007[41]	1,885 White, 704 Latinx, and 627 Black respondents	Adults with a lifetime AUD in the combined 1995 and 2000 NAS	Yes	AA attendance (yes vs. no) in one's lifetime	Bivariate only	In the total sample, analyses showed no racial/ethnic differences.
Kaskutas et al., 2008[60]	1,029 White, 103 Latinx, 120 Black, and 73 Other respondents	Adults who attended a 12-step group in their lifetime (and prior to the past year) for an alcohol problem in the 2001–2002 NESARC	Yes	12-step attendance (yes vs. no) in the past year	Bivariate only	In the total sample, analyses showed no racial/ethnic differences.
Perron et al., 2009[61]	2,682 White, 595 Latinx, and 610 Black respondents	Adults with a lifetime DUD in the 2001–2002 NESARC	Yes	12-step attendance (yes vs. no) in one's lifetime	Bivariate and multivariate; controls were demographics and presence of other lifetime psychiatric disorders	Among those reporting any lifetime help seeking for a drug problem, both bivariate and multivariate analyses showed a significantly higher rate of 12-step attendance among Black vs. White respondents; Latinx and White respondents were equivalent. Among the total sample, bivariate analyses* similarly revealed a significantly higher rate of 12-step attendance among Black vs. White respondents.
Chartier et al., 2011[38]	For the NLAES, 6,016 White, 395 Latinx, and 598 Black respondents; for the NESARC, 8,011 White, 1,677 Latinx, and 1,579 Black respondents	Adults with a lifetime AUD in the 1991–1992 NLAES and the 2001–2002 NESARC	Yes for the NESARC, not stated for NLAES	12-step attendance (yes vs. no) in one's lifetime	Bivariate and multivariate; controls were survey, demographics, insurance status, and alcohol severity	In the NLAES, bivariate analyses* showed no racial/ethnic differences. In NESARC, bivariate analyses* showed a significantly higher rate of 12-step attendance among Black vs. White respondents; Latinx and White respondents were equivalent. In pooled survey data, multivariate analyses showed a significantly higher rate of 12-step attendance among Latinx vs. White respondents; Black and White respondents were equivalent. A significant interaction indicated that the Latinx-White difference was diminished or reversed at higher levels of AUD severity.

Authors	Analytic Sample (All Mixed-Gender)	Data Source	Use of Spanish Interviews	Mutual Help Group Participation Outcome	Analysis	Results
Cummings et al., 2011[39]	8,506 White, 2,004 Latinx, 1,051 Black, 325 American Indian/Alaska Native, 181 Asian American, 68 Native Hawaiian/Pacific Islander, and 499 Multiracial respondents	Adolescents with past-year SUD in the combined 2001–2008 NSDUH	Yes	Self-help attendance (yes vs. no) in one's lifetime	Bivariate and multivariate; controls were demographics, insurance status, any mental health treatment, type of SUD, and self-rated health	In the total sample, both bivariate and multivariate analyses showed significantly lower rates of self-help attendance among both Latinx and Black vs. White respondents; no other differences emerged.
Zemore et al., 2014[42]	3,788 White, 949 Latinx, and 738 Black respondents	Adults with lifetime AUD in combined 2000, 2005, and 2010 NAS	Yes	12-step attendance (yes vs. no) in one's lifetime	Bivariate and multivariate; controls were survey, demographics, and dependence severity (as in Model 3)	Among men, both bivariate and multivariate analyses showed a lower rate of 12-step attendance among Latinx vs. White respondents (though the difference was marginally significant in bivariate analyses); Black and White respondents were equivalent. Among women, both bivariate and multivariate analyses showed lower rates of 12-step attendance among Latinx and Black vs. White respondents.
Mancini et al., 2015[40]	5,754 White, 743 U.S.-born Latinx, and 280 Latinx immigrant respondents	Adults with lifetime drug use in the 2001–2002 and 2004–2005 NESARC (using variables from both)	Yes	12-step attendance (yes vs. no) in one's lifetime	Bivariate and multivariate; controls were demographics, parental drug use history, and lifetime mood and anxiety disorders	In the total sample, both bivariate* and multivariate analyses showed a significantly lower rate of 12-step attendance among Latinx immigrant vs. White respondents; U.S.-born Latinx and White respondents were equivalent.
Wu et al., 2016[62]	4,361 White, 799 Hispanic, 459 Black, 141 American Indian/Alaska Native, 99 Native Hawaiian/Pacific-Islander/Asian American, 266 Multiracial respondents	Respondents age 12 and older reporting past-year OUD in the combined 2005–2013 NSDUH	Yes	Self-help attendance in the past year	Bivariate only	Among those reporting past-year use of any alcohol/drug services, analyses showed a significantly higher rate of self-help attendance among American Indian vs. White respondents; no other differences emerged.

Note: AA, Alcoholics Anonymous; AUD, alcohol use disorder; DUD, drug use disorder; NAS, National Alcohol Survey; NESARC, National Epidemiologic Survey on Alcohol and Related Conditions; NLAES, National Longitudinal Alcohol Epidemiologic Survey; NSDUH, National Survey on Drug Use and Health; OUD, opiate use disorder; SUD, substance use disorder.*Analyses conducted on raw data by this review's lead author.

help participation outcomes for a given study, but relative only to a specific racial/ethnic group. This table reveals a lack of strong support for broad racial/ethnic differences in mutual help group participation. Of 35 comparisons between specific racial/ethnic minority groups and Whites on measures of mutual help group participation in a given study, nearly half ($N = 17$) yielded null results; only six comparisons yielded unequivocal support for racial/ethnic disparities, whereas nine yielded mixed results and three yielded unequivocal support for a minority advantage in mutual help group participation.

Nonetheless, it may be possible that results signify disparities for particular Latinx subgroups, as no results indicated a Latinx-White minority advantage and four results indicated Latinx-White disparities. Also, two of the three results coded as "mixed" reveal some disparities: Mancini et al. (2015) reported disparities in lifetime 12-step attendance among immigrant (but not U.S.-born) Latinx adults with lifetime drug use in a national sample,[40] and Tonigan et al. (1998) reported disparities in AA attendance at the 12-month follow-up exclusively among Latinx adults with AUD in Project MATCH (with Latinx-White differences being nonsignificant at prior follow-ups).[66] Black-White comparisons seem more consistent with null effects, with exceptions, as they yielded a range of results including many null results and several results suggesting a minority advantage. Data were very sparse for other racial/ethnic groups, with no evidence of disparities emerging.

DISCUSSION

Question 1: Extent and Type of Research on Disparities

The present review identified 19 studies addressing racial/ethnic disparities in mutual help group participation among those with SUD treatment need. This set includes eight national, epidemiological, cross-sectional studies that were generally well powered, incorporated Spanish-language interviews (allowing inclusion of Spanish speakers), and incorporated multivariate analyses with some adjustment for potential confounds. Also in this set were 11 treatment/community studies, strengths of which included consideration of level of mutual help group participation, as well as any or none, and analysis of multiple outcomes (including participation over time). Almost all studies used strong measures of SUD treatment need (i.e., SUD/AUD status), and rigorously conducted studies were included among both types.

Despite some strengths, the reviewed studies evidenced multiple design limitations, as follows.

- **Studies were generally dated and not optimally designed to assess racial/ethnic differences, with many studies showing inadequate power.** All but four studies analyzed data collected partially or entirely more than a decade ago. U.S. demographics are in constant flux—for example, recent years have witnessed rapid growth of racial/ethnic minority populations and shifts in Latinx settlement patterns[73,74]—so older findings may not represent current conditions in the United States. Existing analyses also seemed to be largely secondary analyses, and most treatment/community studies were underpowered for detecting differences in mutual help group participation across racial/ethnic groups. Even assuming bivariate analysis and a continuous outcome, tests require at least 99 participants per group to detect a small-to-medium effect size (Cohen's $d = .40$) with adequate power ($\beta = .80$);[75] power is even more limited given multivariate analysis and a dichotomous outcome.
- **Studies provided limited data on racial/ethnic minority groups other than Latinx and Black populations, and on important racial/ethnic subgroups including immigrants, women, and adolescents.** Identified studies included just two or three studies each on American Indian or Alaska Native, Asian American, and Native Hawaiian and Other Pacific Islander populations. One study examined immigrants (Mancini et al., 2015),[40] one study examined women separately (Zemore et al., 2014),[42] and two studies examined adolescents (Cummings et al., 2011;[39] Krentzman et al., 2012[71]). Yet, all of the studies focusing on

Table 2 Treatment and Community Studies of Racial/Ethnic Differences in Mutual Help Group Participation ($N = 11$)

Authors	Analytic Sample (All Mixed-Gender)	Data Source and Analytic Design	Use of Spanish Interviews	Mutual Help Group Participation Outcome	Analysis	Results
Humphreys et al., 1991[63]	201 total with 115 Black respondents at follow-up; precise breakdown not provided	Adults with SUD recruited from 19 public SUD treatment programs (11 outpatient, 8 residential) in Michigan; longitudinal (follow-up rate 63%)	N/A	12-step attendance (any vs. no) between treatment end and 6-month follow-up	Bivariate only	In the total sample, analyses showed a significantly higher rate of 12-step attendance among Black vs. White respondents.
Humphreys & Woods, 1993[29]	267 White and 233 Black respondents at follow-up	Adult "substance abusers" (SUD status unclear) recruited from 22 SUD treatment programs in Michigan; longitudinal (follow-up rate 71%)	N/A	12-step attendance (any vs. no) in the prior 30 days at 12-month follow-up	Bivariate only	In the total sample, analyses* showed no racial/ethnic differences.
Kingree et al., 1997[64]	22 White and 78 Black respondents at follow-up	Adults with SUD recruited from a 120-day, 12-step–oriented addiction treatment program serving indigent poly-drug users, most with cocaine as drug of choice; longitudinal (follow-up rate 56%)	N/A	Scores on the AAAS and endorsement of specific AA-related behaviors and experiences, assessed 60 days post-baseline	Bivariate only	In the total sample, analyses showed marginally higher scores on the AAAS and a significantly higher rate of "sharing in meetings" among Black vs. White respondents; no other differences emerged.
Arroyo et al., 1998[65]	62 White and 46 Latinx respondents at baseline	Adults with AUD recruited from intake at the University of New Mexico's outpatient, publicly funded SUD treatment program; longitudinal (follow-up rates 91% to 97%)	None described	Proportion days AA meeting attendance over the follow-up interval at 2, 4, and 6 months post-baseline	Multivariate only; controls were gender, education, and baseline AA attendance	In the total sample, analyses showed significantly fewer days of AA attendance among Latinx vs. White respondents collapsing across follow-ups.
Tonigan et al., 1998[66]	For outpatient sample, 735 White, 111 Latinx, and 52 Black respondents; for aftercare sample, 592 White, 27 Latinx, and 112 Black respondents at baseline	Project MATCH: Adults with AUD recruited from a broad range of SUD outpatient and residential treatment sites, assigned to one of three interventions; longitudinal (follow-up rates > 90%)	None described	AA attendance (yes vs. no) over the prior 3 months at 3, 6, 9, and 12 months post-baseline	Multivariate only; control was intervention condition	Among outpatients, analyses showed no racial/ethnic differences. Among aftercare patients, analyses showed significantly fewer days of AA attendance among both Latinx and Black vs. White respondents at the 12-month follow-up only; no other differences emerged.

Authors	Analytic Sample (All Mixed-Gender)	Data Source and Analytic Design	Use of Spanish Interviews	Mutual Help Group Participation Outcome	Analysis	Results
Kaskutas et al., 1999[67]	538 White and 253 Black respondents at baseline	Epidemiological Laboratory (EpiLab) Study: Adults recruited from (a) 10 alcohol programs representative of public, HMO, and for-profit programs in northern California ($N = 926$) and (b) the general population of alcohol-dependent and problem drinkers ($N = 672$); analysis uses only sample (a); baseline analysis	N/A	AA and NA/CA attendance (yes vs. no); scores on a composite measure of AA involvement; and endorsement of specific AA-related behaviors/experiences, all for the pretreatment period and assessed at baseline	Bivariate and multivariate (the latter conducted only for AA attendance); controls were demographics, ASI Alcohol Severity, ASI Drug Severity, prior SUD treatment, and any prior NA/CA attendance	In the total sample, bivariate analyses showed significantly higher rates of both AA and NA/CA attendance among Black vs. White respondents. However, multivariate analyses showed no racial/ethnic differences in AA attendance. Among those reporting any AA attendance, there were no racial/ethnic differences in overall AA involvement, but significant differences emerged for specific AA-related behaviors/statuses: Black respondents were more likely to report that they were AA members, had had a spiritual awakening, and did service/volunteer work in the last year (vs. White respondents); White respondents were more likely to currently have a sponsor and to have read the AA literature (vs. Black respondents).
Hillhouse and Fiorentine, 2001[68]	76 White, 72 Latinx, and 110 Black respondents at follow-up	Adults (SUD status not specified) recruited from 26 outpatient SUD treatment programs in the Los Angeles area; only those in treatment for at least 8 weeks included; longitudinal (follow-up rate 74%)	None described	Pattern of 12-step participation (i.e., classification as persister, initiate, dropout, or nonattender) 24 months post-baseline	Bivariate only	In the total sample, analyses showed no racial/ethnic differences.
Tonigan, 2003[69]	1,380 White, 141 Latinx, and 168 Black respondents at baseline	Project MATCH: Adults with AUD recruited from a broad range of SUD outpatient and residential treatment sites, assigned to one of three interventions; baseline analysis	None described	Proportion days AA meeting attendance prior to treatment (period undefined), assessed at baseline	Bivariate only	In the total sample, analyses showed significantly fewer days of AA meeting attendance among both Latinx and Black vs. White respondents.

Authors	Analytic Sample (All Mixed-Gender)	Data Source and Analytic Design	Use of Spanish Interviews	Mutual Help Group Participation Outcome	Analysis	Results
Goebert and Nishimura, 2011[70]	71 "Euro" American, 31 Asian American, and 90 Native Hawaiian respondents at baseline	Adults (SUD status not specified) recruited from intake at two major residential SUD treatment programs in Hawaii; baseline analysis	N/A	AA attendance (yes vs. no) prior to treatment (period undefined), assessed at baseline	Bivariate only	In the total sample, analyses showed no racial/ethnic differences.
Krentzman et al., 2012[71]	124 White and 41 Black respondents at baseline	Adolescents with SUD recruited from intake at the largest adolescent residential treatment provider in a central Midwestern region; longitudinal (follow-up rate 90%)	N/A	12-step helping behaviors and 12-step work in past month/90 days, as measured by Service to Others in Sobriety and General AA Tools of Recovery (GAATOR) scales, assessed 2 months post-baseline	Bivariate and multivariate; controls were baseline value of the outcome, demographics, total number of substance use diagnoses, prior SUD treatment, religiousness, readiness for change, and sexual abuse history	In the total sample, both bivariate and multivariate analyses showed no racial/ethnic differences.
Tonigan et al., 2013[72]	133 White and 63 American Indian respondents	Data merged from two studies recruiting adult participants in early AA affiliation and residing in large southwestern city; longitudinal (follow-up rates not specified)	N/A	Proportion days AA meeting attendance (period undefined), AA meeting attendance (yes vs. no), and 12-step work (assessed using GAATOR) at baseline and at 3, 6, and 9 months post-baseline	Multivariate only with time as the only covariate	In the total sample, analyses showed no racial/ethnic differences in AA attendance or 12-step work from baseline through follow-ups. However, analyses showed a significantly lower decline in any AA attendance over time among American Indian vs. White respondents.

Note: AA, Alcoholics Anonymous; AAAS, AA Affiliation Scale; ASI, Addiction Severity Index; AUD, alcohol use disorder; CA, Cocaine Anonymous; GAATOR, General AA Tools of Recovery; HMO, health maintenance organization; NA, Narcotics Anonymous; N/A, not applicable; SUD, substance use disorder. *Analyses conducted on raw data by this review's lead author.

immigrants, women, and adolescents reported disparities, underlining the importance of studying these populations.

- **Regardless of racial/ethnic group focus, treatment/community studies sampled a restricted range of populations, further limiting generalizability.** Although most national studies provided Spanish-language interviews, none of the treatment/community studies did so. Hence, these studies presumably excluded all those not fluent in English, who differ widely from English speakers on substance use and help-seeking patterns.[58-60,76] Treatment/community studies also focused on a small set of predominantly urban samples. This is an important limitation because, as discussed, geography may moderate racial/ethnic disparities in mutual help group participation and benefits, with those living outside of ethnic enclaves likely to show increased disparities.
- **Studies focused predominantly on respondents with AUD, and all studies examined AA/12-step participation or global "self-help" participation.** Very few studies focused on populations with a drug use disorder (DUD), and none examined 12-step alternatives such as SMART Recovery, a rapidly growing recovery resource. Consequently, findings cannot be confidently generalized to populations with DUD—comprising large proportions of those with SUD treatment need[77,78]—or to 12-step alternatives.

Studies also showed limitations associated with their measures and analysis.

- **Studies often relied on crude, dichotomous measures of 12-step participation (especially in national samples).** Most problematic, national studies relied completely on any/no (usually lifetime) measures of mutual help participation. Although power considerations may preclude use of more detailed measures, this means that national data cannot speak to potential disparities in involvement patterns, such as a tendency for Latinx people to discontinue 12-step involvement more frequently than Whites. Most studies also neglected to measure activity participation, though much of the effectiveness of 12-step participation can be attributed to activity involvement, such as obtaining a sponsor.[79]
- **Studies relied quite heavily on bivariate analyses, and they neglected potential confounds.** Even where multivariate analyses were conducted, very few controlled for differences in SUD severity. Neglect of SUD severity is particularly concerning: Where SUD severity is not controlled, any findings may be distorted by an association between race/ethnicity and problem severity, as higher SUD severity has been consistently associated with greater 12-step participation[80 83] (and indeed implies greater treatment need). These limitations should be addressed in future research.

Question 2: Findings for Racial/Ethnic Disparities

As a whole, studies did not provide strong evidence of racial/ethnic disparities for any racial/ethnic group. Still, six studies revealed some evidence of Latinx-White disparities in mutual help group participation, including national, epidemiological studies using NSDUH, NESARC, and NAS data (Cummings et al., 2011;[39] Mancini et al., 2015;[40] Zemore et al., 2014[42]) and treatment/community studies analyzing data from a New Mexico outpatient SUD treatment program and Project MATCH (Arroyo et al., 1998;[65] Tonigan et al., 1998;[66] Tonigan et al., 2003[69]). Results of a NESARC analysis by Mancini et al. (2015) are particularly notable, showing a sizeable disparity among Latinx immigrants (vs. Whites) reporting drug use across bivariate and multivariate analyses; analyses revealed significantly lower odds of lifetime 12-step attendance among Latinx immigrants vs. Whites (multivariate $OR = 0.39$).[40] Results call for cautious interpretation because, in addition to targeting any/no participation, analyses considered all those with any drug use and did not control for drug use severity. Still, similar results emerged in a within-group (noncomparative) study of Latinx respondents with lifetime AUD interviewed for the 2000–2010 NAS,[60] which reported significantly greater lifetime

Table 3 Summary of Results for Racial/Ethnic Disparities in Mutual Help Group Participation Across Studies

Comparison	Null Results	Mixed Results	Lower Minority Participation (Disparity)	Higher Minority Participation (Advantage)
Latinx vs. White	5 studies *Table 1*: Schmidt et al., 2007;[41] Kaskutas et al., 2008;[60] Perron et al., 2009;[61] Wu et al., 2016;[62] *Table 2:* Hillhouse and Fiorentine, 2001[68]	3 studies *Table 1:* Chartier et al., 2011;[38] Mancini et al., 2015;[40] *Table 2:* Tonigan et al., 1998[66]	4 studies *Table 1:* Cummings et al., 2011;[39] Zemore et al., 2014;[42] *Table 2:* Arroyo et al., 1998;[65] Tonigan et al., 2003[69]	0 studies
Black vs. White	6 studies *Table 1:* Schmidt et al., 2007;[41] Kaskutas et al., 2008;[60] Wu et al., 2016;[62] *Table 2:* Humphreys and Woods, 1993;[29] Hillhouse and Fiorentine, 2001;[68] Krentzman et al., 2012[71]	5 studies *Table 1:* Chartier et al., 2011;[38] Zemore et al., 2014;[42] *Table 2:* Kingree et al., 1997;[64] Tonigan et al., 1998;[66] Kaskutas et al., 1999[67]	2 studies *Table 1:* Cummings et al., 2011;[39] *Table 2:* Tonigan et al., 2003[69]	2 studies *Table 1:* Perron et al., 2009;[61] *Table 2:* Humphreys et al., 1991[63]
American Indian or Alaska Native vs. White	2 studies *Table 1:* Cummings et al., 2011;[39] *Table 2:* Goebert and Nishimura, 2011[70]	1 study *Table 2:* Tonigan et al., 2013[72]	0 studies	1 study *Table 1:* Wu et al., 2016[62]
Asian American, Native Hawaiian or Other Pacific Islander vs. White*	2 studies *Table 1:* Cummings et al., 2011;[39] Wu et al., 2016[62]	0 studies	0 studies	0 studies
Multiracial vs. White	2 studies *Table 1:* Cummings et al., 2011;[39] Wu et al., 2016[62]	0 studies	0 studies	0 studies
Total Results	17 studies	9 studies	6 studies	3 studies

Note: Results coded as "mixed" when differing across outcomes, data sources, and/or subgroups (e.g., genders); marginally significant results coded as significant and not null.
*Comparisons were between Asian Americans vs. Whites and Native Hawaiians/Pacific Islanders vs. Whites[39] and between Native Hawaiians/Pacific Islanders/Asian Americans vs. Whites.[62]

12-step attendance among those interviewed in English vs. Spanish (multivariate *OR* = 3.20) despite comprehensively controlling for severity. As this review's Introduction suggests, multiple studies[58-60] likewise have found diminished use of specialty treatment (and AUD services broadly) among Latinx immigrants and those speaking predominantly Spanish. In general, Latinx immigrants may tend to use fewer services, including mutual help groups, and/or prefer services not fully captured in the literature, such as services in their countries of origin and/or nontraditional services in the United States. For example, literature has documented some use among Latinx populations of *anexos,* which are community-based recovery homes that draw on AA principles and provide care to primarily male Latinx migrants and immigrants.[84,85] Regardless, these disparities raise questions as to whether existing recovery-related services are sufficient to support recovery for Latinx populations.

Also notable, studies reported substantial Latinx-White disparities in analyses targeting women (Zemore et al., 2014)[42] and adolescents (Cummings et al., 2011),[39] again across bivariate and multivariate analyses. These studies are notable because they analyzed large, national data sets and employed multivariate analyses. Moreover, the pattern of effects in each was similar across multiple outcomes, and results were not undermined by findings for null or contrary results in other studies. Using NAS data, Zemore et al. (2014) reported significantly lower odds of lifetime 12-step attendance among Latinx versus White women with lifetime AUD (multivariate *OR,* Model 3 = 0.30).[42] Findings also revealed large disparities in 12-step attendance among Latinx versus White men and Black versus White women, along with the same pattern of disparities for specialty treatment, perhaps implying general obstacles to help seeking among all Latinx individuals and Black women. Using NSDUH data, Cummings et al. (2011) reported substantially lower rates of 12-step attendance among both Latinx and Black (vs. White) adolescents, again in both bivariate and multivariate models; they also found the same pattern of disparities for any SUD treatment and treatment in medical settings.[39] Cummings et al. speculated that these disparities may be explained by lack of SUD services in Latinx and Black neighborhoods; low acculturation among Latinx adolescents; and racial/ethnic differences in stigma, attitudes, and cultural beliefs concerning behavioral health problems and treatment.[39] It is also possible that there are detrimental, cumulative effects of being both young and belonging to a racial/ethnic minority group, such as intensified stigma and difficulties with "fitting in" in treatment and mutual help group settings.

Otherwise, findings for Latinx-White disparities in the general population and among treatment/community samples were quite mixed. Existing data are not sufficient to confidently establish those factors driving variation in results across studies, but variation across national epidemiological studies may at least partially reflect differences in how studies obtained respondents from racial/ethnic minority groups. For example, at the time data relevant to this review were collected, the NSDUH did not oversample racial/ethnic minority groups; the NESARC oversampled racial/ethnic minority groups, although information on oversampling methods could not be located; and the NAS targeted high-minority-density areas. The NAS approach apparently yielded the strongest representation of Latinx respondents low on acculturation, with 45% of Latinx respondents interviewed in Spanish across the pooled 1995–2005 NAS[60] (vs. 16% in the 2001–2002 NESARC[86] and a weighted 23% in the 2001–2013 NSDUH[87]). If disparities are strongest for Latinx populations low on acculturation, as seems evident, this may explain why Zemore et al. (2014) reported Latinx-White disparities for both men and women,[42] and other national studies did not.

Meanwhile, respondents' geographic context—and specifically, access to racial/ethnic minority–inclusive and culturally adapted meetings in the community—may have contributed to variation in results for the treatment/community studies. Humphreys and Woods (1993) have argued that geography and race/ethnicity interact to affect mutual help group participation, and specifically that people with SUD may prefer to attend meetings

in areas where their own race/ethnicity is well represented.[29] In fact, their study of treatment seekers with SUD found that Black participants were more likely to attend a mutual-help group if they resided in a predominantly Black area; similarly, White participants were more likely to attend a mutual help group if they resided in a predominantly White area. Accordingly, the inconsistent results for treatment/community studies may reflect differences in the samples' access to minority-inclusive and culturally adapted meetings. This seems a plausible explanation for the null findings reported for Latinx-White differences in mutual help group participation in the diverse Los Angeles metropolitan area (i.e., Hillhouse & Fiorentine, 2001),[68] versus other studies reporting Latinx-White disparities with samples drawn from less metropolitan areas (i.e., the Arroyo[65] and Tonigan[66,69] studies). Future studies of racial/ethnic disparities that explicitly consider the acculturation status of respondents and access to minority-inclusive and culturally tailored meetings will be needed to better evaluate these possibilities.

Regarding Black populations, studies produced little evidence for disparities in mutual help group participation, and several studies reported evidence of greater mutual help group participation among Blacks than Whites (i.e., Perron et al., 2009;[61] Humphreys et al., 1991;[63] Kingree et al., 1997;[64] Kaskutas et al., 1999[67]). (Exceptions are the notable studies targeting women and adolescents described above.) Several factors could explain the relatively strong participation rates among Black people with SUD treatment need overall. As noted above, studies generally did not control for SUD severity, so they may have missed disparities that would arise when accounting for intensity of treatment need. Another possibility is that prevalent religiosity/spirituality among Black populations[88,89] may make 12-step groups particularly appealing, counteracting any obstacles to participation. Other explanatory factors may include the higher rate of SUD treatment coercion among Black versus White populations,[90] which can include coercion to 12-step group participation, and differences in program emphasis on 12-step principles and participation within programs serving predominantly Blacks vs. Whites.[29] The mixed findings for Black-White differences may reflect chance, geographic factors, and sample characteristics (e.g., proportion with DUD, as those with DUD may be more likely than those with AUD to experience coercion). Findings from the few studies of American Indian, Alaska Native, Asian American, Native Hawaiian, and Other Pacific Islander populations provided no indication of disparities, but the sparse data preclude strong conclusions.

Future Research Needs and Clinical Implications

The sparse and inconsistent evidence base described above highlights a need for additional research on racial/ethnic disparities in mutual help group participation. In particular, current epidemiological studies are needed to better investigate potential disparities, ideally using sophisticated measures of mutual help involvement and accounting for potential differences in clinical severity. NSDUH data would be especially well suited for examination of current disparities in rates of mutual help group participation. Well-powered treatment/community studies are also important to address the potential for racial/ethnic disparities in mutual help group involvement patterns over time, including involvement in key activities such as sponsoring relationships. Both epidemiological and treatment/community studies should pay particular heed to individual and contextual factors—such as gender, age, acculturation level, and access to minority-inclusive and culturally tailored meetings—that may affect participation in mutual help groups. Meanwhile, qualitative studies would be useful to capture the self-perceived needs and barriers of racial/ethnic minorities regarding mutual help groups. Studies might focus particularly on Latinx, American Indian, Alaska Native, Asian American, Native Hawaiian, and other Pacific Islander populations as well as racial/ethnic minority immigrants, women, and adolescents.

Studies also might address a wider range of mutual help groups as recovery resources for racial/ethnic minority individuals, such as SMART Recovery. SMART is the largest known alternative to 12-step groups with more than 2,200 meetings in the United States. SMART's philosophical

focus on empowerment (vs. surrender) may be especially appealing and appropriate for racial/ethnic minority individuals, who are likely to face disenfranchisement by the majority culture. Similarly, research is needed to examine the use of online mutual help meetings and resources among racial/ethnic minority groups. Many mutual help options, including 12-step groups, have online meetings and forums,[17,91] and aspects of these resources (e.g., their greater anonymity and ease of access) may be particularly appealing to racial/ethnic minority individuals. Importantly, online meetings have the potential for substantial cultural tailoring because they are geographically unlimited: A given meeting might be tailored to a very specific subgroup and draw attendees from around the globe. Online recovery resources have become an especially salient target for research in recent times because they offer ongoing, peer-based support during periods of social distancing.

Finally, studies are needed to address racial/ethnic disparities in the relationship between mutual help group participation and benefits. Few studies have addressed whether mutual help group participation is equally beneficial for racial/ethnic minority groups, with existing studies relying on a limited set of data sources.[65,69,72,92,93] A key question is whether Spanish-language 12-step groups are effective among Spanish-speaking Latinx individuals, as 12-step participation may be a more accessible form of treatment than specialty care for disadvantaged Latinx populations, with Spanish meetings available in many urban centers (though the extent of foreign-language meetings in the United States has not been well documented).[94,95] Broadly, it would be valuable to address the effectiveness of all prevalent mutual help group options and participation modes (i.e., in-person, online) for sustaining recovery among racial/ethnic minority individuals.

Together, the directions discussed above have the potential to advance the field not only by better describing existing disparities, but also by improving referral practices and interventions. Ultimately, studies might support the development and dissemination of new mutual help resources for racial/ethnic minority groups (e.g., culturally adapted meetings), which may be particularly important for those who underutilize specialty treatment and/or experience the heaviest burden of problems.

Limitations of This Review

The current review may have omitted relevant studies because inclusion criteria were limited to published studies indexed in PubMed and PsycINFO. The review's search strategy assumed that the vast majority of relevant studies would be indexed in these databases, but other databases may have yielded additional articles. Further, to be expeditious, this review drew upon, but did not fully adopt, guidelines from the PRISMA Group (Preferred Reporting Items for Systematic Reviews and Meta-Analyses).[96] Future reviews may benefit from more formalized review procedures. Last, because the review was limited to U.S. studies, results cannot be generalized to other countries. (For international studies of AA, see Makela, 1996.[97])

FINAL CONCLUSIONS

Mutual help groups are a foundational and an effective component of the SUD treatment system in the United States, so it is critical to understand whether they are as appealing and effective for racial/ethnic minority groups as they are for Whites. Further, there are reasons to believe that racial/ethnic minorities (and especially immigrants) experience elevated barriers to participation in such groups, including barriers to mutual help group participation specifically and help seeking generally. Nonetheless, this comprehensive review found existing data to be insufficient to fully evaluate racial/ethnic disparities in mutual help group participation. Findings provided very tentative evidence for Latinx-White disparities, particularly among certain subgroups (i.e., immigrants, women, adolescents), as well as for disparities among Black women and adolescents. However, identified studies showed numerous limitations. Conclusions emphasize the need for additional research addressing the limitations of existing studies and targeting new and understudied questions, such as widening the lens to examine neglected mutual help group options and modes of participation.

Acknowledgments
This work was supported by National Institute on Alcohol Abuse and Alcoholism grants R01AA027266, R01AA027767, and R01AA027920.

Financial Disclosure
The authors declare no financial or other conflicts of interest.

Publisher's Note
Opinions expressed in contributed articles do not necessarily reflect the views of the National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health. The U.S. government does not endorse or favor any specific commercial product or commodity. Any trade or proprietary names appearing in *Alcohol Research: Current Reviews* are used only because they are considered essential in the context of the studies reported herein.

References
1. Substance Abuse and Mental Health Services Administration (SAMHSA), Center for Behavioral Health Statistics and Quality. *Results from the 2018 National Survey on Drug Use and Health: Detailed Tables.* Rockville, MD: U.S. Department of Health and Human Services (HHS); 2019. https://www.samhsa.gov/data/report/2018-nsduh-detailed-tables. Accessed November 14, 2020.
2. Lee HK, Han B, Gfroerer JC. Differences in the prevalence rates and correlates of alcohol use and binge alcohol use among five Asian American subpopulations. *Addict Behav.* 2013;38(3):1816-1823. https://doi.org/10.1016/j.addbeh.2012.11.001.
3. Iwamoto DK, Kaya A, Grivel M, et al. Under-researched demographics: Heavy episodic drinking and alcohol-related problems among Asian Americans. *Alcohol Res.* 2016;38(1):17-25.
4. Wu L-T, Blazer DG. Substance use disorders and co-morbidities among Asian Americans and Native Hawaiians/Pacific Islanders. *Psychol Med.* 2015;45(3):481-494. https://doi.org/10.1017/s0033291714001330.
5. Roman PM, Johnson JA. *National Treatment Center Study Summary Report: Public Treatment Centers.* Athens, GA: Institute for Behavioral Research, University of Georgia; September 2004. http://www.webcitation.org/6E4OnSSJJ. Accessed January 30, 2013.
6. SAMHSA. *National Survey of Substance Abuse Treatment Services (N-SSATS): 2010. Data on Substance Abuse Treatment Facilities.* DASIS Series S-59, HHS Publication No. (SMA) 11-4665. Rockville, MD: HHS; 2011. http://www.webcitation.org/6E4Pf9aRB. Accessed January 30, 2013.
7. Slaymaker VJ, Sheehan T. The impact of AA on professional treatment. In: Galanter M, Kaskutas LA, Borkman T, et al., eds. *Recent Developments in Alcoholism, Volume 18: Research on Alcoholics Anonymous and Spirituality in Addiction Recovery.* New York, NY: Springer; 2008:59-70.
8. Alcoholics Anonymous. *Alcoholics Anonymous 2014 Membership Survey.* 2014. https://www.aa.org/assets/en_US/aa-literature/p-48-aa-membership-survey. Accessed January 30, 2013.
9. Tonigan JS. Alcoholics Anonymous outcomes and benefits. In: Galanter M, Kaskutas LA, Borkman T, et al., eds. *Recent Developments in Alcoholism, Volume 18: Research on Alcoholics Anonymous and Spirituality in Addiction Recovery.* New York, NY: Springer; 2008:357-371.
10. Timko C. Outcomes of AA for special populations. In: Galanter M, Kaskutas LA, Borkman T, et al., eds. *Recent Developments in Alcoholism, Volume 18: Research on Alcoholics Anonymous and Spirituality in Addiction Recovery.* New York, NY: Springer; 2008:373-392.
11. Moos RH. How and why twelve-step self-help groups are effective. In: Galanter M, Kaskutas LA, Borkman T, et al., eds. *Recent Developments in Alcoholism, Volume 18: Research on Alcoholics Anonymous and Spirituality in Addiction Recovery.* New York, NY: Springer; 2008:393-412.
12. Tonigan JS, Toscova R, Miller WR. Meta-analysis of the literature on Alcoholics Anonymous: Sample and study characteristics moderate findings. *J Stud Alcohol.* 1996;57(1):65-72. https://doi.org/10.15288/jsa.1996.57.65.
13. Ye Y, Kaskutas LA. Using propensity scores to adjust for selection bias when assessing the effectiveness of Alcoholics Anonymous in observational studies. *Drug Alcohol Depend.* 2009;104(1-2):56-64. https://doi.org/10.1016/j.drugalcdep.2009.03.018.
14. McKellar J, Stewart E, Humphreys K. Alcoholics Anonymous involvement and positive alcohol-related outcomes: Cause, consequence, or just a correlate? A prospective 2-year study of 2,319 alcohol-dependent men. *J Consult Clin Psychol.* 2003;71(2):302-308. https://doi.org/10.1037/0022-006x.71.2.302.
15. Kelly JF, Humphreys K, Ferri M. Alcoholics Anonymous and other 12-step programs for alcohol use disorder. *Cochrane Database Syst Rev.* 2020;3(3):CD012880. https://doi.org/10.1002/14651858.cd012880.pub2.
16. Atkins RG, Hawdon JE. Religiosity and participation in mutual-aid support groups for addiction. *J Subst Abuse Treat.* 2007;33(3):321-331. https://doi.org/10.1016/j.jsat.2007.07.001.
17. Zemore SE, Kaskutas LA, Mericle A, et al. Comparison of 12-step groups to mutual help alternatives for AUD in a large, national study: Differences in membership characteristics and group participation, cohesion, and satisfaction. *J Subst Abuse Treat.* 2017;73:16-26. https://doi.org/10.1016/j.jsat.2016.10.004.
18. Zemore SE, Lui C, Mericle A, et al. A longitudinal study of the comparative efficacy of Women for Sobriety, LifeRing, SMART Recovery, and 12-step groups for those with AUD. *J Subst Abuse Treat.* 2018;88:18-26. https://doi.org/10.1016/j.jsat.2018.02.004.
19. Kilbourne AM, Switzer G, Hyman K, et al. Advancing health disparities research within the health care system: A conceptual framework. *Am J Public Health.* 2006;96(12):2113-2121. https://doi.org/10.2105/ajph.2005.077628.
20. Bogenschutz MP. Individual and contextual factors that influence AA affiliation and outcomes. In: Galanter M, Kaskutas LA, Borkman T, et al., eds. *Recent Developments in Alcoholism, Volume 18: Research on Alcoholics Anonymous and Spirituality in Addiction Recovery.* New York, NY: Springer; 2008:413-433.
21. Alvarez J, Jason LA, Olson BD, et al. Substance abuse prevalence and treatment among Latinos and Latinas. *J Ethn Subst Abuse.* 2007;6(2):115-141. https://doi.org/10.1300/j233v06n02_08.
22. Jilek-Aall L. Alcohol and the Indian-white relationship. A study of the function of Alcoholics Anonymous among Coast Salish Indians. *Confin Psychiatr.* 1978;21:195-233.
23. Jilek-Aall L. Acculturation, alcoholism and Indian-style Alcoholics Anonymous. *J Stud Alcohol Drugs Suppl.* 1981;s9:143-158. https://doi.org/10.15288/jsas.1981.s9.143.
24. Venner KL, Greenfield BL, Vicuna B, et al. "I'm not one of them": Barriers to help-seeking among American Indians with alcohol dependence. *Cultur Divers Ethnic Minor Psychol.* 2012;18(4):352-362. https://doi.org/10.1037/a0029757.

25. Harper FD. *Alcohol and Blacks: An Overview.* Alexandria, VA: Douglass; 1976.
26. Durant A. African-American alcoholics: An interpretive/constructivist model of affiliation with alcoholics (AA). *J Ethn Subst Abuse.* 2005;4(1):5-21. https://doi.org/10.1300/j233v04n01_02.
27. Smith DE, Buxton ME, Bilal R, et al. Cultural points of resistance to the 12-Step recovery process. *J Psychoactive Drugs.* 1993;25(1):97-108. https://doi.org/10.1080/02791072.1993.10472596.
28. Hoffman F. Cultural adaptations of Alcoholics Anonymous to serve Hispanic populations. *Int J Addict.* 1994;29(4):445-460. https://doi.org/10.3109/10826089409047392.
29. Humphreys K, Woods MD. Researching mutual help group participation in a segregated society. *J Appl Behav Sci.* 1993;29(2):181-201.
30. Humphreys K, Mavis BE, Stöffelmayr BE. Are twelve step programs appropriate for disenfranchised groups? Evidence from a study of posttreatment mutual help involvement. *Prev Hum Serv.* 1994;11(1):165-179. https://doi.org/10.1080/10852359409511201.
31. White WL. Addiction recovery mutual aid groups: An enduring international phenomenon. *Addiction.* 2004;99(5):532-538. https://doi.org/10.1111/j.1360-0443.2004.00684.x.
32. Coyhis D, Simonelli R. The Native American healing experience. *Subst Use Misuse.* 2008;43:1927-1949. https://doi.org/10.1080/10826080802292584.
33. Gryczynski J, Johnson J, Coyhis D. The healing forest metaphor revisited: The seen and "unseen world" of drug use. *Subst Use Misuse.* 2007;42(2-3):475-484. https://doi.org/10.1080/10826080601142428.
34. Garcia A, Anderson B, Humphreys K. Fourth and fifth step groups: A new and growing self-help organization for underserved Latinos with substance use disorders. *Alcohol Treat Q.* 2015;33(2):235-243. https://doi.org/10.1080/07347324.2015.1018784.
35. Anderson BT, Garcia A. 'Spirituality' and 'cultural adaptation' in a Latino mutual aid group for substance misuse and mental health. *B J Psych Bull.* 2015;39(4):191-195. https://doi.org/10.1192/pb.bp.114.048322.
36. Ja DY, Aoki B. Substance abuse treatment: Cultural barriers in the Asian-American community. *J Psychoactive Drugs.* 1993;25(1):61-71. https://doi.org/10.1080/02791072.1993.10472592.
37. Fong TW, Tsuang J. Asian-Americans, addictions, and barriers to treatment. *Psychiatry (Edgmont).* 2007;4(11):51-59.
38. Chartier KG, Caetano R. Trends in alcohol services utilization from 1991-1992 to 2001-2002: Ethnic group differences in the U.S. population. *Alcohol Clin Exp Res.* 2011;35(8):1485-1497. https://doi.org/10.1111/j.1530-0277.2011.01485.x.
39. Cummings JR, Wen H, Druss BG. Racial/ethnic differences in treatment for substance use disorders among U.S. adolescents. *J Am Acad Child Adolesc Psychiatry.* 2011;50(12):1265-1274. https://doi.org/10.1016/j.jaac.2011.09.006.
40. Mancini MA, Salas-Wright CP, Vaughn MG. Drug use and service utilization among Hispanics in the United States. *Soc Psychiatry Psychiatr Epidemiol.* 2015;50(11):1679-1689. https://doi.org/10.1007/s00127-015-1111-5.
41. Schmidt LA, Ye Y, Greenfield TK, et al. Ethnic disparities in clinical severity and services for alcohol problems: Results from the National Alcohol Survey. *Alcohol Clin Exp Res.* 2007;31(1):48-56. https://doi.org/10.1111/j.1530-0277.2006.00263.x.
42. Zemore SE, Murphy RD, Mulia N, et al. A moderating role for gender in racial/ethnic disparities in alcohol services utilization: Results from the 2000 to 2010 National Alcohol Surveys. *Alcohol Clin Exp Res.* 2014;38(8):2286-2296. https://doi.org/10.1111/acer.12500.
43. Mulia N, Tam TW, Schmidt LA. Disparities in the use and quality of alcohol treatment services and some proposed solutions to narrow the gap. *Psychiatr Serv.* 2014;65(5):626-633. https://doi.org/10.1176/appi.ps.201300188.
44. Cook BL, Alegría M. Racial-ethnic disparities in substance abuse treatment: The role of criminal history and socioeconomic status. *Psychiatr Serv.* 2011;62(11):1273-1281. https://doi.org/10.1176/ps.62.11.pss6211_1273.
45. Cherpitel CJ. Differences in services utilization between white and Mexican American DUI arrestees. *Alcohol Clin Exp Res.* 2001;25(1):122-127.
46. Spence R, Wallisch L, Smith S. Treatment seeking in populations in urban and rural settings on the border. *Alcohol Clin Exp Res.* 2007;31(6):1002-1011.
47. Zemore SE, Mulia N, Ye Y, et al. Gender, acculturation, and other barriers to alcohol treatment utilization among Latinos in three National Alcohol Surveys. *J Subst Abuse Treat.* 2009;36(4):446-456. https://doi.org/10.1016/j.jsat.2008.09.005.
48. Sakai JT, Ho PM, Shore JH, et al. Asians in the United States: Substance dependence and use of substance-dependence treatment. *J Subst Abuse Treat.* 2005;29(2):75-84. https://doi.org/10.1016/j.jsat.2005.04.002.
49. Arndt S, Acion L, White K. How the states stack up: Disparities in substance abuse outpatient treatment completion rates for minorities. *Drug Alcohol Depend.* 2013;132(3):547-554. https://doi.org/10.1016/j.drugalcdep.2013.03.015.
50. Saloner B, Cook BL. Blacks and Hispanics are less likely than Whites to complete addiction treatment, largely due to socioeconomic factors. *Health Aff (Millwood).* 2013;32(1):135-145. https://doi.org/10.1377/hlthaff.2011.0983.
51. Pinedo M, Zemore S, Rogers S. Understanding barriers to specialty substance abuse treatment among Latinos. *J Subst Abuse Treat.* 2018;94:1-8. https://doi.org/10.1016/j.jsat.2018.08.004.
52. Pinedo M, Zemore SE, Mulia N. Black-White differences in barriers to specialty alcohol and drug treatment: Findings from a qualitative study. *J Ethn Subst Abuse.* 2020:1-15. https://doi.org/10.1080/15332640.2020.1713954.
53. Alegría M, Carson NJ, Goncalves M, et al. Disparities in treatment for substance use disorders and co-occurring disorders for ethnic/racial minority youth. *J Am Acad Child Adolesc Psychiatry.* 2011;50(1):22-31. https://doi.org/10.1016/j.jaac.2010.10.005.
54. Guerrero EG, Marsh JC, Khachikian T, et al. Disparities in Latino substance use, service use, and treatment: Implications for culturally and evidence-based interventions under health care reform. *Drug Alcohol Depend.* 2013;133(3):805-813. https://doi.org/10.1016/j.drugalcdep.2013.07.027.
55. Pagano A. Barriers to drug abuse treatment for Latino migrants: Treatment providers' perspectives. *J Ethn Subst Abuse.* 2014;13(3):273-287. https://doi.org/10.1080/15332640.2014.886320.
56. Mulia N, Schmidt LA, Ye Y, et al. Preventing disparities in alcohol screening and brief intervention: The need to move beyond primary care. *Alcohol Clin Exp Res.* 2011;35(9):1557-1560.
57. Mead H, Cartwright-Smith L, Jones K, et al. *Racial and Ethnic Disparities in U.S. Health Care: A Chartbook.* New York, NY: The Commonwealth Fund; 2008. http://www.webcitation.org/6h2eunLac. Accessed April 25, 2016.

58. Vega WA, Rodriguez MA, Gruskin E. Health disparities in the Latino population. *Epidemiol Rev.* 2009;31(1):99-112. https://doi.org/10.1093/epirev/mxp008.
59. Ault-Brutus AA. Changes in racial-ethnic disparities in use and adequacy of mental health care in the United States, 1990-2003. *Psychiatr Serv.* 2012;63(6):531-540. https://doi.org/10.1176/appi.ps.201000397.
60. Kaskutas LA, Ye Y, Greenfield TK, et al. Epidemiology of Alcoholics Anonymous participation. In: Galanter M, Kaskutas LA, Borkman T, et al., eds. *Recent Developments in Alcoholism, Volume 18: Research on Alcoholics Anonymous and Spirituality in Addiction Recovery.* New York, NY: Springer; 2008:261-282.
61. Perron BE, Mowbray OP, Glass JE, et al. Differences in service utilization and barriers among Blacks, Hispanics, and Whites with drug use disorders. *Subst Abuse Treat Prev Policy.* 2009;4:3. https://doi.org/10.1186/1747-597x-4-3.
62. Wu L-T, Zhu H, Swartz MS. Treatment utilization among persons with opioid use disorder in the United States. *Drug Alcohol Depend.* 2016;169:117-127. https://doi.org/10.1016/j.drugalcdep.2016.10.015.
63. Humphreys K, Mavis BE, Stöffelmayr BE. Factors predicting attendance at self-help groups after substance abuse treatment: Preliminary findings. *J Consult Clin Psychol.* 1991;59(4):591-593. https://doi.org/10.1037//0022-006x.59.4.591.
64. Kingree JB. Measuring affiliation with 12-step groups. *Subst Use Misuse.* 1997;32(2):181-194. https://doi.org/10.3109/10826089709027306.
65. Arroyo JA, Westerberg VS, Tonigan JS. Comparison of treatment utilization and outcome for Hispanics and non-Hispanic whites. *J Stud Alcohol.* 1998;59(3):286-291. https://doi.org/10.15288/jsa.1998.59.286.
66. Tonigan JS, Connors GJ, Miller WR. Special populations in Alcoholics Anonymous. *Alcohol Health Res World.* 1998;22(4):281-285.
67. Kaskutas LA, Weisner C, Lee M, et al. Alcoholics Anonymous affiliation at treatment intake among white and black Americans. *J Stud Alcohol*. 1999;60(6):810-816. https://doi.org/10.15288/jsa.1999.60.810.
68. Hillhouse MP, Fiorentine R. 12-Step program participation and effectiveness: Do gender and ethnic differences exist? *J Drug Issues.* 2001;31(3):767-780. https://doi.org/10.1177/002204260103100313.
69. Tonigan JS. Project MATCH treatment participation and outcome by self-reported ethnicity. *Alcohol Clin Exp Res.* 2003;27(8):1340-1344. https://doi.org/10.1097/01.alc.0000080673.83739.f3.
70. Goebert D, Nishimura S. Comparison of substance abuse treatment utilization and preferences among Native Hawaiians, Asian Americans and Euro Americans. *J Subst Use.* 2011;16(2):161-170. https://doi.org/10.3109/14659891.2011.554594.
71. Krentzman AR, Pagano ME, Bradley JC, et al. The role of religiousness on substance-use disorder treatment outcomes: A comparison of Black and White adolescents. *J Soc Social Work Res.* 2012;3(3):113-128. https://doi.org/10.5243/jsswr.2012.8.
72. Tonigan JS, Martinez-Papponi B, Hagler KJ, et al. Longitudinal study of urban American Indian 12-step attendance, attrition, and outcome. *J Stud Alcohol Drugs.* 2013;74(4):514-520. https://doi.org/10.15288/jsad.2013.74.514.
73. Brown A, Lopez MH. *Mapping the Latino population, by state, county and city.* Washington, DC: Pew Research Center: Hispanic Trends; 2013. https://www.pewresearch.org/hispanic/2013/08/29/mapping-the-latino-population-by-state-county-and-city. Accessed February 19, 2020.
74. Haverluk TW, Trautman LD. The changing geography of U.S. Hispanics from 1990-2006: A shift to the South and Midwest. *J Geog.* 2008;107(3):87-101. https://doi.org/10.1080/00221340802208804.
75. Cohen J. *Statistical Power Analysis for the Behavioral Sciences.* 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates; 1988.
76. Zemore SE. Acculturation and alcohol among Latino adults in the United States: A comprehensive review. *Alcohol Clin Exp Res.* 2007;31(12):1968-1990. https://doi.org/10.1111/j.1530-0277.2007.00532.x.
77. SAMHSA, Center for Behavioral Health Statistics and Quality. *Treatment Episode Data Set (TEDS): 2017. Admissions to and Discharges from Publicly Funded Substance Use Treatment.* Rockville, MD: HHS; 2019.
78. SAMHSA, Office of Applied Studies. *Treatment Episode Data Set (TEDS): 1995-2005. National Admissions to Substance Abuse Treatment Services,* DASIS Series: S-37, HHS Publication No. (SMA) 07-4234. Rockville, MD: HHS; 2007.
79. Zemore SE, Subbaraman M, Tonigan JS. Involvement in 12-step activities and treatment outcomes. *J Subst Abuse.* 2013;34(1):60-69. https://doi.org/10.1080/08897077.2012.691452.
80. Timko C, Billow R, DeBenedetti A. Determinants of 12-step group affiliation and moderators of the affiliation-abstinence relationship. *Drug Alcohol Depend.* 2006;83(2):111-121. https://doi.org/10.1016/j.drugalcdep.2005.11.005.
81. Harris J, Best D, Gossop M, et al. Prior Alcoholics Anonymous (AA) affiliation and the acceptability of the Twelve Steps to patients entering UK Statutory Addiction Treatment. *J Stud Alcohol.* 2003;64(2):257-261. https://doi.org/10.15288/jsa.2003.64.257.
82. Zemore SE, Kaskutas LA. 12-step involvement and peer helping in day hospital and residential programs. *Subst Use Misuse.* 2008;43(12-13):1882-1903. https://doi.org/10.1080/10826080802297534.
83. Emrick CD, Tonigan JS, Montgomery HA, et al. Alcoholics Anonymous: What is currently known? In: McCrady BS, Miller WR, eds. *Research on Alcoholics Anonymous: Opportunities and Alternatives.* New Brunswick, NJ: Rutgers Center of Alcohol Studies; 1993:41-78.
84. Garcia V, Pagano A, Recarte C, et al. The *Anexo* in Northern California: An Alcoholics Anonymous-based recovery residence in Latino communities. *J Groups Addict Recover.* 2017;12(2-3):158-176. https://doi.org/10.1080/1556035x.2017.1313147.
85. Pagano A, Garcia V, Recarte C, et al. Sociopolitical contexts for addiction recovery: *Anexos* in the U.S. Latino communities. *Int J Drug Policy.* 2016;37:52-59. https://doi.org/10.1016/j.drugpo.2016.08.002.
86. Grant BF, Stinson FS, Hasin DS, et al. Immigration and lifetime prevalence of DSM-IV psychiatric disorders among Mexican Americans and non-Hispanic Whites in the United States: Results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Arch Gen Psychiatry.* 2004;61(12):1226-1233. https://doi.org/10.1001/archpsyc.61.12.1226.
87. SAMHSA, Center for Behavioral Health Statistics and Quality. *National Survey on Drug Use and Health (NSDUH).* Rockville, MD: HHS; 2016. http://www.webcitation.org/6s6cuM0Jr. Accessed July 20, 2017.
88. Masci D, Mohamed B, Smith GA. *Black Americans are more likely than overall public to be Christian, Protestant.* Washington, DC: Pew Research Center; 2018. https://www.pewresearch.org/fact-tank/2018/04/23/black-americans-are-more-likely-than-overall-public-to-be-christian-protestant. Accessed February 5, 2020.

89. Kelly JF, Eddie D. The role of spirituality and religiousness in aiding recovery from alcohol and other drug problems: An investigation in a national U.S. sample. *Psycholog Relig Spirituality.* 2020;12(1):116-123. https://doi.org/10.1037/rel0000295.
90. Polcin DL, Weisner C. Factors associated with coercion in entering treatment for alcohol problems. *Drug Alcohol Depend.* 1999;54(1):63-68. https://doi.org/10.1016/s0376-8716(98)00143-4.
91. Kelly JF, Yeterian JD. Self-help groups for addictions. In: McCrady BS, Epstein EE, eds. *Addictions: A Comprehensive Guidebook.* 2nd ed. New York, NY: Oxford University Press; 2013:500-525.
92. Arroyo JA, Miller WR, Tonigan JS. The influence of Hispanic ethnicity on long-term outcome in three alcohol-treatment modalities. *J Stud Alcohol.* 2003;64(1):98-104. https://doi.org/10.15288/jsa.2003.64.98.
93. Avalos LA, Mulia N. Formal and informal substance use treatment utilization and alcohol abstinence over seven years: Is the relationship different for blacks and whites. *Drug Alcohol Depend.* 2012;121(1-2):73-80. https://doi.org/10.1016/j.drugalcdep.2011.08.018.
94. A.A. Intergroup of SF and Marin. [Directory of Alcoholics Anonymous meetings in San Francisco and Marin County, CA.] https://aasfmarin.org/meetings?tsml-day=1&tsml-regioN=sf&tsml-time=upcoming&tsml-type=S.
95. Inter-Group Association of A.A. of New York. [Directory of Alcoholics Anonymous meetings in New York City area.] https://www.nyintergroup.org/meetings/?tsml-day=1&tsml-type=S.
96. Moher D, Liberati A, Tetzlaff J, et al., The PRISMA Group. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med.* 2009;6(7):e1000097. https://doi.org/10.1371/journal.pmed.1000097.
97. Mäkelä K, Arminen I, Bloomfield K, et al. *Alcoholics Anonymous as a Mutual-Help Movement: A Study in Eight Societies.* Madison, WI: University of Wisconsin Press; 1996.

ALCOHOL RESEARCH
Current Reviews

Alcohol Res. 2021;41(1):02 ● https://doi.org/10.35946/arcr.v41.1.02

Published: 4 February 2021

Naturalistic Research on Recovery Processes: Looking to the Future

Robert L. Stout

Pacific Institute for Research and Evaluation, Decision Sciences Institute, Pawtucket, Rhode Island

Because recovery is an ongoing process, conducting research on the recovery process presents multiple challenges. The process can play out over many years, but change also can occur quickly. Although researchers are keenly interested in the precursors of these sudden changes, a researcher is unlikely to be present at critical moments; however, technology offers new options not available in prior years. Recovery research at this point, however, must be pursued largely through observational methods. Experiments involving aspects of recovery can and should be done, but observation is an essential part of recovery research. Hence, this paper focuses on technologies for conducting and analyzing observational studies. The author briefly reviews methods for gathering intensive longitudinal data and discusses how recovery researchers can take advantage of existing technology to delve more deeply into the complex processes associated with recovery and relapse. The future of recovery research, however, will require examining new ways of investigating recovery phenomena, including a new option for gathering data based on decision theory. Taking maximum advantage of existing and new technology for recovery research will require increasing collaboration between recovery researchers and quantitative scientists.

KEY WORDS: longitudinal; time-varying predictor; Bayesian decision making; behavior; alcohol

INTRODUCTION

Recovery is an ongoing process. It is ongoing both because the risk for relapse is lifelong and because renewed recovery is always possible no matter how long the relapse. The ongoing nature of recovery presents multiple research challenges. Because the process of recovery can play out over decades, longitudinal research—although often difficult to conduct—is essential. But even though the process is long, change can occur quickly.[1] Although researchers are keenly interested in the precursors of these sudden changes, a researcher is unlikely to be present at critical moments; however, technology offers new options not available in prior years.

At this point in its scientific development, recovery research must be pursued largely through observational methods. One cannot assign research participants either to recover or to relapse at the whim of random assignment. Experiments involving aspects of recovery can and should be done, but at the current very basic stage of knowledge, observation is an essential part of recovery research. Hence, this paper focuses on technologies for conducting and analyzing observational studies. Some of these methods are familiar to addictions researchers; others, although used in other behavioral research, are not yet widely used in addictions. The processes that underlie recovery vs. relapse are exceptionally complex, which will compel us to embrace new ways to study the inner workings of these processes.

The body of the paper has three parts: (1) an overview of current technologies for gathering data on the process of recovery; (2) a review of analytical methods, including some that so far are underused; and (3) a reflection on how to move past our current approach to designing and analyzing longitudinal studies toward more quantitative, dynamic approaches. This paper does not attempt to provide an in-depth review of any of these methods, but to set the stage for a discussion of ways in which the field could develop beyond current practices.

TECHNOLOGIES FOR GATHERING INTENSIVE LONGITUDINAL DATA

In many studies, longitudinal data have been gathered by interviews conducted at fixed intervals such as every 3 months, every 6 months, or once a year.[2,3] Although this research strategy has led to some important recovery-related findings,[4-6] its key limitation from the point of view of recovery research is that the use of cross-sectional data at fixed intervals risks not having adequate data on key moments of change, and it can be more challenging to characterize short-term fluctuations that may be critical in the course of recovery. For example, a client may have good support systems and be well capable of coping with anticipated challenges. But it is unlikely that support system availability is constant, and factors such as tiredness and stress may reduce the client's ability to cope adequately with an unexpected challenge. Thus, variability over time in mediators—so far understudied—may be an important factor in recovery research.

Calendar Recall

One way to attempt to deal with the limitations of interviews done at fixed intervals is to have study participants recall more fine-grained longitudinal data to fill in the gaps between interviews. These methods go by the generic name of calendar recall. In addictions, the most well-known of these is the Timeline Follow-Back interview for recalling alcohol consumption—and subsequently adapted for drug use—and other variables.[7-9] However, these methods have been invented, apparently independently, in other fields of research including psychiatric symptomatology, notably the psychiatric status rating system developed by Keller and colleagues for Axis I disorders,[10,11] and later adapted for personality disorders.[12] Although the calendar recall method has recall and reliability limitations,[13] and probably requires sound training and monitoring of interviewers to be fully successful,[14] the popularity of the method across multiple studies and disciplines indicates that it continues to meet research needs.

Ecological Momentary Assessment

Ecological Momentary Assessment (EMA) has mushroomed in popularity since first described for behavioral health audiences by Stone and Shiffman in 1994.[15] A review of EMA methods is beyond the scope of this paper, except insofar as their implications for recovery research. In theory, EMA and related techniques offer clear advantages for recovery research in that data can be gathered during the course of participants' daily lives, inexpensively, and close in time to the behaviors being assessed. Also, there are many options to tailor timing, prompts, and content. However, the theoretical advantages of EMA for recovery research are not always easy to achieve in practice, in particular for populations who may engage in illegal activities.[16] The presumed benefits in terms of ecological validity may be

undermined by issues such as weak compliance,[17] reactivity from repeated measurements, and other methodological and statistical issues; see Ram et al. for an extensive discussion of threats to validity.[18] And, considering the long-term nature of recovery, the representativeness of those study participants who are willing and able to continue engagement with an EMA protocol for an extended period is an additional issue. This is not to say that EMA studies should not be conducted with persons in recovery; as noted above, other intensive longitudinal assessment procedures have different but also serious limitations. Combining multiple methods may be useful. For example, because missed EMA reports raise the possibility of biased reporting, retrospective interviewing or specially programmed EMA probes could provide clues as to what is happening.

Although standard smartphones cannot assess blood alcohol or drug concentration, investigators have been working for many years on wearable technologies for assessing blood alcohol concentration,[19] and some are now seeking to develop wearable sensors for at least some classes of drugs.[20] However, these sensors continue to have technical issues that limit their accuracy, applicability, and/or device lifetime.[21] In any case, the usefulness of wearable technologies for longitudinal research may be limited, as is the case with EMA, by issues such as selective compliance and the willingness of participants to wear them for long periods of time. The devices are likely to be most useful in short-term studies, and only after further technical development.

DATA ANALYSIS FOR INTENSIVE LONGITUDINAL DATA

Hierarchical Linear or Generalized Linear Modeling

Hierarchical modeling is used in situations where observations are clustered or nested; for example, researchers may wish to predict a drinking outcome at multiple points within a follow-up using measures of the frequency and/or quality of Alcoholics Anonymous participation preceding the outcome measurements. Hierarchical modeling is widely used in addictions research and is well established both for studying treatment outcome[2,3] and for studying mediation of the effects of Alcoholics Anonymous.[22,23] For the present purposes, the analysis will focus on the situation where time points are nested within participants. For naturalistic research on recovery where data are not necessarily gathered at fixed intervals, however, unlocking the full potential of hierarchical modeling requires a somewhat different approach than that used in treatment outcome studies. The ability of hierarchical modeling to accommodate time-varying predictor variables (often called time-varying covariates) can be helpful for studying how processes evolve over time.[24(ch6)] Hierarchical modeling, often in the context of structural equation modeling, has often been used in studies of mediation.[22,23,25] In these studies, however, assessments were usually done at fixed intervals, months apart. The rise of EMA studies and other intensive longitudinal studies, however, presents both new challenges and new opportunities to apply hierarchical methods. In particular, the number of repeated measurements can be much larger, and both missing data and designed irregular spacing of assessments make it difficult to apply the methods that have been successful in fixed-interval studies. However, hierarchical linear or generalized linear models can be used in ways that do not necessarily require predictors to be measured at fixed intervals. When missing values or irregular measurements are present, some investigators use the most recent, or most recent within a fixed window, measurement of the predictor value. This approach assumes that every predictor observation within the specified window is approximately equally strong in predicting the outcome, an assumption that, in at least some studies, can and should be tested.

Event History Analysis

One factor that separates recovery research from outcome research is the focus of recovery research on the history of individuals. That history frequently involves major events, both negative and positive.[1,26]

Event history analysis historically has been largely about studying the predictors of one-time events such as death. Although there is a long history of using event history analysis in addiction,[27] and many applications since,[28,29] there are ways of extending event history models that can be advantageous for recovery researchers. Advances in event history modeling include hierarchical models for repeated events that can be useful in studying the linked processes of relapse and recovery. Like hierarchical linear modeling methods for continuous dependent variables, event history models can include time-varying predictor variables, which is especially useful for studying questions such as how the characteristics of a prior relapse affect a subsequent relapse. Studies linking onset, relapse, and recovery have appeared in the addictions literature,[30] but useful examples also appear in the psychiatric research literature.[31-34]

Graphical Methods

In thinking about the role of key events in recovery, scientists are naturally interested in predicting such events. However, researchers also appreciate that both the precursors and the consequences of a major event can be complex and may play out over extended periods of time. Thus, one mission of recovery researchers is to describe quantitatively the overall course of behavior before and after a key event. For example, if depression helps lead to some relapses, does relapse occur after a sudden spike in depression, or only after a lengthy run-up? Event-locked averaging is a tool to examine such questions. Most graphs of time series data in behavioral science use a static series of time points such as baseline to month 3, month 3 to month 6, and so on. Although such graphs are useful for studying treatment outcome, it is more informative for the study of the precursors and sequelae of events to graph key variables relative to the time of an event of interest. For example, in a study of the relative course of body dysmorphic disorder (BDD) versus other Axis I disorders, the investigators examined how the severity of BDD varied before and after a participant remitted (at least 8 consecutive weeks with few or no symptoms) from major depressive disorder (MDD), and vice versa.[31] This was a naturalistic follow-up study of 200 participants who entered the study qualifying for BDD based on criteria in the fourth edition of the American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV). These participants were interviewed annually, and their clinical status was recorded on a weekly basis by using psychiatric status (clinical severity) categorical ratings; for information on the rating methodology, see Warshaw et al.[10] and Keller et al.[11] In the BDD study, BDD and MDD were each found to be significantly temporally related to one another.[31] To better understand the relationship between the two disorders, event-locked graphs were created. Panel A of Figure 1 suggests that a substantial proportion of study participants who achieved full or partial remission from BDD and who had sufficient data to be included in the graph showed dramatic improvement in MDD symptoms close in time to their full or partial remission from BDD, up to and including full remission from MDD symptoms.[31] Also, further MDD symptom recovery continued for some participants several weeks after BDD remission. (Too few participants achieved a full remission from BDD to allow a useful analysis of that group alone.) Panel B of Figure 1 shows the course of BDD symptom ratings for the 39 participants who achieved full remission from MDD. Although there was improvement in BDD symptomatology relative to MDD remission, the majority of participants continued to have high levels of BDD severity; after 12 weeks, only about 20% were at a psychiatric status rating of 2 or below, indicating few or no symptoms. These graphs tell us that the relationship between BDD and MDD is not symmetric; many with MDD recover fully whereas few with BDD do so, and the time course of change before and after the major event also differs. Although these diagrams are descriptive and must be interpreted with caution, they reveal important aspects of the time course of clinical processes around key events such as remission or relapse.

For making inferences about change in continuous or categorical outcomes before versus

after an event, the method of choice is often interrupted time series analysis.[35] In this type of analysis, it is possible to test for the presence of changes in the intercept and slope of a regression relating time to the outcome of interest. Caution must be taken, however, because the analysis must consider trends that may have existed well before the event of interest.[35]

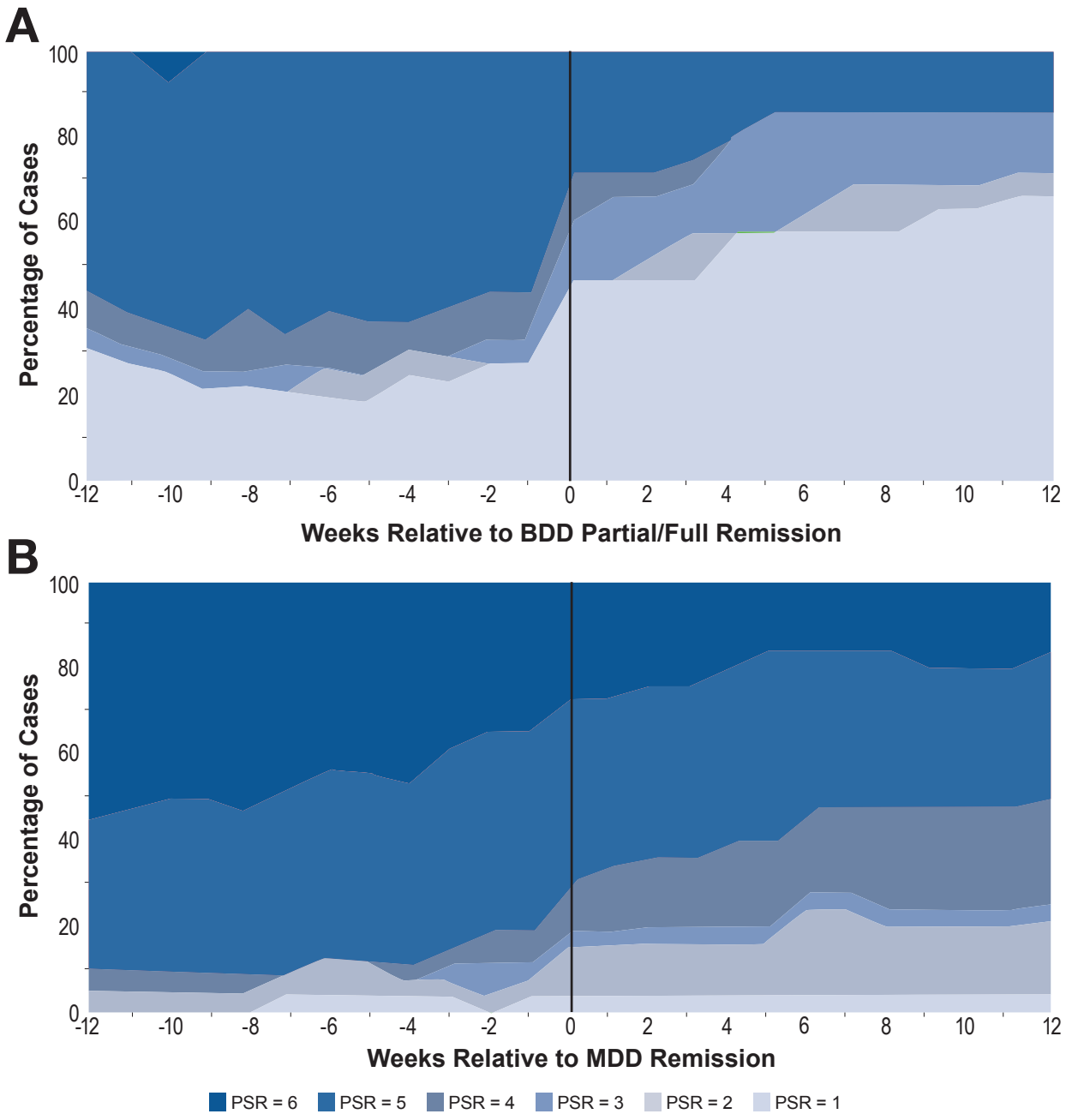

Figure 1 MDD PSRs over time among individuals with partial or full remission of BDD ($N = 23$) (panel A) and BDD PSRs over time among individuals with full remission of MDD ($N = 39$) (panel B). *Note:* BDD, DSM-IV body dysmorphic disorder; MDD, major depressive disorder; PSR, psychiatric status rating (psychiatric severity rating), recorded weekly, higher scores reflecting more severity, from PSR = 1, no symptoms, to PSR = 6 qualifies for full DSM-IV diagnosis. *Source:* Based on a figure from Phillips and Stout.[31]

FUTURE DIRECTIONS

Based on the summaries above, it is evident that there is room for recovery researchers to take more advantage of existing data capture and data analysis technologies. However, ways of advancing the state of the art of recovery research also should be considered. There are two areas where further development is both needed and feasible: (1) examining the time scale of behavior change and the interplay of recovery-related variables, and (2) exploring the potential for new ways of monitoring behavior over long intervals, maximizing information capture while limiting participant burden.

Studying the Dynamics of Behavior

Although researchers have begun to study mediators of the effect of treatment and mutual help on outcome, scant knowledge of how proposed mediators change over time unfortunately makes it difficult to design studies effectively. For example, if a popular mediator such as self-efficacy is measured 6 months after treatment and no effect has been found, would an effect have been found if the measurement had been taken at 2 months? In terms of analyzing data from an EMA study, some data on a predictor may be available from a few minutes to some days before an event of interest. How do researchers decide which of these data are "too old" to use in testing the predictor? Consider a related issue. When a predictor or a mediator assessed weeks or months before the outcome of interest is used, the implicit assumption is that the measured value of the mediator is relatively static, or that the mediator may decay after the measurement, but not before causing other changes that in turn affect outcome.

Although it is useful to do horse race comparisons of mediators,[36] researchers must remain aware that these are static snapshot comparisons, and the importance of specific mediators may shift from within treatment to months later. Thus, researchers need to consider that behaviors, including many favorite mediators, may change over a range of time scales. For example, a mediator such as social support may build up during treatment and may fluctuate modestly as the recovering person loses old relationships and adds new ones; however, there also can be sudden major changes triggered either by the recovering person or others. Of course, in addition to studying the time scale of behavior changes, research is needed to study what variables affect the time course of mediators.

A direct way to address the need to study the time scale and predictors of change in the mediators of long-term outcome is to conduct a multivariate time series study. This would entail gathering naturalistic intensive longitudinal data (not just at two or three time points) on mediators as well as variables, such as affect and life events, that may influence the course of the mediators. As noted above, these studies are challenging, but they have been done successfully. At this stage of research, it is difficult to propose hypotheses about the relative time course of these variables, or about cross-time associations between them, so descriptive analyses may need to be employed initially.

Making Research More Dynamic

Although branching logic and scheduled or random prompts are now common in EMA studies, they leave some problems unsolved. For example, to minimize subject burden and to be compliant with research ethics, studies allow participants to refuse to respond to prompts. Because access to participants is valuable, longitudinal studies should be designed to prioritize gathering information that is most critical to study goals, whether because of its content or because it becomes stale after a period. Writing branching logic to do this would be exceptionally difficult because of the number of combinations of circumstances that would need to be anticipated.

Decision theory offers one way to address such challenges. The most well-known approaches to optimal decision-making[37] start with a simple premise: If two alternative actions are being considered, A1 and A2, choose the one that optimizes expected utility. Mathematically, choose

A1 if E(U(A1)) > E(U(A2)), choose randomly if E(U(A1)) = E(U(A2)), and choose A2 otherwise. Although the mathematics may seem complex, researchers make complex choices all the time that implicitly require such calculations. For example, interviewers frequently encounter participants in follow-up studies who are difficult to engage and/or who have very limited time available for research interviews. To cope with these situations, investigators often give their interviewers instructions such as: "Do whatever you can to get instruments A and B, get C if possible, and finally D and E if there is an opportunity." Mathematically, those instructions translate as: "U(A) and U(B) strongly dominate U(C), which in turn dominates U(D) and U(E), which are approximately equal."

Decision support methods exist to support clinical investigators in estimating utility values of adequate quality to guide an automated process.[38] The goal of that process would be to provide the necessary data to allow an EMA program to choose items in an order that reflects research priorities, much as human interviewers under pressure prioritize data to capture. A simulation study provides a simple proof of concept for this approach.[39] It should be noted that this kind of tool for adaptive monitoring of research participants also could have treatment applications. The fact that addiction is a chronic, relapsing disorder calls out for efficient, low-cost methods for keeping in touch with clients over long periods of time without requiring substantial human labor.

CONCLUSION

Useful technologies are available to recovery researchers to conduct complex studies of behavioral patterns and to extract increasingly useful information from these studies. It is hoped that research can find ways to build and strengthen collaborations between recovery investigators and quantitative scientists, both to take better advantage of existing technologies and to collaborate on developing new tools for further discoveries.

Acknowledgments

The preparation of this paper was supported in part by National Institute on Alcohol Abuse and Alcoholism grant R01 AA025849.

Financial Disclosure

The author has no financial conflicts of interest relevant to this paper.

Publisher's Note

Opinions expressed in contributed articles do not necessarily reflect the views of the National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health. The U.S. government does not endorse or favor any specific commercial product or commodity. Any trade or proprietary names appearing in *Alcohol Research: Current Reviews* are used only because they are considered essential in the context of the studies reported herein.

References

1. Teruya C, Hser YI. Turning points in the life course: Current findings and future directions in drug use research. *Curr Drug Abuse Rev.* 2010;3(3):189-195. https://doi.org/10.2174/1874473711003030189.
2. Project MATCH Research Group. Project MATCH (Matching Alcoholism Treatment to Client Heterogeneity): Rationale and methods for a multisite clinical trial matching patients to alcoholism treatment. *Alcohol Clin Exp Res.* 1993;17(6):1130-1145. https://doi.org/10.1111/j.1530-0277.1993.tb05219.x.
3. COMBINE Study Group. Testing combined pharmacotherapies and behavioral interventions in alcohol dependence: Rationale and methods. *Alcohol Clin Exp Res.* 2003;27(7):1107-1122. https://doi.org/10.1097/00000374-200307000-00011.
4. Morgenstern J, Labouvie E, McCrady BS, et al. Affiliation with Alcoholics Anonymous after treatment: A study of its therapeutic effects and mechanisms of action. *J Consult Clin Psychol.* 1997;65(5):768-777. https://doi.org/10.1037//0022-006x.65.5.768.
5. Tonigan JS, Connors GJ, Miller WR. Participation and involvement in Alcoholics Anonymous. In: Babor TF, Del Boca FK, eds. *Treatment Matching in Alcoholism.* New York, NY: Cambridge University Press; 2003:184-204.
6. Kelly JF, Magill M, Stout RL. How do people recover from alcohol dependence? A systematic review of the research on mechanisms of behavior change in Alcoholics Anonymous. *Addict Res Theory.* 2009;17(3):236-259. https://doi.org/10.1080/16066350902770458.
7. Carey KB, Carey MP, Maisto SA, et al. Temporal stability of the timeline followback interview for alcohol and drug use with psychiatric outpatients. *J Stud Alcohol.* 2004;65(6):774-781. https://doi.org/10.15288/jsa.2004.65.774.
8. Sobell MB, Sobell LC, Klajner F, et al. The reliability of a timeline method for assessing normal drinker college students' recent drinking history: Utility for alcohol research. *Addict Behav.* 1986;11(2):149-161. https://doi.org/10.1016/0306-4603(86)90040-7.
9. Wray TB, Braciszewski JM, Zywiak WH, et al. Examining the reliability of alcohol/drug use and HIV-risk behaviors using Timeline Follow-Back in a pilot sample. *J Subst Use.* 2016;21(3):294-297. https://doi.org/10.3109/14659891.2015.1018974.
10. Warshaw MG, Keller MB, Stout RL. Reliability and validity of the longitudinal interval follow-up evaluation for assessing outcome of anxiety disorders. *J Psychiatr Res.* 1994;28(6):531-545. https://doi.org/10.1016/0022-3956(94)90043-4.

11. Keller MB, Lavori PW, Friedman B, et al. The longitudinal interval follow-up evaluation: A comprehensive method for assessing outcome in prospective longitudinal studies. *Arch Gen Psychiatry.*1987;44(6):540-548. https://doi.org/10.1001/archpsyc.1987.01800180050009.
12. Skodol AE, Gunderson JG, Shea MT, et al. The Collaborative Longitudinal Personality Disorders Study (CLPS): Overview and implications. *J Pers Disord.* 2005;19(5):487-504. https://doi.org/10.1521/pedi.2005.19.5.487.
13. Hoeppner BB, Stout RL, Jackson KM, et al. How good is fine-grained Timeline-Follow-back data? Comparing 30-day TLFB and repeated 7-day TLFB alcohol consumption reports on the person and daily level. *Addict Behav.* 2010;35(12):1138-1143. https://doi.org/10.1016/j.addbeh.2010.08.013.
14. Warshaw MG, Dyck I, Allsworth J, et al. Maintaining reliability in a long-term psychiatric study: An ongoing inter-rater reliability monitoring program using the longitudinal interval follow-up evaluation. *J Psychiatr Res.* 2001;35(5):297-305. https://doi.org/10.1016/s0022-3956(01)00030-9.
15. Stone AA, Shiffman S. Ecological Momentary Assessment (EMA) in behavioral medicine. *Ann Behav Med.* 1994;16(3):199-202. https://doi.org/10.1093/abm/16.3.199.
16. Rudolph AE, Bazzi AR, Fish S. Ethical considerations and potential threats to validity for three methods commonly used to collect geographic information in studies among people who use drugs. *Addict Behav.* 2016;61:84-90. https://doi.org/10.1016/j.addbeh.2016.05.014.
17. Jones A, Remmerswaal D, Verveer I, et al. Compliance with ecological momentary assessment protocols in substance users: A meta-analysis. *Addiction.* 2019;114(4):609-619. https://doi.org/10.1111/add.14503.
18. Ram N, Brinberg M, Pincus AL, et al. The questionable ecological validity of ecological momentary assessment: Considerations for design and analysis. *Res Hum Dev.* 2017;14(3):253-270. https://doi.org/10.1080/15427609.2017.1340052.
19. Swift RM, Swette L. Assessment of ethanol consumption with a wearable, electronic ethanol sensor/recorder. In: Litten RZ, Allen JP, eds. *Measuring Alcohol Consumption: Psychosocial and Biochemical Methods*. Totowa, NJ: Humana Press; 1992:189-202.
20. Carreiro S, Wittbold K, Indic P, et al. Wearable biosensors to detect physiologic change during opioid use. *J Med Toxicol*. 2016;12(3):255-262. https://doi.org/10.1007/s13181-016-0557-5.
21. Wang Y, Fridberg DJ, Leeman RF, et al. Wrist-worn alcohol biosensors: Strengths, limitations, and future directions. *Alcohol*. 2019;81:83-92. https://doi.org/10.1016/j.alcohol.2018.08.013.
22. Kelly JF, Stout RL, Magill M, et al. Mechanisms of behavior change in Alcoholics Anonymous: Does Alcoholics Anonymous lead to better alcohol use outcomes by reducing depression symptoms? *Addiction*. 2010;105(4):626-636. https://doi.org/10.1111/j.1360-0443.2009.02820.x.
23. Kelly JF, Stout RL, Tonigan JS, et al. Negative affect, relapse, and Alcoholics Anonymous (AA): Does AA work by reducing anger? *J Stud Alcohol Drugs.* 2010;71(3):434-444. https://doi.org/10.15288/jsad.2010.71.434.
24. Raudenbush SW, Bryk AS. *Hierarchical Linear Models: Applications and Data Analysis Methods.* 2nd ed. Thousand Oaks, CA: Sage Publications; 2002.
25. Stout RL, Kelly JF, Magill M, et al. Association between social influences and drinking outcomes across three years. *J Stud Alcohol Drugs.* 2012;73(3):489-497. https://doi.org/10.15288/jsad.2012.73.489.
26. Marlatt G, Gordon J. *Relapse Prevention: Maintenance Strategies in the Treatment of Addictive Behaviors.* New York, NY: Guilford Press; 1985.
27. Hunt W, Barnett L, Branch L. Relapse rates in addiction programs. *J Clin Psychol.* 1971;27(4):455-456. https://doi.org/10.1002/1097-4679(197110)27:4<455::aid-jclp2270270412>3.0.co;2-r.
28. Hser YI, Yamaguchi K, Chen J, et al. Effects of interventions on relapse to narcotics addiction: An event-history analysis. *Eval Rev*. 1995;19(2):123-140. https://doi.org/10.1177/019384 1X9501900201.
29. Project MATCH Research Group. Matching alcoholism treatments to client heterogeneity: Project MATCH posttreatment drinking outcomes. *J Stud Alcohol*. 1997;58(1):7-29. https://doi.org/10.15288/jsa.1997.58.7.
30. Shiffman S, Hickcox M, Paty JA, et al. Progression from a smoking lapse to relapse: Prediction from abstinence violation effects, nicotine dependence, and lapse characteristics. *J Consult Clin Psychol*. 1996;64(5):993-1002. https://doi.org/10.1037//0022-006x.64.5.993.
31. Phillips KA, Stout RL. Associations in the longitudinal course of body dysmorphic disorder with major depression, obsessive compulsive disorder, and social phobia. *J Psychiatr Res*. 2006;40(4):360-369. https://doi.org/10.1016/j.jpsychires.2005.10.001.
32. Gunderson JG, Stout RL, Sanislow CA, et al. New episodes and new onsets of major depression in borderline and other personality disorders. *J Affect Disord.* 2008;111(1):4045. https://doi.org/10.1016/j.jad.2008.01.026.
33. Grilo CM, Pagano ME, Skodol AE, et al. Natural course of bulimia nervosa and of eating disorder not otherwise specified: 5-year prospective study of remissions, relapses, and the effects of personality disorder psychopathology. *J Clin Psychiatry*. 2007;68(5):738-746. https://doi.org/10.4088/jcp.v68n0511.
34. Gunderson JG, Weinberg I, Daversa M, et al. Descriptive and longitudinal observations on the relationship of borderline personality disorder (BPD) and bipolar disorders. *Am J Psychiatry*. 2006;163(7):1173-1178. https://doi.org/10.1176/appi.ajp.163.7.1173.
35. Jebb AT, Tay L, Wang W, et al. Time series analysis for psychological research: Examining and forecasting change. *Front Psychol.* 2015;6:727. https://doi.org/10.3389/fpsyg.2015.00727.
36. Kelly JF, Hoeppner B, Stout RL, et al. Determining the relative importance of the mechanisms of behavior change within Alcoholics Anonymous: A multiple mediator analysis. *Addiction.* 2012;107(2):289-299. https://doi.org/10.1111/j.1360-0443.2011.03593.x.
37. Bell D, Raiffa H, Tversky A. *Decision Making.* Cambridge, MA: Cambridge University Press; 1988.
38. Felder S, Mayrhofer T. *Medical Decision Making: A Health Economic Primer.* Berlin Heidelberg, Germany: Springer-Verlag; 2017.
39. Stout RL. New approaches to the design of computerized interviewing and testing systems. *Behavior Research Methods & Instrumentation.* 1981;13(4):436-442. https://doi.org/10.3758/BF03202052.

ALCOHOL RESEARCH
Current Reviews

Alcohol Res. 2021;41(1):01 ● https://doi.org/10.35946/arcr.v41.1.01

Published: 21 January 2021

Impact of Continuing Care on Recovery From Substance Use Disorder

James R. McKay

Department of Psychiatry, University of Pennsylvania, Philadelphia, Pennsylvania
Corporal Michael J. Crescenz Veterans Affairs Medical Center, Philadelphia, Pennsylvania

Continuing care is widely believed to be an important component of effective treatment for substance use disorder, particularly for those individuals with greater problem severity. The purpose of this review was to examine the research literature on continuing care for alcohol and drug use disorders, including studies that addressed efficacy, moderators, mechanisms of action, and economic impact. This narrative review first considered findings from prior reviews (published through 2014), followed by a more detailed examination of studies published more recently. The review found that research has generally supported the efficacy of continuing care for both adolescents and adults, but the picture is complex. Reviews find relatively small effects when results from individual studies are combined. However, continuing care of longer duration that includes more active efforts to keep patients engaged may produce more consistently positive results. Moreover, patients at higher risk for relapse may benefit to a greater degree from continuing care. Several newer approaches for the provision of continuing care show promise. These include incentives for abstinence and automated mobile health interventions to augment more conventional counselor-delivered interventions. Primary care can be used to provide medications for opioid and alcohol use disorders over extended periods, although more research is needed to determine the optimal mix of behavioral treatments and other psychosocial services in this setting. Regardless of the intervention selected for use, the status of most patients will change and evolve over time, and interventions need to include provisions to assess patients on a regular basis and to change or adapt treatment when warranted.

KEY WORDS: substance use disorder; treatment; continuing care; review; recovery; alcohol

As the substance use disorder (SUD) treatment system has evolved, the term "continuing care" has come to have two meanings.[1-4] As originally conceptualized, continuing care was a period of lower-intensity treatment following a more intensive initial period, such as residential care or an intensive outpatient program (IOP).[2,4] As such, continuing care was synonymous with "aftercare" or "stepdown care." In this model, the goals of continuing care were to solidify and sustain the gains made in the initial phase of treatment, to establish abstinence if it was not already achieved, and to prevent subsequent relapses from worsening to the point that further acute treatment was necessary. In addition, disease management models of SUD treatment, sometimes delivered via primary care or via regular checkups, have attempted to improve outcomes by managing patients over extended periods. These models also can be seen as continuing care approaches.[1,3]

Due to the recognition that substance use disorder can be a chronic, long-term disorder, there has been an increase in research on how to improve the effectiveness of continuing care. The purpose of this review is to provide an update on the latest research on SUD continuing care, including newer approaches such as incentives, primary care–based clinical management, measurement-based care, adaptive treatment models, and mobile health components. The review begins with a brief summary of prior reviews (published through 2014) of SUD continuing care research. First, however, this review presents a conceptual model of continuing care and its principal goals with regard to the promotion of extended recovery.

CONCEPTUAL MODEL

A return to substance use following a period of abstinence involves a number of distal and proximal factors, as outlined by Witkiewitz and Marlatt in their dynamic model of relapse.[5] Factors such as family history of SUD, social support, self-efficacy, craving, and outcome expectancies account for level of general vulnerability to relapse. When high-risk situations are encountered, these factors—along with current affective state and the degree to which an effective coping behavior is performed—determine whether relapse occurs. Long-term recovery is a function of a number of factors, including characteristics of the individual's relapse vulnerability as described in the Witkiewitz and Marlatt model, type and duration of treatment received including continuing care, and a variety of non-treatment factors experienced during and after formal treatment.[1,2,6] These factors include participation in mutual help organizations, other forms of social support, and engagement in organizations and activities that promote recovery.

The important functions of continuing care in the recovery process involve maintaining abstinence/initial treatment gains; addressing relapse/non-response, including limiting the severity of relapses; connecting patients to other sources of support; and addressing other recovery issues, including employment, recreation, housing, and involvement in meaningful and/or enjoyable activities. Many of these functions are included in Wagner et al.'s chronic care model,[7] which features interventions to increase self-confidence and skill levels, a focus on goal setting, identification of barriers to achieving goals, methods to overcome such barriers, support for patient self-management, and links to community resources.

Two important challenges faced during the continuing care phase of treatment are patient dropout and changes in the patient's clinical needs over time. Therefore, effective clinical care must include elements that facilitate better retention and must be flexible enough to adapt to the changing needs of individuals. This review examines strategies that address these two issues, including active outreach to patients, use of incentives, measurement-based care, and adaptive treatment.

METHODS USED IN THE REVIEW

PubMed and PsycINFO were used to identify prior reviews of the continuing care research literature

as well as articles published after 2014 that were not included in these reviews. The search terms included substance use disorder, addiction, drug use disorder, alcohol use disorder, continuing care, aftercare, stepped-care, treatment outcome, efficacy, effectiveness, and cost-effectiveness. Studies without control groups were excluded from the review, with the exception of one study on the first evaluation of an intervention based on a package of services formerly offered only to pilots and doctors. Studies were not excluded for other methodological reasons or for country of origin.

PRIOR REVIEWS OF CONTINUING CARE

Adult Participants

One of the first reviews of continuing care included studies of continuing care versus no continuing care or minimal continuing care as well as studies comparing two or more active continuing care interventions.[2] This review reported mixed results, with approximately half the interventions producing positive effects. Compared to studies with negative findings, the studies that generated positive effects tended to feature continuing care interventions with longer planned durations (at least 12 months), more active efforts to engage and retain patients, and weaker control conditions. A subsequent meta-analysis focused on 19 randomized trials published through 2010 that compared continuing care for SUD with minimal or no continuing care.[8] The results of this study indicated a small but significant benefit for continuing care on SUD outcomes at the end of the interventions ($g = .19$, $p < .001$) and at post-treatment follow-up ($g = .27$, $p < .01$). (Hedges' g and Cohen's d are roughly equivalent measures of effect size.)

A systematic review of six methodologically rigorous trials of continuing care for alcohol use disorder found similarly mixed results.[9] The trials tested multimodal interventions based on the chronic care model following initial treatment in more intense addiction and psychiatric programs. The interventions included a range of active outreach techniques, from telephone calls to follow-up by nurses, and various forms of individual or couples counseling. Four of the six trials found that patients receiving continuing care supplemented by active outreach interventions had significantly better drinking outcomes than patients receiving usual continuing care. In summary, prior reviews on the adult SUD continuing care literature found on average relatively small positive effects, which appeared to mask a fair amount of heterogeneity in results across studies.

Adolescent Participants

Studies of continuing care for adolescents were reviewed by Passetti and colleagues.[10] This review identified six studies with randomized designs, and four of these studies evaluated assertive continuing care (ACC).[11] ACC consists of home visits, linkage to other services, transportation to services or other pro-recovery activities, advocacy to access services, and provision of the evidence-based adolescent community reinforcement approach (A-CRA).[12] In three of the four studies of ACC, this intervention produced significantly better SUD outcomes than the continuing care provided as treatment as usual (TAU).[11,13,14] A second intervention, active aftercare, whether delivered via in-person or telephone sessions, was found to be more effective than no aftercare (control condition).[15] Finally, the effects of A-CRA versus continuing care with enhanced cognitive behavioral therapy (CBT) for adolescents who did not achieve abstinence in the initial phase of treatment were studied by Kaminer and colleagues.[16] There were no differences in retention or abstinence rates between the two treatment conditions. It should be noted that three of these studies also were included in the review by Blodgett et al.[8] In summary, prior reviews of continuing care for adolescents with SUD generally found favorable results, particularly for ACC.

CONTINUING CARE STUDIES NOT INCLUDED IN PRIOR REVIEWS

A number of continuing care studies were not included in these reviews, primarily because they were published after 2010.

Mindfulness-Based Relapse Prevention

Mindfulness-based relapse prevention (MBRP), an intervention that combines mindfulness practices and CBT relapse prevention (RP), was evaluated in a study by Bowen and colleagues.[17] Participants who had successfully completed the first phase of treatment were randomly assigned to aftercare—MBRP, RP, or TAU (12-step programming and psychoeducation)—and followed for 12 months. Participants in MBRP and RP had lower rates of relapse to substance use and heavy drinking than did those in TAU. Moreover, among participants with some substance use, those in MBRP and RP had fewer days of substance use and heavy drinking than did those in TAU. RP was superior to MBRP in time to first drug use. Conversely, MBRP produced fewer days of reported substance use and heavy drinking at 12 months than did RP and TAU. These findings suggest that MBRP may be at least as effective as RP.

Telephone-Based Continuing Care

Efficacy and effectiveness analyses

McKay and colleagues have published results from three additional telephone-based continuing care studies that were not included in earlier reviews.[2,8,9] The first of these was conducted among participants with cocaine use disorder who had participated in an IOP for 2 to 4 weeks.[18] About 40% of the sample also had current co-occurring alcohol use disorder (AUD). Participants were randomly assigned to IOP (TAU); IOP plus telephone monitoring and counseling (TMC), which consisted of up to 39 calls provided on a titrated schedule over 24 months; or IOP plus TMC with incentives for completed continuing care sessions (i.e., $10 gift coupons for each continuing care session attended in the first year), and followed for 24 months. The primary outcome was a composite measure that considered cocaine use, other drug use, and heavy alcohol use. There were no significant treatment main effects in this study. However, among participants who continued to use cocaine or drink alcohol in the first 3 weeks of IOP, TMC had significant positive effects on the primary outcome compared with TAU with IOP. Although the incentives almost doubled the number of continuing care sessions that were attended, substance use outcomes in the TMC plus incentives condition were slightly worse than those in TMC.

A second study, also focused on IOP patients with cocaine use disorder, evaluated an augmented version of TMC plus incentives for attendance that was provided to patients from the beginning of IOP, rather than only to those patients who had been attending IOP for several weeks.[19] This 12-month version of TMC also included more vigorous outreach efforts when patients stopped completing calls, and more active efforts to link patients to recovery services in the community. Results of this randomized study indicated that this intervention actually produced worse results than the comparison condition, IOP only, over the 12-month follow-up, as indicated by the composite measure described above and cocaine urine toxicology. The authors speculated that providing such an intensive continuing care intervention in parallel with IOP may have overburdened and possibly confused patients in the study. Finally, 12-month outcomes from an ongoing study examining a 12-month version of TMC and a smartphone recovery program indicated that patients randomized to TMC had better outcomes on measures of status and frequency of alcohol use and heavy alcohol use than did those randomized to TAU.[20]

The impact of telephone continuing care on criminal justice outcomes was examined by combining patients with cocaine use disorder from three continuing care studies[8,21,22] and comparing outcomes among those randomized to IOP plus

TMC and those randomized to IOP only.[23] The outcome measure was criminal convictions in the 4 years after admission to treatment. Controlling for a criminal sentence in the year prior to baseline, gender, age, and continuing care study, people with cocaine use disorder randomized to an IOP plus a telephone-based continuing care intervention had 54% lower odds of a criminal conviction and sentence in the 4 years after enrollment into the continuing care study, compared to those randomized to an IOP alone.

A 12-week version of the TMC protocol described in the studies above also was evaluated by Timko and colleagues.[24] Patients (90% male) with co-occurring SUD and a psychiatric disorder who were receiving treatment in an inpatient psychiatric facility were randomized to receive 12 weeks of TMC or standard continuing care. Outcomes obtained for up to 12 months post–continuing care indicated that TMC did not improve substance use outcomes or increase attendance at self-help programs compared to standard care. The authors speculated that the intervention may have been too brief and not intensive enough to improve outcomes in what was already a fairly comprehensive program. In addition, work by McKay and colleagues has indicated that TMC may be more effective for women than for men.[25,26]

Economic analyses

Two investigations of the economic impact of TMC also have been published. The first study[27] examined the 12-week version of TMC that was evaluated by McKay and colleagues.[21] The study found that TMC was less expensive per client ($569) than treatment as usual aftercare with group counseling ($870) or than individual RP ($1,684). TMC also was more effective, with an abstinence rate of 57% compared to 47% for TAU. Thus, relative to TAU, TMC produced a highly favorable negative incremental cost-effectiveness ratio (-$1,400 per abstinent year). TMC also proved favorable under a benefit-cost perspective.

The second study[28] examined the 24-month version of TMC evaluated by McKay and colleagues.[18] The study evaluated the cost-effectiveness of TMC with and without incentives as a continuing care protocol for individuals with cocaine use disorder. Results suggest that, for the average client, TMC is a cost-effective strategy for reducing substance use, particularly if society is willing to pay more than $30 per day of abstinence. TMC plus incentives, on the other hand, was less cost-effective than TAU and was slightly less effective and more costly than TMC alone.

The results are reinforced by the societal cost analysis, which indicated that TMC generated the greatest reduction in societal costs overall ($1,564 on average). However, the TMC plus incentives condition had very high net savings ($2,138 from provider perspective, and $1,343 from societal perspective) for those patients who had a poor initial response to IOP as indicated by continued substance use. This finding illustrates that, from an economic perspective, it is advantageous to monitor substance use early in treatment and to tailor continuing care on the basis of whether initial abstinence is achieved. Continued substance use early in IOP could flag higher-risk individuals who are more likely to require more extensive and expensive interventions such as TMC plus incentives to achieve good outcomes over longer periods of time. The results of this study suggest that for such individuals, increased societal benefit will more than offset the added costs of the more expensive continuing care intervention.

Mediation effects

In the McKay et al. study, the positive effects of telephone continuing care relative to TAU (group counseling) over a 2-year follow-up were mediated by self-help involvement during continuing care as well as self-efficacy and commitment to abstinence 3 months after treatment.[21] Scores on these measures were higher in the telephone condition relative to TAU, the measures predicted subsequent substance use outcomes, and analyses indicated significant mediation effects.[29]

Summary

Telephone continuing care appears to improve outcomes consistently for individuals with AUD. The findings for individuals with drug use disorders are more varied, with some studies generating no effects or even negative effects and others yielding positive effects in the full sample or in higher-risk subsamples. In addition, telephone continuing care has been found to be cost-effective and cost-beneficial compared to TAU, and to reduce the risk of criminal convictions in the 4 years following treatment intake.

Recovery Management Checkups

Efficacy and effectiveness analyses

Recovery management checkups (RMC) is a continuing care intervention that provides individuals who have entered treatment for SUD with long-term monitoring of their substance use and active attempts to reengage them in treatment when needed.[30-33] In RMC, an in-person clinical assessment is provided every 3 months by using standardized instruments as well as urine testing for substance use. When the clinical assessment indicates a need for active treatment, individuals are transferred to a linkage manager, who uses motivational interviewing techniques to help them recognize and acknowledge their resumption of substance use and need for additional treatment. Formal barriers to reentering treatment are discussed and addressed, and scheduling and transportation to treatment are arranged.

Three randomized trials comparing the RMC intervention with TAU have found positive effects on substance use outcomes.[30-33] The first study in this series assigned 448 adults with chronic substance use to receive RMC plus standard treatment for 2 years or standard treatment alone.[30,32] More than 90% of those randomized to RMC were seen at each quarterly assessment; these adults received the intervention if they were designated as in need of treatment, as indicated by "out of control" use in the prior 90 days. In intent-to-treat analyses, patients assigned to the RMC group, compared to those who received standard treatment alone, had fewer quarterly assessments in which they were found to be in need of SUD treatment. However, there were no significant differences between the two groups in substance-related problems per month or in total days of abstinence.

A second study randomly assigned 446 adults with chronic substance use disorder to receive RMC plus standard treatment for 4 years or standard treatment alone.[31] In intent-to-treat analyses, patients assigned to the RMC group had fewer quarters in which they were found to be in need of SUD treatment, fewer substance-related problems per month, and more total days of abstinence (1,026 vs. 932 days) compared with patients in the control group who got assessments only.

A third trial randomly assigned 480 female offenders referred from incarceration to community-based SUD treatment to TAU versus TAU plus RMC provided for 3 years.[33] Results indicated that RMC was beneficial for women who were not on probation. For example, among women not on probation, those who received RMC, compared with those who received TAU alone, were more likely to receive any days of SUD treatment (9% vs. 5%), less likely to engage in weekly alcohol and drug use (47% vs. 60%), and less likely to engage in any HIV-risk behavior (66% vs. 73%). Conversely, there were no significant positive effects for RMC in women on probation, possibly because they were already closely monitored.

Economic analyses

Cost-effectiveness was examined in the study in which 446 adults with chronic SUD were randomized to receive RMC for 4 years or quarterly assessments only.[31] Over the 4-year trial, RMC cost on average $2,184 more than conducting quarterly assessments only. The incremental cost-effectiveness ratio for RMC was $23.38 per day abstinent and $59.51 per reduced problem related to excessive substance use. When additional costs to society were factored into the analysis, RMC was less costly and more effective than quarterly assessment only.[34]

Summary

RMC has consistently produced better substance use outcomes and quicker reentry into treatment during relapses than have assessments without intervention. Results also have indicated that RMC is a cost-effective and potentially cost-saving intervention.

Continuing Care Based on Physician Health Programs

The model of continuing care used to treat physicians and pilots features intensive treatment initially, combined with extended continuing care for 5 years or more, and frequent random drug testing over that period. The active ingredients of the intervention are thought to be rapid detection of relapse to facilitate outreach, accountability, and social support. Several residential programs have developed continuing care interventions based on this model. One of these programs, My First Year of Recovery (MyFYR), was recently evaluated in a single-group observational study with no control group.[35] MyFYR consists of random urine toxicology tests, recovery coaching, and a web-based application that links important individuals in the patient's life (e.g., spouse, employer, other family members, provider) and supplies updates to these individuals on the patient's urine testing compliance and results.

This evaluation found that patients who received MyFYR provided 70% of the scheduled urine samples over a 12-month period, for an average of 16.4 urine samples per patient.[35] As determined by urine toxicology and client and family reports, 54% of the patients had some use of alcohol or drugs during the follow-up period. Of these relapsed patients, 71% were retained or re-engaged in MyFYR. Of these retained or re-engaged patients, 50% were able to re-establish abstinence for 2 months or more, as documented by multiple negative urine toxicology results. These results suggest that continuing care based on physician health programs also may be effective for individuals who are not motivated to participate in order to regain or maintain a professional license and a high-paying job. However, randomized studies with proper control conditions are needed before any conclusions are drawn about the effectiveness of this approach.

CARE MANAGEMENT IN PRIMARY CARE

Clinical trials have been conducted to determine whether management of SUD, including ongoing continuing care, is feasible in primary care. Fiellin and colleagues randomized primary care patients with opioid use disorder to standard medical management with once-weekly dispensing of buprenorphine–naloxone, standard medical management with thrice-weekly dispensing, or enhanced medical management with thrice-weekly dispensing.[36] All treatments were provided for 24 weeks. Results indicated that there were no differences between the three conditions on any of the primary substance use or retention measures.

In a second study, 563 patients with alcohol or drug use disorders who were completing medically supervised detoxification were randomly assigned to chronic care management for substance use disorder in primary care or to usual care for these disorders in primary care.[37] The chronic care management intervention was delivered by an interdisciplinary team consisting of a nurse care manager, a social worker, an internist, and a psychiatrist with addiction expertise. At the 1-year follow-up, the chronic care management group and the control group did not differ on abstinence from heavy drinking, opioids, and stimulants (40% vs. 42%). There were no significant differences in other outcomes except fewer alcohol problems were reported by those with alcohol use disorder in the chronic care management group, a small effect of questionable clinical significance. Moreover, a follow-up analysis from this study also found no positive effects for subsets of patients in the chronic care management group with co-occurring major depression or post-traumatic stress disorder.[38]

A third clinical trial randomly assigned 82 women with a history of homelessness and alcohol use problems to a 6-month chronic care intervention or to usual care from primary care

doctors without specialized training in alcohol interventions.[39] The chronic care intervention consisted of brief intervention by a primary care doctor, referral to alcohol treatment services, and ongoing support from a case manager. Both conditions significantly reduced their alcohol consumption. There were no differences between the groups in reductions in drinking, housing stability, or mental or physical health.

In a fourth clinical trial, 163 patients with a DSM-IV diagnosis of alcohol dependence treated in primary care were randomly assigned to 26 weeks of alcohol care management or to referral for standard treatment in a specialty outpatient addiction treatment program.[40] The care management program, which was provided in person and by phone, focused on the use of pharmacotherapy and psychosocial support. Compared with patients in the standard treatment group, patients receiving care management attended clinic visits more frequently, were more likely to receive naltrexone (12% vs. 66%), and had a smaller proportion of heavy drinking days per month. Overall abstinence did not differ between groups.

These studies generated little evidence on how to improve the treatment of patients with a drug or alcohol use disorder in primary care. However, offering alcohol care management to patients in primary care who have AUD does appear to be more effective than referring them to specialty care.

USE OF MOBILE HEALTH TECHNOLOGY IN CONTINUING CARE

There are three potential roles for mobile health technology such as smartphone and texting programs in the delivery of continuing care. First, the technology could be used in conjunction with other behavioral interventions to provide automated support between therapy sessions and to convey information on a patient's status back to the provider. For example, the A-CHESS (Addiction–Comprehensive Health Enhancement Support System) smartphone program has a number of supportive functions that can be accessed 24/7, including a chat room populated by others using the app, a library of materials on how to handle risky situations and other stressors, relaxation aids, and rapid connections to specified social supports.[41] In addition, the app sends out daily and weekly assessments to patients using the system, and the patients' responses are available in a dashboard that can be accessed by providers. The system also can be set to automatically send emails to providers when a patient reports worrisome information. Second, apps and SMS (short message service) could be used as stand-alone continuing care, perhaps for individuals who have limited access to more traditional clinic-based continuing care and for those further along in recovery. Finally, mobile heath can be an option for individuals who prefer virtual rather than in-person treatment.

So far, the apps and SMS programs that have been developed for individuals with SUD tend to fall into two main types.[42] Several programs provide simplified versions of complex evidence-based behavioral interventions, such as CBT and the community reinforcement approach. These programs include CBT4CBT[43] as well as reSET and reSET-O by Pear Therapeutics. Others, such as A-CHESS,[41] do not attempt to provide manualized therapy interventions such as CBT to users. Rather, they have a range of other features designed to support recovery, such as self-monitoring, information on dealing with high-risk situations, tools for relaxation or distraction, and ways of connecting with peers or treatment providers. Most of these interventions have not been developed specifically for continuing care, but could potentially be used in that role. However, A-CHESS and two texting interventions were designed for the provision of continuing care.

In a controlled trial of A-CHESS, patients with alcohol use disorder ($N = 349$) who had completed residential treatment were randomized to receive A-CHESS for 8 months or standard continuing care only.[41] The participants continued to use the A-CHESS system throughout the 8-month period during which it was provided. At 8 months, 70% of subjects were using A-CHESS at least

weekly, compared to 92% at 1 month. Overall, participants used the system on 40% of the days they had access to it. Although frequency of reported alcohol use was low in both conditions during follow-up, patients receiving A-CHESS reported 49% fewer days with risky drinking in the prior 30 days at the 4-, 8-, and 12-month follow-up as compared to those in TAU. Rates of alcohol abstinence within the prior 30 days were higher in A-CHESS than in TAU at the 8-month follow-up (78% vs. 67%) and the 12-month follow-up (79% vs. 66%). A secondary analysis found that the positive effects of A-CHESS were mediated by increases in participation in outpatient treatment but not by increases in attendance at mutual health groups.[44]

A second trial of continuing care for patients with AUD found that providing A-CHESS, a smartphone, and a data plan for 12 months significantly reduced days of alcohol use and heavy alcohol use over that period relative to patients who did not receive A-CHESS.[20] However, a condition that combined both A-CHESS and TMC in an integrated package did not produce superior alcohol use outcomes to A-CHESS or TMC alone.[20]

The efficacy of a recovery support program with mobile texting, called Educating and Supporting inQuisitive Youth in Recovery (ESQYIR), was evaluated by Gonzales and colleagues.[45] The intervention consisted of 12 weeks of daily text messages about disease management, which included monitoring, feedback, reminders, education, and support. Monitoring texts were sent out every afternoon, along with feedback texts tailored on the basis of responses to the monitoring texts. In the study, 80 youths who had completed an initial phase of treatment were randomized to aftercare as usual (referral to self-help programs) or to ESQYIR. At 6- and 9-month post-aftercare follow-up, youths randomized to ESQYIR were less likely than those in TAU to test positive for their primary drug. They also reported significantly higher self-efficacy and were more likely to participate in recovery-oriented activities. Secondary analyses found that the positive effect of the intervention was mediated by increased involvement in pro-recovery activities other than Alcoholics Anonymous (AA) or Narcotics Anonymous (NA), but not by participation in AA or NA.[46]

A randomized study in Switzerland evaluated a continuing care intervention using text messaging to monitor self-selected drinking goals. The intervention also provided motivational text messages and telephone calls when participants failed to achieve goals or asked for support.[47] Participants in the SMS condition responded to 88% of the SMS prompts, and 44% sent at least one request for help. Compared to standard continuing care, the intervention reduced the rate of at-risk drinking from 42% to 29%, a nonsignificant decrease.

Finally, Rose and colleagues developed an automated continuing care intervention that is delivered by telephone via interactive voice response (IVR).[48] Participants call into the system once per day to report on 16 factors, including substance use, mood states, craving, self-efficacy, risk situations, sobriety support, substance-free recreation, and coping. When participants are judged to be at risk based on this assessment, tailored feedback is provided. Other features include CBT skills encouragement, coping skills review, and coping skills practice. Each month, participants also receive a personalized voice message from a counselor, which includes comments on progress and suggestions. The IVR system was evaluated in a study in which individuals with AUD who had completed 12 weeks of CBT were randomized to 4 months of the IVR system or of usual care, and followed for 12 months.[48] Most primary analyses indicated no differences in drinking outcomes between the two conditions. However, a group x time interaction on drinking days per week favored the IVR condition. In addition, in participants who were abstinent at the end of the 12-week initial CBT intervention, outcomes on any drinking at the 2- and 4-month follow-up and any heavy drinking at the 4-month follow-up favored IVR over usual care.[48] However, given the large number of analyses performed, these positive results should be interpreted cautiously.

Most of these studies testing continuing care with mobile health interventions have yielded positive effects on substance use outcomes. However, despite the initial promise of mobile health interventions, significant challenges remain in the provision of continuing care via mobile health apps and SMS. A recent systematic review found rapidly declining rates of smartphone use in most studies of interventions for mental health problems.[49] This has sometimes been the case with mobile health interventions for addiction.[20,42] Also, potential users must have access to a smartphone and data plan, or a telephone with SMS capabilities for texting-based interventions.

INCENTIVES FOR ATTENDANCE AND ABSTINENCE

Several studies have examined the impact of providing incentives either for attendance at continuing care or for drug abstinence during continuing care. In one study, patients with cocaine use disorder who had completed 2 to 4 weeks of an IOP were randomized to receive additional individual CBT for 5 months (yes/no) and to receive monetary incentives for cocaine abstinence over 12 weeks (yes/no) in a 2 x 2 design.[50] In the group that received both CBT and incentives for abstinence, participants were eligible for the incentives only if they were attending CBT sessions. Results over an 18-month follow-up found a significant positive main effect for abstinence incentives, and the best outcome was obtained in the group that received both incentives and CBT.[50] Kirby and colleagues compared the standard 12-week contingency management for cocaine abstinence protocol with an extended 36-week protocol in methadone-maintained adults with cocaine use disorder, and found that the extended protocol produced significantly longer durations of continuous cocaine abstinence during weeks 1 through 24 and higher rates of cocaine-free urine samples during weeks 24 through 36.[51] A third study examined the impact of providing $10 as an incentive for each continuing care session attended in the first year of a 2-year intervention for IOP patients with cocaine use disorder.[18] The incentive almost doubled the number of continuing care sessions attended, but had no effect on cocaine use outcomes or on overall drug and alcohol use. Finally, Lash and colleagues found that adding social reinforcement of abstinence to an intervention that included attendance contracts and prompts improved aftercare attendance and abstinence outcomes compared to contracts and prompts only.[52] These studies have found strong evidence of the efficacy of providing incentives for abstinence during continuing care. However, there is no evidence that providing incentives for continuing care attendance improves outcomes.

ADAPTIVE TREATMENT AND CONTINUING CARE

There is a great deal of heterogeneity in how individuals respond to SUD treatment, including continuing care.[4] Even with the most effective interventions, a significant percentage of patients will not exhibit a strongly positive response. Therefore, it is important to be able to adapt, or adjust, treatment when patients are not getting better.[53] Moreover, there can be considerable heterogeneity within individuals in how their recovery is progressing over time. For example, a patient may do well in the first phase of treatment and in the first few months of continuing care, but then relapse and have a difficult time regaining abstinence. In a number of other areas in medicine—such as infectious diseases, hypertension, and cancer—algorithms have been developed to aid physicians in selecting optimal "plan B" treatments when the initial treatment offered does not work well.

In the treatment of SUD, less is known about how to best address heterogeneity of response between patients and within patients. However, some initial progress has been made. RMC addresses within-patient heterogeneity in response over extended periods of time by providing assessments every 3 months, with a protocol to

transition individuals back into SUD treatment if they return to heavy alcohol or drug use.[30-33] The research on TMC found that this extended intervention was most helpful for patients who did not do well in the first month of IOP, as evidenced by continued substance use,[18] poor social support,[25] or low motivation for recovery.[25] Results over a 24-month follow-up period identified several subgroups for which adding TMC to IOP was particularly effective relative to IOP only: participants with poor social support, those with less motivation for recovery, and those with more prior treatment experiences.[25] In addition, TMC was more beneficial for women participants than for male participants in two studies.[25,26]

One study with adolescents sought to determine the kind of continuing care that was best for those who had a poor response to outpatient treatment.[16] Adolescents who did not achieve abstinence after 7 weeks of outpatient treatment were randomized to 10 weeks of individual CBT or A-CRA. Of these patients, 37% completed continuing care and 27% achieved abstinence. However, there were no differences in outcome between the two continuing care conditions.

These findings suggest that assessments conducted prior to and during continuing care provide data that can be used to improve outcomes by triggering changes to treatment.[4,54] Ideally, these assessments should address recent or current substance use as well as other factors that are linked to relapse. For example, current depression, craving poor social support, and lack of commitment to abstinence all have predicted subsequent relapse in multiple studies. Even if a patient remains abstinent during continuing care, it may be important to modify the intervention in some way if craving or depression increases.[4]

RESEARCH ASSESSMENT EFFECTS

There is evidence that research follow-up can have a positive effect on alcohol and drug use outcomes in treatment studies. Clifford and colleagues found that study participants who received more follow-ups had significantly better alcohol use outcomes.[55] In a second study, participants were randomly assigned to one of four research assessment follow-up schedules that varied by frequency and duration. Those assigned to the infrequent and brief assessment condition had worse drinking outcomes (i.e., higher frequency, greater quantity), higher negative consequences of drinking, and worse drug use outcomes than did those assigned to more frequent and longer assessments.[56] Other studies in this area have produced more mixed results.[57] Although the mechanisms of action are not well understood, the process of being asked about substance use may increase its salience for the participant, or may be therapeutic in some other way.

MEDICATIONS

The U.S. Food and Drug Administration (FDA) has approved several medications for AUD and opiate use disorder. With regard to medications for AUD, there is no convincing evidence to date that longer periods of use produce better drinking outcomes than do shorter periods, or that using the medications in the context of continuing care produces better outcomes. However, this is largely because little research in this area has been done; most studies have evaluated only 12- or 24-week courses of medication. In one exception to this general trend, a study with male veterans with chronic, severe alcohol addiction found no differences between placebo, naltrexone for 3 months, and naltrexone for 12 months conditions in frequency of drinking or number of drinks per drinking day at 1-year follow-up.[58] Conversely, there is good evidence that longer periods on medications for opiate use disorder produce better outcomes than shorter periods, and at this point, detoxification is not recommended.[59] There are no FDA-approved medications for stimulant or cannabis use disorder. More research is needed to determine if longer durations on medications for AUD are beneficial, and to identify successful strategies to increase long-term use of effective medications.

CONCLUSIONS

At this point, continuing care is widely believed to be an important component of effective treatment for substance use disorder, particularly for those individuals with a problem severe enough to require specialty care treatment. The research base generally has supported the efficacy of continuing care for both adolescents and adults, but the picture is complex. Reviews have found relatively small to moderate effects when results from individual studies are averaged or combined in some way.[2,8] However, there is some evidence that continuing care of longer duration that includes more active efforts to keep patients engaged may produce more consistently positive results.[2,13] Moreover, patients at higher risk for relapse—by virtue of continued substance use in the first phase of care, or poor social support or low motivation early in treatment—may benefit to a greater degree from continuing care than those patients with a better prognosis.[18,25,26]

Several new approaches show promise for the provision of continuing care. These include incentives for abstinence; use of automated mobile health interventions to augment more conventional counselor-delivered interventions; and extended treatment and monitoring programs that, until very recently, have been provided only to pilots and doctors. There is also evidence that primary care can be used to provide medications for opioid and alcohol use disorders over extended periods; however, more research is needed to determine the optimal mix of behavioral treatments and other psychosocial services in this setting. Regardless of the intervention selected for use, it is clear that the status of most patients with SUD will change and evolve over time, and interventions need to include provisions to assess patients on a regular basis and to change or adapt treatment when warranted.[4,25,26,54] More research is needed to develop evidence-based protocols for adapting continuing care interventions over time and addressing nonresponse. In addition, to promote higher rates of stable, long-term recovery, additional work is needed to develop methods to integrate continuing care interventions more effectively with other supports available in the community and to promote greater involvement in rewarding activities that provide enjoyment and a sense of meaning and purpose.[6]

The field is also starting to move toward more specific guidelines regarding the characteristics of high-quality continuing care. A recent review of evidence-based guidelines and quality indicators derived 13 specific quality indicators, including the provision of information on self-help, relapse prevention strategies, involvement of family members, provision of both behavioral interventions and medications, minimum of 3 months of follow-up, and patient involvement in development of continuing care plans.[60] The development of evidence-based clinical practice guidelines to facilitate wider implementation of effective continuing care would be a major advance for the field. As discussed here, these guidelines likely will need to include information on adapting continuing care over time at the individual level to achieve optimal outcomes. For example, higher-risk patients likely will benefit from continuing care interventions with longer durations, and some patients may have preferences for particular approaches or modalities (e.g., mobile health vs. clinic-based care).

Finally, although the efficacy of specific continuing care interventions is certainly important, the crucial roles played by providers who deliver these interventions have not received sufficient attention. Some providers are simply better than others, but the individual characteristics and training that facilitate greater success as a continuing care provider have received little attention. Intriguing work in this area has been done by Karno and Longabaugh, who conducted an elegant series of studies on the impact of continuing care therapist counseling style, and the interaction between counseling style and patient characteristics, on drinking outcomes.[61,62] This work has involved the careful coding of therapist and patient behaviors during continuing care treatment sessions for factors such as focus on emotional material and directness.

In one study, patients with clinically elevated depression scores had better drinking outcomes if their therapists had a *low* focus on painful emotional material, and worse outcomes when the therapist was more focused on such material.[61] Therapist focus on emotional material did not predict drinking outcomes in patients who were not depressed. A second study looked at therapist directiveness, or the degree to which the therapist employed confrontation, interpretation, and closed-ended questions; addressed in-session resistance; initiated topics; and provided information.[62] Results indicated that higher therapist directiveness predicted worse drinking outcomes in high-anger patients, and better drinking outcomes in low-anger patients. Therefore, in addition to proceeding with the further development and evaluation of innovative continuing care interventions and methods of intervention delivery, much more attention should be devoted to improving the therapeutic skills of providers and studying the process of change within continuing care sessions.

Acknowledgments

Preparation of this article was supported by K24 DA029062 from the National Institute on Drug Abuse; R01 AA022595 from the National Institute on Alcohol Abuse and Alcoholism; and DoD W81XWH-14-1-0060 from the U.S. Department of Defense, U.S. Army Medical Research and Material Command; as well as by the Corporal Michael J. Crescenz VA Medical Center in Philadelphia, PA.

Financial Disclosures

The author has no competing financial interests to disclose.

Publisher's Note

Opinions expressed in contributed articles do not necessarily reflect the views of the National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health. The U.S. government does not endorse or favor any specific commercial product or commodity. Any trade or proprietary names appearing in *Alcohol Research: Current Reviews* are used only because they are considered essential in the context of the studies reported herein.

References

1. Dennis ML, Scott CK. Managing addiction as a chronic condition. *Addict Sci Clin Pract*. 2007;4(1):45-55.
2. McKay JR. Continuing care research: What we've learned and where we're going. *J Subst Abuse Treat*. 2009;36(2):131-145. https://www.doi.org/10.1016/j.jsat.2008.10.004.
3. McLellan AT, Lewis DC, O'Brien CP, et al. Drug dependence, a chronic medical illness: Implications for treatment, insurance, and outcome evaluation. *JAMA*. 2000;284(13):1689-1695. https://doi.org/10.1001/jama.284.13.1689.
4. McKay JR. *Treating Substance Use Disorders With Adaptive Continuing Care*. Washington, DC: American Psychological Association Press; 2009. https://psycnet.apa.org/doi/10.1037/11888-000.
5. Witkiewitz K, Marlatt GA. Relapse prevention for alcohol and drug problems: That was Zen, this is Tao. *Am Psychol.* 2004;59(4):224-235. https://doi.org/10.1037/0003-066x.59.4.224.
6. McKay JR. Making the hard work of recovery more attractive for those with substance use disorders. *Addiction*. 2017;112(5):751-757. https://doi.org/10.1111/add.13502.
7. Wagner EH, Austin BT, Davis C, et al. Improving chronic illness care: Translating evidence into action. *Health Aff (Millwood)*. 2001;20(6):64-78. https://doi.org/10.1377/hlthaff.20.6.64.
8. Blodgett JC, Maisel NC, Fuh IL, et al. How effective is continuing care for substance use disorders? A meta-analytic review. *J Subst Abuse Treat*. 2014;46(2):87-97. https://doi.org/10.1016/j.jsat.2013.08.022.
9. Lenaerts E, Mathei C, Matthys F, et al. Continuing care for patients with alcohol use disorders: A systematic review. *Drug Alcohol Depend*. 2014;135:9-21. https://doi.org/10.1016/j.drugalcdep.2013.10.030.
10. Passetti LL, Godley MD, Kaminer Y. Continuing care for adolescents in treatment for substance use disorders. *Child Adolesc Psychiatr Clin N Am.* 2016;25(4):669-684. https://doi.org/10.1016/j.chc.2016.06.003.
11. Godley MD, Godley SH, Dennis ML, et al. A randomized trial of assertive continuing care and contingency management for adolescents with substance use disorders. *J Consult Clin Psychol*. 2014;82(1):40-51. https://doi.org/10.1037/a0035264.
12. Godley SH, Godley MD, Dennis ML. The assertive aftercare protocol for adolescent substance abusers. In: Wagner E, Waldron H, eds. *Innovations in Adolescent Substance Abuse Interventions*. New York, NY: Elsevier Science. 2001:313-331. https://doi.org/10.1016/B978-008043577-0/50034-1.
13. Godley MD, Godley SH, Dennis ML, et al. The effect of Assertive Continuing Care (ACC) on continuing care linkage, adherence and abstinence following residential treatment for adolescents. *Addiction*. 2006;102(1):81-93. https://doi.org/10.1111/j.1360-0443.2006.01648.x.
14. Henderson CE, Wevodau AL, Henderson SE, et al. An independent replication of the Adolescent–Community Reinforcement Approach with justice-involved youth. *Am J Addict*. 2016;25(3):233-240. https://doi.org/10.1111/ajad.12366.
15. Kaminer Y, Burleson JA, Burke RH. Efficacy of outpatient aftercare for adolescents with alcohol use disorders: A randomized controlled study. *J Am Acad Child Adolesc Psychiatry*. 2008;47(12):1405-1412. https://doi.org/10.1097/chi.0b013e318189147c.
16. Kaminer Y, Ohannessian CM, Burke RH. Adolescents with cannabis disorders: Adaptive treatment for poor responders. *Addict Behav*. 2017;70:102-106. https://doi.org/10.1016/j.addbeh.2017.02.013.
17. Bowen S, Witkiewitz K, Clifasefi SL, et al. Relative efficacy of mindfulness-based relapse prevention, standard relapse prevention, and treatment as usual for substance use disorders: A randomized clinical trial. *JAMA Psychiatry*. 2014;71(5):547-556. https://doi.org/10.1001/jamapsychiatry.2013.4546.
18. McKay JR, Van Horn DHA, Lynch KG, et al. An adaptive approach for identifying cocaine dependent patients who benefit from extended continuing care. *J Consult Clin Psychol*. 2013;81(6):1063-1073. https://doi.org/10.1037/a0034265.

19. McKay JR, Van Horn D, Ivey M, et al. Enhanced continuing care provided in parallel to intensive outpatient treatment does not improve outcomes for patients with cocaine dependence. *J Stud Alcohol Drugs.* 2013;74(4):642-651. https://doi.org/10.15288/jsad.2013.74.642.
20. McKay JR, Gustafson D, Lynch KG, et al. Impact of supplementing intensive outpatient treatment with telephone continuing care and A-CHESS smartphone interventions. In: Garets M, Archer S, Kitchens C, et al. The 2019 Addiction Health Services Research Conference: Insights, review, and abstracts. *Subst Abuse*. 2019;40(4):469-472. https://doi.org/10.1080/08897077.2019.1688221.
21. McKay JR, Lynch KG, Shepard DS, et al. The effectiveness of telephone-based continuing care for alcohol and cocaine dependence: 24-month outcomes. *Arch Gen Psychiatry.* 2005;62(2):199-207. https://doi.org/10.1001/archpsyc.62.2.199.
22. McKay JR, Van Horn DH, Oslin D, et al. A randomized trial of extended telephone-based continuing care for alcohol dependence: Within treatment substance use outcomes. *J Consult Clin Psychol*. 2010;78(6):912-923. https://doi.org/10.1037/a0020700.
23. Wimberly A, Hyatt J, McKay JR. Effect of continuing care for people with cocaine dependence on criminal justice sentences. *Behav Sci Law.* 2018;36(1):116-129. https://doi.org/10.1002/bsl.2330.
24. Timko C, Harris AHS, Jannausch M, et al. Randomized controlled trial of telephone monitoring with psychiatry inpatients with co-occurring substance use and mental health disorders. *Drug Alcohol Depend*. 2019;194:230-237. https://doi.org/10.1016/j.drugalcdep.2018.09.010.
25. McKay JR, Van Horn D, Oslin DW, et al. Extended telephone-based continuing care for alcohol dependence: 24 month outcomes and subgroup analyses. *Addiction*. 2011;106(10):1760-1769. https://doi.org/10.1111/j.1360-0443.2011.03483.x.
26. McKay JR, Van Horn DH, Lynch KG, et al. Who benefits from extended continuing care for cocaine dependence? *Addict Behav*. 2014;39(3):660-668. https://doi.org/10.1016/j.addbeh.2013.11.019.
27. Shepard DS, Daley MC, Neuman MJ, et al. Telephone-based continuing care counseling in substance abuse treatment: Economic analysis of a randomized trial. *Drug Alcohol Depend*. 2016;159:109-116. https://doi.org/10.1016/j.drugalcdep.2015.11.034.
28. McCollister K, Yang K, McKay JR. Cost-effectiveness analysis of a continuing care intervention for cocaine-dependent adults. *Drug Alcohol Depend*. 2016;158:38-44. https://doi.org/10.1016/j.drugalcdep.2015.10.032.
29. Mensinger JL, Lynch KG, TenHave TR, et al. Mediators of telephone-based continuing care for alcohol and cocaine dependence. *J Consult Clin Psychol*. 2007;75(5):775-784. https://doi.org/10.1037/0022-006x.75.5.775.
30. Dennis ML, Scott CK, Funk R. An experimental evaluation of recovery management checkups (RMC) for people with chronic substance use disorders. *Eval Program Plann*. 2003;26(3):339-352. https://doi.org/10.1016/s0149-7189(03)00037-5.
31. Dennis ML, Scott CK. Four-year outcomes from the Early Re-Intervention (ERI) experiment using Recovery Management Checkups (RMC). *Drug Alcohol Depend*. 2012;121(1-2):10-17. https://doi.org/10.1016/j.drugalcdep.2011.07.026.
32. Scott CK, Dennis ML. Results from two randomized clinical trials evaluating the impact of quarterly recovery management checkups with adult chronic substance users. *Addiction*. 2009;104(6):959-971. https://doi.org/10.1111/j.1360-0443.2009.02525.x.
33. Scott CK, Dennis ML, Lurigio AJ. The effects of specialized probation and recovery management checkups (RMCs) on treatment participation, substance use, HIV risk behaviors, and recidivism among female offenders: Main findings of a 3-year experiment using subject by intervention analyses. *J Exp Criminol*. 2017;13(1):53-77. https://doi.org/10.1007/s11292-016-9281-z.
34. McCollister KE, French MT, Freitas DM, et al. Cost-effectiveness analysis of Recovery Management Checkups (RMC) for adults with chronic substance use disorders: Evidence from a 4-year randomized trial. *Addiction*. 2013;108(12):2166-2174. https://doi.org/10.1111/add.12335.
35. McKay JR, Knepper C, Deneke E, et al. An initial evaluation of a comprehensive continuing care intervention for patients with substance use disorders: My First Year of Recovery (MyFYR). *J Subst Abuse Treat*. 2016;67:50-54. https://doi.org/10.1016/j.jsat.2016.04.003.
36. Fiellin DA, Pantalon MV, Chawarski MC, et al. Counseling plus buprenorphine-naloxone maintenance therapy for opioid dependence. *N Engl J Med*. 2006;355(4):365-374. https://doi.org/10.1056/nejmoa055255.
37. Saitz R, Cheng DM, Winter M, et al. Chronic care management for dependence on alcohol and other drugs: The AHEAD randomized trial. *JAMA*. 2013;310(11):1156-1167. https://doi.org/10.1001/jama.2013.277609.
38. Park TW, Cheng DM, Samet JH, et al. Chronic care management for substance dependence in primary care among patients with co-occurring disorders. *Psychiatr Serv*. 2015;66(1):72-79. https://doi.org/10.1176/appi.ps.201300414.
39. Upshur C, Weinreb L, Bharel M, et al. A randomized control trial of a chronic care intervention for homeless women with alcohol use problems. *J Subst Abuse Treat*. 2015;51:19-29. https://doi.org/10.1016/j.jsat.2014.11.001.
40. Oslin DW, Lynch KG, Maisto SA, et al. A randomized clinical trial of alcohol care management delivered in Department of Veterans Affairs primary care clinics versus specialty care addiction treatment. *J Gen Intern Med*. 2014;29(1):162-168. https://doi.org/10.1007/s11606-013-2625-8.
41. Gustafson DH, McTavish FM, Chih M-Y, et al. A smartphone application to support recovery from alcoholism: A randomized clincal trial. *JAMA Psychiatry.* 2014;71(5):566-572. https://doi.org/10.1001/jamapsychiatry.2013.4642.
42. Nesvåg S, McKay JR. Feasibility and effects of digital interventions to support people in recovery from substance use disorders: Systematic review. *J Med Internet Res*. 2018;20(8):e255. https://doi.org/10.2196/jmir.9873.
43. Carroll KM, Ball SA, Martino S, et al. Computer-assisted delivery of cognitive-behavioral therapy for addiction: A randomized trial of CBT4CBT. *Am J Psychiatry*. 2008;165(7):881-887. https://doi.org/10.1176/appi.ajp.2008.07111835.
44. Glass JE, McKay JR, Gustafson DH, et al. Treatment seeking as a mechanism of change in a randomized controlled trial of a mobile health intervention to support recovery from alcohol use disorders. *J Subst Abuse Treat*. 2017;77:57-66. https://doi.org/10./j.jsat.2017.03.011.
45. Gonzales R, Hernandez M, Murphy DA, et al. Youth recovery outcomes at 6 and 9 months following participation in a mobile texting recovery support aftercare pilot study. *Am J Addict*. 2016;25(1):62-68. https://doi.org/10.1111/ajad.12322.
46. Gonzales-Castaneda R, McKay JR, Steinberg J, et al. Testing mediational processes of substance use relapse among youth who participated in a mobile texting aftercare process. *Subst Abus*. 2019:1-12. https://doi.org/10.1080/08897077.2019.1671941.

47. Huag S, Lucht MJ, John U, et al. A pilot study on the feasibility and acceptability of a text message-based aftercare treatment programme among alcohol outpatients. *Alcohol*. 2015;50(2):188-194. https://doi.org/10.1093/alcalc/agu107.
48. Rose GL, Skelly JM, Badger GJ, et al. Efficacy of automated telephone continuing care following outpatient therapy for alcohol dependence. *Addict Behav*. 2015;41:223-231. https://doi.org/10.1016/j.addbeh.2014.10.022.
49. Linardon J, Fuller-Tyszkiewicz M. Attrition and adherence in smartphone-delivered interventions for mental health problems: A systematic and meta-analytic review. *J Consult Clin Psychol*. 2020;88(1):1-13. https://doi.org/10.1037/ccp0000459.
50. McKay JR, Lynch KG, Coviello D, et al. Randomized trial of continuing care enhancements for cocaine-dependent patients following initial engagement. *J Consult Clin Psychol*. 2010;78(1):111-120. https://doi.org/10.1037/a0018139.
51. Kirby KC, Carpenedo CM, Dugosh KL, et al. Randomized clinical trial examining duration of voucher-based reinforcement therapy for cocaine abstinence. *Drug Alcohol Depend*. 2013;132(3):639-645. https://doi.org/10.1016/j.drugalcdep.2013.04.015.
52. Lash SJ, Burden JL, Monteleone BR, et al. Social reinforcement of substance abuse treatment aftercare participation: Impact on outcome. *Addict Behav.* 2004;29(2):337-342. https://doi.org/10.1016/j.addbeh.2003.08.008.
53. Murphy SA, Lynch G, McKay R, et al. Developing adaptive treatment strategies in substance abuse research. *Drug Alcohol Depend*. 2007;88(suppl 2):S24-S30. https://doi.org/10.1016/j.drugalcdep.2006.09.008.
54. McLellan AT, McKay JR, Forman R, et al. Reconsidering the evaluation of addiction treatment: From retrospective follow-up to concurrent recovery monitoring. *Addiction*. 2005;100(4):447-458.
55. Clifford PR, Maisto SA, Franzke LH, et al. Alcohol treatment research follow-up interviews and drinking behaviors. *J Stud Alcohol*. 2000;61(5):736-743. https://doi.org/10.15288/jsa.2000.61.736.
56. Clifford PR, Maisto SA, Davis CM. Alcohol treatment research assessment exposure subject reactivity effects: Part I. Alcohol use and related consequences. *J Stud Alcohol Drugs.* 2007;68(4):519-528. https://doi.org/10.15288/jsad.2007.68.519.
57. Clifford PR, Davis CM. Alcohol treatment research assessment exposure: A critical review of the literature. *Psychol Addict Behav*. 2012;26(4):773-781. https://doi.org/10.1037/a0029747.
58. Krystal JH, Cramer JA, Krol WF, et al. Naltrexone in the treatment of alcohol dependence. *N Engl J Med*. 2001;345(24):1734-1739. https://doi.org/10.1056/nejmoa011127.
59. U.S. Department of Veterans Affairs (VA), U.S. Department of Defense (DoD). *VA/DoD Clinical Practice Guidelines for the Management of Substance Use Disorders*. Version 3.0. 2015. https://www.healthquality.va.gov/guidelines/MH/sud/VADoDSUDCPGRevised22216.pdf. Accessed October 19, 2020.
60. Bekkering GE, Zeeuws D, Lenaerts E, et al. Development and validation of quality indicators on continuing care for patients with AUD: A Delphi study. *Alcohol*. 2016;51(5):555-561. https://doi.org/10.1093/alcalc/agw044.
61. Karno MP, Longabaugh R. Patient depressive symptoms and therapist focus on emotional material: A new look at Project MATCH. *J Stud Alcohol.* 2003;64(5):607-615. https://doi.org/10.15288/jsa.2003.64.607.
62. Karno MP, Longabaugh R. What do we know? Process analysis and the search for a better understanding of Project MATCH's anger-by-treatment matching effect. *J Stud Alcohol.* 2004;65(4):501-512. https://doi.org/10.15288/jsa.2004.65.501.

ALCOHOL RESEARCH
Current Reviews

Alcohol Res. 2020;40(3):06 ● https://doi.org/10.35946/arcr.v40.3.06

Published: 17 December 2020

Recovery and Youth: An Integrative Review

Andrew J. Finch, Jordan Jurinsky, and Billie May Anderson

Department of Human and Organizational Development, Vanderbilt University, Nashville, Tennessee

Although rates of alcohol and other substance use disorders in adolescents have been estimated for decades, little is known about the prevalence, pathways, and predictors of remission and long-term recovery among adolescents. This article provides an integrative review of the literature on youth recovery. A final selection of 39 relevant articles was grouped into five sections: treatment outcomes, special emphasis populations, recovery-oriented systems of care, families, and non–abstinence-based approaches. The review recommends more adolescent research in three basic areas: more research about medication-assisted treatment and recovery as well as harm reduction approaches for adolescents; expansion of research on recovery practices for youth who do not receive treatment due to personal choice or societal disparities; and more life course research, which may begin with adolescent participants and extend across the life span. Additionally, the authors suggest the recovery capital model for adolescents and the neuroscience of addiction may provide additional precision and direction for the study of youth recovery.

KEY WORDS: recovery; substance-related disorders; alcohol-related disorders; adolescence; continuum of care; alcohol; youth; recovery capital

INTRODUCTION

Recovery from alcohol use disorder (AUD) or other substance use disorder (SUD) is an evolving concept. This article reviews youth recovery, as little is known about the prevalence, pathways, and predictors of remission and long-term recovery among adolescents and how these may contrast with recovery in emerging and older adults. Although much of the literature on alcohol or other substance use in youth has focused on prevention, adolescents can and do develop AUD or other SUD. Data reported by the annual National Survey on Drug Use and Health showed nearly 1 million youths (ages 12 to 17) needed treatment for AUD or SUD in 2018, although only 83,000 of them received services in a treatment center.[1]

Historian William White has suggested that the recovery movement began in the late 1990s with an extraordinary cultural and political mobilization supported by the Recovery Community Services Program of the Substance Abuse and Mental Health Services Administration's (SAMHSA) Center for Substance Abuse Treatment.[2] White

identified the 2001 Recovery Summit in St. Paul, Minnesota, which launched Faces and Voices of Recovery, as a milestone in the recovery advocacy movement. The recovery movement impacted research literature as well. Kaskutas, Witbrodt, and Grella conducted a Google Scholar search dating to 1959 and found a significant increase from 2001 to 2012 in the number of articles about alcohol or other substance use with "recovery" in the title.[3] The American Psychiatric Association then released the fifth edition of its *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) in 2013, which revised the diagnostics for SUD, creating a range of symptoms from mild to moderate to severe. This revision helped shift the perception of SUD as existing along a continuum of severity rather than as a distinct positive or negative diagnosis, which was intended to impact how practitioners treated SUD and how researchers studied it.

In the midst of the burgeoning recovery advocacy movement, SAMHSA's Center for Substance Abuse Treatment convened the first National Summit on Addiction Recovery in 2005 to create one of the first definitions of recovery: "Recovery from alcohol and drug problems is a process of change through which an individual achieves abstinence and improved health, wellness, and quality of life."[4] In 2011, SAMHSA broadened this definition even more by removing the mention of abstinence as a criterion for recovery: "a process of self-directed change through which individuals improve their health and wellness, live self-directed lives, and strive to reach their full potential." These were only two of nearly a dozen definitions to come. According to Ashford and colleagues, at least 10 relevant definitions of recovery emerged between 2005 and 2017, from which their own Recovery Science Research Collaborative (RSRC) highlighted three as the "leading definitions of recovery": SAMHSA in 2011, the American Society of Addiction Medicine in 2013, and the Betty Ford Institute Consensus Panel in 2007.[5(p180)] Guided by these statements, the RSRC crafted its own definition: "Recovery is an intentional, dynamic, and relational process that involves sustained efforts to improve multiple aspects of wellness, and which may vary by individual, social, and experiential contexts."[5(p183)] In an effort to be more holistic and inclusive, similar to SAMHSA's 2011 description, the RSRC made no mention of reducing or abstaining from alcohol or substance use.

Along the same lines, none of the major efforts to conceptualize recovery have specified age or developmental concerns, which creates the impression that either the definitions were intended for adults, or the drafters considered adolescent recovery to be indistinguishable from adult recovery. In most instances, youth recovery simply has not been addressed in the definitional literature. Over the last decade, however, addiction neuroscience has shown that alcohol or other substance use during adolescence has a substantial impact on brain development. According to the National Institute on Drug Abuse: "The fact that this critical part of a teen's brain [the prefrontal cortex] is still a work in progress puts them at increased risk for trying drugs or continuing to take them. Introducing drugs during this period of development may cause brain changes that have profound and long-lasting consequences."[6(p10)] In addition, youths under age 18 cannot legally drink alcohol without parental supervision or use cannabis in states where recreational use is allowed, must be enrolled in school, and are considered minors and thus legally dependent on parents or guardians. For youths in recovery, therefore, the developmental, legal, and familial context fundamentally differs in ways that render adult-based conceptualizations of recovery insufficient.

Adolescent treatment and recovery support programs expanded at the same time as definitions of recovery were being adopted, and the youth data from both the annual National Survey on Drug Use and Health and the Monitoring the Future studies have shown precipitous drops in virtually every indicator of alcohol or other substance-related disorder—including youth meeting the criteria for SUD, youth needing treatment, and youth receiving treatment. The number of youths ages 12 to 17 who needed treatment—a key

indicator of potential referrals—was nearly 2.3 million in 2002, but by 2018, the number had fallen to 946,000.[1]

The reason for the decline in adolescents with SUD is uncertain, but the recovery movement no doubt played a role by spurring programs that reduced recidivism and provided tertiary prevention. AUD and SUD, though, have persisted, as have the treatment and recovery support gaps. Despite the efforts to define and potentially quantify the recovery process, the specific phenomenology of youth recovery has remained diffuse. Although substantial literature on adolescent AUD and SUD and treatment outcomes has arisen over the last 20 years, this review of the youth recovery literature has been complicated by inconsistent conceptions of the ages bounding "youth"; the definition, genesis, and life course of adolescent recovery; and the outcomes that are deemed successful. There exists a tapestry from which to divine an understanding of adolescent recovery, but a coherent typology has been elusive. This article thus uses other topics in the Recovery From AUD featured topic series as an organizational guide. As most of the issue's subtopics are not exclusively youth-focused, this article brings adolescence to the forefront, discussing (1) treatment outcomes, (2) special emphasis populations, (3) recovery-oriented systems of care, (4) families, and (5) non–abstinence-based approaches. This article concludes with a call for a clearer and more focused definition of recovery from AUD and SUD for adolescents, as well as more prospective and longitudinal research on sustained recovery and its impact on individual young people and society.

METHODS

This article provides a thorough and current review of the literature supported by representative references, utilizing an integrative review approach.[7] The methodology reflects the topic series' guidelines to review AUD among youth with a focus on recovery and within a limit of 50 references. Having three authors minimized potential bias, and each person conducted an independent review of articles. Multiple meetings were held discussing search criteria, findings, and selection. The process was emergent, iterative, and reflexive, and it considered prior reviews looking at similar issues. The authors ultimately decided the best organizing frame was from the topic series itself. Other frames emerged and were considered, but the topics from the journal itself ultimately worked best for consistency and clarity.

Problem Identification

This review was initially conceived as an exploration of the prevalence, pathways, and predictors of remission and long-term recovery among not only adolescents, but also emerging adults, commonly understood as the population ages 18 to 25. It also was intended to address not only recovery support services but also early interventions. After multiple conceptual discussions and after receiving consent from the editors, the authors agreed to focus on youths ages 12 to 18, the life phase usually referred to as adolescence. The literature and prevalence data on emerging adults (ages 18 to 25) are robust and worthy of their own review, but including that age group in this review could have drowned out the focus on adolescents. Although the life phase of transitional-age youth (ages 16 to 24) includes minors and youths transitioning from state custody and foster care, including that entire group also necessarily adds emerging adults, thus creating similar issues. As the adolescent age group is fundamentally different from emerging adults in a number of ways, including legal status, brain development, recovery capital, and family involvement, the authors felt a study of the trends and gaps in the literature on adolescents was needed. The scope also was narrowed to focus on the recovery process rather than the early intervention and treatment outcome literature highlighting specific treatments (such as multidimensional family therapy or motivational interviewing). This allowed the review to approach recovery as part of the treatment process as well as distinct from it. As treatment was not the focus of this review, the only treatment articles considered

for this review incorporate investigations into specific factors that influence the recovery process. Treatment studies exploring treatment outcomes and/or effectiveness per se were considered beyond the scope of this review.

Literature Search

Articles were included if they explored problematic alcohol and drug use or AUD and recovery among adolescents. As the adolescent life phase is understood differently in the literature—sometimes containing 18-year-olds and sometimes not—this review included articles focused on people age 18 and younger. Articles were included if they explicitly mentioned recovery or expanded on facets of the recovery process, such as personal or environmental characteristics that support recovery, broadly defined. Such topics included abstinence, sobriety, mutual aid, relapse, and alternative peer groups. Studies were excluded that focused solely on treatment outcomes, screening, or prevention. The year of publication was not considered when determining eligibility.

A systematic search was conducted in November 2019 of published studies in PsycINFO and PubMed (see Figure 1). These databases represent curated repositories of health, social science, and medical/clinical literature. Databases were searched for major themes of alcohol and recovery among adolescents. Based upon journal guidelines, articles must have explicitly included alcohol use in order to be considered for the study. Due to the conceptual ambiguity of recovery, additional terms commonly used in the field over the past few decades were included: relapse, remission, self-help, sobriety, and abstinence. Targeted searches also incorporated the key words "alternative peer group" and "recovery high school." After the removal of duplicates, the search resulted in 2,490 unique articles (specific search strings available upon request).

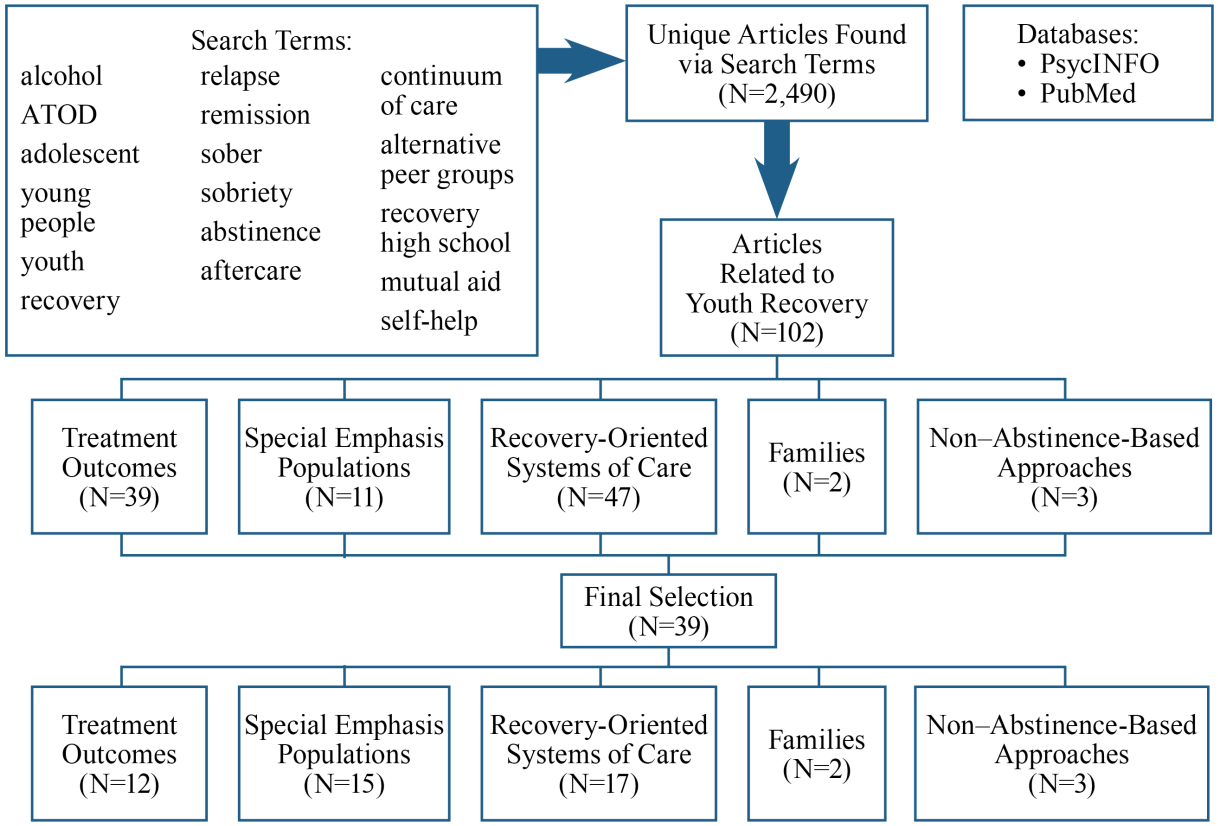

Figure 1 Literature search tree for an integrative review of recovery and young people. *Note:* ATOD, alcohol, tobacco, and other drugs.

Data Evaluation

Two authors independently reviewed half of the articles' titles and abstracts, and the lead author randomly reviewed articles for fidelity. In the initial screening, the full text of any ambiguous article was reviewed by multiple authors until a consensus was reached. After screening, 102 articles were identified as relating to youth recovery.

Data Analysis

Authors independently reviewed the 102 articles identified to create broad categories based on the variables and/or context studied (e.g., mutual aid, adolescent peer group, relapse). Due to the complexity and breadth of the literature, authors independently reviewed and coded articles for key themes and identified one to two main foci. The authors then met and refined the list of key themes. With a unified list of foci, authors again reviewed and coded articles. More than 20 major topics and 53 subtopics were identified. Because of the limited space and the range of topics, authors chose to organize the major topics to mirror those covered in the topic series. The 23 primary categories were thus grouped into five sections for review: treatment outcomes, special emphasis populations, recovery-oriented systems of care, families, and non–abstinence-based approaches. The description and rationale for each of those sections is discussed earlier.

After reaching an agreement on the conceptual framework, two authors independently identified which of the 102 articles to include in the literature review. This process included assessing articles on individual characteristics as well as considering the breadth of articles reviewed. Individual study characteristics included sample size for quantitative studies, credibility enhancements such as triangulation in qualitative work, publication year, recovery focus, and implications of findings. Macro-level considerations included representing a range of authors, study designs, distribution across topic areas, and conceptual frames. Upon completion, those two authors met to reach a consensus, and the lead author then independently assayed the articles to approve of the final selection of 39 for inclusion, a number within the journal's preferred limit of 50 total citations (Table 1).

RECOVERY AS A TREATMENT OUTCOME

Until relatively recently, adolescent recovery from AUD or other SUD has been researched mostly as part of a linear model of addiction treatment. Recovery was understood to be abstinence-based, and adolescent recovery usually was assumed to include some form of treatment. Indeed, most researchers have viewed adolescent recovery as the result of successful treatment rather than a distinct phenomenon. If recovery programs were studied at all, they were seen as aftercare, or continuing care, to sustain the gains of treatment. Articles examining treatment outcomes and relapse thus account for the majority of the articles about recovery and youth. Treatment outcomes (e.g., abstinence, symptom reduction) were identified traditionally as the dependent variable, as opposed to the growing body of research studying recovery itself as the dependent variable. Instead of viewing recovery as its own construct, the following articles represent those studies that evaluated treatment outcomes as a proxy for recovery.

Treatment outcome articles cover myriad modalities, including both specialty (i.e., treatment centers, hospitals) and non–specialty treatment (i.e., doctor's offices, emergency rooms, support groups). Within the context of recovery from a treatment lens, longitudinal treatment outcome studies provide insight into adolescents' behavior post-treatment and the variables that impact abstinence or relapse. For the purpose of this review, articles researching treatment modalities were included if they focused on treatment in a recovery context. This means the study emphasized how the recovery process supported treatment instead of whether a singular treatment modality was effective, with the locus being the aspects of recovery rather than the components of treatment.

Table 1 References Identified in Literature Search (N = 39)

Main Topic	Reference Number	Author	Year
Treatment Outcomes			
	8	Brown et al.	2001
	9	Myers, Brown, and Mott	1993
	10	Brown and Ramo	2006
	11	Latimer et al.	2000
	12	Tapert et al.	1999
	13	Chung et al.	2015
	14	Cornelius et al.	2003
	15	Kaminer and Godley	2010
	16	Cavaiola, Schiff, and Kane-Cavaiola	1990
	17	Maisto et al.	2003
	18	Chung et al.	2005
	19	Kaminer et al.	2018
Special Emphasis Populations			
	20	McCarthy et al.	2005
	21	Sterling et al.	2009
	22	Pagano et al.	2015
	23	Krentzman et al.	2012
	24	Winward et al.	2014
Recovery-Oriented Systems of Care			
	25	Winters et al.	2007
	26	Godley et al.	2019
	27	Kaminer, Burleson, and Burke	2008
	15	Kaminer and Godley	2010
	28	Chi et al.	2009
	29	Dennis et al.	2015
	30	Kelly and Urbanoski	2012
	31	Nash, Hennessy, and Collier	2019
	32	Nash and Collier	2016
	33	Nash	2020
	34	Johnson et al.	2016
	35	Johnson et al.	2018
	36	Pullen et al.	1999
	37	Cloud and Granfield	2008
	38	Hennessy, Cristello, and Kelly	2019
	39	Finch, Moberg, and Krupp	2014
	40	Hennessy et al.	2018
	41	Finch et al.	2018
Families			
	42	Stewart and Brown	1993
	43	Jaffe	2002
Non–Abstinence-Based Approaches			
	44	Marlatt and Witkiewitz	2002
	49	De Sousa	2014
	19	Kaminer et al.	2018

There is much research evaluating potential mediators and moderators of treatment outcomes, such as social skills and cognitive abilities. Brown and colleagues, for example, studied adolescents' behavior for 4 years post-treatment, and their findings elucidate variables impacted by the developmental transition from adolescence into young adulthood, which may uniquely impact treatment outcomes.[8] Other literature explored internal factors, such as coping skills, developmental and neurocognitive considerations, and psychosocial factors.[9-11]

Due to the social and environmental pressures faced by adolescents, the development of positive psychosocial skills can be an essential element in treatment, as such skills have been associated with avoiding relapse.[9,11] From a developmental perspective, coping skills and neurocognitive abilities were found to distinctively impact adolescents' relapse.[12] These factors were more salient for adolescents with lower intellectual abilities, whereas other factors may be more salient for those with average or above-average intellectual abilities.[12] According to Latimer and colleagues, an adolescent with at least one protective factor (e.g., social connectedness, goal directedness, peer abstinence), who completed long-term treatment followed by continuing care, was more likely to achieve successful outcomes compared to those with fewer protective factors.[11]

External factors, such as one's environment or social influences, can also impact treatment outcomes. Peer affiliation and influence have been shown to play critical developmental roles in adolescents' post-treatment behaviors. When adolescents return to their previously held social groups and support systems following treatment, they can be faced with contradicting desires to abstain from alcohol and other substance use while simultaneously maintaining their relationships with substance-using peers.[13] Among adolescents who relapsed post-treatment, Cornelius and colleagues found social pressure, withdrawal, and negative affect to be the most common factors.[14]

Continuing care has been highlighted in the literature as supporting treatment gains and preventing relapse. Kaminer and Godley suggested that, because adolescents were less likely than adults to remain abstinent after one treatment episode, evaluating continuing care was essential.[15] Cavaiola and colleagues highlighted the importance of continuing care as part of the recovery process in an early article published 30 years ago.[16] While still emphasizing abstinence and relapse prevention, Cavaiola et al. evaluated an array of factors impacting post-treatment continuing care among adolescents to provide a more holistic view of recovery, including integration into mutual aid, relapse prevention and relapse management, relationships, resistance and denial, grief and loss issues, self-esteem issues, family treatment issues, and dual diagnosis.[16]

The complex nature of recovery has led to divergence in how researchers have approached relapse and abstinence for youth. It is critical to note the discrepancies in definitions of "relapse" and the subsequent impact on the evaluation of treatment outcomes and recovery for young people.[17] Relapse and relapse prevention are multifaceted phenomena closely associated with treatment outcomes; yet, the field has been moving away from seeing recovery as requiring abstinence. Chung and associates, for example, implemented a trajectory analysis to demonstrate how a return to use does not necessarily indicate an adolescent is not in recovery or reducing their problematic behavior.[18] As of late, the nascent body of literature dedicated to harm reduction has highlighted the differences between abstinence, reducing use, and using less harmful substances as the dependent variables in research studies. Although there have been few studies of harm reduction for youths, Kaminer and colleagues found that the relationship between abstinence as a post-treatment goal and long-term success is stronger than if the goal is harm reduction.[19] A substantial number of studies have been designed through a treatment outcome lens,

which defaults to "recovery" if an adolescent is abstinent. In essence, for youth, recovery has been studied more as an emergent latent variable than as its own designated entity.

SPECIAL EMPHASIS POPULATIONS

Differences in relapse and relapse prevention among subpopulations of adolescents form a subset of the literature viewing adolescent recovery through a treatment outcome lens. The recovery process post-treatment had a different trajectory based upon various factors, such as the intersectionality of an adolescent's recovery and cultural identity, including gender, race, and/or ethnicity. Populations highlighted here include students and adolescents with co-occurring disorders or traumatic experiences.

Although evaluating co-occurring disorders in adolescence can be problematic due to diagnostic criteria that often exclude people under age 18, there is a small body of literature that studies the impact of psychiatric comorbidity on relapse and treatment outcomes. Psychiatric symptoms have been found to influence post-treatment relapse among adolescents with AUD or other SUD and a co-occurring Axis I diagnosis.[20] Sterling and colleagues found engagement during treatment to be essential for adolescents with co-occurring disorders, because abstinence during the first year was associated with reduced substance use and symptoms of mental health disorders after 3 years.[21] The authors suggested mental health symptomology should not be excluded when evaluating the treatment outcomes and recovery process of adolescents with co-occurring disorders, especially given that positive mental health outcomes during treatment were associated with long-term recovery benefits.[21]

Research evaluating the relationship between a high incidence of alcohol and other substance use for adolescents with trauma histories is growing, but the literature is still limited. The contribution or impact of lifetime trauma on an adolescent's substance use or on the treatment process has been studied, but how trauma relates to an adolescent's recovery has not been examined. For example, the relationship between social anxiety disorder and lifetime trauma, as studied by Pagano and colleagues highlighted the indirect influence of trauma on peer support systems and boundary setting in the treatment process.[22]

Similar to other subpopulations, the prevalence of alcohol or other substance-related disorders for adolescents based on gender, race, and/or ethnic identity has been studied at length. Limited literature, however, is available to explain the impact of these identities on recovery. Research has evaluated post-treatment behaviors that have been impacted by an adolescent's culture. For example, although there are differences in spirituality and religiosity levels between Black and White adolescents receiving treatment for AUD or other SUD, the findings suggested that religiosity was a predictor of 12-step-related behaviors but not of treatment outcomes.[23] In the same study, a significant gender disparity was found in that women were more likely to take the actions outlined in the 12 steps.[23]

Another unique consideration for this age group is the status of student. As most states require people under age 18 to be enrolled in school, studies have not compared recovery processes for student versus nonstudent adolescent samples. There is little research, though, studying the impact of recovery on young people's academic outcomes. In one such study, a neuropsychological test battery evaluating five key domains was used as a proxy for academic outcomes by evaluating cognitive functioning.[24] During early abstinence from heavy episodic drinking, adolescents' prospective memory, cognitive switching, inhibition task accuracy, and visuospatial abilities developed significantly.[24]

It can be surmised that due to the relatively small number of adolescents in recovery, it could be prohibitively challenging to study sample sizes that result in statistically significant findings. Although prevalence of alcohol and

other substance use among specific adolescent subpopulations, such as LGBTQ+ youth, is well documented, there are virtually no articles on the impact of various identities on long-term recovery for youth or how recovery may impact the identities youth hold. Based on the literature, it is clear that substance misuse among adolescents varies among subpopulations. There is, however, scant literature detailing the impact of a youth's cultural intersectionality on the youth's recovery process.

RECOVERY-ORIENTED SYSTEMS OF CARE

Recovery-oriented systems of care (ROSC) arose out of the shortcomings of the linear, acute care model of addiction treatment. ROSC is an umbrella concept that represents the entire network of formal and informal relationships and organizations that foster individual, familial, and community recovery processes over time.[2(p497)] Further explanation and elaboration of ROSC can be found elsewhere in this topic series. Although empirical evidence is mounting for adults, there is scarce literature exploring ROSC for youth. The few studies that have investigated adolescent systems have considered continuing care, mutual aid, peer groups, school programs, and technology.

A key aspect of ROSC is the continuum of care. Continuing care, frequently cited as "aftercare," has been situated as following treatment. Like traditional treatment outcome studies, most continuing care research has studied maintenance of treatment gains. The locus of ROSC, however, has been the recovery support systems and processes themselves rather than simply indicators of treatment success. One long-term outcome study followed a treatment group, a waitlist group, and a community control group over 5.5 years post-treatment and found that involvement in continuing care among the treatment group was positively associated with improved treatment outcomes.[25]

As smartphones have taken an ever-more pervasive place in adolescent communication, they also have begun filling a role in continuing care. A recent randomized controlled trial found that voluntary recovery support provided via phone by other youths had direct and indirect effects.[26] Continuing care was directly associated with increased involvement with pro-recovery peers and recovery management activities. It also was indirectly linked to reductions in alcohol and substance use and problems as well as increased remission. Incremental dose effects were also found—for every 10% increase in support call completion, recovery activities increased by nearly one activity.[26] In similar fashion, Kaminer, Burleson, and Burke compared in-person and brief phone continuing care with no continuing care through a randomized design.[27] Findings indicated that continuing care in general slowed the occurrence of post-treatment alcohol use and, for girls, maintained treatment gains; phone-based continuing care was also as effective as in-person models.[27] More structured, manualized continuing care for adolescents, called assertive continuing care, also surfaced as an impactful model for adolescents.[15] Although there is evidence that continuing care plays a key role in supporting recovery among adolescents, additional investigation into the moderators of both participation and effect are called for.

Another emergent youth-specific element is the incorporation of digital technology in recovery supports. Along with the previously mentioned studies utilizing phones for their financial and geographic flexibility in continuing care,[26,28] Dennis and colleagues investigated and found smartphone apps to be feasible and efficacious for recovery monitoring and support among youth.[29] The scale of benefits received from peer-based and technology-based support merits further investigation.[26,30-32]

The recovery-oriented systems of care model emphasizes communities, especially peer recovery support services. Historically, one of the most common continuing care recommendations for adolescents has been to attend mutual aid groups, such as Alcoholics Anonymous and Narcotics Anonymous.[30] Fellowships based on a 12-step approach appear to provide a supportive social

context for adolescents in recovery.[33] Attendance and involvement in 12-step fellowships, specifically particular aspects such as meeting with a sponsor outside of meetings and verbal participation in meetings, have predicted positive recovery outcomes for adolescents over and above simple attendance, which also has been positively associated with outcomes over time.[28,30,33] Other underlying mechanisms of 12-step benefits have included general social support and providing support to others.[28,34,35] In combination with mutual aid, participation in religious services also was found to positively impact adolescent recovery.[28,36] Expansion of youth-specific 12-step communities has been identified as a way to increase youth recovery support.[28,30,33]

ROSC, of course, is not limited to mutual aid groups. A youth model perhaps best aligned with ROSC is the alternative peer group, which began in the early 1970s. Although more evidence of effectiveness is needed, alternative peer groups (APGs) have been described in the literature as a model that integrates recovering peers, prosocial activities, and evidence-based clinical practices.[32] Key elements of the APG model include psychosocial education, case management, social functions, community recovery support, family support, and counseling.[32] A unique and key component of APGs is their focus on developmentally appropriate recovery support services for adolescents.

In reviewing the available evidence presented for youth recovery within ROSC, including APGs, recovery capital (RC) has surfaced as a useful frame for classification of supports and may help target specific systems or characteristics to foster youth recovery. Recovery capital is the breadth and depth of resources that persons can access to support their recovery across ecological levels.[37] The recovery capital for adolescents model (RCAM) highlights the importance of understanding youth-specific recovery processes across four main domains of capital: human, financial, social, and community.[38] The utility of RCAM was supported among APG participants such that RCAM identified specific recovery assets and barriers for youth as well as reflected the four recovery capital domains previously validated for adults.[31,32,38]

The review also yielded evidence of specific systems or domains of recovery capital situated within a ROSC paradigm that support youth recovery. Recovery high schools, for example, are specifically designed for students recovering from a substance use disorder. Although they have been a resource for adolescents since the late 1970s, they have only begun to be systematically empirically evaluated.[39] A recent systematic review found only one rigorous study to date evaluating recovery high schools[40]—indicating a significant need for further investigation. These institutions of continuing support for youth are dynamic and vary widely in regards to enrollment, fiscal stability, governance, staffing, and organization; however, the tailored supports appear to benefit adolescents' recovery and academic performance.[39,41]

Criminal justice institutions also present a system in which changes in practice can be more supportive for youth recovery. Evidence of the role of social support, religious service attendance, and service to others among youth who have been involved with criminal justice institutions indicated that providing a supportive recovery environment reduces the risk of relapse, incarceration, and violent crime.[34,35]

FAMILIES

The family context has been identified as a significant component in the etiology and progression of adolescent alcohol and substance use for decades.[42] Addiction has been commonly referred to as a family disease. Like most adolescent recovery research, though, the focus has been entrenched in the acute addiction treatment paradigm. Jaffe, for example, identifies family therapies as a key treatment modality for youth.[43]

The familial relationship, however, can be especially complex for adolescents seeking recovery, because they often have parents who also engage in problematic drinking or use.[16] Despite the acknowledgement of how critical family is

for adolescents seeking recovery, there remains a significant gap in the research literature focusing on recovery specifically. Possible explanations include but are not limited to the feasibility of family-based research studies. Including additional family participants in the research design increases cost and demands for methodological rigor. Future investigations into mechanisms of youth recovery are needed to better understand the familial context, as well as to situate families within the ROSC and recovery capital frames.

NON–ABSTINENCE-BASED APPROACHES

As ROSC has emerged out of the gaps of acute care models, non–abstinence-based approaches to recovery have facilitated a new organizing paradigm surrounding multiple pathways of recovery.[5] Although the concept of multiple pathways is not new, the exploration of harm reduction and medication-assisted treatment (MAT) and recovery is relatively recent. Shifting the focus to outcomes such as quality of life, personal relationships, life satisfaction, and improved cognition has presented new avenues for investigation and understanding treatment effectiveness. This new paradigm has particular implications for adolescents.[44]

Although the line between abstinence-based treatment and abstinence-based recovery has become less distinct over time, the lines between MAT and medication-assisted recovery have always been blurry. White said:

> The historical stigma attached to methadone and the broader arena of medication-assisted treatment has denied MAT patients the status of recovery and left them isolated from mainstream community life and existing in limbo between cultures of addiction and cultures of recovery. . . . At the very core of this stigma is the deeply imbedded idea that recovery from opioid addiction does not begin until the day the use of medications like methadone and buprenorphine ends. Recovery from no other chronic health condition rests on such a proposition.[45(p6)]

The limbo may be even more profound for adolescents. Levy and colleagues suggest MAT might be effective in the treatment of opioid use disorder for adolescents;[46] however, Feder, Krawczyk, and Saloner found that only 2% of adolescents in treatment for heroin and opioid use received MAT, compared to 26% of adults.[47] Beyond the long-standing philosophical issues about prescribing medications to treat AUD or other SUD, there are also concrete legal barriers in both national and state statutes that make it difficult for physicians to prescribe some medications such as methadone or buprenorphine to minors.[48]

Additional consideration is needed given the legal repercussions of harm reduction for adolescents—namely, that consumption of alcohol and cannabis is illegal for those under age 21—as well as the neurocognitive variables for the still-developing adolescent brain.[19] Moreover, although De Sousa found that MAT, particularly disulfiram, reduced number of drinking days,[49] Kaminer and colleagues found no evidence that harm reduction motivations for AUD yield more desirable outcomes than abstinence-based motivations among adolescents.[19] Empirical evidence of non–abstinence-based approaches for young people is scant. Future research should explore if these approaches are safe and effective for youths.

DISCUSSION

In a speech delivered at the UCLA/Betty Ford Institute Annual Recovery Conference in 2012, historian William White said: "People are entering recovery younger and younger, and yet little information exists about living a life in recovery that begins at age 15 or 25 rather than 45 or 55."[2(p495)] This review has shown White's comments largely still hold. Recovery from AUD or other SUD remains a complex and challenging concept to define and thus to study, and this is even more evident for recovery that begins in

adolescence. Steps have been taken, however, to distinguish recovery for people under age 18 from recovery in adulthood.

Early efforts to research youth recovery viewed it as the result of successful treatment. Recovery for adolescents was understood to be abstinence-based and usually was assumed to include some form of treatment. Studies suggested the post-treatment recovery process had a different trajectory based upon various person-level factors, including the adolescent's cultural identity, student status, trauma history, and co-occurring disorders. Most of these studies, though, still viewed adolescent recovery through a treatment outcome lens.

The recovery-oriented systems of care approach shifted the structural and empirical locus to the recovery process itself, and it moved away from a program-level orientation to a systemic one. Although many studies of aftercare, or continuing care, still remain situated in a treatment outcome frame, the attention has gradually progressed to specific components of successful recovery for youth. Studies of adolescent ROSC, though still relatively small in number, have considered adolescent continuing care, mutual aid, peer groups, and school-based programs—as well as the impact of smartphone technology on youth recovery. Addiction also has long been understood to be a "family disease," and there have been a few attempts to understand family systems in recovery.

Recovery increasingly has been presented as not requiring abstinence, and non–abstinence-based approaches to recovery have generated more attention in the field. The idea of multiple pathways to recovery has included paths without specialty treatment. Harm reduction and MAT approaches for youth have produced few empirical studies while getting more support philosophically. Traditional outcomes, such as relapse or even reduced days of use, have been supplanted by variables such as quality of life, personal relationships, life satisfaction, and improved cognition.

The arc of the recovery paradigm has been moving from acuteness to chronicity, from programmatic to systemic, from pathology to wellness, from exclusivity to accessibility, from homogeneity to diversity, and from selectivity to inclusivity. Diagnosis and treatment of AUD and SUD have shifted away from seeing recovery as a linear progression toward abstinence to understanding recovery moving along a continuum, which may not necessitate complete abstinence. Indeed, alcohol and other substances have even been removed from recent definitions of recovery to allow room for non–substance-related addictions—as supported by neuroscience suggesting similar brain activity for substance and non–substance-related addictions. The turn toward a "big tent" or "many roads" approach for recovery has benefits, such as mitigating stigma and facilitating healthy lives for millions of people. At the same time, the unique properties of recovery from AUD or other SUD have become harder to glean, especially as sobriety becomes less of a goal. As adolescents fundamentally differ from adults, it is essential to determine when the "big tent"/"many roads" concept—established by and for adults—will help youth and when it will not.

FUTURE RESEARCH

A clear organizing framework is missing from the extant adolescent recovery literature. Promising work in this area includes the seminal article by Brown and Ashford around creating a "recovery science"[50] and an article by Finch and Frieden that provides a synthesis of how classic developmental theories form a foundation for recovery high school environments and culture.[51] It is hoped that a theoretical model will emerge from suggested future research to explain behavior change and maintenance, remission, and sustained recovery for young people.

Harm Reduction and Medication-Assisted Recovery

As harm reduction continues to gain legitimacy as a model of recovery, more evidence is needed to understand how ongoing substance use may impact neurological as well as psychosocial development of adolescents. This review also has shown that more research is needed on how psychopharmacological drugs impact a developing brain differently from an adult brain, and how those differences implicate medication-assisted recovery. Both exploratory and effectiveness studies can guide the discussion away from passionate debates toward grounded understanding and evidence-informed program development.

Expanding Beyond a Treatment Outcome Paradigm

The prevalence data have shown that although the number of youths with AUD or other SUD has been declining steadily over the last 2 decades, large numbers of adolescents with SUD or co-occurring disorders still do not have access to treatment and/or do not receive treatment. Although most of those youths likely do not get into recovery as adolescents, many do, and they are not being captured in the literature on recovery as a treatment outcome. One byproduct of widening the umbrella for people in recovery should be the subsequent broadening of who gets included in programs and studies.

Disparities

Regarding the wider umbrella, adult studies of recovery have considered disparities around intersectional identities and social class in treatment and recovery. Much of the discourse about MAT, harm reduction, and abstinence-based recovery has revolved around racial disparities in the mental and behavioral health system. Youth of color "have less access to, and lower quality of, behavioral health services compared to their White counterparts."[52(p22)] These disparities and their impact on adolescent recovery trajectories need more exploration.

Recovery Capital for Adolescents

More studies also are needed for investigating various support modalities for youth, including recovery residences, recovery high schools, alternative peer groups, mutual aid groups, and family systems, and how different combinations of components may be needed for different people and diverse populations. The nascent work on the recovery capital model for adolescents[38] offers great promise in explaining disparities of access to certain types of recovery support, as well as which factors may benefit one young person more than another. The recovery capital model in combination with a clearer comprehension of adolescent neuroscience of addiction will better tune the field of youth recovery.

Recovery Across the Life Span

Finally, recovery research in general needs more life course studies. Recovery begun in adolescence cannot be fully understood until adulthood. Although retrospective studies can provide some data on origination of AUD and SUD and the pathways of recovery, better precision is needed. Prospective, longitudinal, and life course research, beginning in youth and continuing at regular intervals, is the only way to fully appreciate the complex and cascading nature of recovery across the life span.

LIMITATIONS

Neither "youth" nor "recovery" has a commonly accepted definition. Although the authors were diligent in using the literature to frame both for the purpose of this review, it is possible that defining either concept differently would have taken the review in divergent directions.

In making choices to study adolescents and the recovery process, this review did not include studies of emerging adults (ages 18 to 25) and transitional-age youth (ages 16 to 24), unless youth age 18 and younger were explicitly included in the sample. Although this allowed the authors to focus on adolescents, there may have been studies of

adults whose recovery began in their youth, which were not reviewed.

Similarly, in line with the journal's focus on alcohol, the review required alcohol and recovery to be main components in the literature search, which may have left out articles on SUD that did not explicitly mention alcohol. The language used in extant literature guided the findings. In studies related to recovery and young people, AUD and SUD often were discussed in one category instead of referencing alcohol and various substances in their own capacity. Hennessy and Fisher provide an example of how future studies could review literature related to broader substance use and recovery among young people.[53]

Though population effects are considered here, the review does not fully explore the diversity of adolescent recovery experiences based on intersecting identities or social class. This is due in large part to the lack of diversity in both adolescent recovery support programs and in research studies.

Finally, while using this topic series' own categorizations as an organizing frame allowed for conceptual consistency, it can be acknowledged that different reviewers may have arrived at a different heuristic typology. No review of adolescent recovery at this stage should be considered definitive, and this review is no exception. Rather, the intent was that this integrative review would be well designed, thorough, and an accurate representation of the field to date.

CONCLUSION

As the recovery movement has become established and access to recovery has broadened, the need to explain and study how the concept of recovery pertains specifically to adolescents has increased. This integrative review considered studies of youth and recovery across (1) treatment outcomes, (2) special emphasis populations, (3) recovery-oriented systems of care, (4) families, and (5) non–abstinence-based approaches. Although this review found that the literature on adolescent recovery has grown, the authors make the following recommendations:

- More research is needed about the impact and effectiveness of medication-assisted recovery and harm reduction.
- The field of adolescent recovery needs to widen its scope of practice and research beyond youth who have received treatment to include those who have not received treatment due to personal choice or societal disparities.
- The literature would benefit from more prospective and life course research.

Research must not lose sight of the unique properties of either adolescent development or recovery from alcohol or other substance-related disorders, and there is great promise in the recovery capital model for adolescents and the neuroscience of addiction to provide more precision and direction to the field of recovery and youth.

Financial Disclosure

Jordan Jurinsky and Billie May Anderson declare that they have no conflicts of interest. Andrew J. Finch declares that he is a nonvoting, unpaid board member for the Association of Recovery Schools, but he will receive no financial benefit from the findings published in this article.

References

1. Substance Abuse and Mental Health Services Administration (SAMHSA), Center for Behavioral Health Statistics and Quality. *Key Substance Use and Mental Health Indicators in the United States: Results from the 2018 National Survey on Drug Use and Health.* Rockville, MD: SAMHSA; 2019, p. 82.
2. White WL. *Slaying the Dragon: The History of Addiction Treatment and Recovery in America.* 2nd ed. Bloomington, IL: Chestnut Health Systems/Lighthouse Institute; 2014.
3. Kaskutas LA, Witbrodt J, Grella CE. Recovery definitions: Do they change? *Drug Alcohol Depend.* 2015;154:85-92. https://doi.org/10.1016/j.drugalcdep.2015.06.021.

4. SAMHSA Center for Substance Abuse Treatment. *National Summit on Recovery: Conference Report.* Rockville, MD: SAMHSA; 2005.
5. Ashford RD, Brown A, Brown T, et al. Defining and operationalizing the phenomena of recovery: A working definition from the recovery science research collaborative. *Addict Res Theory.* 2019;27(3):179-188. https://doi.org/10.1080/16066359.2018.1515352.
6. National Institute on Drug Abuse. *Drugs, Brains, and Behavior: The Science of Addiction.* 2018. https://www.drugabuse.gov/publications/drugs-brains-behavior-science-addiction/preface. Accessed February 10, 2020.
7. Whittemore R, Knafl K. The integrative review: Updated methodology. *J Adv Nurs.* 2005;52(5):546-553. https://doi.org/10.1111/j.1365-2648.2005.03621.x.
8. Brown SA, D'Amico EJ, McCarthy DM, et al. Four-year outcomes from adolescent alcohol and drug treatment. *J Stud Alcohol.* 2001;62(3):381-388. https://doi.org/10.15288/jsa.2001.62.381.
9. Myers MG, Brown SA, Mott MA. Coping as a predictor of adolescent substance abuse treatment outcome. *J Subst Abuse.* 1993;5(1):15-29. https://doi.org/10.1016/0899-3289(93)90120-z.
10. Brown SA, Ramo DE. Clinical course of youth following treatment for alcohol and drug problems. In: Liddle HA, Rowe CL, eds. *Adolescent Substance Abuse: Research and Clinical Advances.* New York, NY: Cambridge University Press; 2006.
11. Latimer WW, Newcomb M, Winters KC, et al. Adolescent substance abuse treatment outcome: The role of substance abuse problem severity, psychosocial, and treatment factors. *J Consult Clin Psychol.* 2000;68(4):684-696. https://doi.org/10.1037/0022-006X.68.4.684.
12. Tapert SF, Brown SA, Myers MG, et al. The role of neurocognitive abilities in coping with adolescent relapse to alcohol and drug use. *J Stud Alcohol.* 1999;60(4):500-508. https://doi.org/10.15288/jsa.1999.60.500.
13. Chung T, Sealy L, Abraham M, et al. Personal network characteristics of youth in substance use treatment: Motivation for and perceived difficulty of positive network change. *Subst Abus.* 2015;36(3):380-388. https://doi.org/10.1080/08897077.2014.932319.
14. Cornelius JR, Maisto SA, Pollock NK, et al. Rapid relapse generally follows treatment for substance use disorders among adolescents. *Addict Behav.* 2003;28(2):381-386. https://doi.org/10.1016/s0306-4603(01)00247-7.
15. Kaminer Y, Godley M. From assessment reactivity to aftercare for adolescent substance abuse: Are we there yet? *Child Adolesc Psychiatr Clin N Am.* 2010;19(3):577-590. https://doi.org/10.1016/j.chc.2010.03.009.
16. Cavaiola AA, Schiff MM, Kane-Cavaiola C. Continuing care for the chemically dependent adolescent: Aftercare or afterthought? *J Adolesc Chem Depend.* 1990;1(2):77-93.
17. Maisto SA, Pollock NK, Cornelius JR, et al. Alcohol relapse as a function of relapse definition in a clinical sample of adolescents. *Addict Behav.* 2003;28(3):449-459. https://doi.org/10.1016/s0306-4603(01)00267-2.
18. Chung T, Maisto SA, Cornelius JR, et al. Joint trajectory analysis of treated adolescents' alcohol use and symptoms over 1 year. *Addict Behav.* 2005;30(9):1690-1701. https://doi.org/10.1016/j.addbeh.2005.07.016.
19. Kaminer Y, Ohannessian CM, McKay JR, et al. Goal commitment predicts treatment outcome for adolescents with alcohol use disorder. *Addict Behav.* 2018;76:122-128. https://doi.org/10.1016/j.addbeh.2017.07.035.
20. McCarthy DM, Tomlinson KL, Anderson KG, et al. Relapse in alcohol- and drug-disordered adolescents with comorbid psychopathology: Changes in psychiatric symptoms. *Psychol Addict Behav.* 2005;19(1):28-34. https://doi.org/10.1037/0893-164x.19.1.28.
21. Sterling S, Chi F, Campbell C, et al. Three-year chemical dependency and mental health treatment outcomes among adolescents: The role of continuing care. *Alcohol Clin Exp Res.* 2009;33(8):1417-1429. https://doi.org/10.1111/j.1530-0277.2009.00972.x.
22. Pagano ME, Wang AR, Rowles BM, et al. Social anxiety and peer helping in adolescent addiction treatment. *Alcohol Clin Exp Res.* 2015;39(5):887-895. https://doi.org/10.1111/acer.12691.
23. Krentzman AR, Battle D, Pagano ME, et al. The role of religiousness on substance-use disorder treatment outcomes: A comparison of Black and White adolescents. *J Soc Social Work Res.* 2012;3(3):113-128. https://doi.org/10.5243/jsswr.2012.8.
24. Winward JL, Hanson KL, Bekman NM, et al. Adolescent heavy episodic drinking: Neurocognitive functioning during early abstinence. *J Int Neuropsychol Soc.* 2014;20(2):218-229. https://doi.org/10.1017/s1355617713001410.
25. Winters KC, Stinchfield R, Latimer WW, et al. Long-term outcome of substance-dependent youth following 12-step treatment. *J Subst Abuse Treat.* 2007;33(1):61-69. https://doi.org/10.1016/j.jsat.2006.12.003.
26. Godley MD, Passetti LL, Hunter BD, et al. A randomized trial of Volunteer Recovery Support for Adolescents (VRSA) following residential treatment discharge. *J Subst Abuse Treat.* 2019;98:15-25. https://doi.org/10.1016/j.jsat.2018.11.014.
27. Kaminer Y, Burleson JA, Burke RH. Efficacy of outpatient aftercare for adolescents with alcohol use disorders: A randomized controlled study. *J Am Acad Child Adolesc Psychiatry.* 2008;47(12):1405-1412. https://doi.org/10.1097/chi.0b013e318189147c.
28. Chi FW, Kaskutas LA, Sterling S, et al. Twelve-Step affiliation and 3-year substance use outcomes among adolescents: Social support and religious service attendance as potential mediators. *Addiction.* 2009;104(6):927-939. https://doi.org/10.1111/j.1360-0443.2009.02524.x.
29. Dennis ML, Scott CK, Funk RR, et al. A pilot study to examine the feasibility and potential effectiveness of using smartphones to provide recovery support for adolescents. *Subst Abus.* 2015;36(4):486-492. https://doi.org/10.1080/08897077.2014.970323.
30. Kelly JF, Urbanoski K. Youth recovery contexts: The incremental effects of 12-step attendance and involvement on adolescent outpatient outcomes. *Alcohol Clin Exp Res.* 2012;36(7):1219-1229. https://doi.org/10.1111/j.1530-0277.2011.01727.x.
31. Nash AJ, Hennessy EA, Collier C. Exploring recovery capital among adolescents in an alternative peer group. *Drug Alcohol Depend.* 2019;199:136-143. https://doi.org/10.1016/j.drugalcdep.2019.02.025.
32. Nash AJ, Collier C. The alternative peer group: A developmentally appropriate recovery support model for adolescents. *J Addict Nurs.* 2016;27(2):109-119. https://doi.org/10.1097/jan.0000000000000122.
33. Nash AJ. The twelve steps and adolescent recovery: A concise review. *Subst Abuse.* 2020;14. https://doi.org/10.1177/1178221820904397.
34. Johnson BR, Lee MT, Pagano ME, et al. Positive criminology and rethinking the response to adolescent addiction: Evidence on the role of social support, religiosity, and service to others. *Int J Criminol Sociol.* 2016;5:172-181. https://doi.org/10.6000/1929-4409.2016.05.16.

35. Johnson BR, Pagano ME, Lee MT, et al. Alone on the inside: The impact of social isolation and helping others on AOD use and criminal activity. *Youth Soc.* 2018;50(4):529-550. https://doi.org/10.1177/0044118x15617400.
36. Pullen L, Modrcin-Talbott MA, West WR, et al. Spiritual high vs high on spirits: Is religiosity related to adolescent alcohol and drug abuse? *J Psychiatr Ment Health Nurs.* 1999;6(1):3-8. https://doi.org/10.1046/j.1365-2850.1999.00161.x.
37. Cloud W, Granfield R. Conceptualizing recovery capital: Expansion of a theoretical construct. *Subst Use Misuse.* 2008;43(12-13):1971-1986. https://doi.org/10.1080/10826080802289762.
38. Hennessy EA, Cristello JV, Kelly JF. RCAM: A proposed model of recovery capital for adolescents. *Addict Res Theory.* 2019;27(5):429-436. https://doi.org/10.1080/16066359.2018.1540694.
39. Finch AJ, Moberg DP, Krupp AL. Continuing care in high schools: A descriptive study of recovery high school programs. *J Child Adolesc Subst Abuse.* 2014;23(2):116-129. https://doi.org/10.1080/1067828X.2012.751269.
40. Hennessy EA, Tanner-Smith EE, Finch AJ, et al. Recovery schools for improving behavioral and academic outcomes among students in recovery from substance use disorders: A systematic review. *Campbell Systematic Reviews.* 2018;14(1):1-86. https://doi.org/10.4073/csr.2018.9.
41. Finch AJ, Tanner-Smith E, Hennessy E, et al. Recovery high schools: Effect of schools supporting recovery from substance use disorders. *Am J Drug Alcohol Abuse.* 2018;44(2):175-184. https://doi.org/10.1080/00952990.2017.1354378.
42. Stewart MA, Brown SA. Family functioning following adolescent substance abuse treatment. *J Subst Abuse.* 1993;5(4):327-339. https://doi.org/10.1016/0899-3289(93)90002-s.
43. Jaffe SL. Treatment and relapse prevention for adolescent substance abuse. *Pediatr Clin North Am.* 2002;49(2):345-352, vi. https://doi.org/10.1016/s0031-3955(01)00008-6.
44. Marlatt GA, Witkiewitz K. Harm reduction approaches to alcohol use: Health promotion, prevention, and treatment. *Addict Behav.* 2002;27(6):867-886. https://doi.org/10.1016/s0306-4603(02)00294-0.
45. White WL. Medication-assisted recovery from opioid addiction: Historical and contemporary perspectives. *J Addict Dis.* 2012;31(3):199-206. https://doi.org/10.1080/10550887.2012.694597.
46. Levy S, Ryan SA, Gonzalez PK, et al. Medication-assisted treatment of adolescents with opioid use disorders. *Pediatrics.* 2016;138(3):e20161893. https://doi.org/10.1542/peds.2016-1893.
47. Feder KA, Krawczyk N, Saloner B. Medication-assisted treatment for adolescents in specialty treatment for opioid use disorder. *J Adolesc Health.* 2017;60(6):747-750. https://doi.org/10.1016/j.jadohealth.2016.12.023.
48. Saloner B, Feder KA, Krawczyk N. Closing the medication-assisted treatment gap for youth with opioid use disorder. *JAMA Pediatr.* 2017;171(8):729-731. https://doi.org/10.1001/jamapediatrics.2017.1269.
49. De Sousa A. A comparative study using disulfiram and naltrexone in alcohol-dependent adolescents. *J Subst Use.* 2014;19(5):341-345. https://doi.org/10.3109/14659891.2013.813084.
50. Brown AM, Ashford RD. Recovery-informed theory: Situating the subjective in the science of substance use disorder recovery. 2019;1(3):1-15. https://doi.org/10.31886/jors.13.2019.38.
51. Finch AJ, Frieden G. The ecological and developmental role of recovery high schools. *Peabody J Educ.* 2014;89(2):271-287. https://doi.org/10.1080/0161956X.2014.897106.
52. Alegria M, Carson NJ, Goncalves M, et al. Disparities in treatment for substance use disorders and co-occurring disorders for ethnic/racial minority youth. *J Am Acad Child Adolesc Psychiatry.* 2011;50(1):22-31. https://doi.org/10.1016/j.jaac.2010.10.005.
53. Hennessy EA, Fisher BW. A meta-analysis exploring the relationship between 12-step attendance and adolescent substance use relapse. *J Groups Addict Recover.* 2015;10(1):79-96. https://doi.org/10.1080/1556035X.2015.999621.

ALCOHOL RESEARCH
Current Reviews

Alcohol Res. 2020;40(3):05 ● https://doi.org/10.35946/arcr.v40.3.05

Published: 10 December 2020

Recovery in Special Emphasis Populations

Eric F. Wagner[1] and Julie A. Baldwin[2]

[1] Robert Stempel College of Public Health & Social Work, Community-Based Research Institute, and National Institute on Minority Health and Health Disparities (NIMHD) Research Center in a Minority Institution (RCMI), Florida International University, Miami, Florida

[2] Center for Health Equity Research and NIMHD RCMI Southwest Health Equity Research Collaborative, Northern Arizona University, Flagstaff, Arizona

Special emphasis populations in the current context can be defined as groups experiencing health disparities resulting in elevated risk to health, safety, and well-being from drinking alcohol. Individuals from marginalized minority populations often encounter barriers to accessing and receiving effective alcohol treatment due to social inequities and disadvantaged life contexts, which also may adversely affect recovery from alcohol use disorder (AUD). Recovery from AUD often involves the adoption of a stable non-drinking lifestyle (sobriety), increased health and well-being, and increased social connection. Although there has been considerable work on AUD epidemiology among special emphasis populations, little research exists directly examining recovery among racial/ethnic minority populations and/or sexual and gender minority populations. The current narrative review hopes to spark scholarly interest in this critically neglected area. This article opens with a review of special emphasis populations and their alcohol-related risks. Next, definitions of recovery, Alcoholics Anonymous, and culturally adapted recovery models for racial/ethnic minority populations are explored. This is followed by a discussion of factors that may particularly influence recovery among marginalized minority populations. This narrative review concludes with a discussion of research priorities for promoting health equity through studies focused on understanding and supporting recovery from AUD among marginalized minority populations.

KEY WORDS: alcohol-related disorders; alcoholism; minority health; health status disparities; Alcoholics Anonymous; social justice; alcohol; sexual and gender minorities

INTRODUCTION

The National Institute on Alcohol Abuse and Alcoholism (NIAAA) defines special emphasis populations as "groups who face particular risks from drinking alcohol based on personal characteristics such as age or gender."[1] Underage youth, emerging adults (ages 18 to 28), older adults (age 65 and older), women, individuals experiencing co-occurring disorders, and ethnic and racial minorities are special emphasis populations highlighted by NIAAA. Additional

special emphasis populations at heightened risk for AUD include sexual minorities,[2-4] individuals with justice system involvement,[5-10] homeless persons,[11] and former foster care emerging adults.[12]

Underage Youth

Underage youth are a special emphasis population given the ubiquity and inherent danger of underage drinking, as well as the status illegality of drinking among minors. By 12th grade, most Americans will have consumed alcohol, half will have consumed alcohol in the past year, and 1 out of 7 will have had five or more drinks in a row in the past 2 weeks.[13] Underage drinking is remarkably dangerous, carrying with it substantial risk to the health, safety, and well-being of teenagers and those around them.

Emerging Adults

Emerging adults are distinguished by the highest risk for alcohol and drug use problems of any age group.[14] More than a third of emerging adults report binge drinking during the past 2 weeks; those attending college are at higher risk for drinking problems than those not attending college, and collegians who participate in Greek letter organizations ("Greek life") are at especially high risk.[15]

Older Adults

NIAAA considers older adults (age 65 and older) a special emphasis population because many drink despite (1) age-related increases in sensitivity to alcohol, (2) health problems complicated by drinking, and (3) using medications that interact poorly with alcohol.[16] Moreover, drinking problems among older adults often are associated with factors unique to senior adulthood, such as aging-related health worries, boredom after retirement, the death of friends and loved ones, shame about drinking, and the justification that drinking is harmless to others.

Individuals With Co-Occurring Disorders

Co-occurring disorders alongside AUD are common, and individuals with co-occurring disorders are a special emphasis population given the complexities associated with treating AUD alongside other disorders. People with drinking problems are at heightened risk for psychiatric problems (i.e., anxiety disorders, depressive disorders, bipolar disorders, attention-deficit/hyperactivity disorder, borderline personality disorder, antisocial personality disorder, schizophrenia); problems with the use of other drugs in addition to alcohol; and physical problems and conditions (e.g., liver disease, HIV/AIDS, alcohol-related cancers). This comorbidity is a product of genetic vulnerabilities, epigenetics, neurobiology, environment, exposure to stress, and trauma. As highlighted by NIAAA, having co-occurring disorders is associated with greater alcohol problem severity;[17] moreover, it complicates the treatment of AUD, which for optimal effectiveness must be integrated with treatment(s) for co-occurring disorders.

Women

NIAAA regards women as a special emphasis population given the higher risk of certain alcohol-related negative consequences compared to men, such as liver damage, heart disease, brain damage, and breast cancer.[18] Moreover, women are a special emphasis group due to the issues of drinking during pregnancy and fetal alcohol exposure. In general, women report more problems related to physical and mental health as well as more past trauma and abuse (physical and sexual). Notably, women are more likely than men to begin using alcohol and drugs after a specific traumatic event and to suffer from post-traumatic stress disorder.[19] Key principles in women's recovery include addressing any experiences of trauma, including incest and rape, fears of losing their children, and parenting challenges and efficacy.[20-23]

Racial and Ethnic Minorities

NIAAA[24] points out "certain ethnic and racial minorities as well as other underserved populations experience more negative consequences of illness and premature death than other groups," noting disparities affecting (1) Hispanics/Latinx, (2) Blacks, and (3) Native Americans. The life contexts of racial and ethnic minority individuals with AUD are likely to include more economic hardship, stress, systemic discrimination and prejudice, and compounded disadvantage, as well as fewer recovery resources and supports, compared to the life contexts of non-Hispanic White individuals with AUD. The marginalization associated with racial/ethnic minority status produces enduring and significant challenges to recovery for such individuals.

The remainder of this narrative review focuses on individuals from marginalized minority groups in the recovery phase of their drinking careers, with particular attention to what may distinguish recovery challenges experienced by minority populations from those experienced by majority populations. It should be noted that rigorous empirical studies directly investigating recovery among any marginalized minority population(s) are absent from the literature; in contrast, considerable research has been conducted on the epidemiology of AUD and alcohol-related negative consequences among minority populations. The current narrative review draws heavily on that epidemiological work and extends it to recovery by: (1) examining what is known about recovery among minority populations; (2) identifying factors and mechanisms that especially may impact recovery among minority populations; and (3) suggesting avenues for additional research.

DEFINING RECOVERY AMONG SPECIAL EMPHASIS POPULATIONS

Despite widespread common usage of the term "recovery," obtaining expert consensus on the essential elements for defining recovery from AUD has proved challenging. The Substance Abuse and Mental Health Services Administration (SAMHSA) defines recovery as "a process of change through which individuals improve their health and wellness, live a self-directed life, and strive to reach their full potential."[25] Moreover, SAMHSA conceptualizes recovery along four dimensions: health, home, purpose, and community relationships/social networks. The Betty Ford Institute Consensus Panel defines recovery as "a voluntarily maintained lifestyle" characterized by sobriety (abstinence from alcohol and nonprescribed drugs), personal health (improved quality of personal life), and citizenship (respect for others).[26] William White defines recovery as "the experience (a process and a sustained status) through which individuals, families, and communities impacted by severe alcohol and other drug (AOD) problems utilize internal and external resources to voluntarily resolve these problems, heal the wounds inflicted by AOD-related problems, actively manage their continued vulnerability to such problems, and develop a healthy, productive, and meaningful life."[27] Despite considerable overlap among these three influential recovery definitions, they differ in meaningful ways with one another (e.g., whether recovery is voluntary; whether recovery means enduring vulnerability).

Kaskutas et al. reached out to adults in recovery (n = 9,341) and asked them how they defined recovery.[28] Responses revealed three factors: (1) "abstinence" (no use of alcohol); (2) "essential recovery" (being honest with oneself, handling negative feelings without drinking or using, enjoying life without drinking or using); and (3) "enriched recovery" (ongoing growth and development, reacting to life in a more balanced way, taking responsibility). In post hoc analyses, Kaskutas et al. examined possible variation by race/ethnicity and education in definitions of recovery, and found almost none. Notably, adults in recovery with less than a college degree or

from racial/ethnic minorities were less likely than their counterparts to emphasize abstinence in defining recovery, and more likely to emphasize the essential recovery and enriched recovery factors. Overall, these differences were slight, suggesting considerable overlap in definitions of recovery among and across minority and majority populations in recovery.

PARTICIPATION IN ALCOHOLICS ANONYMOUS BY MINORITY POPULATIONS

Participation in formal alcohol treatment typically precedes entering recovery. Kaskutas et al. found that 96% of adults self-identifying as being in recovery had received treatment for AUD.[28] The overwhelming majority of alcohol treatment programs in the United States incorporate 12-step elements and promote participation in Alcoholics Anonymous (AA) as an aid to recovery. AA was founded by non-Hispanic White men in the 1930s, and historically most AA members in the United States have been non-Hispanic White; over time, AA members have become much more diverse, reflecting the increasing demographic diversity of the U.S. population.

Concerned that AA's non-Hispanic White origins might be a barrier to AA participation for minority populations, Tonnigan, Connors, and Miller reviewed the literature and concluded: (1) AA is well known and well liked among minority populations; (2) minority populations are less likely to avail themselves of AA compared to nonminority populations; and, (3) minority populations are as likely to benefit from AA as nonminority populations.[29] In the 2 decades since the published review by Tonnigan et al., AA has grown substantially in the number of interest groups, meetings, conventions, and program resources designed especially for minority populations in recovery from AUD (e.g., http://gal-aa.org/ for gays and lesbians; https://naigso-aa.org/ for Native Americans).

AA Special Emphasis Group Adaptation: The Native American Wellbriety Movement

Some minority populations have adapted AA literature, rituals, and materials to increase AA's appeal, as well as cultural and linguistic appropriateness, for members of their communities. Beginning in the 1960s, AA has been steadily adapted by American Indian communities, culminating in the Wellbriety movement.[30] Wellbriety frames AUD from an American Indian perspective, where all things are holistically connected, and there is no separation between the individual, family, and tribe. Moreover, the fourth edition of the Big Book of Alcoholics Anonymous[31] has revised and updated its depictions of Native American culture, and a growing number of Native American meetings are registering with the AA General Services Office (https://naigso-aa.org/).

Despite the advances of the Wellbriety Movement, the relative dearth of AUD treatment and aftercare approaches congruent with Native American cultural values, beliefs, and traditions remains a major barrier to recovery from AUD for Native Americans.[32,33] Tradition-based Native American practices that may be incorporated into AUD treatment and recovery include: Sweat ceremonies, a cultural practice usually performed in a lodge that uses heat and steam to cleanse toxins from the mind, body, and spirit; smudging or the burning of sacred herbs to purify people and places; the use of ceremonial drums and songs; Talking Circles; traditional healers; and Elder teachings.[34] Additionally, historical trauma impinges upon Native Americans' successful recovery from AUD. Brave Heart notes: "Historical trauma, also referred to as a cumulative trauma, soul wound, and intergeneration trauma, refers to the cumulative emotional and psychological harm experienced throughout an individual's life span and through subsequent generations."[35] Historical trauma is the cumulative result of centuries of subjugation, racism and discrimination, genocidal violence, segregation, and systemic oppression inflicted

upon Native Americans. Incorporating tradition-based practices, and holistic concepts of wellness and community-based recovery support, can help contextualize and ameliorate the impact of historical trauma on recovery from AUD among Native Americans.[32,33]

AA Special Emphasis Group Adaptations: African American and Hispanic

In African American communities, local church-based drug ministries and mutual aid groups often are indigenous sources of services for recovery initiation, stabilization, and maintenance.[36] Given AA's Episcopalian roots and its emphasis on congregation and mutual aid, AA integrates relatively easily with church-based recovery support initiatives in African American communities. In immigrant urban Hispanic/Latinx communities in California, *anexos* are an indigenous adaptation of AA, typically catering to male, lower-income, Spanish-speaking immigrants and migrants.[37,38] Residences literally annexed to AA meeting sites, *anexos* originated in Mexico in 1975 as part of the recovery support "24 Hour Movement" (*Movimiento 24 Horas*), and since have spread to Hispanic/Latinx communities in the United States. Although strides have been made toward the cultural and linguistic adaptation of AA by minority groups, these advances have been limited by an emphasis on heterosexual men; thus, a critical next step is the adaptation of AA for minority women and for intersectional individuals with both racial/ethnic and sexual minority status.

CHALLENGES TO RECOVERY AMONG MINORITY POPULATIONS

Marginalized minority groups possess limited economic and social capital. Such limitations typically result from social and environmental injustices, and often reflect de jure and de facto discrimination.[39] Both before and during recovery from AUD, the life contexts of minority populations are likely to include more pervasive and enduring hardships, stresses, and disadvantages compared to the life contexts of majority populations.[40-47] Among marginalized minority groups, disadvantaged life contexts are (1) socially determined, (2) a function of social injustices, and (3) the primary causes of health inequities and disparities.[41,42] This means that the long-term elimination of health disparities, including those associated with recovery from AUD, is dependent on social change.

Research has identified a range of socially determined disadvantaged life contexts that significantly impact the course of AUD among minority populations;[40-47] it is very likely that these same social determinants significantly impact recovery from AUD. Key social determinants that may influence recovery among minority populations include:

- Material hardship
- Residential segregation
- Neighborhood crime and disorder
- Alcohol access through nearby alcohol outlets including bars and liquor stores
- Stigma about having problems with alcohol use or having AUD
- Unfair treatment, prejudice, and discrimination
- Disparities in medical care, resulting in more untreated or undertreated medical conditions
- Housing instability
- Unemployment and underemployment
- Personal demoralization
- Lack of culturally and linguistically appropriate recovery support services nearby
- Stress, from multiple and interacting sources

Such inequity in exposure to economically disadvantaged and health-compromising life contexts is a pressing environmental justice issue. Racial/ethnic minority populations are marginalized groups living in lower-income areas; residential segregation by income and race/ethnicity is considered "the most critical distinctive social exposure" driving health disparities.[49] Research has shown that the associations between environmental risks and AUD are

stronger in poorer neighborhoods, suggesting that environmental challenges are a particular threat to recovery among individuals with AUD from low-income communities.[50] Although successful recovery from AUD can be difficult and tortuous for anyone, successful recovery for someone from a marginalized minority population includes an added layer of socially determined challenges and environmental injustices. Moreover, a sizable number of people in recovery have more than one minority identity (e.g., a Latinx lesbian, a person of color who is incarcerated); individuals with intersectional identities may be especially likely to encounter socially determined challenges to recovery from AUD.

RECOMMENDATIONS

NIAAA[51] has identified four research priorities for investigations regarding the dynamics of posttreatment recovery. Two of these priorities speak directly to decreasing health inequities and enhancing knowledge related to recovery from AUD among minority populations. NIAAA notes that studies are needed on (1) "the neurobiological, psychological, environmental, and social factors that influence post-treatment recovery" and (2) "trajectories of recovery in subgroups of people with different cultural and socioeconomic backgrounds, cognitive abilities, and medical histories." Keeping these two priorities in mind, the following recommendations are offered for future research on recovery from AUD among minority populations:

- Identify modifiable drivers of recovery among vulnerable populations.
- Estimate the contributions of various life context hardships, stresses, and disadvantages to recovery trajectories among minority populations.
- Explore the intersections of various minority identities (e.g., race, ethnicity, socioeconomic status, sex), alongside experiences of discrimination and injustice, vis-à-vis recovery trajectories.
- Examine how (1) minority populations use or adapt AA, (2) AA practices vary among minority populations, and (3) characteristics of minority populations influence the likelihood of benefitting from AA.
- Investigate the critical transition from treatment completion to community-based recovery, and how that affects long-term recovery trajectories among minority populations.
- Compare the utilization and impact of AA versus other recovery support services (e.g., Wellbriety; SMART [Self-Management and Recovery Training], Celebrate Recovery) among minority populations.

CONCLUSIONS

Rigorous empirical studies of recovery from AUD among minority populations are absent from the literature. Although many individuals from minority populations respond well to alcohol intervention—successfully completing treatment, ending drinking, and starting recovery—minority populations experience numerous challenges and barriers to recovery from AUD. It is very likely social determinants of health disparities significantly impact recovery from AUD among marginalized minority populations (e.g., racial/ethnic minorities, sexual minorities), but this has yet to be directly examined. Thus, there is an urgent need for investigations of recovery among minority populations. Such research is essential for making progress in eliminating alcohol-related health disparities impacting minority populations.

Acknowledgments

This research was supported by the Research Centers in Minority Institutions at Florida International University (U54MD012393) and Northern Arizona University (U54MD012388), which are sponsored by the National Institute on Minority Health and Health Disparities. The authors thank Jordan Quintana for her help with manuscript preparation.

Financial Disclosure

The authors declare no competing financial interests or other conflicts of interest.

Publisher's Note

References

1. National Institute on Alcohol Abuse and Alcoholism. Special populations & co-occurring disorders. Alcohol's Effects on Health website. Accessed November 3, 2020. https://www.niaaa.nih.gov/alcohol-health/special-populations-co-occurring-disorders.
2. Burwick A, Gates G, Baumgartner S, et al. *Human Services for Low-Income and At-Risk LGBT Populations: The Knowledge Base and Research Needs. Project Brief.* Office of Planning, Research and Evaluation (OPRE) Report Number: 2014-84. Washington, DC: OPRE, Administration for Children and Families, U.S. Department of Health and Human Services; 2014. https://www.acf.hhs.gov/sites/default/files/opre/lgbt_hs_project_brief_final_508compliant_122414_0.pdf. Accessed September 17, 2020.
3. Hatzenbuehler ML. The social environment and suicide attempts in lesbian, gay, and bisexual youth. *Pediatrics.* 2011;127(5):896-903. https://doi.org/10.1542/peds.2010-3020.
4. Silvestre A, Beatty R, Friedman MR. Substance use disorder in the context of LGBT health: A social work perspective. *Soc Work Public Health.* 2013;28(3-4):366-376. https://doi.org/10.1080/19371918.2013.774667.
5. Schnittker J, Massoglia M, Uggen C. Out and down: Incarceration and psychiatric disorders. *J Health Soc Behav.* 2012;53(4):448-464. https://doi.org/10.1177/0022146512453928.
6. Slade EP, Stuart EA, Salkever DS, et al. Impacts of age of onset of substance use disorders on risk of adult incarceration among disadvantaged urban youth: A propensity score matching approach. *Drug Alcohol Depend.* 2008;95(1-2):1-13. https://doi.org/10.1016/j.drugalcdep.2007.11.019.
7. Jones GY, Hoffmann NG. Alcohol dependence: International policy implications for prison populations. *Subst Abuse Treat Prev Policy.* 2006;1:33-36. https://doi.org/10.1186/1747-597x-1-33.
8. Cook BL, Alegría M. Racial-ethnic disparities in substance abuse treatment: The role of criminal history and socioeconomic status. *Psychiatr Serv.* 2011;62(11):1273-1281. https://doi.org/10.1177/0022146512453928.
9. Aos S, Miller M, Drake E. *Evidence-Based Adult Corrections Programs: What Works and What Does Not.* Washington State Institute for Public Policy; 2006. https://www.academia.edu/22495328/Evidence-Based_Adult_Corrections_Programs_What_Works_and_What_Does_Not. Accessed January 31, 2020.
10. Mitchell O, Wilson DB, MacKenzie DL. Does incarceration-based drug treatment reduce recidivism? A meta-analytic synthesis of the research. *J Exp Criminol.* 2007;3(4):353-375. https://doi.org/10.1007/s11292-007-9040-2.
11. Foster A, Gable J, Buckley J. Homelessness in schizophrenia. *Psychiatr Clin North Am.* 2012;35(3):717-734. https://doi.org/10.1016/j.psc.2012.06.010.
12. Braciszewski JM, Stout RL, Tzilos GK, et al. Testing a dynamic automated substance use intervention model for youths exiting foster care. *J Child Adolesc Subst Abuse.* 2016;25(3):181-187. https://doi.org/10.1080/1067828x.2014.981771.
13. Miech RA, Johnston LD, O'Malley PM, et al. *Monitoring the Future National Survey Results on Drug Use, 1975-2018. Volume I, Secondary School Students*. Ann Arbor, MI: Institute for Social Research, The University of Michigan; 2019. http://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=ED599067&site=eds-live. Accessed January 31, 2020.
14. Wagner EF, Spadola C, Davis J. Chapter 12: Addictive behaviours during emerging adulthood. In: Begun AL, Murray M, eds. *The Routledge Handbook of Social Work and Addictive Behaviours.* 2020.
15. McCabe SE, Veliz P, Schulenberg JE. How collegiate fraternity and sorority involvement relates to substance use during young adulthood and substance use disorders in early midlife: A national longitudinal study. *J Adolesc Health.* 2018;62(3S):S35-S43. https://doi.org/10.1016/j.jadohealth.2017.09.029.
16. National Institute on Alcohol Abuse and Alcoholism. Older adults. Alcohol's Effects on Health website. Accessed November 3, 2020. https://www.niaaa.nih.gov/older-adults.
17. National Institute on Alcohol Abuse and Alcoholism. Other psychiatric disorders. Alcohol's Effects on Health website. Accessed November 3, 2020. https://www.niaaa.nih.gov/alcohol-health/special-populations-co-occurring-disorders/other-psychiatric-disorders.
18. National Institute on Alcohol Abuse and Alcoholism. Women and alcohol. Brochures and Fact Sheets. Accessed November 3, 2020. https://www.niaaa.nih.gov/publications/brochures-and-fact-sheets/women-and-alcohol.
19. Covington S. Helping women recover: Creating gender-responsive treatment. In: Straussner S, Brown S, eds. *The Handbook of Addiction Treatment for Women: Theory and Practice.* San Francisco, CA: Jossey-Bass; 2002:52-72.
20. Kruk E, Sandberg K. A home for body and soul: Substance using women in recovery. *Harm Reduct J.* 2013;10:39. https://doi.org/10.1186/1477-7517-10-39.
21. Hiersteiner C. Narratives of low-income mothers in addiction recovery centers: Motherhood and the treatment experience. *J Soc Work Pract Addict.* 2004;4(2):51-64. https://doi.org/10.1300/J160v04n02_05.
22. Green CA. Gender and use of substance abuse treatment services. *Alcohol Res Health.* 2006;29(1):55-62.
23. Brady TM, Ashley OS. *Women in Substance Abuse Treatment: Results from the Alcohol and Drug Services Study (ADDS).* HHS Publication No. SMA-04-3968, Analytic Series A-26. Rockville, MD: Substance Abuse and Mental Health Services Administration, Office of Applied Studies; 2005.
24. National Institute on Alcohol Abuse and Alcoholism. Minority health and health disparities. Special populations and co-occurring-disorders. Alcohol's Effects on Health website. Accessed November 3, 2020. https://www.niaaa.nih.gov/alcohol-health/special-populations-co-occurring-disorders/diversity-health-disparities.
25. Substance Abuse and Mental Health Services Administration. SAMHSA's Working Definition of Recovery. Accessed November 3, 2020. https://store.samhsa.gov/sites/default/files/d7/priv/pep12-recdef.pdf.
26. Betty Ford Institute Consensus Panel. What is recovery? A working definition from the Betty Ford Institute. *J Subst Abuse Treat.* 2007;33(3):221-228. https://doi.org/10.1016/j.jsat.2007.06.001.
27. White WL. Addiction recovery: Its definition and conceptual boundaries. *J Subst Abuse Treat.* 2007;33(3):229-241. https://doi.org/10.1016/j.jsat.2007.04.015.
28. Kaskutas LA, Borkman TJ, Laudet A, et al. Elements that define recovery: The experiential perspective. *J Stud Alcohol Drugs.* 2014;75(6):999-1010. https://doi.org/10.15288/jsad.2014.75.999.

29. Tonigan JS, Connors GJ, Miller WR. Special populations in Alcoholics Anonymous. *Alcohol Health Res World.* 1998;22(4):281-285.
30. Coyhis D, White W. *Alcohol Problems in Native America: The Untold Story of Resistance and Recovery—The Truth About the Lie.* Colorado Springs, CO: White Bison, Inc.; 2006.
31. Alcoholics Anonymous. *The Story of How Many Thousands of Men and Women Have Recovered From Alcoholism*. 4th ed. New York, NY: Alcoholics Anonymous World Services; 2001.
32. Dickerson DL, Spear S, Marinelli-Casey P, et al. American Indians/Alaska Natives and substance abuse treatment outcomes: Positive signs and continuing challenges. *J Addict Dis.* 2011;30(1):63-74. https://doi.org/10.1080/10550887.2010.531665.
33. Dickerson DL, Venner KL, Duran B, et al. Drum-Assisted Recovery Therapy for Native Americans (DARTNA): Results from a pretest and focus groups. *Am Indian Alsk Native Ment Health Res.* 2014;21(1):35-58. https://doi.org/10.5820/aian.2101.2014.35.
34. Rowan M, Poole N, Shea B, et al. Cultural interventions to treat addictions in Indigenous populations: Findings from a scoping study. *Subst Abuse Treat Prev Policy.* 2014;9:34. https://doi.org/10.1186/1747-597x-9-34.
35. Brave Heart MYH. The return to the sacred path: Healing the historical trauma and historical unresolved grief response among the Lakota through a psychoeducational group intervention. *Smith College Studies in Social Work*. 1998;68(3):287-305. https://doi.org/10.1080/00377319809517532.
36. White WL, Sanders M. Recovery management and people of color: Redesigning addiction treatment for historically disempowered communities. *Alcohol Treat Q.* 2008;26(3):365-395. http://search.ebscohost.com/login.aspx?direct=true&db=rzh&AN=105812574&site=eds-live. Accessed January 31, 2020.
37. Garcia V, Pagano A, Recarte C, et al. The *Anexo* in Northern California: An Alcoholics Anonymous-based recovery residence in Latino communities. *J Groups Addict Recover.* 2017;12(2-3):158-176. https://doi.org/10.1080/1556035x.2017.1313147.
38. Pagano A, Lee JP, Garcia V, et al. Ethnographic research in immigrant-specific drug abuse recovery houses. *J Ethn Subst Abuse.* 2018;17(1):79-90. https://doi.org/10.1080/15332640.2017.1362726.
39. Ward-Peterson M, Wagner EF. Health Disparities. In: *The Wiley Encyclopedia of Health Psychology. Vol. 4*. Hoboken, NJ: Wiley Press. 2020. https://doi.org/10.1002/9781119057840.ch188.
40. Pinedo M, Zemore S, Beltrán-Girón J, et al. Women's barriers to specialty substance abuse treatment: A qualitative exploration of racial/ethnic differences. *J Immigr Minor Health.* 2020;22(4):653-660. https://doi.org/10.1007/s10903-019-00933-2.
41. Pinedo M. Help seeking behaviors of Latinos with substance use disorders who perceive a need for treatment: Substance abuse versus mental health treatment services. *J Subst Abuse Treat. 2020;109:41-45.* https://doi.org/10.1016/j.jsat.2019.11.006.
42. Chartier KG, Hesselbrock MN, Hesselbrock VM. Ethnicity and gender comparisons of health consequences in adults with alcohol dependence. *Subst Use Misuse. 2013;48(3):200-210.* https://doi.org/10.3109/10826084.2013.747743.
43. Chartier KG, Vaeth PAC, Caetano R. Focus on: Ethnicity and the social and health harms from drinking. *Alcohol Res.* 2013;35(2):229-237.
44. National Academies of Sciences, Engineering, and Medicine. *Communities in Action: Pathways to Health Equity.* Washington, DC: The National Academies Press; 2017.
45. O'Hanlan KA, Isler CM. Health care of lesbian and bisexual women. In: Meyer IH, Northridge ME. *The Health of Sexual Minorities: Public Health Perspectives on Lesbian, Gay, Bisexual, and Transgender Populations.* New York, NY: Springer Science and Business Media; 2007:506-522.
46. Pinedo M, Zemore S, Rogers S. Understanding barriers to specialty substance abuse treatment among Latinos. *J Subst Abuse Treat.* 2018;94:1-8. https://doi.org/10.1016/j.jsat.2018.08.004.
47. Zemore SE, Karriker-Jaffe KJ, Keithly S, et al. Racial prejudice and unfair treatment: Interactive effects with poverty and foreign nativity on problem drinking. *J Stud Alcohol Drugs.* 2011;(3):361-370. https://doi.org/10.15288/jsad.2011.72.361.
48. Braveman P. What is health equity: And how does a life-course approach take us further toward it? *Matern Child Health J.* 2014;18(2):366-372. https://doi.org/10.1007/s10995-013-1226-9.
49. Williams DR, Priest N, Anderson NB. Understanding associations among race, socioeconomic status, and health: Patterns and prospects. *Health Psychol.* 2016;35(4):407-411. https://doi.org/10.1037/hea0000242.
50. Mennis J, Stahler GJ, Mason MJ. Risky substance use environments and addiction: A new frontier for environmental justice research. *Int J Environ Res Public Health.* 2016;13(6):607. https://doi.org/10.3390/ijerph13060607.
51. National Institute on Alcohol Abuse and Alcoholism. Mission and goals. Division of Treatment and Recovery Research website. Accessed November 3, 2020. https://www.niaaa.nih.gov/division-treatment-recovery-research.

ALCOHOL RESEARCH
Current Reviews

Alcohol Res. 2020;40(3):04 ● https://doi.org/10.35946/arcr.v40.3.04

Published: 3 December 2020

Brain Structure and Function in Recovery

Sara Jo Nixon[1,2] and Ben Lewis[1,2]

[1]Department of Psychiatry, University of Florida, Gainesville, Florida
[2]Center for Addiction Research & Education, University of Florida, Gainesville, Florida

Alcohol use disorder (AUD) commonly is associated with compromise in neurobiological and/or neurobehavioral processes. The severity of this compromise varies across individuals and outcomes, as does the degree to which recovery of function is achieved. This narrative review first summarizes neurobehavioral, neurophysiological, structural, and neurochemical aberrations/deficits that are frequently observed in people with AUD after detoxification. Subsequent sections review improvements across these domains during recovery, taking into account modulators of recovery to the extent permitted. Where appropriate, the discussion includes work integrating outcomes across domains, leveraging the strengths of diverse experimental methods. Interventions to ameliorate neurobiological or neurobehavioral deficits do not constitute a primary objective of this review. However, their consideration is a logical inclusion. Therefore, a limited introduction to existing methods is also presented.

KEY WORDS: alcohol; alcohol use disorder; neurobehavioral deficits; brain structure; neurophysiology; neurochemistry; recovery; neural networks

INTRODUCTION

Alcohol use disorder (AUD) is characterized by dysregulation across a range of neurobiological and/or neurobehavioral domains. Neurobiological aberrations include dysregulated neural activity and patterns of brain activation as well as compromise in gray and white matter. Neurobehavioral aberrations are widespread and evident across diverse neuropsychological domains such as problem-solving, learning, memory, and motor functions. An estimated 50% to 80% of people with AUD demonstrate significant cognitive/behavioral compromise relative to community comparison groups, with a substantive minority (i.e., 30% to 40%)[1] exhibiting sufficient compromise to meet criteria for clinical impairment.[2] Describing alcohol-related impairment is further complicated by the fact that neurobiological (e.g., structural) aberrations and behavioral compromise are not universally related. Importantly, empirical studies demonstrate that both neurobiological and behavioral measures improve substantially after

recovery is initiated, although the trajectories vary and are often incomplete. This narrative review focuses on improvements in brain structure and function and briefly explores opportunities for facilitating these processes. To establish an appropriate context, the article begins with a limited overview of alcohol-related biobehavioral deficits. More comprehensive coverage of alcohol-related impairment is provided in several recent reviews.[3,4]

In discussing recovery, several caveats warrant attention. First, there is a paucity of data from individuals who address their alcohol misuse without seeking formal treatment. Thus, this review is largely limited to outcomes obtained from people who participated in inpatient or intensive outpatient treatment.

Second, the phrase "in recovery" eludes ready definition. The goals of both the individuals with AUD and the treatment programs vary. If a program is abstinence based, the objective is to sustain abstinence after treatment, and an individual is considered "in recovery" as long as they maintain abstinence. If the primary treatment objective is harm reduction or controlled drinking, successful recovery is marked by a reduction in negative consequences, without abstinence as a necessary prerequisite. Consequently, while both people who sustain abstinence and those who successfully navigate harm reduction efforts can be considered "in recovery," their continuing exposure to alcohol may vary significantly. Thus, heterogeneity in continued drinking across studies creates a substantive interpretational challenge, prohibiting broad conclusions regarding the effects of "recovery" on neurobiobehavioral improvement. To address this challenge, studies need to incorporate alternate definitions of "successful" outcomes, perhaps also including neurobiobehavioral improvement as one component. In the extant literature, the majority of reports are derived from treatment-seeking individuals in abstinence-based programs. Nevertheless, rather than relying only on binary outcomes (e.g., relapse vs. sustained abstinence), some investigations, as illustrated in later sections, gather data regarding continuing drinking patterns, providing a more granular consideration of alcohol use across time.

Third, many studies use the phrases "recovery" and "improvement" of function interchangeably. At initial glance, distinguishing these terms seems a matter of semantics. However, as addiction science directs attention to the effectiveness of interventions in enhancing outcomes, the distinction is highly relevant.[2] Conservatively defined, improvement references positive change associated with the passage of time (i.e., time-dependent change) or repeated practice (i.e., practice effects). For example, cognition improves with time after detoxification, even without directed intervention, as well as after repeated testing. The phrase "recovery of function," in contrast, refers to positive change that cannot be accounted for by time or practice. Distinguishing "improvement" from "recovery" requires the inclusion of appropriate comparison data and is particularly relevant when evaluating behavioral outcomes and interventions. In the following sections, the terms are used with attention to this distinction. That said, positive change is a desired outcome, whether or not it meets a strict definition of recovery of function.

Fourth, although the potential influence of individual variables such as age and sex/gender on recovery is widely recognized, it has not been systematically studied, particularly in longitudinal assessments. Therefore, these variables are not discussed in depth here.

BRIEF OVERVIEW OF ALCOHOL-RELATED SEQUELAE

This section provides brief overviews of four broad categories of alcohol-related biobehavioral sequelae: neurobehavior, neurophysiology, brain structure, and neurochemistry.

Neurobehavior

A substantial literature has illustrated that cognitive processes relying heavily on the

prefrontal and frontal cortices (i.e., executive functions such as attention, working memory, problem-solving, inhibition, and flexibility) are susceptible to chronic excessive alcohol consumption.[5] However, alcohol-related deficits are not limited to these domains. Compromise in visual-spatial functions, gait/balance, and new learning/memory is also frequently reported.[6] Taken together, alcohol-related deficits in neuropsychological/behavioral functions often are described as reflecting a mild, generalized brain dysfunction.[2,6] Beyond these traditional neuropsychological characteristics, interest in alcohol-related compromise in key facets of emotion processing and social cognition is increasing. Of particular note are deficits in emotion face processing, interpersonal problem solving, and humor processing,[3,7,8] all of which are critical skills in social, work, and family settings.

Neurophysiology

Brain electrophysiology, as obtained from scalp electrodes, also is affected by chronic alcohol misuse. Studies have revealed dysregulation in the electroencephalogram (EEG), as well as in the amplitudes and/or latencies of electrophysiological components that occur at specific times following stimulus presentation or response (i.e., event-related potentials [ERPs]).[9,10] Importantly, both ERP components that occur earlier after stimulus presentation (i.e., exogenous components) and reflect sensory processes and components that occur later (i.e., endogenous components) and reflect cognitive processes are sensitive to chronic excessive alcohol use. This demonstrates alcohol's impact on the temporal dynamics of both sensory and cognitive processes.[7,9,10] A growing body of alcohol research has focused on performance monitoring, which entails ongoing monitoring of response accuracy in the context of changing demands. A common variable studied in these protocols is the error-related negativity (ERN), which is observed after the subject commits an error while completing speeded response tasks.[11] Accurately detecting errors is essential for adaptive behavior. Thus, findings of aberrant ERN amplitudes in people with AUD[12] suggest compromise in the biobehavioral dynamics underlying adaptive behavior.

Repetitive patterns of neural activity (i.e., neural oscillatory activity) and the amount of brain activity in certain frequency bands (i.e., EEG power) reflect a coordinated (i.e., synchronous) neuronal discharge that can be examined as a function of both time and frequency. EEG power can be examined in either a resting state or during specific sensory or cognitive events. In the latter case, the activity is referred to as event-related oscillations. AUD is associated with alterations in both types of measures, demonstrating widespread dysregulation in the temporal dynamics of neural processes.[10]

Brain Structure

People with AUD frequently exhibit volumetric loss in gray and white matter, as well as ventricular expansion in both the cerebrum and cerebellum.[13,14] Data regarding sex differences are mixed, with some studies suggesting that women are more susceptible than men to alcohol's effects while other studies show either no pattern or the opposite pattern.[15] Higher vulnerability also has been reported with increasing age, especially in frontal brain areas.[16] Beyond reduced brain volumes, studies have shown compromised white matter integrity,[17,18] with indications of age interactions.[19]

Dysregulation in brain network activity and connectivity also frequently occurs.[20] Although the default mode network[21] has received greatest attention, other networks are impacted as well, including the executive control, salience, and reward networks.[22,23] Finally, associations may exist between structural compromise and neurobehavioral measures. For example, Pandey and colleagues[18] found significant relationships between white matter fractional anisotropy measures and neuropsychological performance.

Neurochemistry

Several studies have demonstrated that neurochemistry is also disrupted in AUD.[24,25] Using proton magnetic resonance imaging, the most frequently reported findings indicate lower levels of the neuronal metabolite *N*-acetylaspartate (NAA), as well as of choline-containing compounds (Cho) and creatine metabolites (Cr). Findings are mixed regarding alcohol's effects on the glial metabolite myo-inositol, and complex outcomes are associated with measures of the neurotransmitters glutamate and gamma-aminobutyric acid (GABA).[26]

Summary

Although they do not occur in all people with AUD, alcohol-related deficits in neurobehavior, neurophysiology, brain structure, and neurochemistry constitute significant individual and public health concerns. Deficits across the four domains are incompletely correlated and often fall short of criteria for clinical impairment. Nevertheless, they can impact treatment engagement, post-treatment adaptation, and relapse.[27-30] Thus, clarifying recovery trajectories, identifying relevant individual and confounding variables, and determining effective interventions must be research priorities.

EFFECTS OF RECOVERY

Fortunately, with continuing recovery, neurobiobehavioral impairment can improve. The following sections discuss neurobehavioral, neurophysiological, structural, and neurochemical recovery in more detail.

Neurobehavioral Change in Recovery

Investigations suggest that substantial improvements in neurobehavioral functions occur during the first 4 to 8 weeks of abstinence, followed by more modest mid-term (i.e., approximately 1 year) gains. Verbal skills typically improve most quickly, while other domains, although improved, may remain compromised for several months to years.[31] Longitudinal studies also found substantive differences in change trajectories across domains, supporting the general conclusions derived from cross-sectional comparisons of subgroups of people with AUD who differed in abstinence length.[4] Petit and colleagues[32] recently investigated the effects of abstinence on alcohol-related working memory and inhibitory control deficits. By the third week of abstinence, working memory function was indistinguishable between the AUD and control groups, whereas inhibitory control deficits remained. Employing a similar 3-week test interval, Cordovil De Sousa Uva and colleagues[33] also observed deficits in inhibitory control and executive functions at initial testing, but noted no improvements at retest for either function. Not surprisingly, recovery across these three overarching domains appears to be greatest with abstinence.[27,34-36] However, it is noteworthy that some data suggest that low or moderate posttreatment drinking may not preclude improvement.[29]

Studies of improvement in cerebellum-linked behaviors such as gait, balance, and postural sway have produced mixed results. Fein and Greenstein[37] examined these functions in a longitudinal study of people with AUD, with a baseline assessment at 6 to 15 weeks of abstinence and follow-up 4 to 16 months later. Performance was compared with healthy control subjects who also were tested twice. The AUD group performed more poorly than the control group at both assessments and demonstrated no improvement across time. The investigators note that the analyses would have missed improvement occurring before the first assessment (i.e., an average of about 10 weeks of abstinence). However, persistence of deficits in cerebellar functions also has been demonstrated in other studies and in both men and women.[38] To date, most studies on the recovery of alcohol effects on the cerebellum have been restricted to measures of stability and related outcomes. This focus is expected to expand with increasing appreciation of the cerebellum's role in extended brain networks.[39,40]

Research regarding initial deficits as well as recovery in social cognition is limited and has yielded mixed results,[3] but recent work provides encouragement. For example, Erol and colleagues[41] observed improvements in emotion identification accuracy, with performance in people with AUD at 3 months of abstinence equivalent to that of control subjects. It is possible that improvement in emotion processing and social cognition may require more time than do more commonly investigated cognitive functions.

One limitation of these studies is that AUD-focused longitudinal examinations often assess participants only at two time points and typically within a relatively narrow time frame to minimize participant attrition and ensure study feasibility. This practice significantly constrains understanding of continued recovery and limits estimations of within-person heterogeneity, minimizing the opportunity to identify differential predictors and trajectories at the level of the individual. A study by Bates and colleagues[42] provides a notable exception, revealing marked within-person heterogeneity and illustrating substantive challenges in predicting recovery trajectories.

Nicotine use, particularly chronic smoking, is common in people seeking treatment for AUD. Several studies have examined its potential role in exacerbating alcohol-related deficits. Durazzo and colleagues[34] compared recovery trajectories across an 8-month assessment period in active smokers and nonsmokers with similar initial deficits. Whereas the nonsmokers demonstrated recovery of cognitive function, the active smokers retained measurable deficits on multiple measures. Age played a significant role in this relationship, with older active smokers evincing the least improvement over time.[43] In a recent follow-up study, Durazzo and Meyerhoff[44] compared people with AUD who were either never smokers (nvsALC), former smokers (fsALC), or active smokers (asALC) with a healthy control group. All participants were tested twice: The AUD groups were assessed at about 30 days of abstinence and again at about 8 months of sustained abstinence, and the control group was tested and retested at a similar interval. In contrast to earlier work focusing on learning/memory,[34] the researchers administered a more comprehensive battery. Smoking status accounted for differential recovery across all neurocognitive domains, including executive functions (see Figure 1), with active smokers exhibiting the least recovery.

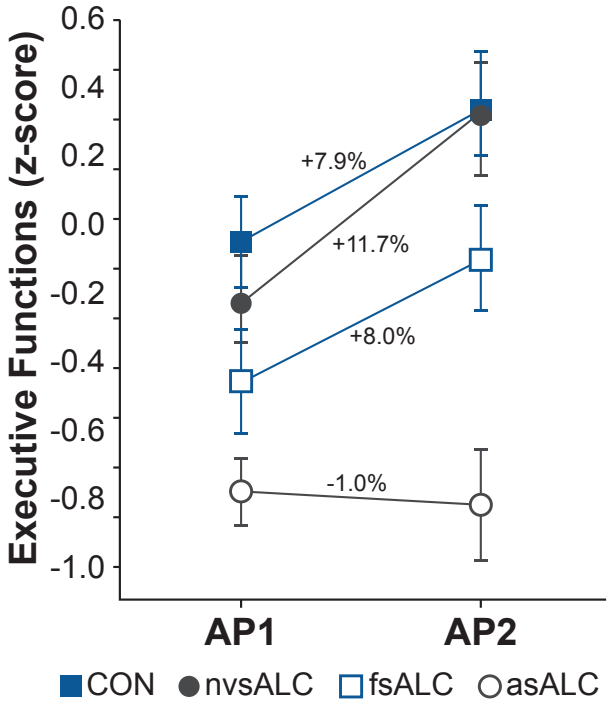

Figure 1 Effect of smoking status on recovery of executive functions during abstinence. Over an 8-month post-treatment period, individuals with alcohol use disorder (AUD) who never smoked evinced greater improvement in executive functions (as indicated by z-score) relative to all other groups. Active smokers showed no improvement between assessments, remaining inferior to controls and people who never smoked. The slight increase in the control group could be expected based on practice effects. *Note:* AP1: 33 ± 9 days abstinent; AP2: 232 ± 56 days abstinent; CON: never-smoking controls; nvsALC: never-smoking individuals with AUD; fsALC: former smokers with AUD; asALC: active smokers with AUD. *Source:* Durazzo and Meyerhoff, 2020.[44] Reprinted with permission from Elsevier Inc.

Neurophysiological Change in Recovery

The degree to which brain electrophysiology improves with abstinence is variable and influenced by family history of AUD. For example, seminal studies showed that components of early sensory potentials, such as the brainstem auditory evoked response, exhibited improved morphology, shortened conduction times, and shorter latencies at 4 months of abstinence than at 1 month of abstinence.[9] In contrast, amplitudes for the P3—a later component associated with context (target) processing, cognitive control, and feedback processing—remained dampened. Importantly, a family history of AUD accounted for much of the variability in P3 amplitude. Similar observations across numerous studies have led to the proposal that P3 aberrations, particularly blunted P3 amplitudes, constitute a possible AUD endophenotype.[10,45,46]

Using a cross-sectional design, Fein and colleagues[47] investigated the effect of abstinence on neurobiological variables, comparing individuals with AUD who were long-term abstinent (abstinence ≥ 6 months, mean abstinence > 6 years) and community controls. The investigators examined the P160—an ERP component with demonstrated sensitivity to face processing and reaction time—using an emotional face expression task. In this task, individuals must select the emotion expressed by individually presented faces. The control task required identifying a neutral face as either male or female. Compared with the community controls, the long-term abstinent group demonstrated longer P160 latencies on both tasks and slower reaction times on the emotional face expression task only. The P160 effects remained significant even after accounting for reaction-time differences. In contrast to other work,[9,10] family history of AUD did not influence outcomes in the current study. Also, no significant sex by group interactions were observed, a finding contrary to the common conclusion that men and women are differentially vulnerable.

Several studies have used resting state synchrony (RSS) in studies of recovery. RSS reflects the level of synchrony in activation and/or deactivation within or across brain areas when an individual is not actively engaged in a neurocognitive task, i.e., at rest. Using RSS, Camchong and colleagues[35,36] examined differences between short-term (mean = 73 days) and long-term (mean = 7.9 years) abstinence as reflected in activation patterns within the executive control and reward processing networks. They found that, when compared to community controls and individuals with short-term abstinence, individuals with long-term abstinence displayed significantly lower levels of RSS in the reward processing network than did either the short-term abstinent or community control groups. Individuals who had achieved short-term abstinence fell intermediate to the community and long-term participants, but did not differ significantly from the control participants. Longer abstinence was also associated with higher levels of RSS in the executive control network, although group comparisons indicated that only the contrast between the long-term and community groups was statistically different.

Alterations in processes underlying intentional behavior likely contribute to long-term outcomes. As previously described, the ERN is an indicator of effective performance monitoring. A recent cross-sectional study examined the ERN in (a) actively drinking, non–treatment-seeking people with AUD; (b) individuals meeting criteria for remitted AUD using clinical criteria assessing drinking consequences and which do not require abstinence (mean = 2.8 years in remission); (c) individuals with a family history of AUD, but not having an AUD themselves; (d) people without histories of AUD who met criteria for non-psychotic disorders such as anxiety or depression; and (e) healthy controls.[12] In contrast to earlier reports indicating that AUD was associated with higher ERN amplitudes,[48] the actively drinking AUD group in this study produced significantly lower ERN amplitudes than each of the other groups, which did not differ among themselves (see Figure 2). Interestingly, there were no group differences in accuracy rate or reaction times for errors. Also, the study found no effect of a family history in the AUD groups, although prior work by Fein and Chang[49] had indicated that an increased family-history density in people with AUD was associated with lower

ERN amplitude. Regardless of the direction of the alcohol effect or the possible role of a family history of AUD, these data implicate dysregulation in neural activity in detecting behavioral errors, which is a critical aspect of effective intentional behavior.

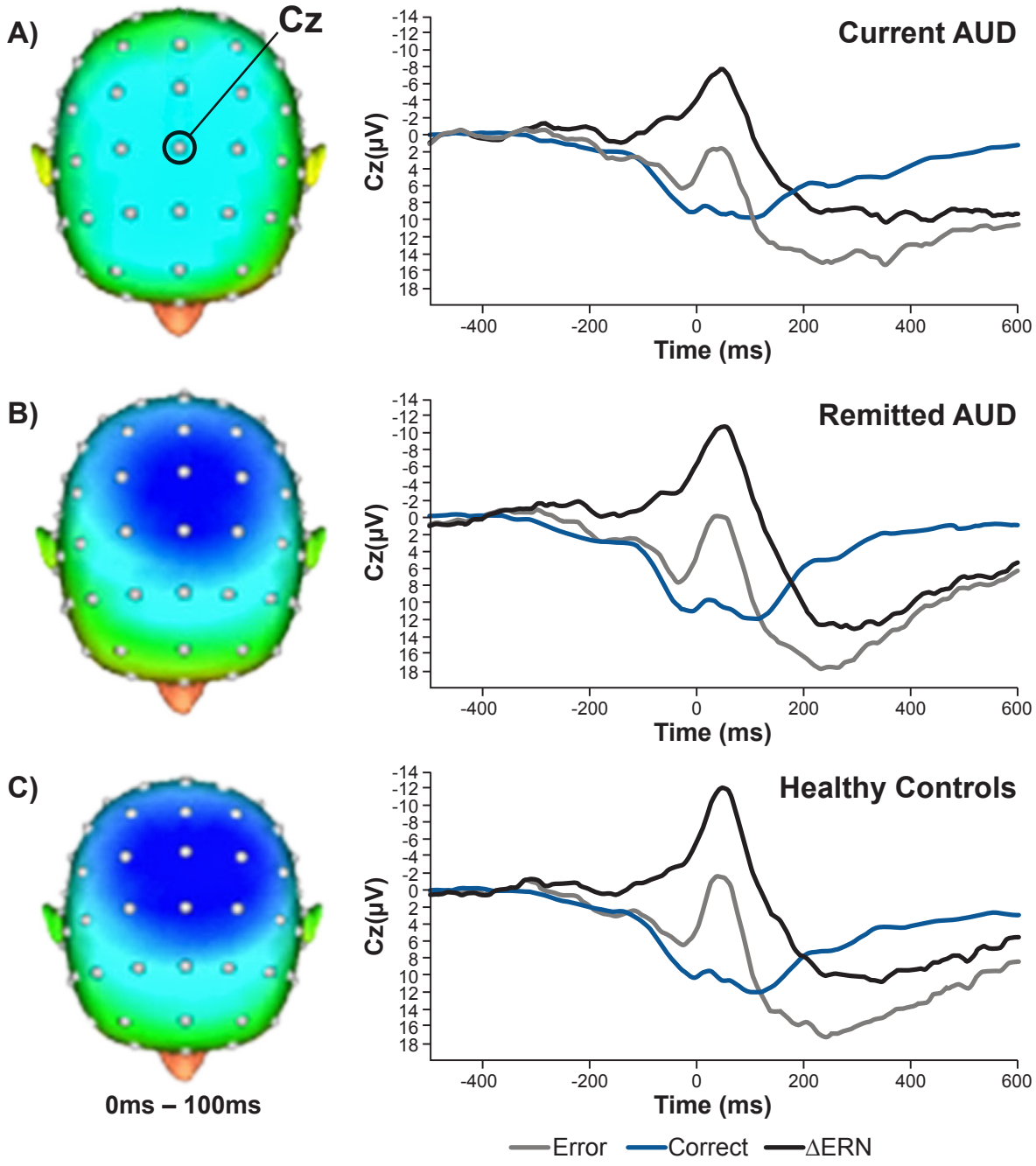

Figure 2 Error-related neural activity among (A) people with current AUD, (B) people with remitted AUD, and (C) healthy controls. (Left) Topographic maps of neural activity (error minus correct). (Right) Response-locked event-related potential waveforms for correct trials, error trials, and difference waves (error-related negativity; ΔERN). Current AUD was associated with greater blunting of the ΔERN amplitude relative to both healthy controls (Cohen's $d = 0.52$) and individuals with remitted AUD (Cohen's $d = 0.37$). Individuals with remitted AUD did not differ from healthy controls. Cz: electrode located at the central midline position; ms, milliseconds. *Source:* Gorka et al., 2019.[12] Reprinted with permission from Elsevier Inc.

Structural Change in Recovery

Demirakca and colleagues[50] studied change in gray and white matter in treatment-seeking men and women between 5 weeks and 3 months of post-treatment abstinence. They found a significant reduction in cerebral spinal fluid (CSF), an indicator of ventricular enlargement and significant increases in gray matter volume, particularly in the insula and cingulate gyrus, for participants who sustained abstinence over the interim period. In contrast, participants who used alcohol, regardless of the amount, demonstrated no change. Unfortunately, the sample size was insufficient to address potential sex differences. Another study compared imaging analyses of treatment-seeking individuals with AUD and healthy controls on day 1 and day 14 of treatment.[51] The treatment group showed significant, but incomplete, recovery in gray matter volume even across the limited time frame, with the cingulate gyrus, temporal gyrus, parietal lobule, cerebellum, and precuneus exhibiting greater improvement than other areas examined. A preliminary examination of sex differences revealed no sex by group interactions, suggesting the absence of sex differences in the trajectory of this measure of brain recovery.

Another longitudinal study examined structural changes over a 6-month period.[29] Rather than using a binary classification of outcomes (i.e., sustained abstinence vs. return to alcohol use), the investigators quantified alcohol use across the study period. The analyses indicated an inverse relationship between consumption across the 6 months and volume increases in diverse brain regions, including the cerebellar vermis, fusiform gyrus, striatum, and cingulate gyrus. The pattern of this association suggested that measurable brain volume improvement may be observed with low to moderate alcohol use after treatment, at least over this 6-month period. However, the small sample size dictates caution in broad generalization.

Employing longitudinal assessments of their sample, Meyerhoff, Durazzo, and colleagues conducted a series of analyses based on longitudinal assessment of individuals with AUD to address recovery trajectories. Imaging sessions at 1 week, 1 month, and 7.5 months of sustained abstinence found substantive volume increases in the frontal, parietal, and occipital lobes as well as increases in the thalamus and cerebellum and a reduction in ventricular volumes.[52] The recovery trajectories differed between gray and white matter. Regional lobar white matter showed a linear increase across the assessment period. In contrast, regional gray matter showed a nonlinear pattern, with most of the change occurring in the interval between 1 week and 1 month. Even with these increases, the AUD group had lower gray matter volumes than control subjects at the final assessment, with the exception of the frontal lobe. The analyses also identified an interaction of age and smoking, such that with increasing age, the recovery of total cortical and frontal gray matter in individuals who smoked was reduced compared with those who did not smoke. This pattern was consistent with the observed behavioral recovery. The sample was composed primarily of men (88% to 93%, depending on group), precluding study of sex differences.

The researchers also used these data to examine differences between the AUD group and the control group, as well as over time, in brain regions representing core components of the executive control, salience, and emotion networks. These included the dorsal lateral prefrontal cortex (DLPFC), the anterior cingulate cortex (ACC), the orbitofrontal cortex (OFC), insula, amygdala, and hippocampus. The analyses determined that amygdala volumes were not compromised at any point in people with AUD. Also, at the final assessment, the volumes of the ACC, DLPFC, OFC, and insula were equivalent in the AUD and control groups, whereas hippocampal volume remained lower in the AUD group.[53]

A third analysis by this research group explored associations between initial compromise, improvement across time, and treatment outcomes. Comparisons of people with AUD who sustained abstinence versus those who relapsed over the 12 months after treatment showed differences between controls and the two groups even at the initial assessment. People with AUD who eventually relapsed had smaller volumes in three times the number of regions (15/20) as did those who sustained abstinence (5/20). Moreover, among the relapse

group, greater gray matter increases during the early weeks of sobriety were associated with longer delays to relapse.[28]

Mueller and Meyerhoff[27] also assessed loss in gray matter and gray matter connectivity within the extended brain reward system—that is, OFC, DLPFC, ACC, insula, striatum, thalami, hippocampi, and amygdala—and its connections with other networks. In longitudinal comparisons at about 1 month abstinent and 3 months later, they found significant resolution in individuals who had sustained abstinence while measures for those who had relapsed remained essentially unchanged (see Figure 3).

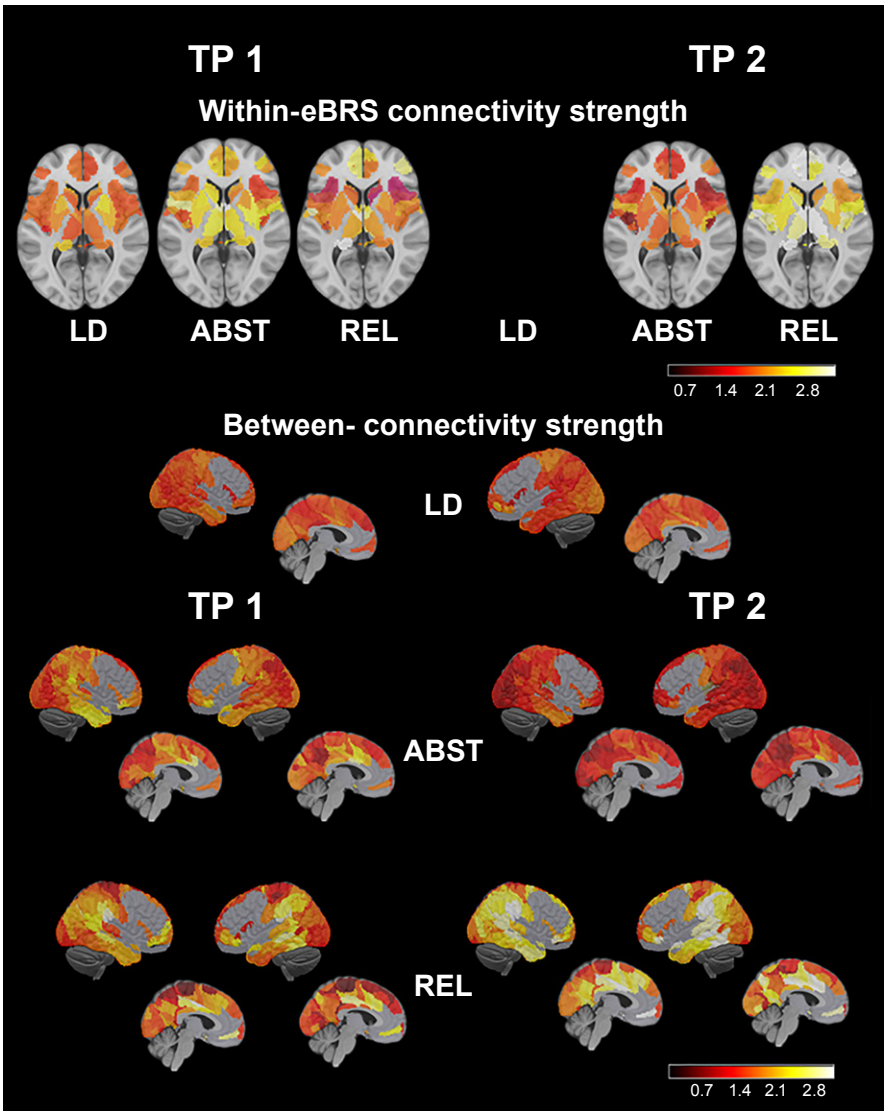

Figure 3 Within-network and between-networks gray matter connectivity. (Top) Images on the left show within-extended brain reward system (eBRS) connectivity strength maps for controls (LD) and individuals who are initiating recovery and will either remain abstinent (ABST) or relapse (REL) across the assessment period at their original assessment (TP1=1 month abstinent). Images on the right reflect the degree of connectivity for the ABST and REL groups at TP2 (~ 3 months later). (Bottom) Images show between-networks connectivity strength maps for the LD group at TP1 as well as for the ABST and REL groups at TP1 (left) and TP2 (right). *Note:* Brighter colors and higher numbers on the color bars indicate regions of interest with relatively greater connectivity losses compared to the LD controls (i.e., less connectivity). *Source:* Mueller and Meyerhoff, 2019.[27] Copyright Society for the Study of Addiction. Reprinted with permission.

Additionally, the research group examined potential genetic modulators of volumetric recovery.[54] In a study of the Val66Met (rs6265) polymorphism in the brain-derived neurotrophic factor gene (BDNF), they found that between weeks 1 and 5 of abstinence, people homozygous for VAL exhibited increases primarily in gray matter volumes, while heterozygous people (VAL/MET genotype) showed volume increases predominately in white matter. However, the total volume was equivalent for both genotypes at each time point (Note that the sample included no individuals homozygous for MET). Neurocognitive improvement was associated with gray matter increases, but not white matter increases. The same polymorphism also was investigated as a modulator of hippocampal change and neurocognitive function across the first 8 months of abstinence in people with AUD who were homozygous for VAL or carried the MET allele (MET hetero- or homozygous).[55] Compared with control subjects without AUD, hippocampal volume was lower in the AUD groups at the initial assessment and remained so across all assessments. However, individuals homozygous for VAL were more likely to show hippocampal volume increases across the test interval. Contrary to other reports from this research group,[44] smoking did not affect initial or recovery measures.

Neurochemical Change in Recovery

Reduction in neurochemical dysregulation has been examined in a relatively small body of work. Zahr and colleagues[56] examined levels of NAA, Cho, CR, and glutamate in recently abstinent individuals with AUD (mean days abstinent = 19.6 ± 12.6) and control participants. NAA and Cho levels were inversely affected by pretreatment drinking variables. Of particular interest were findings showing that reduced levels of NAA in the thalamus were found mainly in individuals who would relapse in the 3 months following treatment.

Prisciandaro and colleagues[57] examined changes in GABA, glutamate, and glutamine by conducting three magnetic resonance spectroscopy sessions across a 1-week monitored abstinence period (i.e., on days 1, 3, and 7) in non–treatment-seeking individuals meeting criteria for an AUD. The participants reported an average of 7.2 drinks/drinking day with an average of 7.8 heavy drinking days (i.e., ≥ 5/4 drinks in a day for men/women, respectively) across the previous 2 weeks. Outcomes showed a significant increase (i.e., normalization) of GABA between scans 1 and 2, without subsequent additional change. In contrast to another report from this research group,[25] changes in glutamate and glutamine were not robust. Age, which ranged from 21 to 40, did not impact outcomes. There were insufficient numbers of women to permit analysis by sex. The investigators concluded that the difference in outcomes across their studies may be related to sample differences in severity of AUD.

Summary

The studies reviewed here offer significant insight regarding brain changes in AUD. Unfortunately, women constituted only a small percentage of the study samples, and thus sex differences cannot be adequately explored. Furthermore, much of the published research cited above derives from the efforts of a single research group, and the samples in the separate reports overlap substantially. Given the realities of human neuroimaging studies (i.e., subject costs, selection criteria, resource availability), sample overlap across investigations to ensure study efficiency is not unexpected. While this pattern does not detract from the potential import of the work, it demonstrates the need to replicate the work and expand the samples to allow for evaluation of sex effects.

INTERVENTION STRATEGIES

An important next question is to what degree the neurobiological and neurobehavioral deficits associated with AUD can be impacted by active interventions. The following sections briefly introduce behavioral and pharmacologic strategies that may facilitate neurobiobehavioral recovery and improve long-term outcomes.[2] Other approaches, including neuromodulation, are gaining

momentum as possible interventions for substance use disorders[58] but will not be discussed.

Cognitive Training/Rehabilitation

Examination of cognitive training in AUD has a long history, but few systematic studies were conducted until relatively recently.[2,30] Performance improvement across training tasks is referred to as "gains," while the impact of training on additional (untrained) tasks constitutes "transfer of training." Adaptive training protocols, which adjust to the skill level of the participant, are more efficacious in facilitating training gains and transfer of training, particularly to novel tasks reliant on the trained process (i.e., proximal transfer), than are nonadjusting training protocols.[59] A key issue is the degree to which training transfers to performance on untrained processes (i.e., distal transfer).

Several examinations applying multi-domain training paradigms reported training-dependent improvements across broad measures. Rupp and colleagues[60] demonstrated improvements in attention and memory performance among treatment-seeking individuals with AUD. Improvements were observed in several cognitive measures, with multivariate analyses suggesting substantial transfer across tasks. Gamito and colleagues[61] administered a web-based training to individuals with AUD during inpatient treatment. Results suggested training-associated improvements in composite scores on a battery of executive function tasks. Fals-Stewart and Lam[62] examined training effects in a 6-month intervention program. Using a training battery engaging diverse neuropsychological domains, they observed transfer to an untrained neuropsychological battery.

In contrast to multi-domain training, contemporary studies often focus on single-domain approaches. Jones and colleagues[63] investigated training with an inhibitory control task. Despite use of a stop-signal paradigm as both a training and outcome measure, they did not note training-associated improvements. Beyond that study, inhibitory control training remains relatively rare among AUD-focused training examinations, despite its relevance to abstinence maintenance. Other single-domain training approaches have assessed memory improvement. Bell and colleagues[64] used a training protocol directed at increasing memory capacity among veterans with AUD. They detected training-associated transfer for untrained verbal memory and learning measures. Most of the recent alcohol-related training investigations have used working memory training. Gunn and colleagues[65] observed proximal transfer on three of six nontrained working memory tasks, two of which continued to display improvement at a 1-month follow-up assessment. Khemiri and colleagues[66] determined transfer in one verbal working memory task, but no improvement across several additional measures, including alternate working memory tasks. Similarly, Hendershot and colleagues[67] identified training-associated improvement in a digit span task, but not in three other working memory transfer measures. Snider and colleagues[68] observed proximal transfer using a "functional" working memory task wherein participants followed a set of sequential object manipulation instructions. In addition to enhanced performance on a functional assessment, this study also noted gains in delay discounting. Although similar assessments of distal transfer remain rare, a recent pilot study suggested that incorporation of emotionally valent stimuli in working memory training may facilitate transfer to social cognition outcomes.[69]

Together, these investigations support assertions that cognitive training may be a useful tool to accelerate cognitive recovery in people with AUD. Proximal transfer has been observed across numerous training studies, while distal transfer has been less commonly examined and, when studied, inconsistently observed. If these interventions are to be effectively utilized, individual and methodological variables contributing to outcome heterogeneity must be systematically interrogated and defined.

Cognitive Enhancing Medication

Despite substantive efforts directed at drug development for AUD,[70] improvement in alcohol-associated cognitive deficits has received little consideration as a primary measure of efficacy. Among the FDA-approved medications for AUD, older studies found little impact of naltrexone, subtle decrements resulting from disulfiram, and some putative benefits associated with acamprosate.[71] A comprehensive review of current AUD-focused drug development efforts is beyond the scope of this article. However, given their demonstrated potential to benefit brain function as evidenced by neurocognitive performance, potential glutamatergic and cholinergic AUD pharmacotherapeutics bear mention.

Glutamatergic medications

NMDA glutamate receptors (NMDARs) are integral to learning/memory function, alcohol cue salience, incentive motivation for alcohol use, and mediation of withdrawal-associated neurotoxicity.[72] Memantine is an FDA-approved, noncompetitive NMDAR channel blocker that may improve AUD-associated outcomes.[73] In preclinical studies, memantine conferred neuroprotection from withdrawal-associated damage[74] and ameliorated withdrawal-associated cognitive deficits.[75] In clinical studies, memantine improved behavioral symptoms and cognitive deficits in alcohol-related dementia.[76] However, a recent double-blind, placebo-controlled pilot study of treatment-seeking individuals with AUD demonstrated no cognitive benefit.[77]

Cholinergic medications

Neuronal nicotinic acetylcholine receptors (nAChRs) are activated by alcohol, facilitating mesolimbic dopamine release.[78] Animal models indicate a substantive role of nAChRs in mediating both alcohol consumption and relapse behaviors. Taken together with the high prevalence of nicotine use in people with AUD, extant data suggest that nAChR agonists may be useful as putative pharmacotherapies for AUD.[79] Varenicline is an nAChR agonist with FDA approval for supporting smoking cessation. Varenicline also reduces alcohol consumption among individuals with AUD.[80] Roberts and McKee[81] recently examined varenicline-associated cognitive alterations in people with AUD. One week of varenicline administration appeared sufficient to induce dose-dependent improvements in working memory performance and reaction time relative to placebo. At the highest varenicline dose, improvement in working memory performance was associated with larger reductions in alcohol consumption. Galantamine, an nAChR agonist and acetylcholinesterase inhibitor,[82] appears to reduce relapse severity.[83] Galantamine appears to improve sustained attention and working memory functions among abstinent individuals with psychostimulant use disorders;[84] however, its cognitive effects in people with AUD have not been investigated.

Summary

It is possible that alcohol-related cognitive deficits can be mitigated by behavioral, pharmacologic, or combination therapies. The current body of research is insufficient to draw strong conclusions. Yet, evolving data indicate the promise of systematic research regarding a range of treatment alternatives, both separately and in combination. A critical part of this research must address the fact that extant data cannot fully answer the related question whether these interventions, if successful in improving cognition, impact long-term alcohol use patterns. Thus, the path forward requires a highly programmatic approach.

CONCLUSIONS, LIMITATIONS, AND FUTURE DIRECTIONS

A large body of research has examined the persistence of alcohol-related neurobiological and behavioral compromise after detoxification. Encouraging data, acquired across decades of research, have revealed a reduction in impairment following the initiation of abstinence. Significant neurobehavioral improvement has been observed in the early weeks of abstinence, with some continuing recovery in later months. For some

measures, deficits are mitigated, but measurable compromise persists compared with healthy controls. Similar conclusions can be drawn regarding improvement in neurophysiological measures, brain volume, neurochemistry, white matter integrity, and brain network integration/activation. One of the most striking outcomes is the substantial research suggesting that improvement is contingent on sustained abstinence. Increased age frequently is associated with less effective recovery. Limited data are available regarding sex differences, with inconsistent results, and still fewer studies have considered the interaction of age and sex. Finally, it is important to keep in mind that adaptive behavior change may occur even in the absence of substantial structural or neurophysiological "recovery" compared with initial brain or behavior compromise. These adaptations may be mediated by the engagement of compensatory mechanisms/processes, such as sacrificing response speed to enhance accuracy or engaging alternate or additional brain areas. This issue remains largely understudied in the context of AUD recovery.[4]

One strength of current research is the ability to probe the interrelationships of structure and function. As shown in previous sections, developing science extends and clarifies earlier conclusions and affords the opportunity to disentangle neurobiobehavioral processes that may differentially contribute to improvement. These advances promote both scientific and clinical progress. For example, Galandra and colleagues[23] demonstrated that alcohol-related deficits in aspects of executive functions may be mediated by dysregulation in the salience network. Based on current understanding of the functions and underlying structure of the salience network, this finding is consistent with cognitive frameworks that emphasize failures in active ignoring as a core component of alcohol-related executive function deficits. Together, the neurobiological and behavioral data provide a rationale for the testable hypothesis that improving the ability to ignore irrelevant stimuli (i.e., enhancing active ignoring skills) may be a useful target for behavioral interventions. Similarly, existing research suggests that programmatic integration of cognitive training interventions and cognitive enhancing medications, as well as evolving technologies such as neuromodulation, may accelerate cognitive recovery and ultimately long-term outcomes.

Despite the promise of existing data, there are notable limitations. First, although there are notable exceptions, post-treatment outcomes are often ascertained across a few weeks or months. Thus, long-term trajectories remain understudied. Second, the complexity of conducting systematic longitudinal studies is daunting. Thus, investigators must take full advantage of available data, resources, and volunteers. The result is that a limited sample may contribute to numerous, interdependent studies. Consequently, the findings from a body of work where the supporting studies are populated by overlapping samples may not be generalizable. Third, as noted in the introduction, individual differences are understudied. To the extent possible, this review has discussed the influence of age and sex. However, other less immediately obvious individual variables, such as nutritional status, also are pertinent,[85] but were beyond the scope of this review. Finally, as summarized above, sustained abstinence was required to show improvement across many of these studies. Moreover, participants in the large majority of these studies were individuals seeking treatment, often in inpatient or intensive outpatient facilities and typically meeting criteria for more severe AUD. Thus, the findings described here do not address outcomes among individuals who meet criteria for AUD but who engage in non–abstinence-based treatment or initiate recovery without employing formal treatment programs. A person's selected pathway to recovery is, no doubt, influenced by significant environmental and individual variables that may, themselves, be associated with differential baseline compromise and recovery trajectories. Therefore, all efforts to advance science and practice must take into consideration alternative definitions of "recovery."[86]

Acknowledgments
Research reported in this publication was supported by the National Institute on Alcohol Abuse and Alcoholism of the National Institutes of Health under grant number R01AA025430. Further support was provided by grants K01AA026893 and U01DA041106.

Financial Disclosures
The authors have no competing financial interests to disclose.

Publisher's Note
Opinions expressed in contributed articles do not necessarily reflect the views of the National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health. The U.S. government does not endorse or favor any specific commercial product or commodity. Any trade or proprietary names appearing in *Alcohol Research: Current Reviews* are used only because they are considered essential in the context of the studies reported herein.

References
1. American Psychiatric Association (APA). *Diagnostic and Statistical Manual of Mental Disorders*. 5th ed. Washington, DC: APA; 2013.
2. Nixon SJ, Lewis B. Cognitive training as a component of treatment of alcohol use disorder: A review. *Neuropsychology*. 2019;33(6):822-841. https://doi.org/10.1037/neu0000575.
3. Le Berre AP. Emotional processing and social cognition in alcohol use disorder. *Neuropsychology*. 2019;33(6):808-821. https://doi.org/10.1037/neu0000572.
4. Sullivan EV, Pfefferbaum A. Brain-behavior relations and effects of aging and common comorbidities in alcohol use disorder: A review. *Neuropsychology*. 2019;33(6):760-780. https://doi.org/10.1037/neu0000557.
5. Le Berre AP, Fama R, Sullivan EV. Executive functions, memory, and social cognitive deficits and recovery in chronic alcoholism: A critical review to inform future research. *Alcohol Clin Exp Res*. 2017;41(8):1432-1443. https://doi.org/10.1111/acer.13431.
6. Oscar-Berman M, Valmas MM, Sawyer KS, et al. Profiles of impaired, spared, and recovered neuropsychologic processes in alcoholism. *Handb Clin Neurol*. 2014;125:183-210. https://doi.org/10.1016/b978-0-444-62619-6.00012-4.
7. Hoffman LA, Lewis B, Nixon SJ. Neurophysiological and interpersonal correlates of emotional face processing in alcohol use disorder. *Alcohol Clin Exp Res*. 2019;43(9):1928-1936. https://doi.org/10.1111/acer.14152.
8. Lewis B, Price JL, Garcia CC, et al. Emotional face processing among treatment-seeking individuals with alcohol use disorders: Investigating sex differences and relationships with interpersonal functioning. *Alcohol Alcohol*. 2019;54(4):361-369. https://doi.org/10.1093/alcalc/agz010.
9. Porjesz B, Begleiter H. Neurophysiological factors associated with alcoholism. In: Hunt WA, Nixon SJ, eds. *Alcohol-Induced Brain Damage*. Rockville, MD: National Institutes of Health; 1993:89-120.
10. Kamarajan C, Porjesz B. Advances in electrophysiological research. *Alcohol Res*. 2015;37(1):53-87.
11. Gehring WJ, Goss B, Coles MG, et al. A neural system for error detection and compensation. *Psychol Sci*. 1993;4(6):385-390. https://doi.org/10.1111/j.1467-9280.1993.tb00586.x
12. Gorka SM, Lieberman L, Kreutzer KA, et al. Error-related neural activity and alcohol use disorder: Differences from risk to remission. *Prog Neuropsychopharmacol Biol Psychiatry*. 2019;92:271-278. https://doi.org/10.1016/j.pnpbp.2019.01.011.
13. Zhao Q, Pfefferbaum A, Podhajsky S, et al. Accelerated aging and motor control deficits are related to regional deformation of central cerebellar white matter in alcohol use disorder. *Addict Biol*. 2020;25(3):e12746. https://doi.org/10.1111/adb.12746.
14. Zahr NM, Pfefferbaum A. Alcohol's effects on the brain: Neuroimaging results in humans and animal models. *Alcohol Res*. 2017;38(2):183-206.
15. Nixon SJ, Prather R, Lewis B. Sex differences in alcohol-related neurobehavioral consequences. *Handb Clin Neurol*. 2014;125:253-272. https://doi.org/10.1016/b978-0-444-62619-6.00016-1.
16. Sullivan EV, Zahr NM, Sassoon SA, et al. The role of aging, drug dependence, and hepatitis C comorbidity in alcoholism cortical compromise. *JAMA Psychiatry*. 2018;75(5):474-483. https://doi.org/10.1001/jamapsychiatry.2018.0021.
17. Crespi C, Galandra C, Canessa N, et al. Microstructural damage of white-matter tracts connecting large-scale networks is related to impaired executive profile in alcohol use disorder. *Neuroimage Clin*. 2020;25:102141. https://doi.org/10.1016/j.nicl.2019.102141.
18. Pandey AK, Ardekani BA, Kamarajan C, et al. Lower prefrontal and hippocampal volume and diffusion tensor imaging differences reflect structural and functional abnormalities in abstinent individuals with alcohol use disorder. *Alcohol Clin Exp Res*. 2018;42(10):1883-1896. https://doi.org/10.1111/acer.13854.
19. Sorg SF, Squeglia LM, Taylor MJ, et al. Effects of aging on frontal white matter microstructure in alcohol use disorder and associations with processing speed. *J Stud Alcohol Drugs*. 2015;76(2):296-306. https://doi.org/10.15288/jsad.2015.76.296.
20. Koob GF, Volkow ND. Neurobiology of addiction: A neurocircuitry analysis. *Lancet Psychiatry*. 2016;3(8):760-773. https://doi.org/10.1016/s2215-0366(16)00104-8.
21. Zhang R, Volkow ND. Brain default-mode network dysfunction in addiction. *Neuroimage*. 2019;200:313-331. https://doi.org/10.1016/j.neuroimage.2019.06.036.
22. Cofresí RU, Bartholow BD, Piasecki TM. Evidence for incentive salience sensitization as a pathway to alcohol use disorder. *Neurosci Biobehav Rev*. 2019;107:897-926. https://doi.org/10.1016/j.neubiorev.2019.10.009.
23. Galandra C, Basso G, Manera M, et al. Salience network structural integrity predicts executive impairment in alcohol use disorders. *Sci Rep*. 2018;8(1):14481. https://doi.org/10.1038/s41598-018-32828-x.
24. de Souza RSM, Rosa M Jr, Rodrigues TM, et al. Lower choline rate in the left prefrontal cortex is associated with higher amount of alcohol use in alcohol use disorder. *Front Psychiatry*. 2018;9:563. https://doi.org/10.3389/fpsyt.2018.00563.
25. Prisciandaro JJ, Schacht JP, Prescot AP, et al. Brain glutamate, GABA, and glutamine levels and associations with recent drinking in treatment-naive individuals with alcohol use disorder versus light drinkers. *Alcohol Clin Exp Res*. 2019;43(2):221-226. https://doi.org/10.1111/acer.13931.
26. Meyerhoff DJ. Brain proton magnetic resonance spectroscopy of alcohol use disorders. *Handb Clin Neurol*. 2014;125:313-337. https://doi.org/10.1016/b978-0-444-62619-6.00019-7.
27. Mueller SG, Meyerhoff DJ. The gray matter structural connectome and its relationship to alcohol relapse: Reconnecting for recovery. *Addict Biol*. 2019:e12860. https://doi.org/10.1111/adb.12860.

28. Durazzo TC, Meyerhoff DJ. Changes of frontal cortical subregion volumes in alcohol dependent individuals during early abstinence: Associations with treatment outcome. *Brain Imaging Behav*. 2019. https://doi.org/10.1007/s11682-019-00089-5.
29. Segobin SH, Chételat G, Le Berre AP, et al. Relationship between brain volumetric changes and interim drinking at six months in alcohol-dependent patients. *Alcohol Clin Exp Res*. 2014;38(3):739-748. https://doi.org/10.1111/acer.12300.
30. Bates ME, Buckman JF, Nguyen TT. A role for cognitive rehabilitation in increasing the effectiveness of treatment for alcohol use disorders. *Neuropsychol Rev*. 2013;23(1):27-47. https://doi.org/10.1007/s11065-013-9228-3.
31. Stavro K, Pelletier J, Potvin S. Widespread and sustained cognitive deficits in alcoholism: A meta-analysis. *Addict Biol*. 2013;18(2):203-213. https://doi.org/10.1111/j.1369-1600.2011.00418.x.
32. Petit G, Luminet O, Cordovil de Sousa Uva M, et al. Differential spontaneous recovery across cognitive abilities during detoxification period in alcohol-dependence. *PLoS One*. 2017;12(8):e0176638. https://doi.org/10.1371/journal.pone.0176638.
33. Cordovil De Sousa Uva M, Luminet O, Cortesi M, et al. Distinct effects of protracted withdrawal on affect, craving, selective attention and executive functions among alcohol-dependent patients. *Alcohol Alcohol*. 2010;45(3):241-246. https://doi.org/10.1093/alcalc/agq012.
34. Durazzo TC, Pennington DL, Schmidt TP, et al. Effects of cigarette smoking history on neurocognitive recovery over 8 months of abstinence in alcohol-dependent individuals. *Alcohol Clin Exp Res*. 2014;38(11):2816-2825. https://doi.org/10.1111/acer.12552.
35. Camchong J, Stenger A, Fein G. Resting-state synchrony in long-term abstinent alcoholics. *Alcohol Clin Exp Res*. 2013;37(1):75-85. https://doi.org/10.1111/j.1530-0277.2012.01859.x.
36. Camchong J, Stenger VA, Fein G. Resting-state synchrony in short-term versus long-term abstinent alcoholics. *Alcohol Clin Exp Res*. 2013;37(5):794-803. https://doi.org/10.1111/acer.12037.
37. Fein G, Greenstein D. Gait and balance deficits in chronic alcoholics: No improvement from 10 weeks through 1 year abstinence. *Alcohol Clin Exp Res*. 2013;37(1):86-95. https://doi.org/10.1111/j.1530-0277.2012.01851.x.
38. Vassar RL, Rose J. Motor systems and postural instability. *Handb Clin Neurol*. 2014;125:237-251. https://doi.org/10.1016/b978-0-444-62619-6.00015-x.
39. Sullivan EV, Zahr NM, Saranathan M, et al. Convergence of three parcellation approaches demonstrating cerebellar lobule volume deficits in alcohol use disorder. *Neuroimage Clin*. 2019;24:101974. https://doi.org/10.1016/j.nicl.2019.101974.
40. Zahr NM, Pfefferbaum A, Sullivan EV. Perspectives on fronto-fugal circuitry from human imaging of alcohol use disorders. *Neuropharmacology*. 2017;122:189-200. https://doi.org/10.1016/j.neuropharm.2017.01.018.
41. Erol A, Akyalcin Kirdok A, Zorlu N, et al. Empathy, and its relationship with cognitive and emotional functions in alcohol dependency. *Nord J Psychiatry*. 2017;71(3):205-209. https://doi.org/10.1080/08039488.2016.1263683.
42. Bates ME, Buckman JF, Voelbel GT, et al. The mean and the individual: Integrating variable-centered and person-centered analyses of cognitive recovery in patients with substance use disorders. *Front Psychiatry*. 2013;4:177. https://doi.org/10.3389/fpsyt.2013.00177.
43. Durazzo TC, Pennington DL, Schmidt TP, et al. Neurocognition in 1-month-abstinent treatment-seeking alcohol-dependent individuals: Interactive effects of age and chronic cigarette smoking. *Alcohol Clin Exp Res*. 2013;37(10):1794-1803. https://doi.org/10.1111/acer.12140.
44. Durazzo TC, Meyerhoff DJ. Cigarette smoking history is associated with poorer recovery in multiple neurocognitive domains following treatment for an alcohol use disorder. *Alcohol*. 2020;85:135-143. https://doi.org/10.1016/j.alcohol.2019.12.003.
45. Pandey G, Seay MJ, Meyers JL, et al. Density and dichotomous family history measures of alcohol use disorder as predictors of behavioral and neural phenotypes: A comparative study across gender and race/ethnicity. *Alcohol Clin Exp Res*. 2020;44(3):697-710. https://doi.org/10.1111/acer.14280.
46. Harper J, Malone SM, Iacono WG. Conflict-related medial frontal theta as an endophenotype for alcohol use disorder. *Biol Psychol*. 2018;139:25-38. https://doi.org/10.1016/j.biopsycho.2018.10.002.
47. Fein G, Key K, Szymanski MD. ERP and RT delays in long-term abstinent alcoholics in processing of emotional facial expressions during gender and emotion categorization tasks. *Alcohol Clin Exp Res*. 2010;34(7):1127-1139. https://doi.org/10.1111/j.1530-0277.2010.01189.x.
48. Padilla ML, Colrain IM, Sullivan EV, et al. Electrophysiological evidence of enhanced performance monitoring in recently abstinent alcoholic men. *Psychopharmacology (Berl)*. 2011;213(1):81-91. https://doi.org/10.1007/s00213-010-2018-1.
49. Fein G, Chang M. Smaller feedback ERN amplitudes during the BART are associated with a greater family history density of alcohol problems in treatment-naïve alcoholics. *Drug Alcohol Depend*. 2008;92(1-3):141-148. https://doi.org/10.1016/j.drugalcdep.2007.07.017.
50. Demirakca T, Ende G, Kämmerer N, et al. Effects of alcoholism and continued abstinence on brain volumes in both genders. *Alcohol Clin Exp Res*. 2011;35(9):1678-1685. https://doi.org/10.1111/j.1530-0277.2011.01514.x.
51. van Eijk J, Demirakca T, Frischknecht U, et al. Rapid partial regeneration of brain volume during the first 14 days of abstinence from alcohol. *Alcohol Clin Exp Res*. 2013;37(1):67-74. https://doi.org/10.1111/j.1530-0277.2012.01853.x.
52. Durazzo TC, Mon A, Gazdzinski S, et al. Serial longitudinal magnetic resonance imaging data indicate non-linear regional gray matter volume recovery in abstinent alcohol-dependent individuals. *Addict Biol*. 2015;20(5):956-967. https://doi.org/10.1111/adb.12180.
53. Zou X, Durazzo TC, Meyerhoff DJ. Regional brain volume changes in alcohol-dependent individuals during short-term and long-term abstinence. *Alcohol Clin Exp Res*. 2018;42(6):1062-1072. https://doi.org/10.1111/acer.13757.
54. Mon A, Durazzo TC, Gazdzinski S, et al. Brain-derived neurotrophic factor genotype is associated with brain gray and white matter tissue volumes recovery in abstinent alcohol-dependent individuals. *Genes Brain Behav*. 2013;12(1):98-107. https://doi.org/10.1111/j.1601-183x.2012.00854.x.
55. Hoefer ME, Pennington DL, Durazzo TC, et al. Genetic and behavioral determinants of hippocampal volume recovery during abstinence from alcohol. *Alcohol*. 2014;48(7):631-638. https://doi.org/10.1016/j.alcohol.2014.08.007.
56. Zahr NM, Carr RA, Rohlfing T, et al. Brain metabolite levels in recently sober individuals with alcohol use disorder: Relation to drinking variables and relapse. *Psychiatry Res Neuroimaging*. 2016;250:42-49. https://doi.org/10.1016/j.pscychresns.2016.01.015.
57. Prisciandaro JJ, Schacht JP, Prescot AP, et al. Intraindividual changes in brain GABA, glutamate, and glutamine during monitored abstinence from alcohol in treatment-naive individuals with alcohol use disorder. *Addict Biol*. 2019:e12810. https://doi.org/10.1111/adb.12810.

58. Sahlem GL, Caruso MA, Short EB, et al. A case series exploring the effect of twenty sessions of repetitive transcranial magnetic stimulation (rTMS) on cannabis use and craving. *Brain Stimul*. 2020;13(1):265-266. https://doi.org/10.1016/j.brs.2019.09.014.
59. Constantinidis C, Klingberg T. The neuroscience of working memory capacity and training. *Nat Rev Neurosci*. 2016;17(7):438-449. https://doi.org/10.1038/nrn.2016.43.
60. Rupp CI, Kemmler G, Kurz M, et al. Cognitive remediation therapy during treatment for alcohol dependence. *J Stud Alcohol Drugs*. 2012;73(4):625-634. https://doi.org/10.15288/jsad.2012.73.625.
61. Gamito P, Oliveira J, Lopes P, et al. Executive functioning in alcoholics following an mHealth cognitive stimulation program: Randomized controlled trial. *J Med Internet Res*. 2014;16(4):e102. https://doi.org/10.2196/jmir.2923.
62. Fals-Stewart W, Lam WK. Computer-assisted cognitive rehabilitation for the treatment of patients with substance use disorders: A randomized clinical trial. *Exp Clin Psychopharmacol*. 2010;18(1):87-98. https://doi.org/10.1037/a0018058.
63. Jones A, McGrath E, Robinson E, et al. A randomized controlled trial of inhibitory control training for the reduction of alcohol consumption in problem drinkers. *J Consult Clin Psychol*. 2018;86(12):991-1004. https://doi.org/10.1037/ccp0000312.
64. Bell MD, Vissicchio NA, Weinstein AJ. Cognitive training and work therapy for the treatment of verbal learning and memory deficits in veterans with alcohol use disorders. *J Dual Diagn*. 2016;12(1):83-89. https://doi.org/10.1080/15504263.2016.1145779.
65. Gunn RL, Gerst KR, Wiemers EA, et al. Predictors of effective working memory training in individuals with alcohol use disorders. *Alcohol Clin Exp Res*. 2018;42(12):2432-2441. https://doi.org/10.1111/acer.13892.
66. Khemiri L, Brynte C, Stunkel A, et al. Working memory training in alcohol use disorder: A randomized controlled trial. *Alcohol Clin Exp Res*. 2019;43(1):135-146. https://doi.org/10.1111/acer.13910.
67. Hendershot CS, Wardell JD, Vandervoort J, et al. Randomized trial of working memory training as an adjunct to inpatient substance use disorder treatment. *Psychol Addict Behav*. 2018;32(8):861-872. https://doi.org/10.1037/adb0000415.
68. Snider SE, Deshpande HU, Lisinski JM, et al. Working memory training improves alcohol users' episodic future thinking: A rate-dependent analysis. *Biol Psychiatry Cogn Neurosci Neuroimaging*. 2018;3(2):160-167. https://doi.org/10.1016/j.bpsc.2017.11.002.
69. Nixon SJ, Lewis B. A pilot study examining working memory cognitive training during treatment: Feasibility and preliminary outcomes contrasting emotional and neutral multimodal stimuli. Presented at: American College of Neuropsychopharmacology; December 8-11, 2019; Orlando, FL.
70. Kranzler HR, Soyka M. Diagnosis and pharmacotherapy of alcohol use disorder: A review. *JAMA*. 2018;320(8):815-824. https://doi.org/10.1001/jama.2018.11406.
71. Koob GF, Mason BJ, De Witte P, et al. Potential neuroprotective effects of acamprosate. *Alcohol Clin Exp Res*. 2002;26(4):586-592. https://doi.org/10.1111/j.1530-0277.2002.tb02578.x.
72. Krystal JH, D'Souza DC, Mathalon D, et al. NMDA receptor antagonist effects, cortical glutamatergic function, and schizophrenia: Toward a paradigm shift in medication development. *Psychopharmacology (Berl)*. 2003;169(3-4):215-233. https://doi.org/10.1007/s00213-003-1582-z.
73. Krupitsky EM, Neznanova O, Masalov D, et al. Effect of memantine on cue-induced alcohol craving in recovering alcohol-dependent patients. *Am J Psychiatry*. 2007;164(3):519-523. https://doi.org/10.1176/ajp.2007.164.3.519.
74. Stepanyan TD, Farook JM, Kowalski A, et al. Alcohol withdrawal-induced hippocampal neurotoxicity in vitro and seizures in vivo are both reduced by memantine. *Alcohol Clin Exp Res*. 2008;32(12):2128-2135. https://doi.org/10.1111/j.1530-0277.2008.00801.x.
75. Idrus NM, McGough NN, Riley EP, et al. Administration of memantine during withdrawal mitigates overactivity and spatial learning impairments associated with neonatal alcohol exposure in rats. *Alcohol Clin Exp Res*. 2014;38(2):529-537. https://doi.org/10.1111/acer.12259.
76. Cheon Y, Park J, Joe KH, et al. The effect of 12-week open-label memantine treatment on cognitive function improvement in patients with alcohol-related dementia. *Int J Neuropsychopharmacol*. 2008;11(7):971-983. https://doi.org/10.1017/s1461145708008663.
77. Lewis B, Merlo L, Greene W, et al. Randomized trial to assess safety/feasibility of memantine administration during residential treatment for alcohol use disorder: A pilot study. *J Addict Dis*. 2020;38(2):91-99. https://doi.org/10.1080/10550887.2020.1721404.
78. Blomqvist O, Engel JA, Nissbrandt H, et al. The mesolimbic dopamine-activating properties of ethanol are antagonized by mecamylamine. *Eur J Pharmacol*. 1993;249(2):207-213. https://doi.org/10.1016/0014-2999(93)90434-j.
79. Chatterjee S, Bartlett SE. Neuronal nicotinic acetylcholine receptors as pharmacotherapeutic targets for the treatment of alcohol use disorders. *CNS Neurol Disord Drug Targets*. 2010;9(1):60-76. https://doi.org/10.2174/187152710790966597.
80. Verplaetse TL, Pittman BP, Shi JM, et al. Effect of varenicline combined with high-dose alcohol on craving, subjective intoxication, perceptual motor response, and executive cognitive function in adults with alcohol use disorders: Preliminary findings. *Alcohol Clin Exp Res*. 2016;40(7):1567-1576. https://doi.org/10.1111/acer.13110.
81. Roberts W, McKee SA. Effects of varenicline on cognitive performance in heavy drinkers: Dose-response effects and associations with drinking outcomes. *Exp Clin Psychopharmacol*. 2018;26(1):49-57. https://doi.org/10.1037/pha0000161.
82. Schilström B, Ivanov VB, Wiker C, et al. Galantamine enhances dopaminergic neurotransmission in vivo via allosteric potentiation of nicotinic acetylcholine receptors. *Neuropsychopharmacology*. 2007;32(1):43-53. https://doi.org/10.1038/sj.npp.1301087.
83. Mann K, Ackermann K, Diehl A, et al. Galantamine: A cholinergic patch in the treatment of alcoholism: A randomized, placebo-controlled trial. *Psychopharmacology (Berl)*. 2006;184(1):115-121. https://doi.org/10.1007/s00213-005-0243-9.
84. DeVito EE, Carroll KM, Babuscio T, et al. Randomized placebo-controlled trial of galantamine in individuals with cocaine use disorder. *J Subst Abuse Treat*. 2019;107:29-37. https://doi.org/10.1016/j.jsat.2019.08.009.
85. Fama R, Le Berre AP, Hardcastle C, et al. Neurological, nutritional and alcohol consumption factors underlie cognitive and motor deficits in chronic alcoholism. *Addict Biol*. 2019;24(2):290-302. https://doi.org/10.1111/adb.12584.
86. Kelly JF, Greene MC, Bergman BG. Beyond abstinence: Changes in indices of quality of life with time in recovery in a nationally representative sample of U.S. adults. *Alcohol Clin Exp Res*. 2018;42(4):770-780. https://doi.org/10.1111/acer.13604.

ALCOHOL RESEARCH
Current Reviews

Alcohol Res. 2020;40(3):03 ● https://doi.org/10.35946/arcr.v40.3.03

Published: 19 November 2020

Sex and Gender Effects in Recovery From Alcohol Use Disorder

Cathryn Glanton Holzhauer,[1,2] Michael Cucciare,[3,4] and Elizabeth E. Epstein[1]

[1]Department of Psychiatry, University of Massachusetts Medical School, Worcester, Massachusetts
[2]Division of Research and Education, VA Central Western Massachusetts, Leeds, Massachusetts
[3]Department of Psychiatry, University of Arkansas for Medical Sciences, Little Rock, Arkansas
[4]VA South Central Mental Illness Research, Education, and Clinical Center and Center for Mental Healthcare and Outcomes Research, Central Arkansas Veterans Healthcare System, North Little Rock, Arkansas

The current article provides a brief summary of biopsychosocial gender differences in alcohol use disorder (AUD), then reviews existing literature on gender differences in treatment access, retention, outcomes, and longer-term recovery. Among psychotherapies for AUD, there is support for the efficacy of providing female-specific treatment, and for female-only treatment settings but only when female-specific treatment is included. However, despite mandates from the National Institutes of Health to do so, there is little work thus far that directly compares genders on outcomes of specific psychotherapies or pharmacotherapies for AUD. Although existing research has mixed findings on sex and gender differences in overall outcomes, there are more consistent findings suggesting different mechanisms of behavior change among men and women in AUD treatment and long-term recovery. Thus, more work is needed that attends to gender and sex differences, including planning studies that are structured to examine not only gender-differentiated outcomes in treatment response, but equally important, differences in treatment access and attendance as well as differences in mechanisms of change in drinking behavior.

KEY WORDS: sex; gender; treatment; recovery; alcohol; substance use disorder; mechanisms

INTRODUCTION

Between 1994 and 2017, the National Institutes of Health (NIH) issued mandates that biomedical researchers include female participants in clinical research,[1] analyze sex/gender differences in NIH Phase III clinical trials,[2] and submit the results from these analyses to Clinicaltrials.gov.[3] Additionally, between 1992 and 2010, the NIH Office of Research on Women's Health strategic plan identified sex difference research as a focus in basic science, as well as incorporation of sex difference findings in treatment for girls

and women.[4,5] These U.S. national policies and strategic plans have had a profound impact on treatment development for alcohol use disorder (AUD) by accelerating attention to sex and gender differences in research, resulting in increased awareness of gender-specific treatment needs. Currently, evidence-based, female-specific AUD treatments are emerging;[6] however, there is still insufficient research (or reporting of research results) on gender differences in all areas of research on AUD treatment and its implementation.

Most recent epidemiological results indicate a higher prevalence among men than women of AUD—defined by criteria of the fifth edition of the American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) —with past-year rates of 10% among women and 18% among men, and respective lifetime rates of 23% and 36%.[7] However, from 2000 to 2013, prevalence rates of 12-month DSM-IV AUD increased by 84% among women compared with 35% among men.[8] Thus, attention to gender differences in clinical research for AUD is needed, given the steep trajectory of gender convergence over the last 20 years. The current article provides a brief overview of gender differences in biological, psychological, and social aspects of AUD, followed by a review of the existing literature on gender differences in AUD treatment, factors that affect long-term recovery from AUD, and mechanisms of behavior change.

Regarding the terminology used in this article—"sex," "gender," and "recovery"— the NIH definition of sex refers to biological differences between females and males in chromosomes, sex organs, and endogenous hormones, whereas gender refers to more socially based roles and behaviors that may vary by historical and cultural contexts.[9] For this article, American Psychological Association guidelines are used: gender refers to women and men as social groups, and sex refers to the predominantly biological distinction between males and females.[10]

Regarding recovery from AUD, there is currently no consensus in definition of this term. Historically, recovery has been associated with Alcoholics Anonymous as "ongoing cognitive, emotional, behavioral, and spiritual reconstruction of the sobered alcoholic"[11,12] and more recently, "a voluntarily maintained lifestyle characterized by sobriety, personal health, and citizenship."[13] In contemporary treatment research, AUD recovery is generally operationalized by primary outcomes related to reduction in drinking, increased abstinence rates, and/or reduction of AUD symptoms. Improvements in secondary outcomes such as other drug use, daily functioning, psychiatric symptoms, physical health, and employment status also are often assessed in AUD clinical trials and are increasingly viewed as outcomes inherent to recovery. Some recent research has focused on the relative importance of abstinence versus reduction of drinking and related symptoms (primary and secondary) in the definition of, and clinical implications for, recovery.[14] In the current article, the term "treatment outcome" is generally used in lieu of recovery, with the understanding that treatment outcome refers to both primary (drinking) and secondary outcome variables.

Lastly, the research reviewed in this paper uses diagnoses from DSM-IV and DSM-5. Whereas DSM-IV described two distinct disorders— alcohol abuse and alcohol dependence—DSM-5 combines these into a single alcohol use disorder (AUD) with mild, moderate, and severe subclassifications reflecting the number of symptoms met. The main criteria change from DSM-IV is that DSM-5 eliminates alcohol-related legal problems and adds alcohol craving as a criterion for AUD. Lastly, although the search did not exclude international research, the majority of findings reviewed are from studies conducted and/ or funded in the United States.

BIOPSYCHOSOCIAL SEX AND GENDER DIFFERENCES IN ALCOHOL USE AND AUD

Biological Sex Differences

Physical effects of alcohol

Alcohol is consistently shown to have more negative effects on women's health than men's, even at weight-adjusted lower levels of alcohol exposure, partly due to gender differences in pharmacokinetics of alcohol.[15] Because women typically have less total body water and greater total body fat, alcohol is more concentrated in women's bodies than in the bodies of men, creating greater blood alcohol content at similar doses and weights.[16] Women with AUD also are more likely to develop alcohol-related heart disease, cancer, and liver disease,[17] and more overall brain atrophy secondary to chronic drinking.[18]

Physiological stress response

Stress plays an important role in the development and maintenance of AUD among both men and women.[19] Yet, alcohol-induced alterations in emotional and biophysiological markers of adaptive stress response are more common in women than men.[20] The nature and extent of some alterations are also gender-specific (e.g., blunted physiological responses to stress cues, alcohol cues, and alcohol exposure; sensitized emotional response to stress; alterations in hormonal fluctuations).[21] Furthermore, inflammatory responses to alcohol exposure, stressors, and trauma are highly sex-specific and have widespread physiological effects.[16] Such altered responses to stress differentially increase risk for and/or maintain AUD, co-occurring emotional disorders, and/or secondary effects of alcohol use (such as neural degeneration) among men and women.

Hormones

Sex hormones affect all body systems directly and indirectly, and for women there appears to be a reciprocal effect of alcohol on sex hormones.[16] Chronic alcohol use has been shown to affect testosterone levels in men,[17] whereas female sex hormones (estradiol, progesterone, and their metabolites) reciprocally interact with alcohol use.[16,22] Specifically, alcohol induces alterations in estrogen receptor physiology and function,[16] which may contribute to osteoporosis, sexual dysfunction, and infertility in women.[17] Further, sex hormones may influence patterns of women's alcohol intake.[23] Research is beginning to elucidate the mechanisms of these interactions. For instance, estrogen levels may enhance the rewarding properties of substances and increase impulsive behavior, whereas progesterone may attenuate substance-rewarding effects.[22,23] Furthermore, decreases in progesterone may increase vulnerability to stress and potentiate stress-induced drinking.[21]

Psychosocial Gender Differences

Co-occurring psychiatric conditions

Women with AUD report higher levels of co-occurring psychiatric conditions than do men with AUD. Co-occurrences of mental health conditions with AUD were examined using data from two waves (2001–2002 and 2004–2005) of the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC).[24] Women were found to have higher rates of all mood and anxiety disorders as well as paranoid, histrionic, borderline, and avoidant personality disorders compared to men, who had higher rates of narcissistic and antisocial personality disorders. After adjusting for sociodemographic factors, among persons reporting alcohol abuse (not dependence), only major depressive disorder was identified to be more likely among women than men. Recent research by Karpyak et al. found that women with AUD, compared to men with AUD, had higher rates of lifetime major depression, substance-induced depression, anxiety disorder, and post-traumatic stress disorder (PTSD) and were more likely to drink alcohol when experiencing negative emotion.[25] Further, among

U.S. military veterans with AUD, women report more co-occurring mental health and substance use disorders than do men.[26]

Mood and coping factors

Among individuals with AUD, women are more likely than men to experience alcohol cravings in response to daily negative emotion and stress.[20,21,25] In a sample of adults with PTSD and AUD, drinking to enhance positive emotions was associated with alcohol use in both men and women, whereas drinking to cope with negative affect was associated with higher alcohol consumption in women but not men.[27] Another study reported a positive association of negative affect with alcohol cravings for men at the beginning of alcohol detoxification, but for women the association persisted throughout detoxification.[28] Additionally, for women, more depressive symptoms at the beginning of detoxification were associated with more alcohol cravings at the end of detoxification. A third study also found that women were more likely to report high anxiety and depression at alcohol detoxification admission and discharge compared to men.[29] In that study, both genders showed increased anxiety and depression symptoms at 6-month follow-up, with more anxiety symptoms predicting men's relapse at 12-month follow-up and more depression symptoms predicting women's relapse at 12-month follow-up.[29]

Trauma exposure

There are high rates of trauma among women receiving treatment for any substance use, and an estimated 25% to 55% of women in substance use treatment have PTSD.[30] Trauma and acute stressors are causally associated with the development of AUD in women, via the effects of stress and trauma on biological processes and the likelihood of women with AUD to drink to cope with negative emotion and stress.[20] One study examining childhood maltreatment and lifetime odds of AUD found that, for both genders, having a history of physical, sexual, and/or emotional abuse and/or physical and/or emotional neglect was associated with higher odds of having a lifetime AUD.[31] For women, the strength of the relationship between lifetime AUD and all types of childhood maltreatment, except emotional abuse, was stronger than for men. In addition, Heffner and colleagues found that, for women, severity of current trauma symptoms and number of lifetime traumas predicted relapse over the course of the study.[32] No association between trauma and relapse was found for men.

Social networks

Research has found gender differences in the relationship between social networks, social support, and alcohol use. For example, compared to men, women with AUD are more likely to have a family history of AUD and a spouse with a history of AUD.[33] Women also are less likely than men to have social support in their recovery.[15] This may be at least partly due to greater stigma related to women's alcohol use compared to men, or to women's fear of interpersonal consequences related to their drinking.[34] Indeed, women tend to be more isolated in their excessive alcohol use and recovery.[15] Men report greater social pressure to change their drinking behaviors than women.[35] However, a study using data from the National Alcohol Study between 1984 and 2010,[36] with data from more than 32,000 people, showed changes over time for women. Although results did show that men displayed overall greater incidences of pressure to change across the years, there was also a significant cohort effect for women, with younger cohorts of women (i.e., born after 1964) reporting greater social pressure to change drinking. Such results coincide with gender convergence in rates of AUD and suggest that there also may be an emerging convergence of social pressure to change drinking. The role of social networks in drinking is evident in predicting treatment outcomes, reviewed below, and is an important risk and maintenance factor for AUD in men and women—albeit in different ways.

Summary

Research has illuminated gender differences in the biopsychosocial factors contributing to the development of, and recovery from, AUD. The physical effects of alcohol are more pervasive for women than men, and sex-specific factors, such as sex hormones, have been associated with alcohol use. In terms of psychosocial differences, stress, trauma, and negative affect are particularly relevant contributors to alcohol use and development of AUD among women. Relatedly, there are gender differences in terms of rates of co-occurring mental health conditions, the rates of major depressive disorder among women with alcohol abuse being particularly high. These differences provide a context for understanding potential gender differences in AUD treatment and recovery and can be used to guide future research.

GENDER DIFFERENCES IN TREATMENT ENTRY, RETENTION, AND OUTCOME

Treatment Entry

A small percentage of individuals with AUD ever receive treatment, with past-year estimates of 7% of men and 5% of women with AUD receiving treatment[37] and lifetime estimates of 22% to 23% for men and 15% for women.[38,39] There are several female-specific barriers to accessing AUD treatment, such as external and internalized stigma, lack of childcare, and systemic barriers.[6] Women are more likely than men to believe their alcohol problem will resolve on its own.[6] Additionally, women who are of minority racial or ethnic groups, of different sexual orientations, in the criminal justice system, living in rural areas, and/or of older age and women who speak languages other than English represent intersectional identities that add barriers to treatment entry.[40]

Among individuals who do enter AUD treatment, there are gender differences in clinical presentation. Women tend to have more severe alcohol and drug use histories, lower education and income, higher unemployment and housing needs, more children living at home, and higher parental stress, and they tend to be younger in age.[15] Primary care settings are a useful portal for AUD treatment access, and for women even more so.[41] Research consistently has found that women access AUD treatment via portals other than specialty AUD options, tending to receive AUD care in mental health and primary care settings.[6,15,16,42-44]

Treatment Retention

Data on gender differences in treatment retention are mixed, and most studies have been completed among samples with substance use disorder (SUD), meaning the results are not specific to AUD. For example, a review by Greenfield and colleagues reported no overall gender differences in SUD treatment retention but hypothesized that there would be different predictors and mediators of retention among men and women.[42] Among both genders, treatment retention has been associated with higher financial resources, fewer mental health problems, less severe substance use problems, more employment, and older age. Female-specific factors related to SUD treatment retention include referral source, personal stability, number of children, and availability of childcare.[42] A separate study found that type of care setting (i.e., detoxification, residential, ambulatory) also may moderate care retention, with women more likely than men to leave a detox facility prematurely.[45]

Treatment Outcome

The following review on outcomes of psychosocial treatments for AUD focuses on empirically supported treatments identified by American Psychological Association Division 12.[46] The pharmacotherapy section focuses on medications approved by the U.S. Food and Drug Administration for treatment of AUD. Search terms included the treatment name (e.g.,

"motivational interviewing" or "naltrexone") + "gender" or "sex" + "alcohol." The authors also searched ClinicalTrials.gov for clinical trials on these AUD treatments, and reviewed publications from large clinical trials for AUD, to determine whether gender differences were analyzed and reported. Lastly, the authors searched for and reviewed reports of clinical trials, literature reviews, or meta-analyses on specific treatments to identify commentary or results regarding sex or gender. This was done to address the fact that analyses not yielding any significant gender differences may not have been identified using the search terms. Thus, for some treatments the authors were able to comment on null gender difference findings. Despite the NIH mandate to include females in biomedical research,[1,2] relatively few AUD treatment outcome studies have reported on gender as a moderator of treatment outcome. The more recent NIH policy mandating analysis and reporting of gender differences in treatment outcomes[3] should result in deepened knowledge of gender differences in response to treatment and in gender-specific mechanisms that help explain treatment effects.

Psychotherapy

Motivational enhancement therapy, cognitive behavioral therapy for AUD, and twelve-step facilitation

Motivational enhancement therapy (MET) is a psychotherapy that helps patients resolve their ambivalence about engaging in treatment and reducing or stopping their substance use. Cognitive behavioral therapy (CBT) is an approach that focuses on the reciprocal effects of cognitions, emotions, and behaviors that maintain problem drinking. In treating SUD, CBT also focuses on identifying and resolving factors that reinforce or punish the substance use behavior and teaching both general coping skills and coping skills to negotiate drinking triggers. Twelve-step facilitation (TSF) treatment for AUD is based on the traditional Alcoholics Anonymous (AA) 12-step model and focuses on AA attendance, personalized spirituality, and guided introspection ("step work").

MET and CBT are among the most widely researched treatments for AUD;[47] however, there has been limited research examining gender differences in the effects of these treatments. Project MATCH (Matching Alcoholism Treatment to Client Heterogeneity) generated studies on gender differences in treatment efficacy, although the samples of the three conditions (CBT, MET, and TSF) were between 70% and 80% male.[48] Project MATCH had a gender matching hypothesis, positing that women receiving CBT would have better outcomes than women in the TSF condition, a difference that would be greater among women than men. This hypothesis was based on the expectation that CBT would better address secondary issues (such as mood and stress) and that TSF could exacerbate stigma and guilt among women.[49] This hypothesis was not supported, with women in the TSF aftercare arm attending more AA meetings and reporting more AA involvement than men. CBT was ultimately not found to improve secondary issues to a greater extent than TSF.[49]

Witkiewitz, Hartzler, and Donovan tested whether matching patients' motivation level to CBT or MET was associated with better outcomes in the aftercare arm of Project MATCH.[50] Men with lower baseline motivation and above-average alcohol dependence severity were found to drink more frequently in the MET than in CBT condition; the authors proposed that this more severe group may not have done as well in the lower-intensity MET treatment. Women with low motivation (regardless of severity, but who had overall fewer AUD symptoms than men), as well as low-motivated men with below-average AUD severity, reported less frequent drinking in MET compared to CBT. Another study on the outpatient arm of Project MATCH found that, compared with women, men showed greater increases in abstinence self-efficacy over time and across all treatment conditions.[51]

A meta-analysis on controlled trials of brief motivational interventions examined gender as a moderator of treatment effect.[52] The study was able to generate aggregate effect sizes only

for two studies, which did not show evidence of differential response between genders. In a meta-analysis of 22 studies on motivational interviewing, only one study reported on gender effects, with no differences between men and women observed on treatment outcomes.[53] A meta-analysis of 53 randomized controlled trials (RCTs) testing CBT for SUD found that the percentage of female participants in each study was positively associated with effect size, suggesting that women may benefit more from CBT than men, but these results must be interpreted with caution, as women comprised only 29% of the total sample.[54]

Alcohol behavioral couples therapy

Couples-based approaches to the treatment of AUD are based in the assumptions that partners engage in malleable behaviors that reinforce and/or punish the client's drinking behaviors, and that enhancing intimate relationships can improve problem-solving, enhance relationship functioning, and reduce likelihood of relapse. Behavioral couples therapy (BCT) and Alcohol BCT (ABCT) have been shown to be effective at increasing rates of abstinence from alcohol, decreasing alcohol-related problems, and improving relationship functioning.[55,56] Only one study to date has directly compared BCT outcomes by gender: O'Farrell et al. compared treatment outcomes among men and women with AUD and their partners receiving BCT in a naturalistic setting (not a clinical trial).[57] Results revealed few differences between genders, with large treatment effects in drinking reduction and small to medium effects in improved relationship satisfaction across the entire sample.

Several studies have tested ABCT separately among samples of men and women. An early study among men with alcohol dependence and their female partners compared three conditions: (1) ABCT, in which the spouse attended all sessions that included both alcohol- and marital-focused treatment; (2) full spousal attendance but alcohol-focused treatment only; and (3) minimal spousal involvement in alcohol-focused individual treatment.[58] Participants in the ABCT condition showed greater drinking reductions and improvements in relationship functioning compared to those in the other conditions. A second study randomized men with AUD and their partners to either ABCT, ABCT and relapse prevention, or ABCT and AA facilitation; this study found no differences in outcome across treatment conditions but high rates of abstinence across all three conditions.[59]

ABCT also has been tested among women with AUD, and one study compared ABCT to a treatment arm in which women received individual CBT for AUD.[60] In that study, however, 31% of the women refused the couples' study arm due to the need to bring their male partner.[61] The women who did participate in ABCT had slightly more days abstinent and fewer heavy-drinking days at follow-up than did women in the individual CBT arm. In response to women's preference for individual treatment—yet recognizing the positive results of ABCT and the role significant others play in women's drinking—a separate study compared ABCT to a "blended-ABCT," in which women with AUD attended five sessions individually and seven with their male partner.[62] Results showed equal outcomes across conditions. Thus, ABCT yielded excellent outcomes for men and women with AUD in separate studies, but gender differences in the effects of, and engagement in, ABCT have yet to be directly tested.

Pharmacotherapy

Three medications are currently approved by the U.S. Food and Drug Administration for the treatment of AUD: acamprosate, naltrexone, and disulfiram. There are important gender differences in their bioavailability, distribution, metabolism, elimination,[63] and side effects,[64] highlighting the importance of examining sex as a moderator of medication treatment efficacy for AUD.

Acamprosate

A meta-analytic study examined acamprosate for AUD treatment separately for men and women from a total of 22 studies,[65] some of which included women and some of which did not.

Patient data were accessed from 1,217 women and 4,794 men across the studies. Results showed no gender differences in any measure of acamprosate efficacy, safety, or tolerability (including percentage of abstinent days, heavy drinking, study completion, and medication compliance). Another study examined gender differences in treatment outcomes of the Combined Pharmacotherapies and Behavioral Interventions (COMBINE) study.[66,67] Participants in COMBINE received medication management with 16 weeks of placebo, naltrexone, acamprosate, or their combinations, with or without a combined behavioral intervention (a combination of empirically supported interventions from different therapies). Analyses showed that acamprosate was no more effective than placebo when separately analyzed in both men and women.

Naltrexone

One of the first studies on naltrexone for AUD was a multicenter, placebo-controlled RCT of injectable naltrexone,[68] with each condition comprising 32% women. Results showed that naltrexone was efficacious for men, but not women, in terms of reducing heavy drinking. Another study tested outcomes of psychotherapy with either oral naltrexone or placebo and found that naltrexone was not efficacious compared to placebo for female participants in reducing drinking, but it did delay the onset of drinking after an initial lapse.[69]

A third study tested high-dose naltrexone in men and women with co-occurring cocaine use disorder and AUD in a double-blind placebo RCT.[70] Participants were randomized to receive either naltrexone (150 mg) or placebo (58 men and 24 women in each condition), combined with either CBT or medication management. Women taking naltrexone used more cocaine and alcohol than did men and the placebo group, whereas men in the naltrexone group used less cocaine and alcohol compared to women and the male placebo group. The authors hypothesized that side effects of naltrexone (e.g., nausea, vomiting) for women may account for this effect. Indeed, women have been shown to have more negative side effects from naltrexone than men, which may be related to women's greater sensitivity to the endogenous opioid system.[71] Women's sensitivity to the effects of naltrexone also may vary across the menstrual cycle, with greater sensitivity in the luteal phase (i.e., post-ovulatory, late phase of the cycle) compared to the early follicular phase (i.e., pre-ovulatory, early phase of the cycle).[72]

Thus, early studies suggested naltrexone for AUD was not as effective for women as for men, or that women may experience worse side effects, contributing to worse outcomes. However, more recent research has suggested that these effects may be due to study characteristics such as sample size or outcomes assessed. Baros, Latham, and Anton used data from two RCTs comparing a naltrexone plus CBT group and a placebo plus CBT group and found effect sizes favoring naltrexone in men compared to women on some outcomes (drinks per drinking day), but not others (percentage of days abstinent, percentage of heavy drinking days).[73] A review of naltrexone RCTs among women suggested that the medication may have modest effects for women in drinking quantity and time to relapse, but not on drinking frequency.[74] However, the number of studies reviewed was small, and additional research is needed.

A secondary analysis of COMBINE data tested treatment effects separately in men and women and found that both genders had better treatment response when they received naltrexone with either medication management or combined behavioral intervention (a combination of empirically supported interventions), in comparison to placebo and any other combination of treatments.[66] The authors concluded that naltrexone is effective among women, and that studies showing noneffectiveness among women may be due to inadequate sample sizes.

Disulfiram

In 2016, Agabio et al. cited the low number of women in clinical trials on disulfiram that preclude evaluation of sex differences in efficacy and safety.[75] A search for any additional trials since 2016 (search terms "sex" or "gender" or "women" + "disulfiram") did not yield new information

on sex differences in the effect of disulfiram for alcohol use.

Digital and Mobile Treatment Technologies

Emerging digital and mobile models of treatment delivery include platforms such as telehealth sessions via videoconference; direct access computer programs such as CBT4CBT;[76] smartphone applications (apps) such as the Addiction—Comprehensive Health Enhancement Support System (A-CHESS)[77] to help patients track their drinking and provide real-time assistance with coping skills; and therapist text-messaging protocols.[78]

The preliminary research on access and use of AUD treatment via digital and mobile technologies suggests gender differences. For instance, a survey of members of an online social network site for women trying to resolve alcohol problems revealed that 47% of the site's members had never tried any other form of support related to their drinking.[79] A large survey study in the United Kingdom showed that women were more likely than men to use online recovery groups (but not recovery websites or apps).[80] A separate study examining use of one social network site for SUD recovery also found a higher proportion of women than men using the site.[81] Secondary analyses of an effectiveness trial testing a computer-assisted behavioral intervention (compared to treatment as usual) did not find gender to moderate the effect of treatment condition; however, results did show that acceptability of the computerized intervention was positively associated with abstinence among women, but not men.[82] Digital and mobile treatment technology for AUD is a burgeoning area of research, which should include analysis and reporting of gender differences in both access and outcomes going forward.

Summary

Existing research suggests no major gender differences in terms of overall outcome in psychosocial or pharmacological treatments for AUD. However, this finding is qualified by the small number of studies that directly test gender differences and the low enrollment of women in clinical trials. Additionally, as demonstrated by secondary analysis of Project MATCH, moderating factors such as AUD severity and motivation may be differentially associated with outcomes for men and women.

SEX AND GENDER DIFFERENCES IN LONG-TERM RECOVERY

Gender Differences and the Broader System of Recovery Care

Recovery is a complicated construct, ill-defined and historically confined to a mutual care, 12-step "disease model" system that considers abstinence as the only viable outcome.[12] AUD is now conceptualized as a chronic, relapsing medical condition and is thought to require a continuum of care, ranging from acute stabilization to ongoing, post-treatment monitoring and maintenance of recovery, and in need of clear benchmarks of disease resolution.[12] In this complicated context, gender differences in recovery historically have been understudied, but there are some limited findings, for instance, on AA use and clinical outcomes. As more sophisticated treatment approaches and definitions of target outcomes (including "recovery") are developed in the field, there will be an accelerated need to identify moderating variables (including gender and other demographic variables) that predict treatment outcomes. The following sections highlight aspects of the intersection between gender differences and recovery research.

Gender Differences and Mutual Help Groups

Alcoholics Anonymous, the largest and most popular mutual help organization available, offers primarily mixed-gender meetings, but also some single-gender meeting options (i.e., men-only, women-only). However, AA meeting content is

consistent across groups and does not necessarily include gender-specific content.[83] One gender-specific and secular mutual help organization is Women for Sobriety, which provides coping skills and reciprocal support for participants.

Outcomes of single-gender versus mixed-gender AA meeting attendance have not been studied; however, studies on gender differences in treatment outcomes among attendees of mixed-gender AA have shown some significant results, including different moderators of attendance for men and women. One longitudinal study followed 466 men and women for 16 years who were initially untreated for problem drinking.[84] Women were more likely to participate in AA, had longer stays in inpatient treatment for alcohol in the year after baseline, achieved better outcomes than men at 1 and 8 years, and benefited more from AA attendance during years 2 through 8. At 16 years post-baseline, women were more likely than men to participate in treatment and in AA, to be free of drinking problems, to consume less alcohol, to have fewer DSM-IV dependence symptoms, and to report less drinking to cope and higher abstinence self-efficacy;[85] women were also more likely to report improvements in depression, friendships, problem-solving, self-confidence, and family relationships and social functioning, compared to men.

Witbrodt and Delucchi followed participation in AA for 7 years and found that men were more likely to stop attending over the 7-year period.[86] Women with higher co-occurring drug severity were less likely to participate in AA than were women with lower drug severity. Women with more severe psychiatric symptoms were more likely to attend AA than women whose symptoms were less severe. Lastly, men who were less religious and those with networks supportive of drinking were less likely to attend AA treatment. Another study that followed 96 women and 180 men for up to 3 years found that AA membership increased participants' odds of achieving a year of abstinence, an association that was stronger for women than for men.[87] Comparing men and women in the United States and Sweden, the odds of AA attendance was greater for women who were both alcohol and drug dependent (versus just alcohol), and for women, the odds of AA attendance increased with the number of friends with whom to talk about personal problems.[83]

In sum, research on gender differences in outcomes of AA attendance are mixed, but the most consistent findings suggest women are more likely to stay in AA longer than men, and there may be different moderators (e.g., drug use, psychiatric comorbidity, religiosity, social networks) of the efficacy of AA for men and women.

Gender Differences in Response to Continuing Care Interventions

In line with contemporary notions of AUD and SUD as chronic, relapsing diseases requiring a continuum of care, McKay and colleagues developed and tested stepped and continuing care interventions with various levels of intervention, including telephone counseling.[88,89] The continuing care approach has implications for women with AUD, for whom social networks supporting abstinence may be particularly relevant for maintenance of recovery.

In a sample of participants who used cocaine, most of whom were also alcohol dependent, McKay and colleagues found that women but not men benefited from telephone continuing care.[89] Further study of gender moderators revealed lower rates of cocaine-positive urine for women at 24 months, but not men, if receiving telephone continuing care versus treatment as usual.[90] More work is encouraged in this area for AUD; sample sizes of women need to be sufficiently large to test for gender differences, and social support for abstinence and emotional support should be incorporated.

Precipitants to Relapse

Sliedrecht and colleagues conducted a review of 321 articles, published between 2000 and 2019, to examine the evidence for precipitants of relapse in AUD.[91] The review focused on 37 potential determinants of relapse in AUD, including gender,

and identified the number of studies that found evidence for (or against) each relapse determinant. The review showed mixed results in terms of rates of relapse among men and women. Specifically, most studies (59%) included in the review found no gender differences in participants' likelihood of relapse after treatment, but 41% of the studies did find gender differences and collectively suggested that women were less likely to relapse.[91]

In another review, Walitzer and Dearing indicated that rates of alcohol relapse did not differ among men and women, but evidence did indicate different predictors of relapse by gender.[92] For women, being married, marital stress, interpersonal conflict, and negative affect were risk factors for alcohol relapse whereas for men, risk factors included isolation and both negative and positive affect. Being married was identified as a protective factor for alcohol relapse in men, and having more children in the home was protective for women. The gender difference in marital status in relation to alcohol relapse (protective for men, risk factor for women) is worth noting, given that women are more likely to be married to a spouse who drinks and men are more likely to be married to a light or non-drinker.[92] Women also are more likely to drink to cope with marital conflict whereas men are more likely to report that their drinking contributes to marital conflict.[92]

Various Forms of Recovery: Abstinence and Moderated Drinking

Gender differences in empirical studies on viability of non-abstinent forms of recovery have recently been studied. Analysis of gender differences in such studies needs to attend to different thresholds for risky or heavy drinking for men and women.[14] Using Project MATCH data (30% female), four recovery profiles were generated at 3 years post-treatment: poor-functioning frequent heavy drinkers, poor-functioning infrequent heavy drinkers, high-functioning occasional heavy drinkers, and high-functioning infrequent non–heavy drinkers. No gender differences in profile assignment were found.[93]

In a study of three clinical trials for AUD—including data from Project MATCH, the COMBINE study, and the United Kingdom Alcohol Treatment Trial—several baseline variables were tested as predictors of low-risk drinking; gender was not found to be predictive.[94] In a large epidemiological sample (41% female), gender differences in past-year likelihood of falling into one of six drinking patterns (ranging from abstinent recovery to five types of non-abstinent recovery) were examined. Women were more likely than men to be in the abstinent recovery or asymptomatic, low-risk drinking categories than in the persistent AUD category. Additionally, women were less likely than men to fall into the symptomatic, high-risk drinking category. These results persisted after adjustment for daily amount of alcohol used, severity of AUD, illicit drug use, SUD, and anxiety/depression.[95]

One study examined men and women with AUD between ages 55 and 77 in a private outpatient program.[96] At 6-month follow-up, 79% of women reported abstinence from alcohol and drugs in the prior 30 days, compared to 54% of men. Among those not abstinent, no women reported heavy drinking in 30 days prior to follow-up, whereas non-abstinent men reported an average of 4 heavy-drinking days (a significant gender difference).

Quality of Life During the Recovery Period

Issues such as co-occurring mental health conditions, social environment, sleep, and physical health are directly affected by problem drinking and are important independent outcomes reflecting quality of life (QoL). Literature reviews have shown that heavy drinking is associated with reduced QoL, which improves with reductions in drinking.[97] There is some evidence that the association between drinking, recovery, and QoL may be moderated by sociodemographic constructs, including

gender.[97] Among women with AUD, both abstinence and moderate consumption of alcohol were associated with improved QoL over a mean follow-up of 46 months.[98] Among 82 patients with AUD admitted for inpatient detoxification and assessed at baseline and 12 weeks later, women with AUD reported lower QoL (general health, psychosocial impairment) than men with AUD.[99] These studies suggest that QoL be examined in gender differences to continue to address the relationship of QoL among women vis-à-vis reduction in drinking.

Summary

Attention to gender differences among various forms of recovery (both in the 12-step model and in the treatment outcome literature)—including examination of abstinence, reduction of drinking, and/or secondary outcomes—has yielded some interesting results, but research is sparse so far. Predictors of relapse appear to differ between men and women, with women being more likely to relapse in response to interpersonal conflict and negative affect whereas men are more likely to relapse in response to isolation and both positive and negative affect. Also, although being married is a protective factor for men, it can act as a risk factor of relapse for women. Having at least one close friend to discuss drinking with is differentially helpful for women. Also, gender differences in treatment outcome and maintenance may depend on the outcome of interest (drinking or secondary outcomes) and the "form of recovery" studied.

SEX AND GENDER DIFFERENCES IN AUD MECHANISMS OF BEHAVIOR CHANGE

There are several behavioral treatments now known to be efficacious for AUD, but there is almost no examination of gender differences in the AUD psychotherapy process and mechanisms of behavior change in this research literature. For example, the authors of this paper found 49 articles published between 2000 and 2012 (26 published since 2010) studying mechanisms of change in CBT, Motivational Interviewing, or MET or examining general therapeutic alliance as a mechanism of change. Of these 49 articles, 22 were review or non-empirical papers and did not mention gender. Of the 27 empirical studies, seven (26%) provided no sample breakdown by gender, one study (4%) had an all-female sample, and 17 (63%) had mixed-gender samples (albeit 11 of the 17 had samples that comprised at least two-thirds men). Furthermore, of these 17 mixed-gender studies, only five (29%) mentioned gender at all, typically as a statistical covariate. Since 2012, researchers have continued to examine mechanisms of change but generally have continued to ignore gender or used single-gender samples.

The Women's Recovery Group (WRG), a treatment for women with SUD (including AUD), examined mechanisms of change between men and women. WRG was compared to a traditional mixed-gender Group Drug Counseling (GDC) treatment in Stage I[100] and Stage II[101] trials. The pilot study and RCT results indicated that WRG was at least comparable to a mixed-gender, traditional drug counseling group. Secondary analyses of the pilot study and/or RCT data tested affiliative (supportive, positive, or empathic) statements as WRG mechanisms of change. Women in WRG emitted more affiliative statements compared to both genders in the GDC condition. Affiliative statements were made more in WRG than GDC and were associated with better drinking outcomes during and 6 months after treatment for women, especially in WRG.[102]

Litt et al. studied Network Support Treatment (NST) for AUD, which is designed to help patients build social support networks for sobriety.[103] Main treatment effects showed that men had a better treatment response than women. NST effects were mediated by changes in abstinence self-efficacy and number of abstinent friends for both men and women. Among those receiving NST,

women reported less improvement in abstinence self-efficacy and fewer abstinent friends. Kelly and Hoeppner explored gender moderation of purported mediators, assessed at 9-month follow-up, of the effects of AA on drinking at 15-month follow-up among Project MATCH participants.[104] Social self-efficacy and pro-abstainer social networks mediated AA's effects on abstinence for both men and women, but a larger proportion of AA's effect on treatment outcome was accounted for by these mediators for men (91%) than for women (57%). Additionally, although self-efficacy in positive social situations at 9-month follow-up was a mediator of the effect of AA on drinking at 15-month follow-up for men, it was not for women. Alternatively, self-efficacy not to drink in negative affect situations was a significant mediator for women, but not for men.

Recent studies have investigated potential mechanisms of behavior change among female-only samples receiving CBT for AUD (see McCrady, Epstein, and Folkus[6] for review). For instance, using times-series network analysis to examine concurrent and sequential relationships among several putative mechanisms of change, Holzhauer et al. examined mechanisms of change in an RCT comparing a gender-neutral to a female-specific CBT for women with AUD.[105] Higher self-confidence to abstain from drinking and increased use of alcohol-related coping skills were associated with less drinking in women in both CBT conditions. Women receiving female-specific CBT also reduced their drinking through decreased sociotropy (reactivity to others) and increased social support for abstinence. Changes in autonomy (importance of one's independence and personal rights) were associated with higher self-confidence in abstinence, use of coping skills, and less drinking in both conditions, suggesting that increasing autonomy may be a treatment mechanism specifically for women.

Identifying mechanisms of behavior change in treatments for AUD is a critical research effort, as it provides an understanding of the active ingredients of effective treatments. Such an understanding provides clinicians information about the critical elements that should be provided for different populations and will aid dissemination of empirically based treatments.[106,107] However, identifying such mechanisms has been difficult,[106] and moderating factors, including sex and gender, may play an important role in how people change.

DISCUSSION

Literature on gender and sex differences in AUD has grown exponentially since 1994. This has been particularly true regarding research on biopsychosocial risk and maintenance factors of AUD and treatment entry and gender-specific barriers to treatment for AUD. However, there is room for improvement regarding analysis and reporting of gender differences in treatment response for AUD and in mechanisms of drinking behavior change. Past reviews of gender differences in treatment outcomes have found mixed results and little evidence for systematic gender differences.[11,42] However, many of the studies covered in these reviews were completed among patients in treatment for other substances or for alcohol and other substances, not AUD alone. Additionally, many of the studies reviewed were set in naturalistic settings rather than in randomized and/or controlled trials, and most studies simply did not recruit enough females and did not present data on gender differences even when there was a subset of female participants.

A recent review conducted by the RAND National Defense Research Institute examined 24 AUD RCTs to examine gender differences in outcome and found mixed results, with little evidence for systematic gender differences in treatment effects across studies.[108] However, the authors of that review also stated: "Most notably, despite an extensive search and thorough screening procedure, we found very few studies reporting on gender differences, which hindered our analyses. . . . The review showed a profound lack of information on presence and absence of gender differences. We contacted authors and scrutinized numerous U.S. RCTs for differential

effects for men and women but found very few relevant studies."[108 (p54)]

Our review and those by Greenfield and colleagues[42] and Epstein and Menges[15] all concur with this assessment—that there is not enough research on the topic of gender differences in treatment outcomes (psychotherapy or pharmacotherapy). There is not enough research on gender differences regarding the efficacy of specific treatments or enough research that examines secondary outcomes, aside from alcohol use, that are especially relevant to long-term recovery (e.g., co-occurring psychological disorders or symptoms, physical health, QoL, moderated drinking). Although some research suggests women may have better outcomes than men in recovery from AUD, multiple factors—including but not limited to sample size/percentage of women, severity of AUD, and motivation to change—may contribute to such findings and preclude conclusions at this point.

As suggested by Moyer and colleagues,[52] future work would be enhanced by clearly delineated hypotheses about why gender differences might be expected in specific treatments—both in terms of treatment efficacy and in terms of mechanisms of behavior change. There has been substantial research on gender differences in risk and maintenance factors for AUD, and there is expanding research on female-specific treatment needs and approaches.[6] The field of AUD treatment development may be well positioned to use this research on gender differences to propose hypotheses about and, perhaps more important, men and women might respond differentially to a given treatment. For example, Project MATCH formulated a priori gender matching hypotheses; although these were not confirmed in the direction expected, gender differences did emerge that were then available to inform continued research.

It is also important to note that even among the studies that examined sex and gender differences, the sample sizes of women were often small, and analyses were likely underpowered. Given the historical differences in prevalence of AUD among men and women, this may have been justifiable in the past. However, the convergence of prevalence rates for lifetime AUD among men and women no longer justifies such small samples of women in treatment. Although studies may recruit men and women, women often comprised less than 50% of the sample, which makes it difficult to examine gender differences. If gender is considered a moderating factor, there must be enough men and women to statistically power the examination of interaction effects. Thus, in conducting clinical trials it may be important to enroll comparable numbers of men and women, with sufficient power to properly examine gender differences.[108] This includes using gender as a variable in randomization and examining gender-related co-occurring conditions and other secondary outcomes. The literature highlighted in this review provides substantial evidence that sex and gender differences impact the factors that are integral to AUD recovery—such as frequency and intensity of drinking, social functioning, physical health, risk for relapse, and possibly mechanisms of change—and therefore deserves to be considered in recovery research as the field moves forward.

Another consideration is single-gender treatment options, with female-only treatment most often a focus of research. This area of research has examined the delivery of treatment in a women-only setting, with or without including female-specific content (see McCrady et al.[6] for a review). There is evidence for differential, positive outcomes for treatment delivered in women-only versus mixed-gender settings,[6,42] but only when female-specific programming (i.e., content) also is provided. Thus, some argue that women-only treatment settings are not necessary, compared to mixed-gender settings, and at least one study of women in a residential treatment setting indicated that female-only treatment is not, at least initially, preferred by all female patients.[109] However, consistent findings have suggested that women express satisfaction and preference for female-specific format and treatment content.[6] Additionally, even if mixed-

gender treatments were shown to be as good as or better than single-gender treatments, women-specific treatments are likely to enhance treatment access for many women.

SUMMARY AND RECOMMENDATIONS FOR FUTURE RESEARCH

Gender differences in AUD treatment and recovery is an area in need of accelerated research. Specific areas of investigation are recommended:

- An overarching factor is the low engagement of men and women with AUD treatment. Gender differences may play important roles in understanding how, when, where, and why individuals seek care for AUD.
- Emerging research on digital and mobile technologies needs to include equal numbers of female and male participants and to analyze data by gender.
- Additional research is needed to test treatment access, retention, and outcomes for women versus men in primary care settings.
- Further research on gender-differentiated use of AA and other mutual help groups, and differences in treatment outcomes and mechanisms of change, is indicated.
- Rigorous, randomized trials for AUD on single-gender versus mixed-gender group settings with gender-specific programming are lacking.
- Another important contextual factor is a clarified definition of "recovery." Variations in treatment goals and non-abstinent outcomes need to be examined, including gender as a moderating variable.
- Gender differences in secondary outcomes (such as co-occurring symptoms, interpersonal functioning, and quality of life) should be reported in AUD treatment outcome research.
- Research suggests gender differences in relapse precipitants. Furthering our understanding of biological, social, and psychological determinants of relapse based on gender has implications for personalized or tailored relapse prevention approaches.
- Clinical trials are mandated to recruit men and women, as well as analyze and report gender differences; however, the field needs to adhere more stringently to these mandates in future research. This involves consistent changes to methods such as intentional oversampling of women, randomization based on gender, and gender-specific analyses.

The research reviewed here provides ample reason to believe that men and women recover from AUD differently. It is important to test and report gender differences when studying mechanisms of change—mediators, moderators, and active therapeutic ingredients—in AUD treatments.

Acknowledgments

This article was supported by the U.S. Department of Veteran Affairs, Veterans Health Administration CSR&D grant CX001951. The opinions expressed here are those of the authors and do not represent the official policy or position of the U.S. Department of Veteran Affairs or the U.S. government.

Financial Disclosure

The authors declare no competing financial or nonfinancial interests.

References

1. National Institutes of Health (NIH). NIH policy and guidelines on the inclusion of women and minorities as subjects in clinical research. *NIH Guide.* 1994;23(11).
2. NIH. Amendment: NIH Policy and Guidelines on the Inclusion of Women and Minorities as Subjects in Clinical Research—October, 2001. Notice Number: NOT-OD-02-001. https://grants.nih.gov/grants/guide/notice-files/not94-100.html.
3. NIH. Amendment: NIH Policy and Guidelines on the Inclusion of Women and Minorities as Subjects in Clinical Research. 2017. Notice Number: NOT-OD-02-014. https://grants.nih.gov/grants/guide/notice-files/NOT-OD-18-014.html.
4. Tingen C, Nagel JD, Clayton JA. Monitoring the implementation of the National Institutes of Health strategic plan for women's health and sex/gender differences research: Strategies and successes. *Glob Adv Health Med.* 2013;2(5):44-49. https://doi.org/10.7453/gahmj.2013.051.

5. U.S. Department of Health and Human Services (HHS), NIH, Office of Research on Women's Health. *Moving Into the Future With New Dimensions and Strategies: A Vision for 2020 for Women's Health Research. Strategic Plan—Executive Summary.* Bethesda, MD: NIH; 2010. https://orwh.od.nih.gov/sites/orwh/files/docs/ORWH_StrategicPlan2020_Vol1.pdf.
6. McCrady BS, Epstein EE, Fokas KF. Treatment interventions for women with alcohol use disorder. *Alcohol Res.* 2020;40(2):08. https://doi.org/10.35946/arcr.v40.2.08.
7. Grant BF, Goldstein RB, Saha TD, et al. Epidemiology of DSM-5 alcohol use disorder: Results from the National Epidemiologic Survey on Alcohol and Related Conditions III. *JAMA Psychiatry.* 2015;72(8):757-766. https://doi.org/10.1001/jamapsychiatry.2015.0584.
8. Grant BF, Chou SP, Saha TD, et al. Prevalence of 12-month alcohol use, high-risk drinking, and DSM-IV alcohol use disorder in the United States, 2001-2002 to 2012-2013: Results from the National Epidemiologic Survey on Alcohol and Related Conditions. *JAMA Psychiatry.* 2017;74(9):911-923. https://doi.org/10.1001/jamapsychiatry.2017.2161.
9. NIH. *Consideration of Sex as a Biological Variable in NIH-Funded Research.* Notice Number: NOT-OD-15-102. https://grants.nih.gov/grants/guide/notice-files/not-od-15-102.html.
10. American Psychological Association (APA). *Publication Manual of the American Psychological Association.* 7th ed. Washington, DC: APA; 2019.
11. *Alcoholics Anonymous: The Story of How More Than One Hundred Men Have Recovered From Alcoholism.* New York, NY: Works Publishing, 1939.
12. El-Guebaly N. The meanings of recovery from addiction: Evolution and promises. *J Addict Med.* 2012;6(1):1-9. https://doi.org/10.1097/adm.0b013e31823ae540.
13. The Betty Ford Consensus Panel. What is recovery? A working definition from the Betty Ford Institute. *J Subst Abuse Treat.* 2007;33(3):221-228. https://doi.org/10.1016/j.jsat.2007.06.001.
14. Witkiewitz K, Tucker JA. Abstinence not required: Expanding the definition of recovery from alcohol use disorder. *Alcohol Clin Exp Res.* 2020;44(1):36-40. https://doi.org/10.1111/acer.14235.
15. Epstein EE, Menges D. Women and addiction. In: McCrady BS, Epstein EE, eds. *Addictions: A Comprehensive Guidebook.* New York, NY: Oxford University Press; 2013:788-818.
16. McCaul ME, Roach D, Hasin DS, et al. Alcohol and women: A brief overview. *Alcohol Clin Exp Res.* 2019;43(5):774-779. https://doi.org/10.1111/acer.13985.
17. Erol A, Karpyak VM. Sex and gender-related differences in alcohol use and its consequences: Contemporary knowledge and future research considerations. *Drug Alcohol Depend.* 2015;156:1-13. https://doi.org/10.1016/j.drugalcdep.2015.08.023.
18. Mann K, Ackermann K, Croissant B, et al. Neuroimaging of gender differences in alcohol dependence: Are women more vulnerable? *Alcohol Clin Exp Res.* 2005;29(5):896-901. https://doi.org/10.1097/01.alc.0000164376.69978.6b.
19. Koob GF, Volkow ND. Neurocircuitry of addiction. *Neuropsychopharmacology.* 2010;35(1):217-238. https://doi.org/10.1038/npp.2009.110.
20. Peltier MR, Verplaetse TL, Mineur YS, et al. Sex differences in stress-related alcohol use. *Neurobiol Stress.* 2019;10:100149. https://doi.org/10.1016/j.ynstr.2019.100149.
21. Fox HC, Sinha R. Sex differences in drug-related stress-system changes: Implications for treatment in substance-abusing women. *Harv Rev Psychiatry.* 2009;17(2):103-119. https://doi.org/10.1080/10673220902899680.
22. Carroll ME, Smethells JR. Sex differences in behavioral dyscontrol: Role in drug addiction and novel treatments. *Front Psychiatry.* 2016;6:175. https://doi.org/10.3389/fpsyt.2015.00175.
23. Hudson A, Stamp JA. Ovarian hormones and propensity to drug relapse: A review. *Neurosci Biobehav Rev.* 2011;35(3):427-436. https://doi.org/10.1016/j.neubiorev.2010.05.001.
24. Goldstein RB, Dawson DA, Chou SP, et al. Sex differences in prevalence and comorbidity of alcohol and drug use disorders: Results from wave 2 of the National Epidemiologic Survey on Alcohol and Related Conditions. *J Stud Alcohol Drugs.* 2012;73(6):938-950. https://doi.org/10.15288/jsad.2012.73.938.
25. Karpyak VM, Biernacka JM, Geske JR, et al. Gender-specific effects of comorbid depression and anxiety on the propensity to drink in negative emotional states. *Addiction.* 2016;111(8):1366-1375. https://doi.org/10.1111/add.13386.
26. Kalpakci A, Sofuoglu M, Petrakis I, et al. Gender differences among veterans with alcohol use disorder nationally in the Veterans Health Administration. *J Addict Dis.* 2018;37(3-4):185-194. https://doi.org/10.1080/10550887.2019.1653739.
27. Lehavot K, Stappenbeck CA, Luterek JA, et al. Gender differences in relationships among PTSD severity, drinking motives, and alcohol use in a comorbid alcohol dependence and PTSD sample. *Psychol Addict Behav.* 2014;28(1):42-52. https://doi.org/10.1037/a0032266.
28. Petit G, Luminet O, Cordovil de Sousa Uva M, et al. Gender differences in affects and craving in alcohol-dependence: A study during alcohol detoxification. *Alcohol Clin Exp Res.* 2017;41(2):421-431. https://doi.org/10.1111/acer.13292.
29. Oliva F, Nibbio G, Vizzuso P, et al. Gender differences in anxiety and depression before and after alcohol detoxification: Anxiety and depression as gender-related predictors of relapse. *Eur Addict Res.* 2018;24(4):163-172. https://doi.org/10.1159/000490046.
30. Hien D, Litt LC, Cohen LR, et al. *Trauma Services for Women in Substance Abuse Treatment: An Integrated Approach.* APA; 2009.
31. Afifi TO, Henriksen CA, Asmundson GJ, et al. Childhood maltreatment and substance use disorders among men and women in a nationally representative sample. *Can J Psychiatry.* 2012;57(11):677-686. https://doi.org/10.1177/070674371205701105.
32. Heffner JL, Blom TJ, Anthenelli RM. Gender differences in trauma history and symptoms as predictors of relapse to alcohol and drug use. *Am J Addict.* 2011;20(4):307-311. https://doi.org/10.1111/j.1521-0391.2011.00141.x.
33. Khan S, Okuda M, Hasin DS, et al. Gender differences in lifetime alcohol dependence: Results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Alcohol Clin Exp Res.* 2013;37(10):1696-1705. https://doi.org/10.1111/acer.12158.
34. Lale R, Sklar M, Wooldridge J, et al. Gender congruence moderates beliefs about the causes of alcohol dependence and major depression. *Int J Ment Health Addict.* 2014;12(4):395-405. https://doi.org/10.1007/s11469-013-9465-y.
35. Bischof G, Rumpf HJ, Hapke U, et al. Gender differences in natural recovery from alcohol dependence. *J Stud Alcohol.* 2000;61(6):783-786. https://doi.org/10.15288/jsa.2000.61.783.
36. Polcin DL, Korcha RA, Kerr WC, et al. Gender and social pressure to change drinking behavior: Results from the National Alcohol Surveys from 1984 to 2010. *Addict Res Theory.* 2014;22(6):481-489. https://doi.org/10.3109/16066359.2013.877455.
37. Substance Abuse and Mental Health Services Administration (SAMHSA). *National Survey on Drug Use and Health—Public-Use File Dataset.* 2015. https://www.datafiles.samhsa.gov/study/national-survey-drug-use-and-health-nsduh-2015-nid16893.

38. Alvanzo AA, Storr CL, Mojtabai R, et al. Gender and race/ethnicity differences for initiation of alcohol-related service use among persons with alcohol dependence. *Drug Alcohol Depend.* 2014;140:48-55. https://doi.org/10.1016/j.drugalcdep.2014.03.010.
39. Cohen E, Feinn R, Arias A, et al. Alcohol treatment utilization: Findings from the National Epidemiologic Survey on Alcohol and Related Conditions. *Drug Alcohol Depend.* 2007;86(2-3):214-221. https://doi.org/10.1016/j.drugalcdep.2006.06.008.
40. SAMHSA. *Substance Abuse Treatment: Addressing the Specific Needs of Women.* Treatment Improvement Protocol (TIP) Series, No. 51. Rockville, MD: SAMHSA; 2009. https://store.samhsa.gov/sites/default/files/d7/priv/sma15-4426.pdf.
41. Wakeman SE, Rigotti NA, Chang Y, et al. Effect of integrating substance use disorder treatment into primary care on inpatient and emergency department utilization. *Gen Intern Med.* 2019;34(6):871-877. https://doi.org/10.1007/s11606-018-4807-x.
42. Greenfield SF, Brooks AJ, Gordon SM, et al. Substance abuse treatment entry, retention, and outcome in women: A review of the literature. *Drug Alcohol Depend.* 2007;86(1):1-21. https://doi.org/10.1016/j.drugalcdep.2006.05.012.
43. Green CA. Gender and use of substance abuse treatment services. *Alcohol Res Health.* 2006;29(1):55-62.
44. Weisner C, Schmidt L. Gender disparities in treatment for alcohol problems. *JAMA.* 1992;268(14):1872-1876.
45. Bornstein K, Longinaker N, Bryant-Genevier M, et al. Sex differences in substance abuse treatment adherence in the United States. *Addict Disord Their Treat.* 2015;14(3):131-138. https://doi.org/10.1097/ADT.0000000000000063.
46. American Psychological Association, Presidential Task Force on Evidence-Based Practice. Evidence-based practice in psychology. *Am Psychol.* 2006;61(4):271-285. https://doi.org/10.1037/0003-066X.61.4.271.
47. McCrady BS, Owens MD, Borders AZ, et al. Psychosocial approaches to alcohol use disorders since 1940: A review. *Stud Alcohol Drugs Suppl.* 2014;75(suppl 17):68-78.
48. Project MATCH Research Group. Matching patients with alcohol disorders to treatments: Clinical implications from Project MATCH. *J Ment Health.* 1998;7(6):589-602. https://doi.org/10.1080/09638239817743.
49. Del Boca FK, Mattson ME. The gender matching hypothesis. In: Longabaugh R, Wirtz PW, eds. *Project MATCH Hypotheses: Results and Causal Chain Analyses.* Rockville, MD: HHS, Public Health Service, NIH, NIAAA. 2001;8:186-203.
50. Witkiewitz K, Hartzler B, Donovan D. Matching motivation enhancement treatment to client motivation: Re-examining the Project MATCH motivation matching hypothesis. *Addiction.* 2010;105(8):1403-1413. https://doi.org/10.1111/j.1360-0443.2010.02954.x.
51. Maisto SA, Roos CR, O'Sickey AJ, et al. The indirect effect of the therapeutic alliance and alcohol abstinence self-efficacy on alcohol use and alcohol-related problems in Project MATCH. *Alcohol Clin Exp Res.* 2015;39(3):504-513. https://doi.org/10.1111/acer.12649.
52. Moyer A, Finney JW, Swearingen CE, et al. Brief interventions for alcohol problems: A meta-analytic review of controlled investigations in treatment-seeking and non-treatment-seeking populations. *Addiction.* 2002;97(3):279-292. https://doi.org/10.1046/j.1360-0443.2002.00018.x.
53. Vasilaki EI, Hosier SG, Cox WM. The efficacy of motivational interviewing as a brief intervention for excessive drinking: A meta-analytic review. *Alcohol Alcohol.* 2006;41(3):328-335. https://doi.org/10.1093/alcalc/agl016.
54. Magill M, Ray LA. Cognitive-behavioral treatment with adult alcohol and illicit drug users: A meta-analysis of randomized controlled trials. *J Stud Alcohol Drugs.* 2009;70(4):516-527. https://doi.org/10.15288/jsad.2009.70.516.
55. McCrady BS, Wilson AD, Muñoz RE, et al. Alcohol-focused behavioral couple therapy. *Fam Process.* 2016;55(3):443-459. https://doi.org/10.1111/famp.12231.
56. O'Farrell TJ, Cutter HS, Floyd FJ. Evaluating behavioral marital therapy for male alcoholics: Effects on marital adjustment and communication from before to after treatment. *Behav Ther.* 1985;16(2):147-167. https://doi.org/10.1016/S0005-7894(85)80042-3.
57. O'Farrell TJ, Schreiner A, Schumm J, et al. Do outcomes after behavioral couples therapy differ based on the gender of the alcohol use disorder patient? *Addict Behav.* 2016;54:46-51. https://doi.org/10.1016/j.addbeh.2015.12.005.
58. McCrady BS, Stout R, Noel N, et al. Effectiveness of three types of spouse-involved behavioral alcoholism treatment. *Br J Addict.* 1991;86(11):1415-1424. https://doi.org/10.1111/j.1360-0443.1991.tb01727.x.
59. McCrady BS, Epstein EE, Kahler CW. Alcoholics Anonymous and relapse prevention as maintenance strategies after conjoint behavioral alcohol treatment for men: 18-month outcomes. *J Consult Clin Psychol.* 2004;72(5):870-878. https://doi.org/10.1037/0022-006x.72.5.870.
60. McCrady BS, Epstein EE, Cook S, et al. A randomized trial of individual and couple behavioral alcohol treatment for women. *J Consult Clin Psychol.* 2009;77(2):243-256. https://doi.org/10.1037/a0014686.
61. McCrady BS, Epstein EE, Cook S, et al. What do women want? Alcohol treatment choices, treatment entry and retention. *Psychol Addict Behav.* 2011;25(3):521-529. https://doi.org/10.1037/a0024037.
62. McCrady BS, Epstein EE, Hallgren KA, et al. Women with alcohol dependence: A randomized trial of couple versus individual plus couple therapy. *Psychol Addict Behav.* 2016;30(3):287-299. https://doi.org/10.1037/adb0000158.
63. Gandhi M, Aweeka F, Greenblatt RM, et al. Sex differences in pharmacokinetics and pharmacodynamics. *Annu Rev Pharmacol Toxicol.* 2004;44:499-523. https://doi.org/10.1146/annurev.pharmtox.44.101802.121453.
64. Agabio R, Campesi I, Pisanu C, et al. Sex differences in substance use disorders: Focus on side effects. *Addict Biol.* 2016;21(5):1030-1042. https://doi.org/10.1111/adb.12395.
65. Mason BJ, Lehert P. Acamprosate for alcohol dependence: A sex-specific meta-analysis based on individual patient data. *Alcohol Clin Exp Res.* 2012;36(3):497-508. https://doi.org/10.1111/j.1530-0277.2011.01616.x.
66. Greenfield SF, Pettinati HM, O'Malley S, et al. Gender differences in alcohol treatment: An analysis of outcome from the COMBINE study. *Alcohol Clin Exp Res.* 2010;34(10):1803-1812. https://doi.org/10.1111/j.1530-0277.2010.01267.x.
67. Anton RF, O'Malley SS, Ciraulo DA, et al. Combined pharmacotherapies and behavioral interventions for alcohol dependence: The COMBINE study: A randomized controlled trial. *JAMA.* 2006;295(17):2003-2017. https://doi.org/10.1001/jama.295.17.2003.
68. Garbutt JC, Kranzler HR, O'Malley SS, et al. Efficacy and tolerability of long-acting injectable naltrexone for alcohol dependence: A randomized controlled trial. *JAMA.* 2005;293(13):1617-1625. https://doi.org/10.1001/jama.293.13.1617.

69. O'Malley SS, Sinha R, Grilo CM, et al. Naltrexone and cognitive behavioral coping skills therapy for the treatment of alcohol drinking and eating disorder features in alcohol-dependent women: A randomized controlled trial. *Alcohol Clin Exp Res.* 2007;31(4):625-634. https://doi.org/10.1111/j.1530-0277.2007.00347.x.
70. Pettinati HM, Kampman KM, Lynch KG, et al. Gender differences with high-dose naltrexone in patients with co-occurring cocaine and alcohol dependence. *J Subst Abuse Treat.* 2008;34(4):378-390. https://doi.org/10.1016/j.jsat.2007.05.011.
71. O'Malley SS, Krishnan-Sarin S, Farren C, et al. Naltrexone-induced nausea in patients treated for alcohol dependence: Clinical predictors and evidence for opioid-mediated effects. *J Clin Psychopharmacol.* 2000;20(1):69-76. https://doi.org/10.1097/00004714-200002000-00012.
72. Roche DJ, King AC. Sex differences in acute hormonal and subjective response to naltrexone: The impact of menstrual cycle phase. *Psychoneuroendocrinology.* 2015;52:59-71. https://doi.org/10.1016/j.psyneuen.2014.10.013.
73. Baros A, Latham P, Anton R. Naltrexone and cognitive behavioral therapy for the treatment of alcohol dependence: Do sex differences exist? *Alcohol Clin Exp Res.* 2008;32(5):771-776. https://doi.org/10.1111/j.1530-0277.2008.00633.x.
74. Canidate SS, Carnaby GD, Cook CL, et al. A systematic review of naltrexone for attenuating alcohol consumption in women with alcohol use disorders. *Alcohol Clin Exp Res.* 2017;41(3):466-472. https://doi.org/10.1111/acer.13313.
75. Agabio R, Pani PP, Preti A, et al. Efficacy of medications approved for the treatment of alcohol dependence and alcohol withdrawal syndrome in female patients: A descriptive review. *Eur Addict Res.* 2016;22(1):1-16. https://doi.org/10.1159/000433579.
76. Carroll KM, Ball SA, Martino S, et al. Computer-assisted delivery of cognitive-behavioral therapy for addiction: A randomized trial of CBT4CBT. *Am J Psychiatry.* 2008;165(7):881-888. https://doi.org/10.1176/appi.ajp.2008.07111835.
77. Gustafson DH, McTavish FM, Chih MY, et al. A smartphone application to support recovery from alcoholism: A randomized clinical trial. *JAMA Psychiatry.* 2014;71(5):566-572. https://doi.org/10.1001/jamapsychiatry.2013.4642.
78. Muench F, Weiss RA, Kuerbis A, et al. Developing a theory driven text messaging intervention for addiction care with user driven content. *Psychol Addict Behav.* 2013;27(1):315-321. https://doi.org/10.1037/a0029963.
79. Sinclair JM, E Chambers S, C Manson C. 2017. Internet support for dealing with problematic alcohol use: A survey of the Soberistas online community. *Alcohol Alcohol.* 2017;52(2):220-226. https://doi.org/10.1093/alcalc/agw078.
80. Graham S, Irving J, Cano I, et al. Participation with online recovery specific groups—Findings from the UK Life in Recovery survey 2015. *Alcohol Treat Q.* 2018;36(4):459-481. https://doi.org/10.1080/07347324.2018.1500873.
81. Bergman BG, Kelly NW, Hoeppner BB, et al. Digital recovery management: Characterizing recovery-specific social network site participation and perceived benefit. *Psychol Addict Behav.* 2017;31(4):506-512. https://doi.org/10.1037/adb0000255.
82. Campbell AN, Nunes EV, Pavlicova M, et al. Gender-based outcomes and acceptability of a computer-assisted psychosocial intervention for substance use disorders. *Subst Abuse Treat.* 2015;53:9-15. https://doi.org/10.1016/j.jsat.2014.12.006.
83. Witbrodt J, Romelsjo A. Gender differences in mutual-help attendance one year after treatment: Swedish and U.S. samples. *J Stud Alcohol Drugs.* 2010;71(1):125-135. https://doi.org/10.15288/jsad.2010.71.125.
84. Timko C, Moos RH, Finney JW, et al. Gender differences in help-utilization and the 8-year course of alcohol abuse. *Addiction.* 2002;97(7):877-889. https://doi.org/10.1046/j.1360-0443.2002.00099.x.
85. Moos RH, Moos BS, Timko C. Gender, treatment and self-help in remission from alcohol use disorders. *Clin Med Res.* 2006;4(3):163-174. https://doi.org/10.3121/cmr.4.3.163.
86. Witbrodt J, Delucchi K. Do women differ from men on Alcoholics Anonymous participation and abstinence? A multi-wave analysis of treatment seekers. *Alcohol Clin Exp Res.* 2011;35(12):2231-2241. https://doi.org/10.1111/j.1530-0277.2011.01573.x.
87. Krentzman AR, Brower KJ, Cranford JA, et al. Gender and extroversion as moderators of the association between Alcoholics Anonymous and sobriety. *J Stud Alcohol Drugs.* 2012;73(1):44-52. https://doi.org/10.15288/jsad.2012.73.44.
88. McKay JR. Continuing care research: What we've learned and where we're going. *J Subst Abuse Treat.* 2009;36(2):131-145. https://dx.doi.org/10.1016%2Fj.jsat.2008.10.004.
89. McKay JR, Van Horn DH, Lynch KG. Who benefits from extended continuing care for cocaine dependence? *Addict Behav.* 2014;39(3):660-668. https://doi.org/10.1016/j.addbeh.2013.11.019.
90. McKay JR, Van Horn D, Oslin D, et al. Extended telephone-based continuing care for alcohol dependence: 24-month outcomes and subgroup analyses. *Addiction.* 2011;106(10):1760-1769. https://doi.org/10.1111/j.1360-0443.2011.03483.x.
91. Sliedrecht W, de Waart R, Witkiewitz K. Alcohol use disorder relapse factors: A systematic review. *Psychiatry Res.* 2019;278:97-115. https://doi.org/10.1016/j.psychres.2019.05.038.
92. Walitzer KS, Dearing RL. Gender differences in alcohol and substance use relapse. *Clin Psychol Rev.* 2006;26(2):128-148. https://doi.org/10.1016/j.cpr.2005.11.003.
93. Witkiewitz K, Wilson AD, Pearson MR, et al. Profiles of recovery from alcohol use disorder at three years following treatment: Can the definition of recovery be extended to include high functioning heavy drinkers? *Addiction.* 2009;114(1):69-80. https://doi.org/10.1111/add.14403.
94. Witkiewitz K, Pearson MR, Hallgren KA, et al. Who achieves low risk drinking during alcohol treatment? An analysis of patients in three alcohol clinical trials. *Addiction.* 2017;112(12):2112-2121. https://doi.org/10.1111/add.13870.
95. Fan AZ, Chou SP, Zhang H, et al. Prevalence and correlates of past-year recovery from DSM-5 alcohol use disorder: Results from National Epidemiologic Survey on Alcohol and Related Conditions-III. *Alcohol Clin Exp Res.* 2019;43(11):2406-2420. https://doi.org/10.1111/acer.14192.
96. Satre DD, Mertens JR, Arean PA, et al. Five-year alcohol and drug treatment outcomes of older adults versus middle-aged and younger adults in a managed care program. *Addiction.* 2004;99(10):1286-1297. https://doi.org/10.1111/j.1360-0443.2004.00831.x.
97. Donovan D, Mattson ME, Cisler RA, et al. Quality of life as an outcome measure in alcoholism treatment research. *J Stud Alcohol Suppl.* 2005;(15):119-139. https://doi.org/10.15288/jsas.2005.s15.119.
98. Foster J, Powell J, Marshall E, et al. Quality of life in alcohol-dependent subjects–A review. *Qual Life Res.* 1999;8(3):255-261. https://doi.org/10.1023/a:1008802711478.
99. Peters TJ, Millward LM, Foster J. Quality of life in alcohol misuse: Comparison of men and women. *Arch Womens Ment Health.* 2003;6(4):239-243. https://doi.org/10.1007/s00737-003-0012-x.

100. Greenfield SF, Trucco EM, McHugh RK, et al. The women's recovery group study: A stage I trial of women-focused group therapy for substance use disorders versus mixed-gender group drug counseling. *Drug Alcohol Depend.* 2007;90(1):39-47. https://doi.org/10.1016/j.drugalcdep.2007.02.009.
101. Greenfield SF, Sugarman DE, Freid CM, et al. Group therapy for women with substance use disorders: Results from the Women's Recovery Group Study. *Drug Alcohol Depend.* 2014;142:245-253. https://doi.org/10.1016/j.drugalcdep.2014.06.035.
102. Valeri L, Sugarman DE, Reilly ME, et al. Group therapy for women with substance use disorders: In-session affiliation predicts women's substance use treatment outcomes. *J Subst Abuse Treat.* 2018;94:60-68. https://doi.org/10.1016/j.jsat.2018.08.008.
103. Litt MD, Kadden RM, Tennen H. Network Support treatment for alcohol dependence: Gender differences in treatment mechanisms and outcomes. *Addict Behav.* 2015;45:87-92. https://doi.org/10.1016/j.addbeh.2015.01.005.
104. Kelly JF, Hoeppner BB. Does Alcoholics Anonymous work differently for men and women? A moderated multiple-mediation analysis in a large clinical sample. *Drug Alcohol Depend.* 2013;130(1-3):186-193. https://doi.org/10.1016/j.drugalcdep.2012.11.005.
105. Holzhauer CG, Hildebrandt T, Epstein EE, et al. Mechanisms of change in female-specific and gender-neutral cognitive behavioral therapy for women with alcohol use disorder. *J Consult Clin Psychol.* 2020;88(6):541-553. https://doi.org/10.1037/ccp0000492.
106. Longabaugh R. The search for mechanisms of change in behavioral treatments for alcohol use disorders: A commentary. *Alcohol Clin Exp Res.* 2007;31(suppl 10):21s-32s. https://doi.org/10.1111/j.1530-0277.2007.00490.x.
107. Magill M, Kiluk BD, McCrady BS, et al. Active ingredients of treatment and client mechanisms of change in behavioral treatments for alcohol use disorders: Progress 10 years later. *Alcohol Clin Exp Res.* 2015;39(10):1852-1862. https://doi.org/10.1111/acer.12848.
108. Newberry S, Booth M, Rutter CM, et al. *Gender Differences in Response to Alcohol Use Disorder Treatment: A Systematic Review.* Santa Monica, CA: RAND National Defense Research Institute; 2019.
109. Neale J, Tompkins CNE, Marshall AD, et al. Do women with complex alcohol and other drug use histories want women-only residential treatment? *Addiction.* 2018;113(6):989-997. https://doi.org/10.1111/add.14131.

ALCOHOL RESEARCH
Current Reviews

Alcohol Res. 2020;40(3):02 ● https://doi.org/10.35946/arcr.v40.3.02

Published: 12 November 2020

Epidemiology of Recovery From Alcohol Use Disorder

Jalie A. Tucker,[1] Susan D. Chandler,[1] and Katie Witkiewitz[2]

[1]Department of Health Education and Behavior and the Center for Behavioral Economic Health Research, University of Florida, Gainesville, Florida
[2]Department of Psychology and the Center on Alcoholism, Substance Abuse, and Addictions, University of New Mexico, Albuquerque, New Mexico

Almost one-third of the U.S. population meets alcohol use disorder (AUD) criteria on a lifetime basis. This review provides an overview of recent research on the prevalence and patterns of alcohol-related improvement and selectively reviews nationally representative surveys and studies that followed risk groups longitudinally with a goal of informing patients with AUD and AUD researchers, clinicians, and policy-makers about patterns of improvement in the population. Based on the research, alcohol use increases during adolescence and early adulthood and then decreases beginning in the mid-20s across the adult life span. Approximately 70% of persons with AUD and alcohol problems improve without interventions (natural recovery), and fewer than 25% utilize alcohol-focused services. Low-risk drinking is a more common outcome in untreated samples, in part because seeking treatment is associated with higher problem severity. Sex differences are more apparent in help-seeking than recovery patterns, and women have lower help-seeking rates than men. Whites are proportionately more likely to utilize services than are Blacks and Hispanics. Improving recovery rates will likely require offering interventions outside of the health care sector to affected communities and utilizing social networks and public health tools to close the longstanding gap between need and utilization of AUD-focused services.

KEY WORDS: alcohol; alcohol use disorder; recovery; remission; natural recovery; epidemiology; alcohol treatment utilization; low-risk drinking

INTRODUCTION

Substance use disorder (SUD) is among the most prevalent mental health disorders in the United States and in general clinical practice, with 7% of the U.S. population age 12 and older (19.7 million people) having an SUD of some kind in 2018.[1] Alcohol use disorder (AUD) is the most prevalent SUD, with 5% of persons age 12 and older reporting AUD in 2018.[1] Of persons with an SUD in 2018, and excluding those with a tobacco use disorder, 60% had AUD, 27% had an illicit drug use disorder, and 13% had disorders

involving alcohol and illicit drugs.[1] On a lifetime basis, almost one-third of persons in the United States meet criteria for AUD.[2] In addition to the high AUD prevalence, many more individuals engage in risky drinking or experience alcohol-related negative consequences that fall short of meeting clinical diagnostic criteria for AUD.[3] Thus, harmful alcohol use is a major public health problem, costing the United States approximately $250 billion per year, and it is the third leading cause of preventable death.[4]

Most individuals who develop an AUD or have subclinical alcohol-related problems will reduce or resolve their problem on their own or with assistance from professional alcohol treatment or mutual help groups.[5-9] The epidemiology of this robust phenomenon is the focus of this article. After initial consideration of complexities involved in defining improvement in alcohol-related problems, which is discussed in depth by Witkiewitz et al.,[10] this article describes the prevalence and heterogeneity of pathways to recovery and examines relationships between patterns of seeking help for and improvements in alcohol-related problems. Then, the topic is examined from a life span developmental perspective, which is less well-researched and involves relationships among age-related rates of problem onset, reduction, and persistence. The final section discusses differences in the overall patterns previously discussed as a function of gender and race/ethnicity. Emphasis is placed on illustrative recent findings. Earlier work is covered in prior literature.[11,12]

DEFINING IMPROVEMENT IN ALCOHOL-RELATED PROBLEMS

As discussed by Witkiewitz et al.,[10] the conceptualization and measurement of improvements among persons with AUD and the constellation of improvements that define "recovery" have been debated for decades and continue to evolve. Clinical diagnostic criteria for AUD are offered by the American Psychiatric Association's fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5)[3] and the World Health Organization,[13] with the former predominating in the United States. Numerous reputable organizations offer definitions of low- and high-risk drinking practices[4,14] as well as AUD recovery or remission.[15] These various criteria have been revised over time as research evidence has accumulated, generally in the direction of recognizing that alcohol consumption and AUD occur on severity continua. Furthermore, most individuals who engage in harmful alcohol use either do not meet AUD criteria or meet criteria for a mild disorder characterized by lower levels of symptomology.[16]

Characterizations of improvement in alcohol-related problems have correspondingly become more nuanced over time in recognition of the heterogeneity of pathways, processes, and outcomes relevant to understanding how people reduce or resolve alcohol-related problems.[10] The term "recovery" is generally reserved for broad-based, sustained improvements in drinking practices and other areas of functioning adversely affected by drinking. Therefore, this article uses the term "recovery" to refer to a broadly conceived process resulting in sustained improvements in multiple domains, and uses the term "remission" to refer to more limited improvements in specific symptoms or problem behaviors (e.g., drinking practices). This is in line with the National Institute on Alcohol Abuse and Alcoholism's (NIAAA) recent definition of recovery from AUD as distinct from remission from AUD, defined symptomatically based on DSM-5 criteria, or cessation of heavy drinking without characterizing the presence or absence of other symptoms or improvements. It also is consistent with other recovery definitions, including those from the recovery community or patient perspectives, that encompass improved well-being and functioning

and are not limited to attainment of abstinence or stable low-risk drinking.[8,17]

It is also important to acknowledge the association of the term "recovery" with Alcoholics Anonymous (AA) and other mutual support groups. Even though the term is widely used in the clinical literature, many persons attempting to resolve their alcohol problems do not identify with being in recovery[8] and reject clinical labels indicative of AUD, especially those individuals attempting to resolve a drinking problem on their own.[9] Moreover, salutary improvements can occur in circumscribed areas of alcohol-related dysfunction, and reductions in drinking can contribute to improved health and well-being even if ongoing drinking falls short of traditional definitions of recovery that emphasize abstinence as a required element.[18]

As discussed by Witkiewitz and Tucker,[16] a core issue debated for decades is the extent to which drinking practices should be central to defining improvement or recovery. Early writings regarded sustained abstinence as the hallmark of recovery among persons with severe alcohol problems who had repeatedly been unable to limit their drinking or abstain.[19] Newer clinical diagnostic systems such as DSM-5 emphasize development of tolerance and physical dependence and drinking in harmful ways and under conditions that increase risk for adverse consequences.[3] Drinking practices are not a criterion in accepted diagnostic systems for AUD, including DSM-5, and most schemes define recovery based on symptom reduction, improved functioning, and well-being and are not heavily focused on drinking practices per se. Yet, the large treatment outcome literature concerned with promoting recovery has relied heavily on drinking practices as the major outcome metric, typically by using quantity-frequency criteria considered indicative of higher-risk drinking practices (any occasions of more than 14 drinks weekly or more than five drinks daily for men; more than seven drinks weekly or more than four drinks daily for women in the past year).[4,14]

Recent work, however, has shown that such consumption-based thresholds lack sensitivity and specificity for predicting problems related to drinking and do not differentiate individuals based on measures of health, functioning, and well-being.[20,21] Improvements in functioning and life circumstances are considered central features of recovery in many models, including AA, but assessment of these domains is a relatively recent development, primarily evident in clinical research.[18,21] It is generally lacking in survey research that has provided the bulk of epidemiological data on population patterns of alcohol-related improvement, so this body of work only partially addresses the multiple domains considered important for investigating recovery, broadly defined.

A second core issue is that improvement in alcohol-related problems, including recovery from AUD, is a dynamic process of behavior change. Thus, longitudinal studies provide superior information to cross-sectional studies with retrospective assessments of drinking status, although the latter are common in the literature. Cross-sectional surveys have utility if they employ sound retrospective measures of past drinking status, but this is another qualification of the current epidemiological database on alcohol-related improvement and recovery. Longitudinal research has become more common in recent years. However, the intervals over which repeated measures are obtained rarely exceed 3 to 5 years, although there are notable exceptions with follow-ups of 8 to 10 years or more.[22-24] Following large nationally representative samples for decades would be ideal, but the inevitable limitations on research resources have resulted in a collective body of work that generally comprises large representative studies that are cross-sectional or have short-term (e.g., 1 year) follow-ups. Studies with longer-term follow-ups tend to employ smaller, less representative samples. These core issues should be kept in mind when considering the epidemiology of improvements in alcohol-

related problems, including recovery from AUD, as discussed next.

RECOVERY PATHWAYS AND RELATIONSHIPS BETWEEN HELP-SEEKING AND DRINKING-RELATED OUTCOMES

Population-based survey research conducted over many decades has consistently revealed the following patterns with respect to improvements in alcohol-related problems:

- The majority of individuals who develop AUD reduce or resolve their problem over time.[7,8,25] Rates of improvement vary widely depending on features of the research, such as the intervals over which drinking status was assessed (e.g., lifetime basis, shorter-term assessment based on a year or more); demographic characteristics, problem severity, and help-seeking status of respondents; and how improvement or recovery/remission was measured. But improvement over time is a reliable pattern and one that argues against a view of AUD as an inevitably progressive disease process.
- Seeking help for drinking problems from professional treatment or community and peer resources such as mutual help groups is uncommon,[1,26] and a large gap persists between population need and service utilization. Most surveys indicate that less than 25% of persons in need utilize alcohol-focused helping resources.
- The great majority of persons who resolve their drinking problems do so without interventions, and such "natural recoveries" are the dominant pathway to problem resolution. Survey research has typically found that more than 70% of problem resolutions occur outside the context of treatment.[7,9]
- Stable low-risk drinking (moderation) is a relatively more common outcome in untreated samples, in part because seeking treatment is associated with higher problem severity,[7,12] and most treatment programs emphasize abstinence.

For example, Fan and colleagues[7] reported on the past-year prevalence of AUD recovery in the United States by using data from the NIAAA-funded 2012–2013 National Epidemiologic Survey on Alcohol and Related Conditions (NESARC-III)[2] and DSM-5 diagnostic criteria.[3] Survey respondents who met AUD criteria prior to the past year (n = 7,785) were assessed with respect to their current (past-year) AUD and risk drinking status. Drinking status was determined based on quantity-frequency criteria considered indicative of higher-risk drinking practices and DSM-5 AUD symptom counts. Measures of functioning and well-being were not collected.

Only 34% of respondents had persistent AUD, and most respondents had some degree of problem reduction; 16% achieved abstinence without symptoms, and 18% achieved low-risk drinking without symptoms. In addition, only 23% of the Fan et al. sample reported having ever received alcohol treatment, and those who did tended to fall into the persistent AUD (26%) or abstinent without symptoms (43%) outcome groups that generally are associated with higher problem severity.[7] In contrast, among the subset of respondents who reported abstinence or low-risk drinking without symptoms, 87% of those who reported low-risk drinking without symptoms were never treated, and only 12% were treated. An additional 15% of the sample reported low-risk drinking with symptoms, and 15% reported high-risk drinking without symptoms.[7] This is a refinement in outcome measurement compared to earlier surveys and illustrates the heterogeneity of recovery-relevant outcomes even in the absence of assessment of functioning and well-being.

This illustrative representative sample survey, among others,[8,9] reveals a more optimistic and variable view of recovery pathways and outcomes than suggested by early research using treatment samples, which emphasized the chronic, relapsing nature of alcohol problems and the difficulty of maintaining remission. Population data indicate that, even though alcohol problems are prevalent, most affected individuals have less serious problems than the minority who seek treatment,

and many improve on their own, including achieving stable abstinence or low-risk drinking without problems.

In contrast to these encouraging findings concerning rates of improvement, population research on the prevalence and patterns of help-seeking for alcohol-related problems indicates that the gap between need and service utilization is large and chronic. This is the case even though alcohol-related services have improved and expanded considerably over the past several decades[27,28] and reliably yield benefits for a majority of recipients. Among the 25% or fewer who seek care, sources of care span the professional, community, and peer-helping sectors. Within the professional sector, care is diffused through mental health, medical, and community services systems, and only a minority receive alcohol-focused services from qualified programs or professionals.[8,27]

Prevalence estimates for utilization of different types of alcohol services are not reliably available for several reasons. For example, specialty treatment programs are often addiction-oriented and not alcohol-specific, most include mutual help group participation as a program requirement, and the anonymity principle of mutual help groups deters determination of utilization rates apart from treatment. Nevertheless, membership estimates for AA (2.1 million members worldwide, including 1.3 million U.S. residents; https://www.aa.org) suggest that AA participation is relatively widespread. Comparable membership data are not available for other mutual help groups such as Self-Management and Recovery Training (SMART Recovery), which holds more than 3,000 meetings per week worldwide (https://www.smartrecovery.org/), and LifeRing Secular Recovery, which offers more than 140 face-to-face meetings in the United States as well as online meetings and other electronic supports (https://www.lifering.org/). Regarding professional treatment, the 2016 National Survey on Drug Use and Health estimated that about 3.8 million U.S. residents age 12 and older received any type of substance use treatment in the past year,[27] but these numbers are not specific to alcohol treatment. Also missing are data on relative remission rates as a function of type of care-seeking.

Higher problem severity predicts help-seeking, with higher severity reflected in greater alcohol dependence levels and alcohol-related impairment in areas of life functioning such as intimate, family, and social relationships; employment and finances; and legal affairs.[29] Perceived need also predicts help-seeking; however, even among those who perceive a need, only 15% to 30% receive help,[30] and problem recognition often precedes seeking care by a decade.[28] Thus, although most individuals who develop AUD will eventually resolve their problem, treatment utilization remains less used as a pathway to recovery. This pattern has persisted for decades despite recent expansion in the spectrum of services beyond clinical treatment to offer less costly and less intensive services that often can be accessed outside of the health care system and are suitable for those with less severe problems.[28] In addition, provisions of the Patient Protection and Affordable Care Act expanded access to and coverage of services for SUD.

RECOVERY ACROSS THE LIFE SPAN

Studies that followed risk groups and people with drinking problems longitudinally—typically using smaller samples than survey research—provide information on patterns of improvement and recovery across the life span. Some studies assessed functioning and life circumstances, in addition to drinking practices, and revealed the following age-related patterns with respect to the onset of and improvements in alcohol-related problems:

- Drinking to intoxication, binge drinking, and alcohol-related problems increase during adolescence and early adulthood, generally peaking between ages 18 and 22. Prevalence of past-year binge drinking (45%) and AUD (19%) is highest in the early 20s[31] and then decreases beginning in the mid-20s and continuing well

after early adulthood. This nonlinear trajectory for the majority of adolescents and young adults, often termed "maturing out," has been found in cross-sectional and longitudinal research using large national samples[2,32,33] and by the annual cross-sectional National Survey on Drug Use and Health.[1]

- Adult role transitions (e.g., employment, marriage, parenthood) and personal maturation (e.g., decreased impulsivity) are associated with remission or recovery in early adulthood.[31,34-36] As is the case for the general adult population with AUD, only about a quarter of adolescents and young adults in need of treatment receive it.[1]
- A subset of young adults who engage in harmful alcohol use and develop AUD in early adulthood show persistent or escalating problems in later life. Alcohol use before age 21 predicts persistence and severity of harmful use throughout the life span;[37] however, reductions in problem drinking in early adulthood are more likely to occur among individuals who had the most severe problems at earlier ages.[34]
- Development of AUD is less common after age 25, and reductions in problem drinking, including recovery from AUD, continue past early adulthood and across the adult life span, including through late middle and old age (ages 60 to 80 and older).[22,34] Reductions in problem drinking at older ages are predicted by relatively heavier alcohol use in early old age that prompted complaints from concerned others.[22]

These trends favoring increased remission rates over the life span are generally representative of the population, but can mask important nuances about age-related associations between problem onset, remission, and recurrence rates.[31,34-36] For example, Vergés and colleagues[35,36] used NESARC data from Waves 1 and 2 (from 2001–2002 to 2004–2005) to "deconstruct" age-related patterns of three different dynamic changes that contributed to overall age-related trends in the prevalence of DSM-IV alcohol dependence at each wave. Although rates of new alcohol problem onset and recurrence of or relapse to earlier problems declined with age, rates of persistence of alcohol problems over time were relatively stable across ages 18 to 50 and older. These different processes that contributed to the overall trend of decreased alcohol-related problems with increasing age suggest that "maturing out"—as young people assume adult roles—is not a sufficiently complete account of remission rates across the life span.

In related research that also used NESARC data from Waves 1 and 2, Lee and colleagues examined how rates of remission, which they termed "desistance," from mild, moderate, or severe levels of AUD varied across age groups ranging between ages 20 to 24 and 48 to 55.[34] Using Markov models to characterize patterns of longitudinal transitions in drinking status, they found differences in rates of AUD desistance from young adulthood to middle age as a function of AUD severity levels. Desistance rates from severe AUD, defined as six or more DSM-IV symptoms, were considerably higher in earlier age groups (ages 25 to 29 and 30 to 34) relative to older age groups (ages 35 to 39, 40 to 47, and 48 to 55) as compared to rates found in surveys that aggregated data across AUD severity levels. Desistance rates from moderate AUD showed a similar, but less dramatic pattern across age groups, whereas desistance rates from mild AUD were relatively stable across age groups. When considered with the work of Vergés and colleagues,[35,36] these studies (1) show that resolution of severe AUD contributes heavily and distinctively to early adulthood remission prevalence, and (2) highlight the importance of deconstructing overall AUD prevalence curves by taking into account onset, remission, and recurrence of different levels of AUD severity over the life span.

Finally, a few studies observed increased binge drinking among middle-aged and older adults,[33] suggesting dynamic changes may occur in binge drinking in midlife; these changes are not well researched. Similarly, most natural recovery research comprises samples showing that midlife recovery from AUD is normative.[9,38] Middle age is also when treatment entry tends to occur.[5] Recovery in midlife and later ages is

associated with an accumulation of alcohol-related problems coupled with life contexts that support and reinforce maintenance of drinking reductions and involve post-resolution improvements in functioning and well-being.[38,39]

ROLE OF GENDER AND RACE/ETHNICITY

Remission

In addition to age, rates of recovery or remission of AUD symptoms vary by gender and race/ethnicity. Using NESARC Wave 1 data, Dawson et al. found that older age and female gender predicted abstinence, but not low-risk drinking, in both treated and untreated respondents who had alcohol dependence prior to the past year.[5] Compared to non-Hispanic Whites, non-Hispanic Blacks had proportionately higher rates of abstinence than low-risk drinking. In the Fan et al.[7] replication of Dawson et al.[5] using NESARC-III data, female gender predicted both abstinence and low-risk drinking.

Also using NESARC-III data, Vasilenko et al. examined AUD prevalence by age and race/ethnicity (White, Black, Hispanic).[40] Although AUD prevalence generally peaked in the 20s and declined steadily with age, prevalence was higher for Whites at younger ages and higher for Blacks at older ages. This cross-over pattern typically occurred around age 60. In midlife, prevalence was similar for Blacks and Whites. Also, Whites reported higher AUD rates than Hispanic respondents at all ages, and men reported higher AUD rates than women until older age, when women were more likely than men to report AUD in their 70s. However, the number of participants older than age 70 was very small.

The study by Lee et al. that investigated age-related patterns of AUD desistance as a function of AUD severity also found gender and race/ethnicity differences.[34] Desistance patterns for males were generally consistent with the full sample findings—namely, elevated desistance rates for severe AUD in early adulthood and relatively stable rates for mild and moderate AUD. In contrast, females showed markedly higher rates of desistance from moderate AUD in early adulthood compared to older ages and attenuated rates of desistance from severe AUD compared to males during ages 30 to 34 only. With respect to race/ethnicity, results for Whites were generally consistent with the full sample, but findings differed for Hispanics and Blacks. For Hispanics, the early adulthood spike in rates of desistance from severe AUD was more time-limited, occurring only during ages 30 to 34 with much lower rates during ages 25 to 29. For Blacks, desistance rates for mild AUD also were relatively stable but were elevated for both moderate AUD (ages 25 to 29 and 30 to 34) and severe AUD (ages 25 to 29). For severe AUD, desistance rates among Blacks were very low during ages 30 to 34.

Patrick and colleagues analyzed age and gender relations with binge drinking using data from 27 cohorts of the annual Monitoring the Future surveys (1976 to 2004).[41] Participants were followed from 12th grade (modal age 18) through modal age 29/30. Across cohorts, the age of peak binge drinking prevalence increased from age 20 in 1976–1985 to age 22 in 1996–2004 for women, and from age 21 in 1976–1985 to age 23 in 1996–2004 for men. Similar to the typical population life span trajectory for AUD remission, for men the high prevalence of binge drinking persisted through ages 25 to 26, followed by reductions during the late 20s. For women ages 21 to 30, more recent cohorts reported significantly higher binge drinking prevalence than in earlier cohorts, with risk remaining high throughout the 20s. These shifts toward older age of peak binge drinking prevalence indicate an extension of risks associated with harmful alcohol consumption in young adulthood, especially for women.

Taken together, these studies on rates of improvement by gender and race/ethnicity suggest that many of the differences observed involve variations in the timing and extent of reductions in binge drinking and AUD during either young adulthood or older age, even though all groups tended to show overall patterns similar to the

population as a whole. Differences during midlife were less extensive, although this developmental period has not been the focus of much research.

Help-Seeking

Help-seeking patterns and preferences also vary by gender and race/ethnicity. The gap between need and receipt of treatment is larger for women than for men, even after controlling for the higher prevalence of AUD and greater problem severity among men.[42,43] For example, using NESARC data from Waves 1 and 2, Gilbert et al. found that women identified as having DSM-IV alcohol abuse or dependence at Wave 1 had significantly lower odds than men at Wave 2 of having used any alcohol service, specialty treatment, or mutual help groups.[42] These utilization differences occurred even though women and men reported similar low perceived need for help and similar numbers of treatment barriers. Women were more likely to report expecting that their problem would improve without intervention, whereas men were more likely to report prior help-seeking that was unhelpful. No differences in service utilization or perceived need were found for race/ethnicity among White, Black, and Hispanic respondents. Consistent with the larger literature, greater alcohol problem severity was associated with higher odds of service utilization.

Studies using pooled data from multiple waves of the national probability samples collected in the National Alcohol Surveys found differences in service utilization as a function of gender and race/ethnicity.[44,45] Zemore et al. used pooled data from three waves (1995–2005) to investigate lifetime alcohol treatment utilization and perceived barriers among Latinx respondents ($N = 4,204$).[44] Among respondents, 3.4%, 2.7%, and 2.1% reported any lifetime treatment, AA participation, and institutional treatment, respectively. Men were significantly more likely than women to report receipt of any treatment services (5.6% vs. 1.1%), AA (4.7% vs. 0.6%), or institutional treatment (3.2% vs. 1.0%). Completion of the study interview in English (4.3%) versus Spanish (2.3%) also predicted higher utilization. These patterns were similar among the subsample of respondents who reported lifetime alcohol dependence, among whom rates of service utilization were much higher (20.4% for men and 15.3% for women). The authors suggested that underutilization of treatment by women and Spanish speakers may be due to cultural stigma against women with an alcohol problem, concerns about racial/ethnic stereotyping or stigmatization when seeking treatment, and additional barriers faced by individuals who are uncomfortable speaking English.

A later study using pooled data from the 2000–2010 National Alcohol Surveys included Whites, Blacks, and Latinx participants and found lower service utilization among Latinx, Blacks (vs. Whites), and women (vs. men).[45] Racial/ethnic differences in utilization were moderated by gender. Among women, only 2.5% of Latinas and 3.4% of Blacks with lifetime AUD used specialty treatment compared to 6.7% of Whites; among men, the corresponding figures were 6.8% for Latinos, 12.2% for Blacks, and 10.1% for Whites.[45] Higher utilization among Whites than among Blacks and Hispanics also was found using the 2014 cohort from the National Survey on Drug Use and Health.[46]

Overall, research on race/ethnicity and help-seeking is not extensive, and groups other than Whites, Blacks, and Hispanics/Latinx have not been well studied.[47] Available research suggests that the gap between need and service utilization common among those with an alcohol problem is accentuated among ethnic and racial minority groups; however, research is in its infancy on why this is the case and how to address it.

DISCUSSION

Research on the epidemiology of recovery from AUD is somewhat uneven in scope and methods, and gaps remain in the knowledge base. Nonetheless, the bulk of evidence converges in showing that (1) improvements in alcohol-related problems, including recovery from AUD, are commonplace; (2) natural recovery is the

dominant pathway; (3) greater problem severity is associated with treatment utilization; and (4) low-risk drinking outcomes are more common among untreated samples. Problem prevalence and rates of remission of AUD symptoms in the U.S. population peak during the 20s and are followed by a slow, steady decline over the adult life span. The specific ages when these characteristic dynamics in the temporal patterning of harmful alcohol use and remission of symptoms occur vary somewhat as a function of gender and race/ethnicity, but the overall general pattern is well established.

These findings provide a rich foundation concerning population patterns and dynamics of recovery, remission, and help-seeking. Future research aimed at disaggregating these complex associations at the population level should be a priority and can inform approaches to promoting remission and recovery in two general ways.[48] First, longitudinal studies of the onset of and improvements in alcohol-related problems[31,34-36] exemplify how epidemiological risk factors are reliably associated with the course of alcohol problem development and improvement and can be used to target at-risk individuals for preventive interventions. Second, "upstream" population-level interventions can be applied to prevent or reduce the determinants of risk (e.g., through changes in policy, taxation, and health and community infrastructure). The latter approach, although less common, takes advantage of the well-established prevention paradox—small reductions in harmful alcohol use by risky drinkers with less serious problems result in far greater health improvements at the population level than do changes in harmful alcohol use by the minority of persons with AUD.

This body of research qualifies the usual characterization of AUD as a chronic, relapsing/remitting disorder for which intensive intervention is essential for recovery. That characterization may be representative for a small minority of persons with more severe AUD, but it is inaccurate for the large majority of persons with mild to moderate problems, many of whom resolve their problems the first time they attempt to quit and often without interventions.[9,49] Whether this qualification applies to SUD other than AUD is not established.

The recovery literature is characterized by a mix of cross-sectional population surveys with short-term retrospective assessments (1 year is typical) and prospective follow-ups of smaller-sized samples of risk groups that, with some notable exceptions,[22-24] also had relatively short follow-ups. Use of data from the multiple waves of the NESARC dominates this research literature. Although the NESARC obtained data from a very large nationally representative sample of the U.S. population age 18 and older (e.g., $N = 36{,}309$ in NESARC-III), it shares limitations inherent to most survey research—namely, assessments must be relatively brief, meaning that the domains of inquiry must be limited and selected carefully and cannot be probed to obtain the detail typically useful in clinical applications.

These design characteristics have contributed to gaps in the literature due to overreliance on drinking practices as the major outcome metric and less common measurement of functioning, well-being, and life circumstances, which are central features of recovery and can occur with or without reductions in drinking. Correlates of remission rates are being reported with increasing frequency in survey research, but tend to be limited to demographic characteristics, problem severity variables related to drinking practices, help-seeking history, and, in some cases, psychiatric comorbidity. Other than the seminal research program of Moos and colleagues,[22,39] assessment of functioning, context, and well-being surrounding drinking behavior change is a relatively recent development, primarily evident in clinical research[18,21] and process-oriented research on natural recovery.[38] Connecting these research literatures in meaningful ways in future investigations is essential for broadening scientific knowledge about how affected individuals reduce and resolve their alcohol-related problems and for guiding improvements in alcohol services that are responsive to heterogeneity in recovery-related outcomes and pathways.

Another issue in need of further research involves deconstruction of separable processes that contribute to overall problem prevalence and remission rates across the life span. As highlighted in the research of Vergés, Lee, Sher, and colleagues,[31,34-36] overall population rates are influenced by age-related associations between problem onset, remission, and recurrence rates, which raises questions about whether remission patterns reflect a simple "maturing out" of harmful alcohol use that began in early adulthood. Based on the available data, Lee and Sher[31] concluded: "[T]he continual declines in AUD rates observed throughout the life span . . . appear mainly attributable to reductions in new onsets . . . whereas potential for desistance from an existing AUD may peak in young adulthood . . . [especially] for those with a severe AUD" (p. 37).

The timing and targeting of prevention and treatment programs could be refined to enhance intervention effectiveness if these age-related associations between problem onset, remission, and recurrence rates were firmly established and used to guide intervention delivery. Conducting this kind of research is challenging because it requires collecting data on all three processes over the life span, and there are additional complexities in studying the tails of the age distribution. For example, clinical diagnostic systems may overdiagnose AUD in adolescence, which would inflate estimates of remission rates in early adulthood.[50] Attrition biases are of concern with advancing age as poor health and death may remove proportionately more older adults with AUD from population samples, thereby inflating estimates of remission rates in old age particularly from severe AUD.[5,34]

A final generalization from this research concerns the limited contribution of alcohol treatment or other alcohol-focused services to recovery prevalence in the population. Low rates of service utilization have persisted despite improvements in AUD treatment and lower threshold options[28] and the expansion of access and coverage of services for SUD provided by the Affordable Care Act. The enduring gap between population need and service utilization despite these advances strongly suggests that alternative avenues are needed to increase intervention diffusion and uptake. It has proven insufficient to offer improved treatment predominately through the health care sector, and priority needs to be given to reaching broader segments of the at-risk population of drinkers who contribute most of the alcohol-related harm and cost. Nevertheless, a sizable subset of individuals with AUD improve or recover without interventions, and recent evidence suggests that individuals with more severe AUD exercise some degree of appropriate self-selection into treatment.[29] Empirical questions warranting further investigation are how to distinguish among individuals or risk groups for whom natural recovery is a high probability outcome and how to segment the market so that treatment services are targeted and available for those in need who are not likely to achieve recovery without treatment.

Further improvements in reducing the prevalence of AUD and increasing the prevalence of recovery likely depend on dissolving the silos that have long existed between clinical and epidemiological research and applications[11] and finding novel ways to disseminate evidence-based services to the large underserved at-risk population of drinkers who will not use professional services, at least in their present form. It is also important to consider a broader public health approach to dispel long-held beliefs that alcohol is a problem only for those with severe AUD and that those with AUD can resolve their problem only through abstinence. Perpetuation of these myths over many decades has stigmatized the disorder and deterred help-seeking among the millions of people who would benefit from drinking reductions.

In conclusion, recovery from AUD and alcohol-related problems is the most common outcome among those with problem alcohol use, and recovery without abstinence is possible, even among those with severe AUD. Changing

the narrative to highlight the high likelihood of recovery could help engage more individuals in alcohol-related services and may encourage individuals to reduce their drinking in the absence of formal treatment.

Acknowledgments

Portions of the research reported were supported in part by National Institutes of Health, National Institute on Alcohol Abuse and Alcoholism grant R01 AA022328.

Financial Disclosure

The authors have no competing financial interests to disclose.

References

1. Substance Abuse and Mental Health Services Administration (SAMHSA). *Key Substance Use and Mental Health Indicators in the United States: Results From the 2018 National Survey on Drug Use and Health*. Rockville, MD: SAMHSA; 2019. https://www.samhsa.gov/data/sites/default/files/cbhsq-reports/NSDUHNationalFindingsReport2018/NSDUHNationalFindingsReport2018.pdf. Accessed August 16, 2020.
2. Grant BF, Goldstein RB, Saha TD, et al. Epidemiology of DSM-5 alcohol use disorder: Results from the National Epidemiologic Survey on Alcohol and Related Conditions III. *JAMA Psychiatry*. 2015;72(8):757-766. https://doi.org/10.1001/jamapsychiatry.2015.0584.
3. American Psychiatric Association (APA). *Diagnostic and Statistical Manual of Mental Disorders*. 5th ed. Washington, DC: APA; 2013. https://doi.org/10.1176/appi.books.9780890425596.
4. National Institute on Alcohol Abuse and Alcoholism (NIAAA). *Alcohol Facts and Statistics*. Rockville, MD: NIAAA; 2019. https://www.niaaa.nih.gov/alcohol-facts-and-statistics. Accessed January 9, 2020.
5. Dawson DA, Grant BF, Stinson FS, et al. Recovery from DSM-IV alcohol dependence: United States, 2001-2002. *Addiction*. 2005;100(3):281-292. https://doi.org/10.1111/j.1360-0443.2004.00964.x.
6. Dawson DA, Goldstein RB, Grant BF. Rates and correlates of relapse among individuals in remission from DSM-IV alcohol dependence: A 3-year follow-up. *Alcohol Clin Exp Res*. 2007;31(12):2036-2045. https://doi.org/10.1111/j.1530-0277.2007.00536.x.
7. Fan AZ, Chou SP, Zhang H, et al. Prevalence and correlates of past-year recovery from DSM-5 alcohol use disorder: Results from National Epidemiologic Survey on Alcohol and Related Conditions-III. *Alcohol Clin Exp Res*. 2019;43(11):2406-2420. https://doi.org/10.1111/acer.14192.
8. Kelly JF, Bergman B, Hoeppner BB, et al. Prevalence and pathways of recovery from drug and alcohol problems in the United States population: Implications for practice, research, and policy. *Drug Alcohol Depend*. 2017;181:162-169. https://doi.org/10.1016/j.drugalcdep.2017.09.028.
9. Sobell LC, Cunningham JA, Sobell MB. Recovery from alcohol problems with and without treatment: Prevalence in two population studies. *Am J Public Health*. 1996;86(7):966-972. https://doi.org/10.2105/ajph.86.7.966.
10. Witkiewitz K, Montes K, Schwebel F, et al. What is recovery? *Alcohol Res*. 2020;40(3):01. https://doi.org/10.35946/arcr.v40.3.01.
11. Room R. Measurement and distribution of drinking patterns and problems in general populations. In: Edwards G, Gross MS, Keller M, et al., eds. *Alcohol-Related Disabilities.* Geneva, Switzerland: World Health Organization; 1977:61-87.
12. Tucker JA. Natural resolution of alcohol-related problems. In: Galanter M, et al., eds. *Recent Developments in Alcoholism. Volume 16: Research in Alcoholism Treatment.* Boston, MA: Springer; 2002;77-90. https://doi.org/10.1007/0-306-47939-7_7.
13. World Health Organization (WHO). *The ICD-10 Classification of Mental and Behavioural Disorders: Clinical Descriptions and Diagnostic Guidelines*. Geneva, Switzerland: WHO;1992.
14. NIAAA. *Helping Patients Who Drink Too Much: A Clinician's Guide*. Rockville, MD: NIAAA; 2005. https://pubs.niaaa.nih.gov/publications/practitioner/cliniciansguide2005/guide.pdf. Accessed August 16, 2020.
15. Betty Ford Institute Consensus Panel. What is recovery? A working definition from the Betty Ford Institute. *J Subst Abuse Treat*. 2007;33(3):221-228. https://doi.org/10.1016/j.jsat.2007.06.001.
16. Witkiewitz K, Tucker JA. Abstinence not required: Expanding the definition of recovery from alcohol use disorder. *Alcohol Clin Exp Res*. 2020;44(1)36-40. https://doi.org/10.1111/acer.14235.
17. Kaskutas LA, Borkman TJ, Laudet A, et al. Elements that define recovery: The experiential perspective. *J Stud Alcohol Drugs*. 2014;75(6): 999-1010. https://doi.org/10.15288/jsad.2014.75.999.
18. Witkiewitz K, Wilson AD, Pearson MR, et al. Profiles of recovery from alcohol use disorder at three years following treatment: Can the definition of recovery be extended to include high functioning heavy drinkers? *Addiction*. 2019;114(1):69-80. https://doi.org/10.1111/add.14403.
19. Jellinek EM. *The Disease Concept of Alcoholism*. New Haven, CT: Hillhouse Press; 1960.
20. Pearson MR, Kirouac M, Witkiewitz K. Questioning the validity of the 4+/5+ binge or heavy drinking criterion in college and clinical populations. *Addiction*. 2016;111(10):1720-1726. https://doi.org/10.1111/add.13210.
21. Wilson AD, Bravo AJ, Pearson MR, et al. Finding success in failure: Using latent profile analysis to examine heterogeneity in psychosocial functioning among heavy drinkers following treatment. *Addiction*. 2016;111(12):2145-2154. https://doi.org/10.1111/add.13518.
22. Brennan PL, Schutte KK, Moos BS, et al. Twenty-year alcohol-consumption and drinking-problem trajectories of older men and women. *J Stud Alcohol Drugs*. 2011;72(2):308-321. https://doi.org/10.15288/jsad.2011.72.308.

23. Vaillant GE. *The Natural History of Alcoholism Revisited*. Cambridge, MA: Harvard University Press; 1995.
24. Mattisson C, Bogren M, Horstmann V, et al. Remission from alcohol use disorder among males in the Lundby Cohort during 1947–1997. *Psychiatry J*. 2018;4829389. https://doi.org/10.1155/2018/4829389.
25. Sarich P, Canfell K, Banks E, et al. A prospective study of health conditions related to alcohol consumption cessation among 97,852 drinkers aged 45 and over in Australia. *Alcohol Clin Exp Res*. 2019;43(4):710721. https://doi.org/10.1111/acer.13981.
26. Grella CE, Stein JA. Remission from substance dependence: Differences between individuals in a general population longitudinal survey who do and do not seek help. *Drug Alcohol Depend*. 2013;133(1):146-153. https://doi.org/10.1016/j.drugalcdep.2013.05.019.
27. SAMHSA. *National Survey of Substance Abuse Treatment Services (N-SSATS): 2016. Data on Substance Abuse Treatment Facilities*. Rockville, MD: SAMHSA; 2017. https://www.samhsa.gov/data/sites/default/files/2016_NSSATS.pdf.
28. Tucker JA, Simpson CA. The recovery spectrum: From self-change to seeking treatment. *Alcohol Res Health*. 2011;33(4):371-379.
29. Tuithof M, ten Have M, van den Brink W, et al. Treatment seeking for alcohol use disorders: Treatment gap or adequate self-selection? *Eur Addict Res*. 2016;22(5):277-285. https://doi.org/10.1159/000446822.
30. Schuler MS, Puttaiah S, Mojtabai R, et al. Perceived barriers to treatment for alcohol problems: A latent class analysis. *Psychiatr Serv*. 2015;66(11):1221-1228. https://doi.org/10.1176/appi.ps.201400160.
31. Lee MR, Sher KJ. "Maturing out" of binge and problem drinking. *Alcohol Res*. 2018;39(1):31-42.
32. Grant BF, Chou SP, Saha TD, et al. Prevalence of 12-month alcohol use, high-risk drinking, and DSM-IV alcohol use disorder in the United States, 2001–2002 to 2012–2013: Results from the National Epidemiologic Survey on Alcohol and Related Conditions. *JAMA Psychiatry*. 2017;74(9):911-923. https://doi.org/10.1001/jamapsychiatry.2017.2161.
33. Grucza RA, Sher KJ, Kerr WC, et al. Trends in adult alcohol use and binge drinking in the early 21st-century United States: A meta-analysis of 6 national survey series. *Alcohol Clin Exp Res*. 2018;42(10):1939-1950. https://doi.org/10.1111/acer.13859.
34. Lee MR, Boness CL, McDowell YE, et al. Desistance and severity of alcohol use disorder: A lifespan-developmental investigation. *Clin Psychol Sci*. 2018;6(1):90-105. https://doi.org/10.1177/2167702617736852.
35. Vergés A, Jackson KM, Bucholz KK, et al. Deconstructing the age-prevalence curve of alcohol dependence: Why "maturing out" is only a small piece of the puzzle. *J Abnorm Psychol*. 2012;121(2):511-523. https://doi.org/10.1037/a0026027.
36. Vergés A, Haeny AM, Jackson KM, et al. Refining the notion of maturing out: Results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Am J Public Health*. 2013;103(12):e67-e73. https://doi.org/10.2105/ajph.2013.301358.
37. Hingson RW, Hereen T, Winter MR. Age at drinking onset and alcohol dependence: Age at onset, duration, and severity. *Arch Pediatr Adolesc Med*. 2006;160(7):739-746. https://doi.org/10.1001/archpedi.160.7.739.
38. Tucker JA, Cheong J, James TG, et al. Preresolution drinking problem severity profiles associated with stable moderation outcomes of natural recovery attempts. *Alcohol Clin Exp Res*. 2020;44(3):738-745. https://doi.org/10.1111/acer.14287.
39. Moos RH, Finney JW, Cronkite RC. *Alcoholism Treatment: Context, Process, and Outcome*. New York, NY: Oxford University Press; 1990.
40. Vasilenko SA, Evans-Polce RJ, Lanza ST. Age trends in rates of substance use disorders across ages 18-90: Differences by gender and race/ethnicity. *Drug Alcohol Depend*. 2017;180:260-264. https://doi.org/10.1016/j.drugalcdep.2017.08.027.
41. Patrick ME, Terry-McElrath YM, Lanza ST, et al. Shifting age of peak binge drinking prevalence: Historical changes in normative trajectories among young adults aged 18 to 30. *Alcohol Clin Exp Res*. 2019;43(2):287-298. https://doi.org/10.1111/acer.13933.
42. Gilbert PA, Pro G, Zemore SE, et al. Gender differences in use of alcohol treatment services and reasons for nonuse in a national sample. *Alcohol Clin Exp Res*. 2019;43(4):722-31. https://doi.org/10.1111/acer.13965.
43. Greenfield SF, Black SE, Lawson K, et al. Substance abuse in women. *Psychiatr Clin North Am*. 2010;33(2):339-355. https://doi.org/10.1016/j.psc.2010.01.004.
44. Zemore SE, Mulia N, Ye Y, et al. Gender, acculturation, and other barriers to alcohol treatment utilization among Latinos in three National Alcohol Surveys. *J Subst Abuse Treat*. 2009;36(4):446-456. https://doi.org/10.1016/j.jsat.2008.09.005.
45. Zemore SE, Murphy RD, Mulia N, et al. A moderating role for gender in racial/ethnic disparities in alcohol services utilization: Results from the 2000 to 2010 National Alcohol Surveys. *Alcohol Clin Exp Res*. 2014;38(8):2286-2296. https://doi.org/10.1111/acer.12500.
46. SAMHSA. *Behavioral Health Trends in the United States: Results From the 2014 National Survey on Drug Use and Health*. Rockville, MD: SAMHSA; 2015. https://store.samhsa.gov/product/results-from-the-2014-national-survey-on-drug-and-use-and-health-summary-of-national-findings/sma15-4927. Accessed August 16, 2020.
47. Vaeth PAC, Wang-Schweig M, Caetano R. Drinking, alcohol use disorder, and treatment access and utilization among U.S. racial/ethnic groups. *Alcohol Clin Exp Res*. 2017;41(1):6-19. https://doi.org/10.1111/acer.13285.
48. Rose G. Sick individuals and sick populations. *Int J Epidemiol*. 2001;30(3):427-434. https://doi.org/10.1093/ije/30.3.427.
49. Kelly JF, Greene MC, Bergman BG, et al. How many recovery attempts does it take to successfully resolve an alcohol or drug problem? Estimates and correlates from a national study of recovering U.S. adults. *Alcohol Clin Exp Res*. 2019;43(7):1533-1544. https://doi.org/10.1111/acer.14067.
50. Caetano R, Babor TF. Diagnosis of alcohol dependence in epidemiological surveys: An epidemic of youthful alcohol dependence or a case of measurement error? *Addiction*. 2006;101(s1):111-114. https://doi.org/10.1111/j.1360-0443.2006.01599.x.

ALCOHOL RESEARCH
Current Reviews

Alcohol Res. 2020;40(3):01. https://doi.org/10.35946/arcr.v40.3.01

Published: 30 September 2020

What Is Recovery?

Katie Witkiewitz,[1,2] Kevin S. Montes,[3] Frank J. Schwebel,[2] and Jalie A. Tucker[4]

[1]Department of Psychology, University of New Mexico, Albuquerque, New Mexico
[2]Center on Alcohol, Substance Use, and Addictions, University of New Mexico, Albuquerque, New Mexico
[3]Department of Psychology, California State University Dominguez Hills, Carson, California
[4]Department of Health Education and Behavior and Center for Behavioral Economic Health Research, University of Florida, Gainesville, Florida

Alcohol use disorder (AUD) is among the most prevalent psychiatric disorders and is associated with enormous public health costs. Although AUD and other addictive behaviors have been described as chronic relapsing conditions, most individuals who develop AUD will eventually recover. This narrative review provides an overview of definitions of recovery, with a focus on recovery from AUD. The definitions reviewed include those developed by key stakeholder groups, as well as definitions derived from recent quantitative and qualitative studies of individuals who meet criteria for AUD and attempt to resolve their problems with or without treatment or who self-identify as pursuing or achieving recovery. The literature reviewed supports a definition of recovery as an ongoing dynamic process of behavior change characterized by relatively stable improvements in biopsychosocial functioning and purpose in life. The review concludes that definitions of recovery that rely solely on abstinence from alcohol and the absence of AUD symptoms fail to capture the multidimensional and heterogeneous pathways to recovery that are evident among individuals in general population and clinical samples.

KEY WORDS: recovery; alcohol use disorder; alcohol dependence; remission; life-health-functioning; alcohol consumption; alcohol

INTRODUCTION

Alcohol use is associated with tremendous social and economic costs and contributes to 5% of the global disease burden.[1] Most of the costs are due to excessive drinking and alcohol use disorder (AUD), with AUD defined by the fifth edition of the *Diagnostic and Statistical Manual for Mental Disorders* (DSM-5) as clinically significant impairment or distress resulting from endorsing at least two of 11 symptoms in the past 12 months.[2] Based on epidemiological survey data in the United States, as many as 14% of individuals meet criteria for current AUD, and nearly one-third (29%) meet lifetime criteria for AUD.[3] Importantly, data from national epidemiological surveys, prospective observational studies, and randomized clinical trials of patients with AUD and individuals who

engage in problem use of alcohol indicate that most affected persons will ultimately recover[4]—with "recovery" defined in various ways by different stakeholders including researchers, clinicians, mutual help groups, health care organizations and policymakers, and persons with AUD.

Defining recovery consistently across studies and by various stakeholder groups is critical for advancing the science of AUD. First, through an agreed-upon definition of recovery, a better understanding can be gained of the clinical course of AUD and how AUD symptoms change over time. Second, an agreed-upon definition will facilitate the evaluation and dissemination of treatments for AUD, thereby increasing understanding of which treatments are associated with shorter- versus longer-term recovery from AUD and guiding development of new treatments to offer recovery support. Third, a definition of recovery will help individuals with AUD and their family and friends, health care providers and organizations, and policymakers gain a better understanding of the process of change in AUD and will help clarify expectations about change goals during the process of change. Fourth, operationalizing recovery may help to reduce the stigma associated with AUD by highlighting its possibility and prevalence and by providing both hope and a positive characterization of the AUD recovery process.[5,6]

The goals of this narrative review are to examine historical and current definitions of recovery, which are variable across studies and stakeholders; to review recent quantitative, qualitative, and mixed-methods studies that have examined the recovery construct among individuals with AUD; and to provide a new conceptual definition of recovery that is based on recent empirical findings. The discussion begins with an overview of the major diagnostic systems developed by the American Psychiatric Association in DSM-5 and the World Health Organization *International Classification of Diseases* (ICD-10) and the definitions of AUD and remission based on those systems. Historical definitions of recovery are then reviewed as defined by the Temperance Movement, early medical literature, the "Big Book" of Alcoholics Anonymous,[7] and the early behavior therapy movement. Current definitions of recovery as proposed by key stakeholder groups are considered next, followed by consideration of findings from quantitative and qualitative research that informs definitions of recovery among individuals who are attempting to resolve alcohol-related problems with or without formal treatment and who do and do not identify as being in or achieving recovery. A final section concludes with a summary of common themes across definitions and proposes an expanded definition of recovery that emphasizes improvements in well-being and functioning.

CLINICAL DIAGNOSIS OF AUD

DSM-5 defines AUD based on meeting criteria for two of 11 symptoms in the past 12 months.[2] The 11 symptoms can be roughly organized into four symptom clusters:

- Physiological correlates of alcohol use—(1) tolerance, (2) craving, and (3) symptoms of withdrawal;
- Loss of control over alcohol use—(4) drinking longer or larger amounts than intended, and (5) unsuccessful efforts to cut down or control drinking;
- Alcohol taking over other meaningful activities—(6) time spent in activities related to alcohol, and (7) other activities given up because of alcohol; and
- Problems resulting from alcohol use—(8) failure to fulfill role obligations, (9) social or interpersonal problems, (10) physical or psychological problems, and (11) use in situations that are physically hazardous.

DSM-5 also provides a definition of remission from AUD based on the length of time that symptoms are no longer present. Early remission is defined as greater than 3 months and less than 12 months of endorsing no symptoms of AUD, with the exception of craving. Sustained remission is defined as 12 months or more of endorsing no symptoms of AUD, with the exception of craving.

Craving is excluded from definitions of remission given that craving could persist long after remission of other AUD symptoms is achieved.[8]

ICD-10 defined alcohol dependence based on meeting three or more of six symptoms in the past 12 months, including (1) tolerance, (2) craving, (3) physiological withdrawal, (4) loss of control, (5) alcohol taking over other activities, and (6) problems resulting from alcohol use.[9] ICD-11 defines alcohol dependence as endorsement of two of three core features in the past 12 months, including (1) impaired control over alcohol, often including craving; (2) alcohol becomes increasingly prioritized in life, often despite problems; and (3) physiological features caused by pharmacological tolerance and withdrawal.[10] ICD-11 also includes codes for early full remission, defined as abstinence from alcohol lasting 1 to 12 months; sustained partial remission, defined as "significant reduction in alcohol consumption for more than 12 months" and not meeting criteria for ICD-11 alcohol dependence; and sustained full remission, defined as abstinence from alcohol lasting 12 months or longer.[11] Thus, according to ICD-11, full remission (early or sustained) requires abstinence from alcohol, and partial remission is defined by reductions in drinking and the absence of symptoms of disorder. In contrast, as noted above, the DSM-5 definition of remission is based solely on not meeting symptoms of the disorder and does not consider alcohol consumption.

DEFINITIONS OF RECOVERY

Historical Perspectives and Definitions of Recovery

As early as the late 1700s, American physician Benjamin Rush wrote about the effects of alcohol on the human body and mind, as well as potential remedies for "curing the ardent use of spirits on the body and mind."[12] Rush noted that abstinence from liquor was critical, while allowing consumption of larger quantities of beer or wine as acceptable substitutes for liquor. He concluded: "By the temporary use of these substitutes for spirits, I have never known the transition to sober habits, to be attended with any bad effects but often with permanent health of body, and peace of mind" (p. 32).

This very early harm reduction perspective contrasts with the subsequent focus of the Temperance Movement on ridding society of alcohol. The movement was active through the remainder of the 1800s and into the early 1900s and had many distinct groups and societies. Initially, the Temperance Movement focused on promoting abstinence from liquor, then transitioned to a singular goal of abstinence from alcohol, and later advocated for the legal prohibition of alcohol.[14] Inebriate asylums, which required abstinence from alcohol, emerged as a residential treatment option in the 1840s.[13]

The Temperance Movement was followed by the founding of Alcoholics Anonymous (AA) in the 1930s,[14] and AA has since had tremendous influence on modern conceptualizations of recovery. AA proposed a mutual help program defined by a 12-step recovery process for achieving and maintaining lifelong abstinence from alcohol. The "Big Book" of AA, first published in 1939, also made very clear that abstinence from alcohol was not sufficient to define recovery.[7] The Big Book describes the process of recovery through many of the chapters as a journey that includes major transformative changes that lead to improvements in health, functioning, and well-being.[7] Most of the 12 steps focus on addressing and resolving past and present problems associated with "alcoholism," a term first used by Swedish physician Magnus Huss in the mid-1800s.

In the mid-20th century, biostatistician and physiologist E. M. Jellinek led several initiatives aimed at increasing the study and dissemination of science related to "alcoholism," including early work studying members of AA and patients in treatment. Jellinek also proposed the disease concept of alcoholism, which he characterized as a progressive and chronic disease with several variants or "species.").[15(pp154-158)] Glatt expanded on Jellinek's model by developing a plan for rehabilitation and remission through a group treatment program largely based on AA principles

and practices.[16] Early work by Edwards further helped define the disease concept,[17] and pioneering work by Vaillant shed light on the possibility that individuals with AUD could recover in the absence of treatment.[18] Thus, early work was heavily influenced by AA, and abstinence was generally considered critical to recovery until the late 1900s.

In the 1970s, psychiatrist Mansell Pattison and psychologists Mark and Linda Sobell introduced modern behavioral conceptualizations of alcohol dependence that have replaced the disease concept of alcohol dependence in research and evidence-based treatments.[19] They defined alcohol dependence as a serious health problem "defined by drinking patterns and the adverse physical, psychological and/or social consequences of such drinking"; considered patterns of alcohol use as "lying on a continuum ranging from non-pathological to severely pathological" and noted that problem development "follows variable patterns over time and does not necessarily proceed inexorably to severe fatal stages;" and concluded that "[r]ecovery from alcohol dependence bears no necessary relation to abstinence, although such a concurrence is frequently the case" (pp. 4-5). This seminal reconceptualization of alcohol dependence and recovery remains relevant and influential in current research on AUD today. It was foundational in behavior therapy research and practice beginning in the 1970s to the present, a movement that produced evidence-based treatments in use today, including relapse prevention, motivational interviewing, reinforcement-based treatments, and cognitive behavioral therapy for AUD.

Also in the 1970s, the Sobells' clinical research demonstrating controlled drinking outcomes (defined as drinking fewer than 4.3 standard drinks on most days with allowance of up to 6.5 drinks for an isolated 1- or 2-day sequence) among a subset of treated patients with alcohol dependence sparked virulent controversy and challenged the then dominant view that recovery required lifelong abstinence.[20] Subsequent research has replicated and extended their findings.[21] Although specific quantity/frequency criteria used to define low- versus high-risk drinking practices are somewhat variable across studies and countries, low-risk drinking is now well established as a favorable outcome among persons previously diagnosed with AUD. For example, in the United States, low-risk drinking has been defined as consumption of fewer than 14 drinks per week with fewer than four drinks on any given day for men and fewer than seven drinks per week with fewer than three drinks on any given day for women. In contrast, consumption criteria considered indicative of higher-risk drinking practices are any occasions of more than 14 drinks weekly or more than five drinks daily for men and more than seven drinks weekly or more than four drinks daily for women.[22] As discussed in the rest of this paper and elsewhere,[4,23] these criteria have been widely adopted in recovery research, but have been found wanting as an outcome metric on several grounds and have contributed to a lesser focus on measures of well-being and functioning, which are central to most current definitions of recovery.

Current Definitions of Recovery

Recent illustrative definitions of recovery (summarized in Table 1) have focused on the importance of functioning and general well-being in defining recovery. For example, the Substance Abuse and Mental Health Services Administration (SAMHSA) advanced a working definition of recovery as "a process of change through which individuals improve their health and wellness, live a self-directed life, and strive to reach their full potential."[5] SAMHSA noted the importance of abstinence as one example of achieving improvements in health. Similarly, the Betty Ford Institute Consensus Panel in 2007 defined recovery as "a voluntarily maintained lifestyle characterized by sobriety, personal health, and citizenship."[24(p222)] Similar to the Big Book of AA, these definitions acknowledge that abstinence is not a sufficient condition for recovery and that an individual who merely abstains from alcohol, with little or no improvement in functioning or well-being, would

not be considered to be in recovery. In 2017, a Recovery Science Research Collaborative meeting was convened by recovery researchers with a specific focus on examining the concept of recovery based on a literature review and ideas generated by group members.[25] Their final definition was: "Recovery is an individualized, intentional, dynamic, and relational process involving sustained efforts to improve wellness." [25(p5)] This definition acknowledges the presence and importance of individual differences in the recovery process; it focuses on the recovery process as being both intentional and dynamic and as requiring sustained efforts to improve wellness. Improving wellness includes not only the physical benefits associated with reducing alcohol use,[26] but also benefits related to psychosocial and functional dimensions of wellness (e.g., social, emotional, financial).[27]

Table 1 Definitions of Alcohol Recovery

Source	Definition
Life functioning and context	
Substance Abuse and Mental Health Services Administration (SAMHSA) (2012)[5]	"a process of change through which individuals improve their health and wellness, live a self-directed life, and strive to reach their full potential" (p. 3)
Recovery Science Research Collaborative (2017)[25]	"an individualized, intentional, dynamic, and relational process involving sustained efforts to improve wellness" (p. 5)
Best et al. (2016)[41]	"a social process, underpinned by transitions in social network composition, that includes the addition of new recovery-oriented groups, where such groups are perceived as attractive, beneficial, and relevant, and involves the concurrent emergence of a new recovery-based social identity" (p. 120)
Abstinence/Drinking	
Betty Ford Institute Consensus Panel (2007)[24]	"a voluntarily maintained lifestyle characterized by sobriety, personal health, and citizenship" (p. 222)
Center for Substance Abuse Treatment (2007)[51]	Abstinence; essential recovery (e.g., handling negative feelings without using drugs or alcohol); enriched recovery (e.g., taking responsibility for the things I can change); and spirituality in recovery (p. 1008)
What do individuals think of recovery?	
Kaskutas et al. (2014)[6]	Abstinence; essential recovery (e.g., handling negative feelings without using drugs or alcohol); enriched recovery (e.g., taking responsibility for the things I can change); and spirituality in recovery (p. 1008)
Neale et al. (2016)[40]	Substance use, material resources, outlook on life, self-care, and relationships (p. 165)
SAMHSA (2012)[5]	"a process of change through which individuals improve their health and wellness, live a self-directed life, and strive to reach their full potential" (p. 3)
Recovery Science Research Collaborative (2017)[25]	"an individualized, intentional, dynamic, and relational process involving sustained efforts to improve wellness" (p. 5)
Best et al. (2016)[41]	"a social process, underpinned by transitions in social network composition that includes the addition of new recovery-oriented groups, where such groups are perceived as attractive, beneficial and relevant, and involves the concurrent emergence of a new recovery-based social identity" (p. 120)

On balance, similar to AA's view that recovery is optimally broad in scope, these recent consensus definitions of recovery focus heavily on enhanced well-being and functional improvements in areas adversely affected by drinking. They do not emphasize or are silent about changes in drinking or achieving abstinence. These characterizations, as well as recent empirical research on AUD recovery (described next), are similar to definitions of recovery for other psychiatric disorders (e.g., depression, schizophrenia) that emphasize recovery of functioning and do not require absence of any symptoms. These definitions differ from definitions of recovery from other health conditions such as cancer, that do not require improvement in well-being and quality of life.

EMPIRICAL RESEARCH EXAMINING RECOVERY AMONG INDIVIDUALS WITH AUD

Recent Quantitative Research on Recovery

As summarized by Tucker et al., research using both clinical and non-treatment-seeking samples has shown that the majority of individuals who develop AUD reduce or resolve their problem over time.[4] The pathways to improvement are heterogeneous, may occur with or without participation in treatment or mutual help groups, and involve improved functioning and well-being with or without reductions in drinking. Several lines of quantitative research, ranging from treatment outcome to naturalistic observational studies, have converged to support this expanded characterization of improvement in alcohol-related problems. Collectively, this body of work questions conventional views that alcohol and other drug use disorders are "chronically relapsing" conditions, for which treatment or mutual help group involvement is essential for recovery.[28,29]

For example, using data-driven approaches to studying longer-term outcomes among individuals with AUD who enrolled in clinical trials targeting AUD, Witkiewitz and colleagues followed treatment recipients for 3 years and identified four profiles of individuals based on intensity and frequency of alcohol consumption, as well as other indicators of health and well-being: (1) low-functioning frequent heavy drinkers, (2) low-functioning infrequent heavy drinkers, (3) high-functioning occasional heavy drinkers, and (4) high-functioning infrequent non–heavy drinkers.[30] Relative to high-functioning infrequent non–heavy drinkers, individuals who were high-functioning occasional heavy drinkers had lower baseline alcohol dependence severity, lower abstinence self-efficacy, and lower AA involvement, but they did not differ on other measures of functioning. High-functioning occasional heavy drinkers had significantly higher purpose in life compared to poor-functioning profiles and greater satisfaction with life compared to abstainers. Beyond portraying a broader representation of AUD outcomes to include both consumption and functioning, this work also helped clarify factors that may contribute to both consumption and functional outcomes. At baseline, greater social support for drinking predicted heavier drinking. Better mental health—including less severe psychiatric symptoms, depression, and anger—and greater purpose in life at 1 year following treatment were significantly associated with higher functioning at 3 years following treatment. Social support at 3 years following treatment was also greatest among the higher-functioning profiles. These findings were recently replicated in an independent sample.[31]

Using a similar data-driven approach, Witbrodt and colleagues identified five latent classes based on recovery elements reported in in-depth interviews and surveys completed by 9,341 individuals who self-identified as being in recovery. The five classes were characterized as (1) 12-step traditionalist, (2) 12-step enthusiast, (3) secular, (4) self-reliant, and (5) atypical.[6,32] Individuals in the 12-step traditionalist and enthusiast classes were most likely to have been or to be currently engaged in AA or other 12-step programs and were mostly abstinent. Those in the

secular, self-reliant, and atypical recovery classes were less likely to be abstinent or engaged in 12-step programs. Across all five classes, four items were commonly endorsed from among the top 10 ranking items as important to recovery: (1) being honest with oneself, (2) handling negative feelings without using drugs or alcohol, (3) being able to enjoy life, and (4) engaging in a process of growth and development.

In prospective research that followed a community sample of individuals who drank alcohol over 20 years, Moos and colleagues found that cognitions, attitudes, and beliefs, as well as contextual, social, and environmental factors, were critically important in predicting long-term reductions in drinking.[33,34] In terms of the role of drinking, any drinking was not predictive of long-term negative outcomes, but persistent average heavy drinking and heavy episodic drinking were each associated with greater problems related to alcohol use.[35]

Natural recovery studies also have highlighted the role of contextual variables in different pathways to AUD resolution. Tucker and colleagues conducted a series of studies guided by behavioral economics among individuals with AUD who resolved a drinking problem in the absence of treatment.[36,37] In addition to showing that many participants maintained stable abstinence or low-risk drinking without problems over 1- to 2-year follow-ups, this research distinguished those who maintained low-risk drinking from other outcome groups by how they handled their monetary spending before and after they initially stopped problem drinking (i.e., pre-resolution). Pre-resolution, participants who achieved stable low-risk drinking outcomes had more balanced allocations between spending on alcohol versus saving money for the future compared to those who remained abstinent or relapsed and who spent proportionately more on alcohol than savings. After initial resolution, the spending patterns of stable low-risk drinkers changed in ways that led to receipt of heretofore delayed large rewards (housing in particular) that yielded ongoing lifestyle benefits. By comparison, after resolution, participants who remained abstinent or relapsed spent less overall and tended to spend on smaller rewards (e.g., consumable goods, entertainment, gifts) throughout the post-resolution year, appearing to substitute alcohol with small frequent substance-free rewards. Thus, different recovery-relevant outcomes were associated with patterns and contexts of non-drinking behaviors before and after a quit attempt.

Another issue informed by recent quantitative research concerns the typical number of quit attempts before recovery is achieved. Kelly and colleagues surveyed a national sample of adults in the United States who successfully resolved a significant substance use problem and assessed the number of prior recovery attempts and the relationships between recovery attempts and post-recovery measures of psychological well-being and quality of life.[38] The mean, median, and modal numbers of recovery attempts were 5.4, 2.0, and 1.0, respectively; however, the distribution was positively skewed and included outliers, suggesting that a subgroup of individuals require many more attempts to change than others and may require a higher level of care. Another subset of participants reported not making a prior serious change attempt. These results are similar to another arm of the National Recovery Study, which reported reasons why individuals did not adopt or dropped the label "recovery" (e.g., putting problem behind them, perceiving low problem severity).[39]

Collectively, these studies support adoption of a more flexible definition of recovery (or other inclusive term) that focuses on improvements in areas of functioning adversely affected by drinking and enhanced access to non-drinking rewards. Furthermore, beneficial changes in limited areas of alcohol-related dysfunction and reductions in drinking can occur that contribute to improved health and well-being, even if they fall short of traditional definitions of recovery that emphasize abstinence as a required element. Although recent research is consistent in supporting these conclusions, they are advanced preliminarily, given that each of the aforementioned findings are from single studies

and require additional investigation to establish their robustness and generalizability across diverse AUD populations.

Recent Qualitative and Mixed-Methods Research on Recovery

Mixed-methods research in the United States and the United Kingdom has elucidated elements of recovery from the perspective of persons seeking to resolve AUD, and findings show consistencies with quantitative research on recovery. For example, Kaskutas and colleagues surveyed 9,341 individuals who self-identified as being in recovery to delineate specific aspects of recovery from the perspective of persons engaged in the process.[6] The survey consisted of 47 elements of recovery developed via initial qualitative work, which participants rated as (1) definitely belonging in their definition of recovery; (2) somewhat belonging in their definition of recovery; (3) not belonging in their definition, but potentially belonging in others' definitions of recovery; and (4) not belonging in a definition of recovery. Based on exploratory and confirmatory factor analyses, 35 elements were retained, and a four-factor solution emerged: (1) abstinence, (2) essentials of recovery, (3) enriched recovery, and (4) spirituality in recovery. The "essentials of recovery" factor refers to ways of being considered crucial to maintaining changes in alcohol and drug use (e.g., dealing with challenging negative feelings, realistic self-appraisal). This factor is distinct from the "enriched recovery" factor, which refers to an individual's ability to look inward (e.g., inner peace) and outward (e.g., living a life that contributes to others and society) and to engage in self-care. The six elements endorsed by more than 90% of participants as definitely belonging to their recovery definition were classified in the "essential recovery" and "enriched recovery" factors and were not in the "abstinence" factor.

Neale and colleagues developed a new patient-reported outcome measure of recovery from drug and alcohol dependence, named the Substance Use Recovery Evaluator (SURE), which incorporates input from addiction psychiatrists and staff as well as individuals in recovery (e.g., former and current users of drug and alcohol services).[40] Based on exploratory and confirmatory factor analyses, 21 items were retained, and a five-factor solution emerged: (1) substance use, (2) material resources, (3) outlook on life, (4) self-care, and (5) relationships. Similar to the findings of Kaskutas and colleagues,[6] only six of the 21 items pertained specifically to substance use–related recovery outcomes.[40] SURE provides a patient-centered method to assess a broad range of recovery-related outcomes valued and experienced by those who embark on various pathways toward recovery.

In addition to recent efforts to understand the concept of recovery from the perspective of persons attempting it, another body of research has investigated mechanisms of behavior change that may help explain how individuals are able to recover. For example, Best and colleagues developed the Social Identity Model of Recovery,[41] which, when applied to alcohol recovery, posits that an individual's social identity shifts during recovery and becomes defined more by the norms and behaviors of individuals who do not use alcohol (e.g., family members, spouse, friends, members of AA) than by those who drink alcohol. Research on AA has similarly shown that higher rates of AA attendance are associated with greater rates of abstinence and with reporting having more non-drinking friends.[42] AA engagement also has been found to be a catalyst for social network change that facilitates recovery.[43]

These findings highlight how changes in one's social identity and social network may support AUD recovery. Further investigation of social identity models, the role of social networks, and patient-centered research on the recovery experience is important for broadening the scope of assessment of recovery-relevant outcomes. In addition to contributing knowledge about how people recover, such qualitative research can inform improvements in alcohol services that are responsive to the preferences and needs of consumers of services and thus may help close the long-standing gap between need and alcohol services utilization.

WHAT IS RECOVERY? CONCEPTUALIZATION AND FUTURE DIRECTIONS FOR RESEARCH AND PRACTICE

Drawing from prior definitions and informed by recent empirical work, the authors conclude that recovery is a process of behavior change characterized by improvements in biopsychosocial functioning and purpose in life. As shown in Table 1, this conceptualization of recovery is similar to definitions of recovery developed by SAMHSA and the Recovery Science Research Collaborative, and it aligns with the empirical findings from Kaskutas, Neale, Kelly, and Witkiewitz, among others. These conceptualizations of recovery, including that of the authors, differ from the Betty Ford Institute Consensus Panel, which requires abstinence. Similarities across definitions of recovery shown in Table 1 indicate that alcohol recovery is a process that is dynamic and focuses on improvement of health and wellness. Definitions differ with respect to the inclusion of language pertaining to abstinence or changes and improvement in biopsychosocial functioning and purpose in life.

Based on the available literature, the authors question the validity of any definitions of recovery that rely solely on abstinence from alcohol or the absence of AUD symptoms and fail to consider changes in other outcomes related to improved functioning and purpose in life. Abstinence will be important for some individuals to start the recovery process and will likely contribute to the abatement of many AUD symptoms, both of which may be important for some individuals in the recovery process. But this is not universal, and limiting definitions of recovery to the elimination of alcohol consumption and AUD symptoms fails to capture the multidimensional and heterogeneous pathways to recovery that are evident in general population samples, as well as among patients who receive alcohol treatment.[23]

Such a shift in emphasis involves reducing the focus on a pathology-based conception of AUD recovery in favor of incorporating a broader strengths-based, resilience-building approach to behavior change.[44] Focusing on strengths and building resilience may shift emphasis toward helping people live the life of greatest value to them, which differs from most clinical treatment models and practices that focus on amelioration of disease. Examples of tactics to facilitate this goal include building and strengthening social and community ties, increasing physical activity, and increasing non–substance reinforcement and activities that do not require alcohol use. Clinically, many practitioners using evidence-based treatment approaches are likely already working in alignment with this conceptualization of recovery, which takes a whole person approach to clinical care and focuses on individual strengths, strengthening resilience, and engagement with community support systems. Achieving and maintaining financial stability, as well as housing and food security, is also critically important. Future work is needed to ascertain whether reduced alcohol consumption and remission from AUD symptoms are essential elements in defining recovery or whether a strengths-based model that focuses on well-being and functioning is sufficient to characterize recovery from AUD, or if some combination of relative emphasis on these two broad domains is optimal.

In the AUD field, this shift in emphasis toward improved functioning is exemplied by the concept of "recovery capital" introduced by Granfield and Smith in the context of understanding and promoting natural recovery without treatment.[45] Their approach focused on building and using internal and external resources (e.g., social, physical, cultural, community) needed for initiation and maintenance of recovery and recognized that recovery capital varies across individuals and is changeable over time. Yet, most American treatment programs remain focused on initiation and maintenance of abstinence, and relatively few address improving well-being, functioning, and life satisfaction. Mutual help groups offer fellowship and support, an important element of recovery capital and positive psychology approaches to

behavior change. So the field has made some progress in shifting away from a pathology-based model toward a strengths-based model of AUD recovery. However, these developments have largely been limited to behavioral treatments and recovery attempts outside the context of formal treatment, and many clinical treatment programs have not expanded their focus beyond reducing or eliminating alcohol use and associated symptoms.

Importantly, a shift in focus toward health and well-being should not go too far, as is the case in definitions of recovery that focus heavily on good citizenship and giving back to communities. As discussed by Lancaster, definitions of recovery should never require superhuman changes, and expecting a great abundance of citizenship and other aspirational goals among those in recovery "fail[s] to take into account the differences in the normative and social contexts of people's lives."[46(p758)] Some individuals who are in the process of recovery live in societal and cultural systems of disadvantage with ongoing experiences of discrimination that cannot be remediated through individual effort and are made more acute by the stigma of addiction.[47]

More generally, given that alcohol use is legal among adults and consuming alcohol without problems is socially normative behavior, the stigma of AUD is exacerbated when total abstinence from alcohol is a defining feature of health and well-being for one subgroup of individuals (those meeting AUD criteria) and is absent as a defining feature of health and well-being for another much larger subgroup (those not meeting AUD criteria). Moreover, defining recovery by abstinence reinforces the empirically debunked belief that alcohol is harmful only for those with AUD and that they can never drink again. Instead, from a public health perspective, it is crucial to focus on reductions in risks associated with drinking as the primary target for all individuals in the population, not just those with AUD. This is justified given the known deleterious effects of excessive alcohol consumption on health[27,48] and the well-established prevention paradox, i.e., greater health improvements at the population level will come from even small reductions in alcohol use by risky drinkers with less serious problems, who far outnumber the small minority of individuals who meet criteria for severe AUD.[23] Furthermore, recent work indicates that presenting information about AUD as existing on a continuum of severity, as compared to a disease model orientation of presence or absence of AUD, was associated with greater problem recognition among non–treatment-seeking heavy drinkers.[49] Defining AUD and recovery from AUD on a continuum could increase help seeking and/or promote self-change among individuals with AUD.

In conclusion, the authors define recovery as a dynamic process of change characterized by improvements in health and social functioning, as well as increases in well-being and purpose in life. The empirical literature compels this extension of definitions of recovery beyond a singular focus on drinking and symptom reduction to include facilitation and support of improved well-being during active recovery and beyond. Like prior work in the field, this definition is still conceptual, and future work is needed to validate a formal operational definition of recovery that recognizes that positive change often occurs in multiple domains, that recovery may lie along continua, and that there is no singular recovery pathway. The use of standardized instruments that are already widely used in the field—such as the World Health Organization's Quality of Life measure[50] and future research on SURE[40]—could move us closer to having a formal operational definition that could be widely useful for individuals with AUD, their families, providers, policymakers, and other stakeholder groups.

Acknowledgments

This study was funded by National Institute on Alcohol Abuse and Alcoholism grants T32 AA018108, K01 AA026309, and R01 AA022328.

Financial Disclosures

The authors declare no competing financial interests.

Publisher's Note

Opinions expressed in contributed articles do not necessarily reflect the views of the National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health. The U.S. government does not endorse or favor any specific commercial product or commodity. Any trade or proprietary names appearing in *Alcohol Research: Current Reviews* are used only because they are considered essential in the context of the studies reported herein.

References

1. World Health Organization (WHO). *Global Status Report on Alcohol and Health 2018*. Geneva, Switzerland: WHO; 2018.
2. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 5th ed. Washington, DC: American Psychiatric Association; 2013. https://doi.org/10.1176/appi.books.9780890425596.
3. Grant BF, Goldstein RB, Saha TD, et al. Epidemiology of DSM-5 alcohol use disorder: Results from the National Epidemiologic Survey on Alcohol and Related Conditions III. *JAMA Psychiatry*. 2015;72(8):757-766. https://doi.org/10.1001/jamapsychiatry.2015.0584.
4. Tucker JA, Chandler SD, Witkiewitz K. Epidemiology of recovery from alcohol use disorder. *Alcohol Res*. 2020, in press.
5. Substance Abuse and Mental Health Services Administration (SAMHSA). *SAMHSA Working Definition of Recovery: 10 Guiding Principles of Recovery.* Rockville, MD: Department of Health and Human Services; 2012. https://store.samhsa.gov/sites/default/files/d7/priv/pep12-recdef.pdf. Accessed June 29, 2020.
6. Kaskutas LA, Borkman TJ, Laudet A, et al. Elements that define recovery: The experiential perspective. *J Stud Alcohol Drugs*. 2014;75(6):999-1010. https://doi.org/10.15288/jsad.2014.75.999.
7. Anonymous. *Alcoholics Anonymous: The Story of How Many Thousands of Men and Women Have Recovered from Alcoholism*. New York, NY: Works; 1939.
8. Hasin DS, O'Brien CP, Auriacombe M, et al. DSM-5 criteria for substance use disorders: Recommendations and rationale. *Am J Psychiatry*. 2013;170(8):834-851. https://doi.org/10.1176/appi.ajp.2013.12060782
9. WHO. *International Classification of Diseases and Related Health Problems.* 10th Revision, 2010 Edition (ICD-10). Geneva, Switzerland: WHO; 2011.
10. Saunders JB, Degenhardt L, Reed GM, et al. Alcohol use disorders in ICD-11: Past, present, and future. *Alcohol Clin Exp Res*. 2019;43(8):1617-1631. https://doi.org/10.1111/acer.14128 .
11. WHO. *International Classification of Diseases, Eleventh Revision*. 2019. https://doi.org/10.1016/S0140-6736(19)31205-X.
12. Rush B. *An Inquiry into the Effects of Ardent Spirits upon the Human Body and Mind*. Philadelphia, PA: Tract Association of Friends; 1785.
13. Baumohl J. Inebriate institutions in North America, 1840–1920. *Br J Addict*. 1990;85(9):1187-1204. https://doi.org/10.1111/j.1360-0443.1990.tb03444.x.
14. White WL, Kurtz E. Twelve defining moments in the history of Alcoholics Anonymous. *Recent Dev Alcohol*. 2008;18:37-57. https://doi.org/10.1007/978-0-387-77725-2_3.
15. Jellinek EM. *The Disease Concept of Alcoholism*. New Haven, CT: Hillhouse Press; 1960.
16. Glatt MM. Group therapy in alcoholism. *Addiction*. 1958;54(2):133-148. https://doi.org/10.1111/j.1360-0443.1958.tb04266.x.
17. Edwards G, Gross MM. Alcohol dependence: Provisional description of a clinical syndrome. *Br Med J*. 1976;1(6017):1058-1061. https://doi.org/10.1136/bmj.1.6017.1058.
18. Vaillant GE. A twelve-year follow-up of New York narcotic addicts. I. The relation of treatment to outcome. *Am J Psychiatry*. 1966;122(7):727-737. https://doi.org/10.1176/ajp.122.7.727.
19. Pattison EM, Sobell MB, Sobell LC. *Emerging Concepts of Alcohol Dependence*. New York, NY: Springer; 1977.
20. Sobell MB, Sobell LC. Controlled drinking after 25 years: How important was the great debate? *Addiction*. 1995;90(9):1149-1177. https://pubmed.ncbi.nlm.nih.gov/7580815/.
21. Rosenberg H. Prediction of controlled drinking by alcoholics and problem drinkers. *Psychol Bull*. 1993;113(1):129-139. https://doi.org/10.1037/0033-2909.113.1.129.
22. Dawson DA. Alcohol consumption, alcohol dependence, and all-cause mortality. *Alcohol Clin Exp Res*. 2000;24(1):72-81. http://www.ncbi.nlm.nih.gov/pubmed/10656196.
23. Witkiewitz K, Tucker JA. Abstinence not required: Expanding the definition of recovery from alcohol use disorder. *Alcohol Clin Exp Res*. 2020;44(1):36-40. https://doi.org/10.1111/acer.14235.
24. Betty Ford Institute Consensus Panel. What is recovery? A working definition from the Betty Ford Institute. *J Subst Abuse Treat*. 2007;33(3):221-228. https://doi.org/10.1016/j.jsat.2007.06.001.
25. Ashford RD, Brown A, Brown T, et al. Defining and operationalizing the phenomena of recovery: A working definition from the Recovery Science Research Collaborative. *Addict Res Theory*. 2019;27(3):179-188. https://doi.org/10.1080/16066359.2018.1515352.
26. Rehm J. The risks associated with alcohol use and alcoholism. *Alcohol Res Health*. 2011;34(2):135-143.
27. Substance Abuse and Mental Health Services Administration. *What Individuals in Recovery Need to Know about Wellness.* Rockville, MD: SAMHSA; 2016.
28. Dennis M, Scott CK. Managing addiction as a chronic condition. *Addict Sci Clin Pract*. 2007;4(1):45-55. https://doi.org/10.1151/ascp074145.
29. McLellan AT, Lewis DC, O'Brien CP, et al. Drug dependence, a chronic medical illness. *JAMA*. 2000;284(13):1689-1695. https://doi.org/10.1001/jama.284.13.1689.
30. Witkiewitz K, Wilson AD, Pearson MR, et al. Profiles of recovery from alcohol use disorder at three years following treatment: Can the definition of recovery be extended to include high functioning heavy drinkers? *Addiction*. 2019;114:69-80. https://doi.org/10.1111/add.14403.
31. Witkiewitz K, Pearson MR, Wilson, AD, et al. Can alcohol use disorder recovery include some heavy drinking? A replication and extension up to nine years following treatment. *Alcohol Clin Exp Res*., in press.
32. Witbrodt J, Kaskutas LA, Grella CE. How do recovery definitions distinguish recovering individuals? Five typologies. *Drug Alcohol Depend*. 2015;148:109-117. https://doi.org/10.1016/j.drugalcdep.2014.12.036.
33. Moos RH, Moos BS. Protective resources and long-term recovery from alcohol use disorders. *Drug Alcohol Depend*. 2007;86(1):46-54. https://doi.org/10.1016/j.drugalcdep.2006.04.015.
34. Brennan PL, Schutte KK, Moos BS, et al. Twenty-year alcohol-consumption and drinking-problem trajectories of older men and women. *J Stud Alcohol Drugs*. 2011;72(2):308-321. https://doi.org/10.15288/jsad.2011.72.308.
35. Holahan CJ, Brennan PL, Schutte KK, et al. Late-life drinking problems: The predictive roles of drinking level vs. drinking pattern. *J Stud Alcohol Drugs*. 2017;78(3):435-441. https://doi.org/10.15288/jsad.2017.78.435.

36. Tucker JA, Roth DL, Vignolo MJ, et al. A behavioral economic reward index predicts drinking resolutions: Moderation revisited and compared with other outcomes. *J Consult Clin Psychol*. 2009;77(2):219-228. https://doi.org/10.1037/a0014968.
37. Tucker JA, Cheong J, James T, et al. Pre-resolution drinking problem severity profiles associated with stable moderation outcomes of natural recovery attempts. *Alcohol Clin Exp Res*. 2020;44(3):738-745. https://doi.org/10.1111/acer.14287.
38. Kelly JF, Greene MC, Bergman BG, et al. How many recovery attempts does it take to successfully resolve an alcohol or drug problem? Estimates and correlates from a national study of recovering U.S. adults. *Alcohol Clin Exp Res*. 2019;43(7):1533-1544. https://doi.org/10.1111/acer.14067.
39. Kelly JF, Abry AW, Milligan CM, et al. On being "in recovery": A national study of prevalence and correlates of adopting or not adopting a recovery identity among individuals resolving drug and alcohol problems. *Psychol Addict Behav*. 2018;32(6):595-604. https://doi.org/10.1037/adb0000386.
40. Neale J, Vitoratou S, Finch E, et al. Development and validation of SURE: A patient reported outcome measure for recovery from drug and alcohol dependence. *Drug Alcohol Depend*. 2016;165:159-167. https://doi.org/10.1016/j.drugalcdep.2016.06.006.
41. Best D, Beckwith M, Haslam C, et al. Overcoming alcohol and other drug addiction as a process of social identity transition: The social identity model of recovery (SIMOR). *Addict Res Theory*. 2016;24(2):111-123. https://doi.org/10.3109/16066359.2015.1075980.
42. Humphreys K, Mankowski ES, Moos RH, et al. Do enhanced friendship networks and active coping mediate the effect of self-help groups on substance abuse? *Ann Behav Med*. 1999;21(1):54-60. https://doi.org/10.1007/bf02895034.
43. Kelly JF, Hoeppner B, Stout RL, et al. Determining the relative importance of the mechanisms of behavior change within Alcoholics Anonymous: A multiple mediator analysis. *Addiction*. 2012;107(2):289-299. https://doi.org/10.1111/j.1360-0443.2011.03593.x.
44. Seligman ME, Csikszentmihalyi M. Positive psychology. An introduction. *Am Psychol*. 2000;55(1):5-14. https://doi.org/10.1037//0003-066x.55.1.5.
45. Granfield R, Smith W. *Coming Clean: Overcoming Addiction Without Treatment*. New York, NY: New York University Press; 1999.
46. Lancaster K. Rethinking recovery. *Addiction*. 2017;112(5):758-759. https://doi.org/10.1111/add.13552.
47. Vilsaint CL, Hoffman LA, Kelly JF. Perceived discrimination in addiction recovery: Assessing the prevalence, nature, and correlates using a novel measure in a U.S. national sample. *Drug Alcohol Depend*. 2020;206. https://doi.org/10.1016/j.drugalcdep.2019.107667.
48. Witkiewitz K, Hallgren KA, Kranzler HR, et al. Clinical validation of reduced alcohol consumption after treatment for alcohol dependence using the World Health Organization risk drinking levels. *Alcohol Clin Exp Res*. 2017;41(1):179-186. https://doi.org/10.1111/acer.13272.
49. Morris J, Albery IP, Heather N, et al. Continuum beliefs are associated with higher problem recognition than binary beliefs among harmful drinkers without addiction experience. *Addict Behav*. 2020;105. https://doi.org/10.1016/j.addbeh.2020.106292.
50. Development of the World Health Organization WHOQOL-BREF quality of life assessment. The WHOQOL Group. *Psychol Med*. 1998;28(3):551-558. https://doi.org/10.1017/s0033291798006667.
51. Substance Abuse and Mental Health Services Administration, Center for Substance Abuse Treatment. *National Summit on Recovery: Conference Report.* 2007. http://www.webcitation.org/6IML7OyMP.

Neuroplasticity and Predictors of Alcohol Recovery

Dongju Seo, Ph.D., and Rajita Sinha, Ph.D.

Dongju Seo, Ph.D., is an associate research scientist in the Department of Psychiatry, and Rajita Sinha, Ph.D., is a Foundations Fund Professor in the Departments of Psychiatry, Neurobiology, and Child Study at Yale University School of Medicine, New Haven, Connecticut.

Chronic alcohol-related neuroadaptations in key neural circuits of emotional and cognitive control play a critical role in the development of, and recovery from, alcoholism. Converging evidence in the neurobiological literature indicates that neuroplastic changes in the prefrontal–striatal–limbic circuit, which governs emotion regulation and decisionmaking and controls physiological responses in the autonomic nervous system and hypothalamic–pituitary–adrenal axis system, contribute to chronic alcoholism and also are significant predictors of relapse and recovery. This paper reviews recent evidence on the neuroplasticity associated with alcoholism in humans, including acute and chronic effects, and how these neurobiological adaptations contribute to alcohol recovery, along with the discussion of relevant clinical implications and future research directions.

Key words: Alcohol use, abuse, and dependence; alcoholism; alcohol effects and consequences; alcohol-related neuroadaptations; neurobiology; brain; neuroplasticity; prefrontal-striatal-limbic circuit; autonomic nervous system; hypothalamic-pituitary-adrenal axis system; recovery; relapse

Recovery from alcoholism is a complex and long-term process with high relapse rates. Therefore, understanding why people relapse has been critically important to improving treatment outcomes. To that end, researchers are looking for clinical and biological markers that predict relapse after treatment and to use those risk factors to develop effective treatments to reduce relapse rates. One promising research area is examining how alcohol changes structure and function in the brain, affecting what neuroscience calls neuroplasticity and causing neuroadaptations that can affect the brain's reward and decision-making centers and, in turn, affect relapse and recovery.

During recovery, individuals with alcohol use disorder (AUD) psychologically and physiologically recuperate from the deleterious effects of alcohol exposure by achieving complete abstinence or low-level, nonhazardous alcohol intake. The National Epidemiologic Survey of Alcohol-Related Conditions (NESARC) conducted 43,093 in-person interviews with a national sample of adults and found that 4,422 subjects, at some point prior to the past year, met the criteria for alcohol dependence, as defined by the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM–IV). According to the survey, during the preceding year, of those 4,422 alcohol-dependent people, 35.9 percent achieved either low-risk drinking (17.7 percent) or abstinence (18.2 percent) (Dawson et al. 2005). The study also noted that recovery rates tend to be even lower in clinical samples of people with severe dependence and for people with lifetime dependence or at high risk of relapse (Dawson et al. 2005). Additionally, the risk of relapse after treatment for AUD increases if people have concurrent conditions, such as anxiety or stress sensitivity (Kushner et al. 2005; Sinha et al. 2011).

In an effort to identify clinical and biological markers that predict relapse risk, researchers have looked toward the brain and alcohol-related changes in the brain that might make it more difficult for people with AUD to recover successfully. In particular, recent research has capitalized on advances in neuroimaging techniques to examine neuroplastic changes that may increase vulnerability to alcoholism and alcohol relapse (Buhler and Mann 2011). In fact, evidence suggests that chronic, heavy alcohol consumption is related to neuronal changes that target critical central nervous system (CNS) functions governing homeostasis, emotion regulation, and decisionmaking. These changes, in turn, may make it significantly more challenging for people to stop drinking and may result in various comorbid, psychological,

and physiological symptoms (Bechara 2005; Breese et al. 2011). For instance, when people with AUD are abstinent, altered neural circuits of stress and reward modulation make them highly sensitive to stress and increase alcohol craving and other withdrawal symptoms, including anxiety, negative emotion, autonomic nervous system (ANS) disruption, fatigue, and sleep problems (Breese et al. 2011; Seo and Sinha 2014).

These chronic alcohol-related neuronal changes and their co-occurring symptoms, such as stress, may serve as markers of alcohol relapse and long-term recovery but are not currently addressed in most AUD treatment programs. Already there is evidence that people who maintain long-term abstinence show functional differences in resting-state brain synchrony relative to those with short-term abstinence (Camchong et al. 2013).

This paper reviews the evidence for neuronal changes associated with alcoholism in humans, including those resulting from acute and chronic effects of alcohol, and how these changes contribute to alcohol relapse. To help understand alcohol recovery in a clinical research setting, the review will specifically focus on neuroplastic changes associated with alcohol relapse immediately following treatment. This paper also reviews the effects of stress on alcohol-related neuroplasticity and alcohol recovery, along with relevant clinical implications and future research directions. Elucidating the link between neuroplastic changes and alcohol recovery will contribute to our understanding of complex alcohol-related symptomatology and provide insights into the development of effective treatments to improve recovery from alcoholism.

Neuroplastic Changes in the PSL Circuit

Neuroplasticity refers to changes in the nervous system that occur in response to various stimuli or experiences and include structural and functional re-organization (Sale et al. 2014). These neuroplastic changes can be acute or take place over time (Sale et al. 2014) and can either be positive or negative, depending on the experience (Vance and Wright 2009). Neuroplastic changes in response to alcohol or other addictive substances are most commonly regarded as negative neuroplasticity associated with suboptimal functioning and maladaptive behaviors (Kalivas and O'Brien 2008). Addiction researchers frequently use the term "neuroadaptation" when referring to alcohol- or drug-related neuroplastic changes in the CNS (Breese et al. 2011; Cohen 2003; Shaham and Hope 2005). Thus, the addiction neuroscience literature uses the concepts of neuroadaptation and neuroplasticity interchangeably.

In studies of alcoholism, substantial evidence indicates short-term and long-term pharmacological effects of alcohol on the nervous system and related neurophysiological dysfunction (Seo and Sinha 2014). Specifically, research has well documented acute and chronic alcohol-related neuroadaptations in the prefrontal–striatal–limbic (PSL) circuit, which helps modulate motivation and emotion (Buhler and Mann 2011). The circuit consists of the striatal-limbic system, which is involved in the brain's reward system in the striatum, and its stress system, in the amygdala; and the prefrontal regulatory region, which includes the medial prefrontal cortex (PFC), the anterior cingulate cortex (ACC), the orbitofrontal cortex (OFC), and the dorsolateral PFC. As a whole, the PSL circuit plays a pivotal role in modulating reward, stress, and decision-making throughout the course of alcoholism, including the disorder's initial development, alcohol dependence, uncontrollable alcohol seeking, and continued alcohol relapse despite its negative consequences (Seo and Sinha 2014).

One way this circuit could interact with alcohol to influence these phases of alcoholism is through a part of the PSL circuit called the ventromedial prefrontal cortex (VmPFC), a brain region critical for emotional and behavioral control and that regulates the ANS and hypothalamic–pituitary–adrenal (HPA) axis systems (Radley 2006). If repeated alcohol use disturbs the VmPFC, it could disrupt the regulation and homeostasis of ANS and HPA axis system functioning, which can result in high physiological and emotional arousal, and, in turn, is associated with high alcohol craving (Sinha et al. 2009). Continued chronic alcohol-related changes in the PSL circuit could place individuals in a neurobiologically vulnerable state, substantially compromising their ability to control the urge to drink heavily and increasing the risk that they will resume drinking after a period of abstinence. For this reason, researchers have suggested that maintaining an intact PSL circuit is critical to a person's ability to overcome alcohol seeking and relapse urge (Koob 2009; Seo and Sinha 2014; Sinha 2008). Thus, understanding acute and chronic neuroadaptive patterns in the course of alcohol illness, especially in the PSL circuit, may provide insights into alcohol-related clinical symptoms, emotional and behavioral changes, and the potential impact of these patterns on alcohol recovery.

Acute Effects of Alcohol on Brain Response

Alcohol has clear and immediate pharmacological effects on the brain (see for example, Wallner and Olsen 2008). Specifically, neuroimaging studies of acute alcohol consumption in healthy social drinkers find specific effects on emotional processing and modulation (Gilman et al. 2008), cognitive disruption (Soderlund et al. 2007), and decisionmaking (Gilman et al. 2012).

In relation to emotional processing and modulation, several functional magnetic resonance imaging (fMRI) studies report acute effects of alcohol on reducing anxious and negative

emotion and increasing alcohol craving by modulating limbic-striatal activity. In one study (Gilman et al. 2008), researchers administered an intoxicating dose of alcohol to healthy individuals via intravenous injection and found they had reduced limbic response to fearful faces and increased striatal activity. In another study (Sripada et al. 2011), researchers found decreased activity in the amygdala when 12 healthy but heavy social drinkers ingested alcohol and then viewed socioemotional stimuli, including fearful/angry faces. Another study (Gorka et al. 2013), using the same study sample and design, found that drinking alcohol reduced the connectivity between the amygdala and orbitofrontal cortex, suggesting that the regulatory part of the brain is interacting less with the amygdala during the processing of socioemotional stimuli under the influence of alcohol. When a different group of healthy but heavy social drinkers received an alcohol taste cue, researchers saw increased activity in the VmPFC, the ACC, and the ventral striatum (Filbey et al. 2008). Consistent with this, researchers saw enhanced activity in regions of the ventral and dorsal striatum in healthy male social drinkers asked to imagine an alcohol cue–related situation, with a significant correlation between alcohol craving and activity in these regions (Seo et al. 2011).

Several fMRI studies also have reported an influence of alcohol on cognitive function and decisionmaking. Alcohol consumption in healthy individuals resulted in impaired episodic memory encoding, which, in turn, was associated with reduced activity in the lateral PFC (Soderlund et al. 2007). In addition, during a decision-making task, acute alcohol administration via intravenous injection increased risk-taking behaviors, increased striatal reactivity to risk choices, and blunted brain response to emotional feedback related to both winning and losing (Gilman et al. 2012).

Taken together, neuroimaging studies demonstrate the significant influence of alcohol in healthy individuals via alterations in the PSL circuit, including reduced limbic response to negative emotional stimuli (Gilman et al. 2008; Sripada et al. 2011), enhanced striatal response to rewarding stimuli (Filbey et al. 2008; Gilman et al. 2008; Seo et al. 2011) and to risky decision-making (Gilman et al. 2012), and impaired episodic memory functioning (Soderlund et al. 2007). These studies clearly point to the PSL circuit as a critical early target of alcohol effects and its potential, deleterious impact on neuroplasticity with chronic alcohol abuse.

Neuroadaptations, Chronic Alcoholism, and Recovery

Not surprisingly, just as acute alcohol consumption affects the brain, so does chronic, heavy alcohol consumption. In fact, studies consistently report alcohol-related neuroadaptive changes in the PSL circuit, along with related allostatic changes in physiological functions, including ANS and HPA axis systems (Breese et al. 2011; Seo and Sinha 2014). The brain regions affected include the reward system, the stress system, and the prefrontal regulatory system (Seo and Sinha 2014).

Reward System Dysfunction and Alcohol Recovery

Several lines of research link changes in the striatum and, therefore, the brain's reward system to chronic alcohol use:

- Blunted dopamine release and other types of dopamine dysfunction in the striatum may be a biomarker indicating increased vulnerability to alcohol and other substance use (Trifilieff and Martinez 2014);
- Chronic alcohol abuse and exposure result in alterations in reward brain regions, such as the ventral striatum, leading to disrupted dopamine transmission and striatal activity (Martinez et al. 2005; Seo and Sinha 2014; Volkow et al. 2002).
- Detoxified AUD patients show signs of altered reward responses, such that enhanced ventral striatal activity is more biased toward alcohol cues than other reward cues, such as money (Wrase et al. 2007); and
- People with AUD had reduced levels of dopamine D2 receptors in their frontal-striatal regions compared with control subjects (Volkow and Fowler 2000).

Researchers have suggested that repeated alcohol use gradually enhances incentive salience and craving response toward alcoholic beverages by altering the reward pathways and triggering more alcohol craving and drug seeking (Breese et al. 2011; Robinson and Berridge 1993). Altered reward-system function, in turn, could further aggravate a lack of control over the reward response and intensify alcohol craving and the urge to drink alcohol, both of which are associated with increased vulnerability to alcohol relapse (Breese et al. 2011; Sinha 2008). Several lines of research support this theory, reporting significant associations between altered striatal response and alcohol relapse:

- Decreased levels of striatal dopamine D2 receptor persisted in AUD patients and did not recover up to 4 months after alcohol detoxification (Volkow et al. 2002).
- Patients who relapsed within 3 months after discharge had lower levels of dopamine during detoxification than patients who did not relapse, according to a study that measured dopamine in 21 AUD inpatients using [^{123}I] iodobenzamide (IBZM) single-photon emission computerized tomography (SPECT) (Guardia et al. 2000).
- AUD patients who relapsed within 3 months of becoming abstinent

showed increased activity in part of the striatum, called the ventral putamen, when viewing visual alcohol cues during the early weeks of abstinence (at least 1 week after detoxification) (Braus et al. 2001).

- On the other hand, recently detoxified (1 to 3 weeks) alcoholic patients with a blunted striatal response to positive emotional pictures relative to neutral pictures had a greater number of drinking days and a higher amount of alcohol consumed during the 6-month followup (Heinz et al. 2007).

These studies suggest that striatal reward system function plays a key role in the development of alcoholism and continues to influence the course of alcoholism by affecting alcohol recovery. Continued alcohol use seems to sensitize striatal reward function and increase incentive salience toward alcohol stimuli. In AUD patients, this altered striatal system may further intensify craving responses and trigger withdrawal symptoms during alcohol-free periods, increasing risk for relapse (Vanderschuren and Pierce 2010).

Neuroadaptations in the Neural Circuit of Stress Modulation

As excessive alcohol use continues, alterations in the reward system could result in allostatic changes in other brain regions closely connected with the striatum, including the limbic regions and the PFC (Breese et al. 2011; Koob and Volkow 2010). In particular, alterations in the stress system may play a crucial role in the well-known comorbid symptoms associated with alcohol dependence, including aversive emotional states such as anxiety, negative mood, high stress sensitivity, and stress-induced alcohol craving (for example, see Sinha et al. 2009).

Stress is a critical factor in increasing alcohol craving and compulsive alcohol consumption (Breese et al. 2005; Koob 2009), as evidenced by both preclinical and clinical studies, including overconsumption of alcohol in male mice with prenatal stress (Campbell et al. 2009), early trauma associated with greater alcohol use and alcohol craving (Schumache et al. 2006), and increased alcohol use after the 9/11 terrorist attacks among New York City residents (Vlahov et al. 2006). Individuals suffering from chronic alcoholism frequently report high stress sensitivity and stress-triggered intense craving (Fox et al. 2007; Sinha et al. 2009). And stress sensitivity plays a crucial role in increased alcohol craving to alleviate aversive emotions or stimuli (Gilpin and Koob 2008)—known as "negatively reinforced craving"—which becomes a main driving force for drinking as excessive alcohol use continues (Koob 2009; Koob et al. 2004; Sinha 2008).

Stress is a critical factor in increasing alcohol craving and compulsive alcohol consumption.

The brain's stress response involves activation of the ANS and HPA axis systems to promote regulation of physiological arousal and also facilitate adaptive coping (Sinha 2008). Chronic alcoholism is associated with impaired autonomic regulation characterized by high basal heart rate, reduced heart rate variability, and increased blood pressure (Quintana et al. 2013; Sinha et al. 2009; Stormark et al. 1998; Thayer et al. 2006). Further, upregulated HPA axis function, including elevated levels of basal cortisol and adreno-corticotrophic hormone (ACTH), has been frequently found in people with AUD (Breese et al. 2011; Sinha 2008; Sinha et al. 2009). Consistent with this, alcoholics who continue to drink, and those experiencing withdrawal symptoms, have increased levels of basal stress hormones, including cortisol, norepinephrine, and corticotropin-releasing factor (CRF) (for review, see Breese et al. 2011). In addition, a study of 93 treatment-engaged, 1-month-abstinent AUD patients found strong associations between alcohol relapse and HPA axis system function. In this study, greater morning adrenal sensitivity indexed by the cortisol-to-ACTH ratio significantly predicted a shorter time to future initial relapse as well as heavy-drinking relapse (Sinha et al. 2011), indicating a significant role of chronic alcohol-related stress pathology in alcohol recovery.

In terms of brain regions involved, researchers postulate that neuroadaptations in the amygdala may influence negatively reinforced craving and alcohol seeking (Koob 2009; Koob et al. 2004; Sinha 2008). The amygdala is involved in stress-induced physiological responses via modulation of CRF and norepinephrine pathways, which are well known for their contribution to negative reinforcement aspects of addiction (Koob 1999, 2009). Research with AUD patients abstinent for 1 week shows a potential role of altered amygdala functioning in alcohol recovery. In this study, patients who relapsed had reduced amygdala volume compared with patients who did not relapse, and the reduction of the amygdala volume was significantly associated with alcohol craving and the amount of follow-up alcohol drinking (Wrase et al. 2008). Consistent with these data, preclinical studies report associations between altered response in the extended amygdala and stress-primed drug reinstatement (for review, see Kalivas and McFarland 2003).

During stress, ANS and HPA axis function are under the regulatory control of the VmPFC (Figueiredo et al. 2003; Radley 2006). Preclinical studies demonstrate decreased HPA axis response to stress following VmPFC lesions (Radley 2006) and find that the VmPFC maintains stress-related inhibitory control over HPA axis arousal (Figueiredo et al. 2003). In addition, a meta-analysis of

studies in humans reported significant associations between brain activity in the VmPFC and amygdala and ANS function indexed by heart rate variability (Thayer et al. 2012). Given that chronic alcoholism is associated with HPA axis and ANS system dysfunctions, as discussed earlier, these findings on the VmPFC regulation over stress-related HPA axis and ANS arousal suggest that individuals with chronic alcoholism may have underlying VmPFC dysfunction in response to stress. Consistent with this hypothesis, a recent fMRI study (Seo et al. 2013) found lowered activity in the stress modulatory regions involving VmPFC/ACC during stress exposure in 30 AUD patients engaged in inpatient treatment and abstinent for 4 weeks, compared with 30 matched healthy control subjects (figure 1A). Interestingly, the researchers observed an opposite pattern when the subjects were relaxed: AUD patients showed hyperactive VmPFC/ACC compared with control subjects (figure 1A). More importantly, to prospectively assess relapse and early recovery, these researchers followed the same 30 AUD patients, plus 15 others, after they completed inpatient treatment. Results indicated that lowered VmPFC activity in response to stress exposure relative to the response when patients were relaxed was significantly associated with stress-induced alcohol craving and also predicted a shorter time to future relapse (see figure 1B) (Seo et al. 2013). In addition, lower VmPFC activity and insula response to stress was significantly correlated with more days of alcohol use during subsequent followup, emphasizing the contribution of altered stress neural circuitry to relapse susceptibility (Seo et al. 2013).

Although further work still is needed to fully understand the associations between stress-related neural response during abstinence, treatment, and early alcohol recovery, available data suggest that neuroadaptations in the peripheral and CNS involved in stress modulation play a significant role in recovery from chronic alcoholism. Altered emotional and stress responses and poor abilities to cope under stress observed in people with AUD may increase vulnerability to high-stress–related craving, relapse, and alcohol drinking, especially under challenging life circumstances.

PFC Regulatory Function in Alcohol Recovery

If repeated alcohol exposure disrupts the limbic-striatal system, the result could progressively debilitate prefrontal executive functions (Seo and Sinha 2014). Chronic alcohol-related PFC impairments, in turn, can compromise one's ability to recover from alcoholism by adversely influencing executive function, inhibitory control, and decisionmaking (Bechara 2005; Goldstein and Volkow 2011). Many neuroimaging studies consistently have indicated structural and functional deficits in prefrontal regulatory regions associated with chronic alcoholism (for review, see Buhler and Mann 2011).

Structural imaging studies, for example, find reduced gray matter volume in the medial PFC/OFC and its surrounding regions in AUD patients, and this is associated with poor treatment outcome. One study (Durazzo et al. 2011) examined cortical thickness in people with AUD who averaged 35 to 36 years of lifetime drinking and were seeking treatment. Patients who relapsed by a 12-month followup had decreased cortical thickness, especially in the OFC and right rostral/caudal middle frontal cortex, compared with AUD patients who continued to abstain after 12 months. (Durazzo et al. 2011). In an MRI study that examined AUD patients with an average of 18.6 years of alcohol use, soon after they became abstinent during treatment, patients had decreased brain volume in the gray matter of their medial PFC and posterior parietal-occipital area. At a 3-month followup after treatment, the researchers found that the degree of volume reductions significantly predicted a shorter time to initial relapse as well as heavy-drinking relapse, even after controlling for years of alcohol use and baseline alcohol intake (Rando et al. 2011). Furthermore, a study investigating both structural and functional patterns in detoxified AUD patients found that patients who relapsed within 3 months after completing treatment showed atrophy in regions of OFC and right medial PFC and ACC compared with patients who did not relapse. Relapsed patients also showed increased alcohol cue–induced activation in the left medial PFC regions in this study (Beck et al. 2012).

Functional neuroimaging studies also have reported connections between alcoholism, alcohol recovery, and altered activity in the medial PFC, OFC, and striatum. In AUD individuals, PET imaging studies found decreased glucose metabolism in the frontal cortex during alcohol withdrawal (for review, see Volkow and Fowler 2000) and reduced availability in striatal D2 receptors associated with lowered OFC/ACC function (Volkow et al. 2007). A study performing a 3-month followup on alcohol-dependent patients who had been abstinent for an average of 7 weeks prior to the start of the study, found that the five patients who relapsed showed pronounced activity in the medial PFC, ACC, and striatum when they viewed alcohol pictures. In these patients, there was a significant association between medial PFC activity and the amount of subsequent alcohol consumption (Grusser et al. 2004). Another study used SPECT to study brain blood flow in AUD inpatients at the end of an alcohol detoxification program that lasted at least 7 days. The nine patients who relapsed 2 months later displayed decreased blood flow in the medial frontal lobe and poor working-memory performance relative to 11 abstainers. The working-memory deficits were associated with low blood flow in the medial frontal lobe (Noel et al. 2002). These neuroimaging studies point to a potential significant role of structural and func-

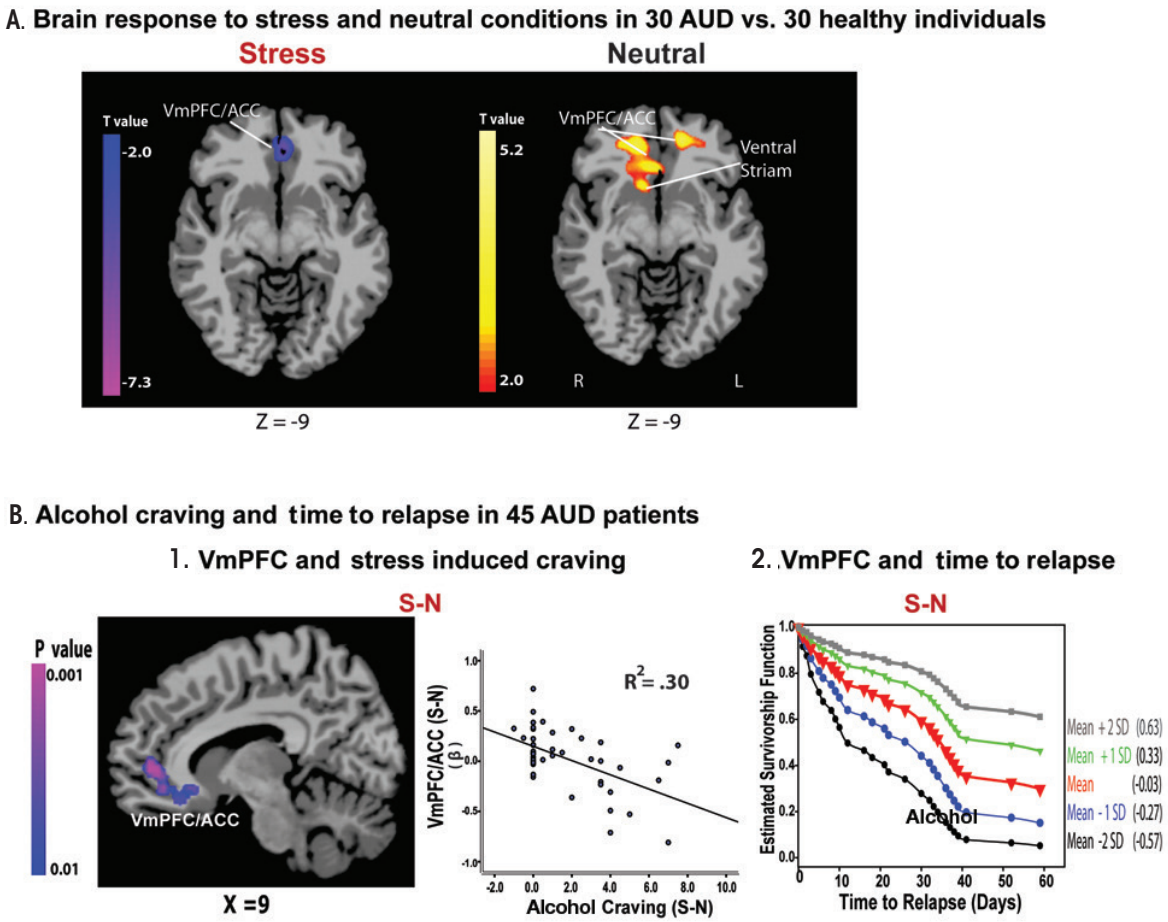

Figure 1 Hypoactive ventromedial prefrontal cortex (VmPFC) response to stress, alcohol craving, and relapse risk. **(A)** Hypoactive VmPFC response to stress but hyperactive response to neutral-relaxing condition in 30 patients with alcohol use disorder (AUD) compared with 30 healthy control subjects. AUD patients showed hypoactive VmPFC and anterior cingulate cortex (ACC) response to stress compared with demographically matched healthy control subjects ($P < 0.05$; whole-brain familywise error correction [FWE] corrected). **(B)** Neural correlates of alcohol craving and relapse in 45 AUD patients. **(B-1)** Whole-brain correlation analyses indicated that hypoactive VmPFC/ACC response to stress, compared with a neutral condition, was associated with increased alcohol craving during stress ($r = –0.55$; $R^2 = 0.30$; $P < 0.01$ whole-brain FWE corrected). No other regions were significantly associated with craving in this whole-brain voxel-based analysis. **(B-2)** Estimated survival functions for time to initial alcohol relapse are presented to illustrate the increasing risk of relapse with signal changes in the VmPFC hypoactivity during stress relative to the neutral condition: mean (in red) +1 (green) and +2 (gray) standard deviation (SD) above the mean, and –1 (blue) and –2 (black) SD below the mean. Cox proportional hazards regression analysis also indicates that hypoactive response during stress-neutral predicted a shorter time to initial alcohol use ($\chi^2 = 5.37$, $P < 0.05$; hazard ratio [HR] = 0.22, confidence interval [CI] = 0.06–0.79) as well as heavy-drinking relapse ($\chi^2 = 5.5$, $P < 0.05$; HR = 0.21, CI = 0.06–0.77). S-N = stress-neutral.

NOTE: This figure is reproduced with the permission of the American Medical Association (Seo et al. 2013).

tional neuroplasticity in the prefrontal regulatory regions involving the medial PFC, OFC, and ACC in increased relapse risk and poor alcohol recovery.

Neuronal Hyperexcitability and Alcohol Recovery

Recent evidence in humans suggests that excessive, chronic alcohol consumption may lead to hyperexcitability of neurons in the CNS, which, in turn, plays a role in alcohol addiction and recovery (Porjesz and Begleiter 2003; Seo et al. 2013; Sinha et al. 2011). Indeed, studies have found hyperactive CNS and electroencephalogram (EEG) responses in people with AUD, including increased excitatory neurotransmission associated with long-term alcohol use and hyperactive EEG responses in the frontal regulatory regions (Bauer 2001; Porjesz and Begleiter 2003). Studies also have found that alcohol-related neuronal adaptations on basal-state physiology, including upregulated ANS and HPA axis systems, underlie high alcohol craving, poor clinical outcome, and relapse vulnerability by disrupting physiological arousal (Breese et al. 2011; Seo et al. 2013; Sinha et al. 2011). In addition, a recent fMRI study found significant associations between hyperactive brain response during a relaxed state and susceptibility to alcohol craving and relapse in AUD patients who were engaged in treatment and 4 to 8 weeks abstinent. In this study, hyperactivity during relaxation in the VmPFC/ACC, but no other region, was associated with greater alcohol craving when subjects were presented with alcohol cues (figure 2A). In addition, the VmPFC/ACC hyperactivity predicted a shorter time to subsequent initial relapse and heavy-drinking relapse (figure 2B), as well as more alcohol use during a 90-day follow-up period (Seo et al. 2013). These findings highlight the important role of basal-state hyperactivity and integrity of VmPFC function in recovery from chronic alcoholism.

Conclusion and Future Directions

Alcoholism is a chronic illness, characterized by high relapse risk. Research now suggests that underlying this chronic relapse risk may be negative neuroplastic changes in the brain caused by the cycle of continued alcohol abuse and repeated brief alcohol abstinence and/or alcohol withdrawal. These neuroplastic changes occur in the PSL circuit, which regulates emotions and decisionmaking, which, in turn, influence alcohol recovery (Bechara 2005; Everitt and Robbins 2005; Goldstein and Volkow 2011). Within the PSL circuit, the PFC regulates limbic and striatal regions to modulate emotional and physiological responses to various

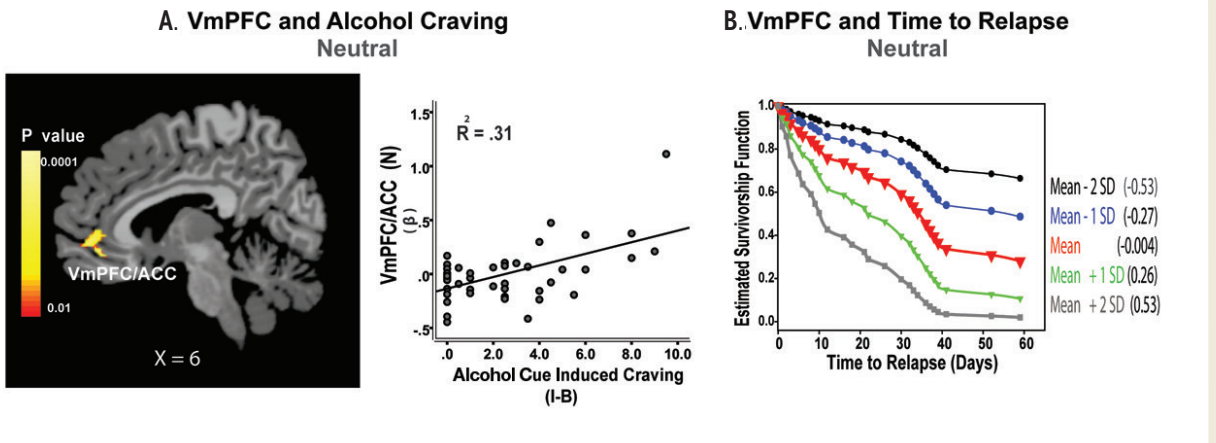

Figure 2 Hyperactive ventromedial prefrontal cortex (VmPFC) response to the neutral-relaxing condition, alcohol craving, and relapse risk. **(A)** In 45 patients with alcohol use disorder (AUD), hyperactive response in the VmPFC and anterior cingulate cortex (ACC) when they are exposed to neutrally relaxing situations during brief guided imagery was significantly associated with high alcohol craving during alcohol cue imagery ($R = 0.56$; $R^2 = 0.31$, $P < 0.01$ whole-brain FWE corrected). **(B)** Estimated survival functions for time to initial alcohol relapse, showing that the more VmPFC hyperactivity during the neutral condition, the shorter the time to subsequent initial relapse and heavy drinking relapse: mean (in red) +1 (green) and +2 (gray) standard deviation (SD) above the mean, and –1 (blue) and –2 (black) SD below the mean. Cox proportional hazards regression analysis indicates that hyperactive VmPFC response during the neutral condition predicted a shorter time to initial alcohol use ($\chi^2 = 6.39$, $P = 0.01$; hazard ratio [HR] = 8.45, confidence interval [CI] = 1.6–44.2) as well as heavy drinking relapse ($\chi^2 = 7.39$, $P < 0.01$, HR = 8.68, CI = 1.8–41.2). I-B = imagery minus baseline ratings.

SOURCE: This figure is reproduced with the permission of the American Medical Association (Seo et al. 2013).

reward- and stress-related stimuli (Seo and Sinha 2014). In individuals with chronic alcoholism, persistent sensitization of subcortical limbic-striatal regions from prolonged alcohol use could compromise the PFC regulatory function, resulting in difficulties in emotional regulation, poor impulse control, and high alcohol craving. Substantially weakened PFC function could, in turn, further disinhibit limbic-striatal responses especially under challenging situations, including stress and exposure to alcohol-related cues. In addition, given the crucial role of the PFC in inhibitory control and decisionmaking (Bechara 2005; Goldstein and Volkow 2011), altered PFC function could result in an inability to inhibit compulsive alcohol seeking and poor decisionmaking when confronted with the choice to return to drinking and continued alcohol use despite negative consequences, thereby aggravating the relapse cycle.

The evidence supporting a role of the neuroadaptative changes in the PSL circuit in alcohol recovery points to important clinical implications:

- The neuroadaptive patterns in this circuit may serve as a set of neurobiological markers of alcohol relapse and recovery. Future research can validate these patterns and investigate their use to help predict relapse vulnerability and to identify people with the greatest challenge to alcohol recovery in the clinical setting.

- Researchers could develop and test novel treatment strategies that target these validated biomarkers and attempt to reverse these neuroadaptations and significantly improve the chances of recovery from alcoholism. Already evidence supports a mediating role of neuroplasticity in the PSL circuit in improving treatment outcome. A study (Muller et al. 2009) with deep brain stimulation showed the effectiveness of this method in recovering ventral striatal function in AUD individuals. In addition, a recent fMRI study (Brewer et al. 2011) showed that meditators with mindfulness training experience have stable VmPFC and posterior cingulate cortex activity compared with control subjects as well as stronger connectivity between cingulate cortex and dorsolateral PFC, suggesting that mindfulness training may hold potential for treating alcoholism. Consistent with these data, a recent clinical outcome study (Bowen et al. 2014) reported that participants assigned to a mindfulness-based relapse prevention program had fewer days of drug use and decreased heavy drinking, compared with cognitive–behavioral relapse prevention or 12-step–based program approaches at a12-month followup.

- Researchers could develop treatments that target withdrawal symptoms and stress-related pathology, such as stress-induced craving and alcohol seeking, implicated by the alcohol-related neuroadaptations in the PSL circuit. For instance, alpha1-adrenergic antagonists, such as Prazosin, show promise for improving stress-induced deficits and impaired PFC function from chronic stress (for a review, see Arnsten 2009). This drug also reduces alcohol withdrawal symptoms and stress-related alcohol seeking in animals (Kukolja et al. 2011; Walker et al. 2008) and improves stress and alcohol cue–induced craving and alcohol use outcomes in humans (Fox et al. 2012; Simpson et al. 2009). Alternative medicines, such as herbal remedies, are another area of interest. For example, Ge Gen (Kudzu root, Rx. Pueriariae), an herbal remedy frequently used in Eastern medicine, is effective in controlling alcohol intake and alcohol-related withdrawal symptoms (Benlhabib et al. 2004; Lukas et al. 2005). Studies that examine whether the treatments can restore PSL circuit function, especially the VmPFC, and improve alcoholism recovery rates, would be beneficial.

In conclusion, current neurobiological research in humans has identified neuroplasticity in the PSL circuit and its related dysfunctions as key factors increasing relapse risk and jeopardizing alcohol recovery. Further development of biomarkers for these alcohol-related neuroadaptive changes and new treatments that aim to restore the brain have the potential to influence the development of new treatment strategies to promote alcohol recovery and reduce the global burden associated with alcoholism.

Acknowledgments

This work was supported by National Institutes of Health grants R01–AA–013892, R01–AA–20504, R01–AA–20095, UL1–RR–024139, and the NIH Common Fund grant UL1–DE–19856, PL1–DA–024859.

Financial Disclosure

The authors declare that they have no competing financial interests.

References

Arnsten, A.F. Stress signalling pathways that impair prefrontal cortex structure and function. *Nature Reviews. Neuroscience* 10(6):410–422, 2009. PMID: 19455173

Bauer, L.O. Predicting relapse to alcohol and drug abuse via quantitative electroencephalography. *Neuropsychopharmacology* 25(3):332–340, 2001. PMID: 11522462

Bechara, A. Decision making, impulse control and loss of willpower to resist drugs: A neurocognitive perspective. *Nature Neuroscience* 8(11):1458–1463, 2005. PMID: 16251988

Beck, A.; Wustenberg, T.; Genauck, A.; et al. Effect of brain structure, brain function, and brain connectivity on relapse in alcohol-dependent patients. *Archives of General Psychiatry* 69(8):842–852, 2012. PMID: 22868938

Benlhabib, E.; Baker, J.I.; Keyler, D.E.; and Singh, A.K. Kudzu root extract suppresses voluntary alcohol intake and alcohol withdrawal symptoms in P rats receiving free access to water and alcohol. *Journal of Medicinal Food* 7(2):168–179, 2004. PMID: 15298764

Bowen, S.; Witkiewitz, K.; Clifasefi, S.L.; et al. Relative efficacy of mindfulness-based relapse prevention, standard relapse prevention, and treatment as usual for substance use disorders: A randomized clinical trial. *JAMA Psychiatry* 71(5):547–556, 2014. PMID: 24647726

Braus, D.F.; Wrase, J.; Grusser, S.; et al. Alcohol-associated stimuli activate the ventral striatum in abstinent alcoholics. *Journal of Neural Transmission* 108(7): 887–894, 2001. PMID: 11515754

Breese, G.R.; Overstreet, D.H.; and Knapp, D.J. Conceptual framework for the etiology of alcoholism: A "kindling"/ stress hypothesis. *Psychopharmacology (Berlin)* 178(4): 367–380, 2005. PMID: 15765253

Breese, G.R.; Sinha, R.; and Heilig, M. Chronic alcohol neuroadaptation and stress contribute to susceptibility for alcohol craving and relapse. *Pharmacology & Therapeutics* 129(2):149–171, 2011. PMID: 20951730

Brewer, J.A.; Worhunsky, P.D.; Gray, J.R.; et al. Meditation experience is associated with differences in default mode network activity and connectivity. *Proceedings of the National Academy of Sciences of the United States of America* 108(50):20254–20259, 2011. PMID: 22114193

Buhler, M., and Mann, K. Alcohol and the human brain: A systematic review of different neuroimaging methods. *Alcoholism: Clinical and Experimental Research* 35(10):1771–1793, 2011. PMID: 21777260

Camchong, J.; Stenger, V.A.; and Fein, G. Resting-state synchrony in short-term versus long-term abstinent alcoholics. *Alcoholism: Clinical and Experimental Research* 37(5):794–803, 2013. PMID: 23421812

Campbell, J.C.; Szumlinski, K.K.; and Kippin, T.E. Contribution of early environmental stress to alcoholism vulnerability. *Alcohol* 43(7):547–554, 2009. PMID: 19913199

Cohen, B.J. *Theory and Practice of Psychiatry*. New York: Oxford University Press, 2003

Dawson, D.A.; Grant, B.F.; Stinson, F.S.; et al. Recovery from DSM-IV alcohol dependence: United States, 2001-2002. *Addiction* 100(3):281–292, 2005. PMID: 15733237

Durazzo, T.C.; Tosun, D.; Buckley, S.; et al. Cortical thickness, surface area, and volume of the brain reward system in alcohol dependence: Relationships to relapse and extended abstinence. *Alcoholism: Clinical and Experimental Research* 35(6):1187–11200, 2011. PMID: 21410483

Everitt, B.J., and Robbins, T.W. Neural systems of reinforcement for drug addiction: From actions to habits to compulsion. *Nature Neuroscience* 8(11):1481–1489, 2005. PMID: 16251991

Figueiredo, H.F.; Bruestle, A.; Bodie, B.; et al. The medial prefrontal cortex differentially regulates stress-induced c-fos expression in the forebrain depending on type of stressor. *European Journal of Neuroscience* 18(8):2357–2364, 2003. PMID: 14622198

Filbey, F.M.; Claus, E.; Audette, A.R.; et al. Exposure to the taste of alcohol elicits activation of the mesocorticolimbic neurocircuitry. *Neuropsychopharmacology* 33(6):1391–1401, 2008. PMID: 17653109

Fox, H.C.; Anderson, G.M.; Tuit, K.; et al. Prazosin effects on stress- and cue-induced craving and stress response in alcohol-dependent individuals: Preliminary findings. *Alcoholism: Clinical and Experimental Research* 36(2):351–360, 2012. PMID: 21919922

Fox, H.C.; Bergquist, K.L.; Hong, K.I.; and Sinha, R. Stress-induced and alcohol cue-induced craving in recently abstinent alcohol-dependent individuals. *Alcoholism: Clinical and Experimental Research* 31(3):395–403, 2007. PMID: 17295723

Gilman, J.M.; Ramchandani, V.A.; Davis, M.B.; et al. Why we like to drink: A functional magnetic resonance imaging study of the rewarding and anxiolytic effects of alcohol. *Journal of Neuroscience* 28(18):4583–4591, 2008. PMID: 18448634

Gilman, J.M.; Smith, A.R.; Ramchandani, V.A.; et al. The effect of intravenous alcohol on the neural correlates of risky decision making in healthy social drinkers. *Addiction Biology* 17(2):465–478, 2012. PMID: 21995446

Gilpin, N.W., and Koob, G.F. Neurobiology of alcohol dependence: Focus on motivational mechanisms. *Alcohol Research & Health* 31(3):185–195, 2008. PMID: 19881886

Goldstein, R.Z., and Volkow, N.D. Dysfunction of the prefrontal cortex in addiction: Neuroimaging findings and clinical implications. *Nature Reviews. Neuroscience* 12(11):652–669, 2011. PMID: 22011681

Gorka, S.M.; Fitzgerald, D.A.; King, A.C.; and Phan, K.L. Alcohol attenuates amygdala-frontal connectivity during processing social signals in heavy social drinkers: A preliminary pharmaco-fMRI study. *Psychopharmacology (Berlin)* 229(1):141–154, 2013. PMID: 23584670

Grusser, S.M.; Wrase, J.; Klein, S.; et al. Cue-induced activation of the striatum and medial prefrontal cortex is associated with subsequent relapse in abstinent alcoholics. *Psychopharmacology (Berlin)* 175(3):296–302, 2004. PMID: 15127179

Guardia, J.; Catafau, A.M.; Batlle, F.; et al. Striatal dopaminergic D(2) receptor density measured by [(123)I] iodobenzamide SPECT in the prediction of treatment outcome of alcohol-dependent patients. *American Journal of Psychiatry* 157(1):127–129, 2000. PMID: 10618027

Heinz, A.; Wrase, J.; Kahnt, T.; et al. Brain activation elicited by affectively positive stimuli is associated with a lower risk of relapse in detoxified alcoholic subjects. *Alcoholism: Clinical and Experimental Research* 31(7):1138–1147, 2007. PMID: 17488322

Kalivas, P.W., and McFarland, K. Brain circuitry and the reinstatement of cocaine-seeking behavior. *Psychopharmacology (Berlin)* 168(1-2):44–56, 2003. PMID: 12652346

Kalivas, P.W., and O'Brien, C. Drug addiction as a pathology of staged neuroplasticity. *Neuropsychopharmacology* 33(1):166–180, 2008. PMID: 17805308

Koob, G.F. Corticotropin-releasing factor, norepinephrine, and stress. *Biological Psychiatry* 46(9):1167–1180, 1999. PMID: 10560023

Koob, G.F. Dynamics of neuronal circuits in addiction: Reward, antireward, and emotional memory. *Pharmacopsychiatry* 42(Suppl. 1):S32–S41, 2009. PMID: 19434554

Koob, G.F.; Ahmed, S.H.; Boutrel, B.; et al. Neurobiological mechanisms in the transition from drug use to drug dependence. *Neuroscience and Biobehavioral Reviews* 27(8):739–749, 2004. PMID: 15019424

Koob, G.F., and Volkow, N.D. Neurocircuitry of addiction. *Neuropsychopharmacology* 35(1):217–238, 2010. PMID: 19710631

Kukolja, J.; Klingmuller, D.; Maier, W.; et al. Noradrenergic-glucocorticoid modulation of emotional memory encoding in the human hippocampus. *Psychological Medicine* 41(10):2167–2176, 2011. PMID: 21375794

Kushner, M.G.; Abrams, K.; Thuras, P.; et al. Follow-up study of anxiety disorder and alcohol dependence in comorbid alcoholism treatment patients. *Alcoholism: Clinical and Experimental Research* 29(8):1432–1443, 2005. PMID: 16131851

Lukas, S.E.; Penetar, D.; Berko, J.; et al. An extract of the Chinese herbal root kudzu reduces alcohol drinking by heavy drinkers in a naturalistic setting. *Alcoholism: Clinical and Experimental Research* 29(5):756–762, 2005. PMID: 15897719

Martinez, D.; Gil, R.; Slifstein, M.; et al. Alcohol dependence is associated with blunted dopamine transmission in the ventral striatum. *Biological Psychiatry* 58(10):779–786, 2005. PMID: 16018986

Muller, U.J.; Sturm, V.; Voges, J.; et al. Successful treatment of chronic resistant alcoholism by deep brain stimulation of nucleus accumbens: First experience with three cases. *Pharmacopsychiatry* 42(6):288–291, 2009. PMID: 19924591

Noel, X.; Sferrazza, R.; Van Der Linden, M.; et al. Contribution of frontal cerebral blood flow measured by (99m)Tc-Bicisate spect and executive function deficits to predicting treatment outcome in alcohol-dependent patients. *Alcohol and Alcoholism* 37(4):347–354, 2002. PMID: 12107037

Porjesz, B., and Begleiter, H. Alcoholism and human electrophysiology. *Alcohol Research & Health* 27(2):153–160, 2003. PMID: 15303626

Quintana, D.S.; Guastella, A.J.; McGregor, I.S.; et al. Heart rate variability predicts alcohol craving in alcohol dependent outpatients: Further evidence for HRV as a psychophysiological marker of self-regulation. *Drug and Alcohol Dependence* 132(1-2):395–398, 2013. PMID: 23601925

Radley, J.; Arias, C.; and Sawchenkole P.E. Regional differentiation of the medial prefrontal cortex in regulating adaptive responses to acute emotional stress. *Journal of Neuroscience* 26(50):12967–12976, 2006. PMID: 17167086

Rando, K.; Hong, K.I.; Bhagwagar, Z.; et al. Association of frontal and posterior cortical gray matter volume with time to alcohol relapse: A prospective study. *American Journal of Psychiatry* 168(2):183–192, 2011. PMID: 21078704

Robinson, T.E., and Berridge, K.C. The neural basis of drug craving: An incentive-sensitization theory of addiction. *Brain Research. Brain Research Reviews* 18(3):247–291, 1993. PMID: 8401595

Sale, A.; Berardi, N.; and Maffei, L. Environment and brain plasticity: Towards an endogenous pharmacotherapy. *Physiological Reviews* 94(1):189–234, 2014. PMID: 24382886

Schumacher, J.A.; Coffey, S.F.; and Stasiewicz, P.R. Symptom severity, alcohol craving, and age of trauma onset in childhood and adolescent trauma survivors with comorbid alcohol dependence and posttraumatic stress disorder. *American Journal on Addictions* 15(6):422–425, 2006. PMID: 17182443

Seo, D.; Jia, Z.; Lacadie, C.M.; et al. Sex differences in neural responses to stress and alcohol context cues. *Human Brain Mapping* 32(11):1998–2013, 2011. PMID: 21162046

Seo, D.; Lacadie, C.M.; Tuit, K.; et al. Disrupted ventromedial prefrontal function, alcohol craving, and subsequent relapse risk. *JAMA Psychiatry* 70(7):727–739, 2013. PMID: 23636842

Seo, D., and Sinha, R. Prefrontal limbic-striatal circuits and alcohol addiction in humans. In: Noronha, A.B.; Cui, C.; Harris, A.; and Crabbe, J.C.; Eds. *Neurobiology of Alcohol Dependence*. London: Academic Press, Elsevier Science, 2014, pp. 49–59.

Shaham, Y., and Hope, B.T. The role of neuroadaptations in relapse to drug seeking. *Nature Neuroscience* 8(11):1437–1439, 2005. PMID: 16251983

Simpson, T.L.; Saxon, A.J.; Meredith, C.W.; et al. A pilot trial of the alpha-1 adrenergic antagonist, prazosin, for alcohol dependence. *Alcoholism: Clinical and Experimental Research* 33(2):255–263, 2009. PMID: 18945226

Sinha, R. Chronic stress, drug use, and vulnerability to addiction. *Annals of the New York Academy of Sciences* 1141:105–130, 2008. PMID: 18991954

Sinha, R.; Fox, H.C.; Hong, K.A.; et al. Enhanced negative emotion and alcohol craving, and altered physiological responses following stress and cue exposure in alcohol dependent individuals. *Neuropsychopharmacology* 34(5):1198–1208, 2009. PMID: 18563062

Sinha, R.; Fox, H.C.; Hong, K.I.; et al. Effects of adrenal sensitivity, stress- and cue-induced craving, and anxiety on subsequent alcohol relapse and treatment outcomes. *Archives of General Psychiatry* 68(9):942–952, 2011. PMID: 21536969

Soderlund, H.; Grady, C.L.; Easdon, C.; and Tulving, E. Acute effects of alcohol on neural correlates of episodic memory encoding. *NeuroImage* 35(2):928–939, 2007. PMID: 17303439

Sripada, C.S.; Angstadt, M.; McNamara, P.; et al. Effects of alcohol on brain responses to social signals of threat in humans. *NeuroImage* 55(1):371–380, 2011. PMID: 21122818

Stormark, K.M.; Laberg, J.C.; Nordby, H.; and Hugdahl, K. Heart rate responses indicate locked-in attention in alcoholics immediately prior to drinking. *Addictive Behaviors* 2392):251–255, 1998. PMID: 9573428

Thayer, J.F.; Ahs, F.; Fredrikson, M.; et al. A meta-analysis of heart rate variability and neuroimaging studies: Implications for heart rate variability as a marker of stress and health. *Neuroscience and Biobehavioral Reviews* 36(2):747–756, 2012. PMID: 22178086

Thayer, J.F.; Hall, M.; Sollers, J.J., 3rd; and Fischer, J.E. Alcohol use, urinary cortisol, and heart rate variability in apparently healthy men: Evidence for impaired inhibitory control of the HPA axis in heavy drinkers. *International Journal of Psychophysiology* 59(3):244–250, 2006. PMID: 16325293.

Trifilieff, P., and Martinez, D. Blunted dopamine release as a biomarker for vulnerability for substance use disorders. *Biological Psychiatry* 76(1):4–5, 2014. PMID: 24925889

Vance, D.E., and Wright, M.A. Positive and negative neuroplasticity: Implications for age-related cognitive declines. *Journal of Gerontological Nursing* 35(6):11–17; quiz 18–19, 2009. PMID: 19537290

Vanderschuren, L.J., and Pierce, R.C. Sensitization processes in drug addiction. *Current Topics in Behavioral Neurosciences* 3:179–195, 2010. PMID: 21161753

Vlahov, D.; Galea, S.; Ahern, J.; et al. Alcohol drinking problems among New York City residents after the September 11 terrorist attacks. *Substance Use & Misuse* 41(9):1295–1311, 2006. PMID: 16861180

Volkow, N.D., and Fowler, J.S. Addiction, a disease of compulsion and drive: Involvement of the orbitofrontal cortex. *Cerebral Cortex* 10(3):318–325, 2000. PMID: 10731226

Volkow, N.D.; Wang, G.J.; Maynard, L.; et al. Effects of alcohol detoxification on dopamine D2 receptors in alcoholics: A preliminary study. *Psychiatry Research* 116(3):163–172, 2002. PMID: 12477600

Volkow, N.D.; Wang, G.J.; Telang, F.; et al. Profound decreases in dopamine release in striatum in detoxified alcoholics: Possible orbitofrontal involvement. *Journal of Neuroscience* 27(46):12700–12706, 2007. PMID: 18003850

Walker, B.M.; Rasmussen, D.D.; Raskind, M.A.; and Koob, G.F. alpha1-noradrenergic receptor antagonism blocks dependence-induced increases in responding for ethanol. *Alcohol* 42(2):91–97, 2008. PMID: 18358987

Wallner, M., and Olsen, R.W. Physiology and pharmacology of alcohol: The imidazobenzodiazepine alcohol antagonist site on subtypes of GABAA receptors as an opportunity for drug development? *British Journal of Pharmacology* 154(2):288–298, 2008. PMID: 18278063

Wrase, J.; Makris, N.; Braus, D.F.; et al. Amygdala volume associated with alcohol abuse relapse and craving. *American Journal of Psychiatry* 165(9):1179–1184, 2008. PMID: 18593776

Wrase, J.; Schlagenhauf, F.; Kienast, T.; et al. Dysfunction of reward processing correlates with alcohol craving in detoxified alcoholics. *NeuroImage* 35(2):787–794, 2007. PMID: 17291784

How Does Stress Lead to Risk of Alcohol Relapse?

Rajita Sinha, Ph.D.

Rajita Sinha, Ph.D., *is professor of psychiatry and child study, Yale University School of Medicine, New Haven, Connecticut.*

Empirical findings from human laboratory and brain-imaging studies are consistent with clinical observations and indicate that chronic alcohol-related dysfunction in emotional and stress responses plays a role in motivation to consume alcohol in people with alcohol use disorders. Recent findings on differences in stress responsivity in alcohol-dependent versus nondependent social drinkers demonstrate alterations in stress pathways that partially may explain the significant contribution of stress-related mechanisms on craving and relapse susceptibility. These findings have significant implications for clinical practice, including (1) the development of novel brain and stress biology–related measures of relapse risk that could serve as biomarkers to identify those most at risk of alcohol relapse during early recovery from alcoholism; and (2) the development of novel interventions that target stress-related effects on the motivation to drink alcohol and on relapse outcomese **KEY WORDS: Alcoholism; alcohol dependence; alcohol and other drug (AOD)-seeking behavior; AOD craving; alcohol cue; relapse; relapse prevention; recovery; motivation; risk factors; stress; stress response; brain; brain imaging; biomarker; intervention; human studies**

It has long been known that stress increases the risk of alcohol relapse (Sinha 2001). Clinical observations, surveys, and epidemiological studies document an association between self-reports of stressors and subsequent return to drinking. Studies assessing alcohol relapse after treatment completion and discharge also indicate the contribution of highly stressful events independent of alcohol use history that increase the risk of subsequent relapse (Brown et al. 1990). Furthermore, negative mood and stress are associated with increased craving, and high levels of urges to use alcohol predict relapse (Cooney et al. 2007). However, the mechanisms by which stress exposure increases alcohol relapse risk have been elusive, until recently. The last two decades have seen a dramatic increase in preclinical and clinical research to understand psychobiological and neural evidence linking stress and alcohol consumption. Evidence suggests that the neural circuits involved in stress and emotions overlap substantially with the brain systems involved in drug reward. Chronic alcohol use can result in neuroadaptive changes in stress and reward pathways. Such changes may alter an alcohol-dependent person's response to stress, particularly with respect to stress and emotion regulation and motivation for alcohol, which in turn may increase the risk of relapse (Sinha 2001, 2005).

To put the stress and alcohol relapse linkage in the clinical context, the sidebar presents sample descriptions of an acute stressful life event and an acute alcohol-related situation that led to subsequent alcohol use in a person with alcohol dependence. The patient vignettes are descriptions provided by patients currently in treatment and refer to previous experiences and episodes of alcohol use and relapse.

Chronic Alcohol-Related Changes in Emotion, Stress, and Motivational Systems

Converging lines of evidence indicate that regular and chronic alcohol use is associated with changes in emotion, stress, and motivational pathways. These changes may in turn influence alcohol craving and relapse risk. Chronic alcohol use increases stress-related symptoms and is associated with increased anxiety and negative emotions; changes in sleep and appetite; aggressive behaviors; changes in attention, concentration, and memory; and desire/craving for alcohol (Sinha 2001, 2007, 2009). Stress-related symptoms are most prominent during early abstinence from chronic alcohol use, but some of these changes also have been documented during active use of specific drugs. Chronic alcohol abuse and acute alcohol withdrawal states are associated

with heightened activity in the brain stress systems, such as increased secretion of the stress hormones corticotropin-releasing factor (CRF), norepinephrine, and cortisol in a number of the brain's stress and emotion centers, such as the hypothalamus[1], amygdala, hippocampus, and prefrontal regions (Koob and Kreek 2007). Chronic alcohol abuse also alters dopaminergic signaling in the ventral striatum (VS) and the ventral tegmental area (VTA). And such changes are associated with increased alcohol seeking (craving) and alcohol self-administration in laboratory animals (Cleck and Blendy 2008; Koob and Kreek 2007; Koob et al. 2004; Rasmussen et al. 2006). Further corroboration from human neuroimaging studies indicates that chronic alcohol abuse reduces dopamine receptors (i.e., D2 receptors) in striatal regions and dopamine transmission in the frontal lobe in alcoholics during acute withdrawal and protracted withdrawal (up to 3–4 months) (see Volkow 2004 for review). Functional imaging studies indicate increased VS activity in response to alcohol cues and altered brain response in the amygdala to emotional stimuli with chronic alcohol use (Gilman and Hommer 2008; Heinz et al. 2004, 2005; Martinez et al. 2007).

The biological stress response is most commonly detected in humans by activation of the hypothalamic–pituitary–adrenal (HPA) axis involving CRF-stimulated release of adrenocorticotropin (ACTH) from the anterior pituitary, which in turn stimulates the adrenal glands to release the stress hormone cortisol, which is involved in mobilizing and regulating the body's stress response. The second pathway involved in the biological stress response is the autonomic nervous system, comprising the sympathetic and the parasympathetic components. The sympathetic component mobilizes arousal by increasing heart rate and blood pressure; the parasympathetic component enforces the "brakes" for sympathetic arousal and functions to decrease and regulate autonomic function. Alcohol use stimulates the HPA axis and initially stimulates the autonomic systems by provoking sympathetic arousal, followed by depressing such activation (Ehrenreich et al. 1997; Lee and Rivier 1997). Reductions in this alcohol-related HPA axis response (similar to tolerance) has been demonstrated with regular and chronic alcohol abuse in animals (Lee and Rivier 1997; Richardson et al. 2008; Zhou et al. 2000) and in humans (Adinoff et al. 1998, 2005; Wand and Dobs 1991).

Likewise, chronic alcohol abuse increases physiological arousal as measured by heart rate but also decreases heart rate variability, which serves as a measure of parasympathetic function (Ingjaldsson et al. 2003; Rechlin et al. 1996; Shively et al. 2007; Thayer and Sternberg 2006). These data represent alcohol-induced changes in peripheral stress pathways, which parallel basic science findings of alcohol-related adaptations in central stress systems, namely the extrahypothalamic CRF and the noradrenergic pathways that are indicative of hyperresponsive brain stress pathways noted in the previous paragraph (Cleck and Blendy 2008; Koob and Kreek 2007; Koob 2009; Rasmussen et al. 2006). These neurochemical changes indicate specific dysregulation in the neurochemical systems that play a role in emotion, stress, and motivation functions in alcoholics. Such changes raise the question of whether these measures contribute to the high levels of emotional distress, alcohol craving, and compulsive alcohol seeking that may lead to increased relapse susceptibility.

Effects of Stress on Alcohol Craving and Arousal

Drug craving or "wanting" for drug is a hallmark feature of addiction. It is an important component in maintaining addictive behaviors (Dackis and Gold 1985; O'Brien et al. 1998; Robinson and Berridge 1993, 2000; Tiffany 1990). Chronic alcohol use leads to changes in the brain reward and motivation pathways that can increase alcohol craving in the context of alcohol and alcohol-related stimuli, but also in the context of stress. In support of these ideas, a growing literature indicates that people with alcohol abuse show greater alcohol craving than social drinkers (Glautier et al. 1992; Greeley et al. 1993; Kaplan et al. 1985; Pomerleau et al. 1983; Willner et al. 1998). Furthermore, severity of alcohol use has been shown to affect the magnitude of cue-related physiological arousal, compulsive alcohol seeking, and stress-related changes, including alcohol-related morbidity (Fox et al. 2005; Grusser et al. 2006, 2007; Rosenberg and Mazzola 2007; Sinha 2008; Yoon et al. 2006). These data are consistent with large population-based studies indicating that the risk of alcohol-related problems, addiction, and chronic diseases increases with greater weekly or daily alcohol and drug use (Dawson et al. 2005; Rehm et al. 2009; Room et al. 2005). Given these responses, the author's research examined whether increases in craving are associated with altered stress responses that occur with chronic alcohol use.

In the clinical context, alcoholic patients entering outpatient substance abuse treatment report high levels of stress and an inability to manage distress adaptively, thereby increasing the risk of succumbing to high levels of drug craving and relapse to drug use (Sinha 2007). Although patients often are successful in learning cognitive–behavioral strategies in treatment, relapse rates remain high (Brandon et al. 2007; Sinha 2011). These data suggest possible difficulties in applying and accessing cognitive–behavioral strategies in real-world relapse situations. Thus, to understand the biobehavioral mechanisms underlying the high stress and craving state during early recovery, the author began to study this phenomenon in the laboratory, using an ecologically relevant method that models such relapse risk. This research used two of the most

[1] For definitions of this term and other technical terms used in this article, see the Glossary on pp. 522–524.

common relapse situations—emotionally stressful situations and alcohol-/drug-related situations—in order to develop a comparable method of provoking stress and the drug-related craving state, and these are compared to a relaxing situation that serves as an experimental control condition to account for the nonspecific aspects of the experimental procedures (Sinha 2009).

Provoking Relapse Situations and Inducing Alcohol and Drug Craving in the Laboratory

To assess relapse risk in laboratory studies, Sinha and O'Malley (1999) targeted alcohol and drug craving as a primary outcome measure that is both a common feature of alcoholism and substance abuse and also is known to relate to the disease state (i.e., high amounts of alcohol use and abuse). The researchers initially compared a commonly used standard social stress task (i.e., giving a speech in front of a video camera with the potential for a monetary reward) with 5-minute individualized guided imagery exposure of each participants' own recent stressful scenarios. In addicted individuals, stress imagery elicited multiple emotions of fear, sadness, and anger when compared with the stress of public speaking, which elicited increased fear, but no anger and sadness. In addition, individualized stress imagery resulted in significant increases in drug craving, whereas public speaking did not (Sinha and O'Malley 1999).

Another study examined stress-induced and drug-related craving and physiological responses using individualized scripts of comparable length and style for stress, drug- related, and neutral-related situations. Among cocaine-dependent individuals, the imagery exposure to stress and nonstress drug cues resulted in significant increases in heart rate, salivary cortisol levels, drug craving, and subjective anxiety, compared with neutral-relaxing cues (Sinha et al. 2000). Using these methods, researchers have been able to reliably induce alcohol and drug craving in multiple groups of treatment-engaged cocaine-, alcohol-, and opiate-dependent individuals and also increase the desire for the drug in healthy social drinkers (Chaplin et al. 2008; Fox et

Patient Vignettes

These patient descriptions illustrate several points about stress and motivation for alcohol use that are relevant from a clinical perspective. The first vignette is an example of an interpersonal stress situation that is a typical precipitant of relapse. Although patients are less likely to divulge specific details of craving situations in a clinical context, the second vignette illustrates that alcohol cues and increased craving states also promote anxiety and stress-related arousal in people who are alcohol dependent. These clinical situations raise many questions about the role of stress in drug seeking and relapse susceptibility. One such question is whether stress and alcohol cues provoke similar drug craving states that may be targeted in treatment. Additional research questions are whether the response to stress and alcohol-related stimuli differs for alcohol-dependent and non–alcohol-dependent people and whether stress responses and managing stress is altered as a function of chronic alcohol use. These vignettes provide anecdotal evidence; research is needed to address the question of whether craving and stress-related arousal are predictive of relapse outcomes and whether stress causes relapse. Finally, if stress plays an important role in both stress- and cue-related relapse, research is needed to identify the most beneficial types of interventions and how clinicians might use the stress and craving responses to better address the treatment needs of alcohol-dependent individuals in early recovery. The main article addresses each of these questions to elucidate how stress increases the risk of alcohol relapse.

Stressful Situation

This situation was rated as a 10 on a 10-point scale of "0 = not at all stressful," to "10 = highly stressful—most you've felt recently" and was narrated by an alcohol-dependent male patient who had been in recovery for 5 weeks. The patient is describing a stressful event that previously led to a relapse episode and an alcohol-related context that led to alcohol use.

"I remember it was about 4:00 pm in the afternoon when Kay woke me up. Her face was red—she looked really upset. She was holding the phone in her hand. She was screaming that I have to call home. I felt tight all over. My heart was pounding. I rolled out of bed. My heart was beating faster. She wants me to call my Dad and tell him about the accident. I did not want to call him yet. She kept following me around the apartment. I tensed up the muscles all over my body. She is badgering me to call. Wherever I go, she was behind me with the phone. I clenched my jaw. I don't want to face this now, I was thinking. Just call them now and get it over with, she kept saying. My heart was racing. Suddenly, she dialed the number and throws the phone at me while it is ringing. I am

al. 2007; Hyman et al. 2007; Sinha et al., 2003; see Sinha 2009 for review). In addition, mild to moderate levels of physiological arousal and subjective levels of distress were found to accompany the alcohol/drug craving state (Sinha 2009).

Stress Dysregulation and Enhanced Drug Craving in Addicted Individuals

As discussed in the previous section, alcohol-dependent individuals in early recovery show increased stress and alcohol cue–induced craving responses. In a study comparing 4-week abstinent alcoholics with matched social drinkers (drinking less than 25 drinks per month), Sinha and colleagues (2009) found that the recovering alcoholics showed greater levels of basal heart rate and salivary cortisol levels compared with the control drinkers. Upon stress and alcohol cue exposure, they showed greater subjective distress, alcohol craving, and blood pressure responses but blunted stress-induced heart rate and cortisol responses compared with control subjects (Sinha et al. 2009). Furthermore, after exposure to stress imagery, alcoholic patients showed a persistent increase in alcohol craving, subjective distress, and blood pressure responses across multiple time points compared with social drinkers, suggesting an inability to regulate this high alcohol craving and emotional stress state. These data indicate greater allostatic load in abstinent alcoholics, which is accompanied by dysregulated stress responses and high levels of craving or compulsive seeking for the preferred drug.

Together, these data indicate altered stress responses in alcoholics, and these alterations also include an enhanced susceptibility to stress and cue-induced alcohol seeking, which is not seen in healthy nonaddicted individuals. In addition, there are basal alterations in peripheral markers of stress (i.e., stress hormones, such as ACTH and cortisol and in heart rate), indicative of stress-related dysregulation in the CRF–HPA axis and in autonomic responses as measured by basal salivary cortisol and heart rate responses. These high basal responses are associated with lower or

gritting my teeth. I put the phone to my ear. My dad answers the phone. I hear his voice. My stomach is in a knot. I start to have a normal conversation. My fists are clenched. I am thinking, "How am I going to tell him about the car accident last night?" I feel jittery and panicky all over. I am pacing back and forth. Casually I say I had a car accident last night. I feel hot all over. He starts screaming, "That's it! Pack your bags! You're coming home!" There are butterflies in my stomach. I see Kay burst into tears. I am breathing faster, gasping for air. She is listening to everything he is saying. "What the hell will I tell your mother? I told her you'd be safe. Now I put myself on the line" he is shouting. My head is pounding. Kay is crying, and I can't do anything about it. I feel stuck. My heart is pounding. My father says he can't talk anymore now and hangs up the phone. I was so mad, I wanted to smash something. I slam down the phone. I did not want to call him. I knew he would be upset. There is a sinking feeling in my chest. If I could fix it, make it all better, I would. I see Kay crying. I get choked up. I had promised her this would not happen. I feel so mad at myself I want to scream. Now I've betrayed her and my Dad."

Alcohol-Related Situation

"It was a bright and sunny summer morning in June. M was gone for the day, and I had the whole day off. I am out working in the yard. It was a warm day and I start to feel hot. I sit down for a break. I've done my chores. I've paid the bills and vacuumed out the pool. I breathe in deeply. My eyes glance around the yard. I've got all the yard work done as well. It looks nice. Now I have half a day left. My heart quickens. I am thinking, 'is there anything else left to do'. I can't think of anything else. I feel warm all over. I sit back and try to relax. Now I start feeling very hot. I feel very thirsty. It would be great to have a nice cold beer, I think. I tighten the muscles of my face and forehead. I've worked hard, I deserve one, you think. I feel a rush of excitement inside you. I walk inside and head toward the refrigerator. My heart is beating faster. I promised M I won't drink. My jaws are tight. The thoughts start racing through my head– "She doesn't need to know." "She won't be home for another four hours." "She won't be able to smell it on my breath by then." My hands feel clammy. I open the fridge and grab an ice cold can of beer. My mouth starts to water. Holding that cold can of beer starts to cool down my whole body. I feel a tingling sensation inside me. I start to think—I shouldn't be drinking this. My stomach is in a knot. I look down at it—it's right here in my hand, and I deserve it. I wet my lips. Before I know it, I have cracked it open. I see the condensation vapor fly into the air. I can almost taste it now. I am holding on to the can tightly. I raise the can to my lips. I let the beer flow into my mouth and down my throat. It is so cold that it makes my teeth ache. It goes down quickly. I feel a sense of being more alive. Now I have a taste for it. I can't wait to have another one."

blunted stress-related arousal (Sinha et al. 2009). It is important to note that these alterations cannot be accounted for by smoking status or lifetime history of anxiety or mood disorders and therefore seem to be related to history of chronic alcohol abuse. The persistence of emotional distress and alcohol craving induced by stress and alcohol cue exposure suggests a dysfunction in emotion regulatory mechanisms. As HPA axis responses and autonomic–parasympathetic responses contribute to regulating and normalizing stress responses and regaining homeostasis, dysfunction in these pathways and their related central mechanisms may be involved in perpetuating alcohol craving and relapse susceptibility.

Laboratory Response to Relapse Situations and Subsequent Alcohol Relapse

An important aspect of modeling hallmark addictive symptoms, such as alcohol craving, in the laboratory is to understand the related mechanisms. Furthermore, researchers should test the predictive validity of the laboratory model by examining whether laboratory responses predict future drug-use behaviors and/or real-world clinical outcomes. Because the laboratory studies described earlier were conducted with treatment-engaged alcoholics who were inpatients at a treatment research unit, it was possible to assess relapse rates after discharge. Then researchers could examine specific markers of the stress and craving states that are predictive of relapse outcomes. They followed the alcohol-dependent individuals (who had been in inpatient treatment for 5 weeks) after discharge for 90 days to assess relapse outcomes. Face-to-face follow-up assessments were conducted at 14, 30, 90, and 180 days after discharge from the inpatient unit. The follow-up rates for these assessments were 96, 89, 92, and 86 percent, respectively.

Initial evidence suggested that laboratory responses to stress- and alcohol-related stimuli exposure were predictive of alcohol treatment outcomes. Stress-induced alcohol craving in the laboratory during inpatient treatment was predictive of number of days of alcohol used and total number of drinks consumed during the 90-day follow-up period (Breese et al. 2005). These data corroborate findings in cocaine abusers, showing that stress-induced cocaine craving and HPA arousal are associated with earlier relapse and more cocaine use at follow-up (Sinha et al. 2006). In a more comprehensive analysis of stress dysregulation, anxiety, alcohol craving, and subsequent return to drinking, researchers found clear evidence of stress dysregulation and alcohol craving relating to relapse risk (Sinha et al. 2011*a*). Alcohol-dependent patients, compared with the control group, were more likely to have significant HPA axis dysregulation, marked by higher basal ACTH and higher basal salivary cortisol, lack of stress- and cue-induced ACTH and cortisol responses, higher anxiety after exposure to neutral relaxed and to alcohol cues, and greater stress- and cue-induced alcohol craving (Sinha et al. 2009, 2011*a*). Stress- and cue-induced anxiety and stress-induced alcohol craving were associated with fewer days in aftercare alcohol treatment. High alcohol craving to both stress and to alcohol cue provocation and greater neutral-relaxed state cortisol/ACTH ratio (adrenal sensitivity) were each predictive of shorter time to alcohol relapse. Although a greater cortisol-to-ACTH ratio in the stress and alcohol cue conditions also predicted relapse, the strongest predictor of relapse was the neutral relaxed state adrenal sensitivity (Sinha et al. 2011*a*). These results identify a significant effect of high adrenal sensitivity, anxiety, and increased stress- and cue-induced alcohol craving on subsequent alcohol relapse and treatment outcomes. They also are consistent with earlier reports of stress system involvement in relapse outcomes in alcoholics. Negative mood and stress-induced alcohol craving and blunted stress and cue-induced cortisol responses have been associated with alcohol relapse outcomes (Breese et al. 2005; Cooney et al. 1997; Junghanns et al. 2003). In summary, these findings support the involvement of stress-related pathophysiology in the alcohol relapse process. Among alcoholics in early recovery, the alcohol-craving state is marked by anxiety and compulsive motivation for drugs, along with poor stress regulatory responses (i.e., high basal HPA axis responses but blunted stress HPA responses), resulting in an enhanced susceptibility to addiction relapse.

Brain-Imaging Studies of Alcoholics' Responses to Alcohol Cues and Stress and Implications for Relapse Risk

Several studies have used brain-imaging techniques to assess chronic alcohol-related brain changes and whether such changes are associated with alcohol craving and alcohol use. Neuroanatomically, the cortico–striatal–limbic brain regions have been most studied in the context of stress, emotion, and motivation for alcohol reward. These regions include the frontal and insular cortices, the ventral and dorsal striatum, the amygdala, hippocampus, and thalamic nuclei, and midbrain regions, such as the VTA and the substantia nigra. An early study to measure blood flow with single-photon emission computed tomography found a change in the caudate nucleus during induction of craving in alcoholics (Modell and Mountz 1995). Subsequently, George and colleagues (2001) found a greater increase in brain response to alcohol cues in alcoholics compared with controls in the anterior thalamus and left dorsal lateral prefrontal cortex using functional magnetic resonance imaging (fMRI). Using a memory task during fMRI, Tapert and colleagues (2001) found dysfunctional cortical responses in alcoholics distinct from those of control subjects. Subsequently, other imaging studies with alcoholic patients have shown an increased association between dorsal striatum regions and

alcohol craving in response to the presentation of alcohol-related stimuli (Grusser et al. 2004; Wrase et al. 2002). Myrick and colleagues (2004) reported that alcohol cues produced changes in the left orbital frontal cortex, anterior cingulate cortex, and nucleus accumbens in alcoholics but not in other study participants (Myrick et al. 2004).

Using fMRI, Sinha and colleagues (2007) compared alcohol-dependent individuals abstinent from alcohol for 4 weeks with social drinkers to assess brain structural changes and also functional responses to stress, alcohol cues, and neutral relaxing guided imagery. Alcoholic patients showed greater activity in the ventromedial prefrontal cortex, the ventral striatum, insula, and specific regions of the thalamus and cerebellum during the neutral-relaxing condition (Sinha 2007; Sinha and Li 2007). These findings indicate that abstinent alcoholics show overall hyperresponsivity of the medial prefrontal and striatal-limbic regions, with no differences in brain responses to the neutral relaxed and stressful cues (Sinha and Li 2007; Sinha et al. 2007*a*). Hyperresponsivity of prefrontal and striatal-limbic regions is consistent with an overall kindling[2] process, which blunts the neural informational processing responses to stressful stimuli, resulting in a dysregulated response to stress in alcoholics (see also review by Breese et al. 2011).

Using positron emission tomography (PET) techniques, researchers have documented reduced glucose metabolism, especially in frontal regions during both acute and protracted alcohol withdrawal (up to 3 to 4 months) (see Volkow and Fowler 2000 for review). Alcoholics also show significant reductions in dopamine D_2 receptors compared with nonalcoholics, particularly in frontal-striatal regions (Volkow and Fowler 2000). Researchers have reported significant associations between dopamine D_2 receptor binding in the ventral striatum and alcohol craving (Heinz et al. 2004, 2005) as well as motivation for alcohol self-administration in alcoholics (Martinez et al. 2005, 2007). To emphasize the importance of this approach, recent PET studies have shown significant positive correlations between selected dorsal striatum brain regions and drug cue–induced cocaine craving (Volkow et al. 2006; Wong et al. 2006). These data point to alterations in frontal and striatal regions of the dopaminergic and noradrenergic pathways that exist past acute withdrawal and may be associated with difficulties in regulating emotions, stress, and problems selecting goal-directed adaptive responses as opposed to the selection of habitual maladaptive responses such as alcohol consumption.

In addition, the research literature has documented chronic alcohol-related structural brain changes, particularly in frontal, parietal, and temporal cortical regions associated with stress, emotion, and cognitive functioning (Cardenas et al. 2007; Fein et al. 2002; Pfefferbaum et al. 1995, 1998). More severe gray matter deficits have been reported in alcohol relapsers than those who maintained abstinence (Pfefferbaum et al. 1998). In a whole-brain analysis, Rando and colleagues (2011) found significantly smaller gray-matter volume in recently abstinent alcohol-dependent patients relative to healthy study participants in three regions: the medial frontal cortex, right lateral prefrontal cortex, and a posterior region surrounding the parietal-occipital sulcus. Smaller medial frontal and parietal-occipital gray-matter volume were each predictive of shorter time to subsequent any alcohol use (first lapse) and to heavy-drinking relapse (Rando et al. 2011). These data suggest that smaller gray-matter volume in specific medial frontal and posterior parietal-occipital brain regions are predictive of an earlier return to alcohol drinking and relapse risk, suggesting a significant role for gray matter atrophy in poor clinical outcomes in alcoholism. Thus, the extent of gray-matter volume deficits in these regions involved in impulse control, emotion regulation, and abstraction abilities could serve as useful neural markers of relapse risk and alcoholism treatment outcome.

[2] Kindling is a phenomenon in which a weak electrical or chemical stimulus, which initially causes no overt behavioral responses, results in the appearance of behavioral effects, such as seizures, when it is administered repeatedly.

Clinical Implications and Conclusion

The previous sections cite evidence from clinical, laboratory, and neuroimaging studies to examine whether stress increases the risk of relapse. Psychobiological and neuroimaging research points to alcohol-related changes in brain volume and function and in biological stress responses. These alterations were found to contribute to higher craving and increased alcohol relapse risk. For example, early abstinence from alcohol is associated with higher levels of anxiety when relaxed and when exposed to alcohol cues, greater emotional distress, and increased stress- and alcohol cue-induced craving. These states are accompanied by disruption in normal functioning of the peripheral stress pathways, including the HPA axis and the autonomic components, which are involved in mobilizing the body for action during stress but also in physiological regulation of the stress response. A lack of normal stress regulation during this early abstinence period leaves the recovering alcoholic highly vulnerable to high craving, anxiety, and risk of relapse, particularly under stressful conditions and when faced with alcohol-related stimuli in the environment. The findings discussed indicate that stress- and cue-induced alcohol craving increase the risk of subsequent relapse. High levels of stress- and cue-induced anxiety are associated with less follow-up in aftercare during the recovery period. Furthermore, disrupted functioning of the HPA axis, particularly in people who have hyperresponsive cortisol release from the adrenal cortex in response to the ACTH signal (cortisol-to-ACTH ratio as a measure of adrenal sensitivity) in the neutral relaxed state, increased the risk of alcohol relapse 2.5 times more than those with lower cortisol

release from the adrenal cortex. Finally, changes in volume and function of the brain regions involved in impulse control and emotion regulation also are predictive of alcohol relapse outcomes. Each of these measures could be further developed as biomarkers of alcohol relapse risk (see Sinha 2011). If validated in future studies, they may be used clinically to identify people at high risk of relapse. In addition, the findings reviewed also indicate that stress-related pathophysiology is important in the alcohol relapse process. Thus, individuals who show chronic alcohol-related effects on neural, biological, and psychological aspects of stress and craving could benefit from treatments that target stress effects on craving and alcohol seeking. Several novel medications that target the stress pathways, such as agents that block CRF, as well as noradrenergic and GABAergic agents, are being tested to assess their efficacy in stress-related relapse (Breese et al. 2011; Sinha et al. 2011*b*). Development of such treatment strategies may be of tremendous help in normalizing stress responses and decreasing alcohol craving so as to improve relapse outcomes in alcoholism. ■

Acknowledgements

Preparation of this review was supported by grants R01–AA–13892, UL1–DE019856, and PL1–DA024859 from the National Institutes of Health. Dr. Sinha also is on the scientific advisory board for Embera NeuroTherapeutics.

Financial Disclosure

The author declares that he has no competing financial interests.

References

ADINOFF, B.; IRANMANESH, A.; VELDHUIS, J.; AND FISHER, L. Disturbances of the stress response: The role of the HPA axis during alcohol withdrawal and abstinence. *Alcohol Health and Research World* 22(1):67–72, 1998. PMID: 15706736

ADINOFF, B.; JUNGHANNS, K.; KIEFER, F.; AND KRISHNAN-SARIN, S. Suppression of the HPA axis stress-response: Implications for relapse. *Alcoholism: Clinical and Experimental Research* 29(7):1351–1355, 2005. PMID: 16088999

BRANDON, T.H.; VIDRINE, J.I.; AND LITVIN, E.B. Relapse and relapse prevention. *Annual Review of Clinical Psychology* 3:257–284, 2007. PMID: 17716056

BREESE, G.R.; CHU, K.; DAYAS, C.V.; ET AL. Stress enhancement of craving during sobriety: A risk for relapse. *Alcoholism: Clinical and Experimental Research* 29(2):185–195, 2005. PMID: 15714042

BREESE, G.R.; SINHA, R.; AND HEILIG, M. Chronic alcohol neuroadaptation and stress contribute to susceptibility for alcohol craving and relapse. *Pharmacology & Therapeutics* 129(2):149–171, 2011. PMID: 20951730

BROWN, S.A.; VIK, P.W.; MCQUAID, J.R.; ET AL. Severity of psychosocial stress and outcome of alcoholism treatment. *Journal of Abnormal Psychology* 99(4):344–348, 1990. PMID: 2266207

CARDENAS, V.A.; STUDHOLME, C.; GAZDZINSKI, S.; ET AL. Deformation-based morphometry of brain changes in alcohol dependence and abstinence. *NeuroImage* 34(3):879–887, 2007. PMID: 17127079

CARTER, B.L., AND TIFFANY, S.T. Meta-analysis of cue-reactivity in addiction research. *Addiction* 94(3):327–340, 1999. PMID: 10605857

CHAPLIN, T.M.; HONG, K.; BERGQUIST, K.; AND SINHA, R. Gender differences in response to emotional stress: An assessment across subjective, behavioral, and physiological domains and relations to alcohol craving. *Alcoholism: Clinical and Experimental Research* 32(7):1242–1250, 2008. PMID: 18482163

CLECK, J.N., AND BLENDY, J.A. Making a bad thing worse: Adverse effects of stress on drug addiction. *Journal of Clinical Investigation* 118(2):454–461, 2008. PMID: 18246196

COONEY, N.L.; LITT, M.D.; MORSE, P.A.; ET AL. Alcohol cue reactivity, negative-mood reactivity, and relapse in treated alcoholic men. *Journal of Abnormal Psychology* 106(2):243–250, 1997. PMID: 9131844

COONEY, N.L.; LITT, M.D.; COONEY, J.L.; ET AL. Alcohol and tobacco cessation in alcohol-dependent smokers: Analysis of real-time reports. *Psychology of Addictive Behaviors* 21(3):277–286, 2007. PMID: 17874878

DACKIS, C.A., AND GOLD, M.S. New concepts in cocaine addiction: The dopamine depletion hypothesis. *Neuroscience and Biobehavioral Reviews* 9(3):469–477, 1985. PMID: 2999657

DAWSON, D.A.; GRANT, B.F.; STINSON, F.S.; AND CHOU, P.S. Psychopathology associated with drinking and alcohol use disorders in the college and general adult populations. *Drug and Alcohol Dependence* 77(2):139–150, 2005. PMID: 15664715

EHRENREICH, H.; SCHUCK, J.; STENDER, N.; ET AL. Endocrine and hemodynamic effects of stress versus systemic CRF in alcoholics during early and medium term abstinence. *Alcoholism: Clinical and Experimental Research* 21(7):1285–1293, 1997. PMID: 9347091

FEIN, G.; DI SCLAFANI, V.; CARDENAS, V.A.; ET AL. Cortical gray matter loss in treatment-naive alcohol dependent individuals. *Alcoholism: Clinical and Experimental Research* 26(4):558–564, 2002. PMID: 11981133

FOX, H.C.; BERGQUIST, K.L.; HONG, K.I.; AND SINHA, R. Stress-induced and alcohol cue-induced craving in recently abstinent alcohol-dependent individuals. *Alcoholism: Clinical and Experimental Research* 31(3):395–403, 2007. PMID: 17295723

FOX, H.C.; TALIH, M.; MALISON, R.; ET AL. Frequency of recent cocaine and alcohol use affects drug craving and associated responses to stress and drug-related cues. *Psychoneuroendocrinology* 30(9):880–891, 2005. PMID: 15975729

GEORGE, M.S.; ANTON, R.F.; BLOOMER, C.; ET AL. Activation of prefrontal cortex and anterior thalamus in alcoholic subjects on exposure to alcohol-specific cues. *Archives of General Psychiatry* 58(4):345–352, 2001. PMID: 11296095

GILMAN, J.M., AND HOMMER, D.W. Modulation of brain response to emotional images by alcohol cues in alcohol-dependent patients. *Addiction Biology* 13(3–4): 423–434, 2008. PMID: 18507736

GLAUTIER, S.; DRUMMOND, D.C.; AND REMINGTON, B. Different drink cues elicit different physiological responses in non-dependent drinkers. *Psychopharmacology (Berlin)* 106(4):550–554, 1992. PMID: 1579627

GOEDERS, N.E. The HPA axis and cocaine reinforcement. *Psychoneuroendocrinology* 27(1-2):13–33, 2002. PMID: 11750768

GREELEY, J.D.; SWIFT, W.; PRESCOTT, J.; AND HEATHER, N. Reactivity to alcohol-related cues in heavy and light drinkers. *Journal of Studies on Alcohol* 54(3):359–368, 1993. PMID: 8487545

GRUSSER, S.M.; WRASE, J.; KLEIN, S.; ET AL. Cue-induced activation of the striatum and medial prefrontal cortex is associated with subsequent relapse in abstinent alcoholics. *Psychopharmacology (Berlin)* 175(3):296–302, 2004

GRUSSER, S.M.; MORSEN, C.P.; AND FLOR, H. Alcohol craving in problem and occasional alcohol drinkers. *Alcohol and Alcoholism* 41:421–425, 2006. PMID: 15127179

GRUSSER, S.M.; MORSEN, C.P.; WOLFLING, K.; AND FLOR, H. The relationship of stress, coping, effect expectancies and craving. *European Addiction Research* 13(1):31–38, 2007. PMID: 17172777

HEINZ, A.; SIESSMEIER, T.; WRASE, J.; ET AL. Correlation of alcohol craving with striatal dopamine synthesis capacity and D2/3 receptor availability: A combined [18F]DOPA and [18F]DMFP PET study in detoxified alcoholic patients. *American Journal of Psychiatry* 162(8):1515–1520, 2005. PMID: 16055774

HEINZ, A.; SIESSMEIER, T.; WRASE, J.; ET AL. Correlation between dopamine D(2) receptors in the ventral striatum and central processing of alcohol cues and craving. *American Journal of Psychiatry* 161(10):1783–1789, 2004. PMID: 15465974

HYMAN, S.M.; FOX, H.; HONG, K.I.; ET AL. Stress and drug cue-induced craving in opioid-dependent individuals in naltrexone treatment. *Experimental and Clinical Psychopharmacology* 15(2), 134-143, 2007. PMID: 17469937

INGJALDSSON, J.T.; LABERG, J.C.; AND THAYER, J.F. Reduced heart rate variability in chronic alcohol abuse:

Relationship with negative mood, chronic thought suppression, and compulsive drinking. *Biological Psychiatry* 54(12):1427–1436, 2003. PMID: 14675808

Junghanns, K.; Backhaus, J.; Tietz, U.; et al. Impaired serum cortisol stress response is a predictor of early relapse. *Alcohol and Alcoholism* 38(2):189–193, 2003. PMID: 12634269

Kaplan, R.F.; Cooney, N.L.; Baker, L.H.; et al. Reactivity to alcohol-related cues: Physiological and subjective responses in alcoholics and nonproblem drinkers. *Journal of Studies on Alcohol* 46(4):267–272, 1985. PMID: 4033125

Koob, G., and Kreek, M.J. Stress, dysregulation of drug reward pathways, and the transition to drug dependence. *American Journal of Psychiatry* 164(8):1149–1159, 2007. PMID: 17671276

Koob, G.F. Dynamics of neuronal circuits in addiction: Reward, antireward, and emotional memory. *Pharmacopsychiatry* 42(Suppl. 1): S32–S41, 2009. PMID: 19434554

Koob, G.F.; Ahmed, S.H.; Boutrel, B.; et al. Neurobiological mechanisms in the transition from drug use to drug dependence. *Neuroscience and Biobehavioral Reviews* 27(8):739–749, 2004. PMID: 15019424

Lee, S., and Rivier, C. An initial, three-day-long treatment with alcohol induces a long-lasting phenomenon of selective tolerance in the activity of the rat hypothalamic-pituitary-adrenal axis. *Journal of Neuroscience* 17(22):8856–8866, 1997. PMID: 9348353

Litt, M.D., and Cooney, N.L. Inducing craving for alcohol in the laboratory. *Alcohol Research & Health* 23(3):174–178, 1999. PMID: 10890812

Martinez, D.; Gil, R.; Slifstein, M.; et al. Alcohol dependence is associated with blunted dopamine transmission in the ventral striatum. *Biological Psychiatry* 58(10):779–786, 2005. PMID: 16018986

Martinez, D.; Kim, J.H.; Krystal, J.; and Abi-Dargham, A. Imaging the neurochemistry of alcohol and substance abuse. *Neuroimaging Clinics of North America* 17(4):539–555, 2007. PMID: 17983969

Modell, J.G., and Mountz, J.M. Focal cerebral blood flow change during craving for alcohol measured by SPECT. *Journal of Neuropsychiatry and Clinical Neurosciences* 7(1):15–22, 1995. PMID: 7711486

Myrick, H.; Anton, R.F.; Li, X.; et al. Differential brain activity in alcoholics and social drinkers to alcohol cues: Relationship to craving. *Neuropsychopharmacology* 29(2):393–402, 2004. PMID: 14679386

O'Brien, C.P. Anticraving medications for relapse prevention: A possible new class of psychoactive medications. *American Journal of Psychiatry* 162(8):1423–1431, 2005. PMID: 16055763

O'Brien, C.P.; Childress, A.R.; Ehrman, R.; and Robbins, S.J. Conditioning factors in drug abuse: Can they explain compulsion? *Journal of Psychopharmacology* 12(1): 15–22, 1998. PMID: 9584964

Pfefferbaum, A.; Sullivan, E.V.; Mathalon, D.H.; et al. Longitudinal changes in magnetic resonance imaging brain volumes in abstinent and relapsed alcoholics. *Alcoholism: Clinical and Experimental Research* 19(5):1177–1191, 1995. PMID: 8561288

Pfefferbaum, A.; Sullivan, E.V.; Rosenbloom, M.J.; et al. A controlled study of cortical gray matter and ventricular changes in alcoholic men over a 5-year interval. *Archives of General Psychiatry* 55(10):905–912, 1998. PMID: 9783561

Pomerleau, O.F.; Fertig, J.; Baker, L.; and Cooney, N. Reactivity to alcohol cues in alcoholics and non-alcoholics: Implications for a stimulus control analysis of drinking. *Addictive Behaviors* 8(1):1–10, 1983. PMID: 6880920

Rando, K.; Hong, K.I.; Li, C.S.; et al. Association of frontal and posterior cortical gray matter volume with time to alcohol relapse: A prospective study. *American Journal of Psychiatry* 168(2):183–192, 2011. PMID: 21078704

Rasmussen, D.D.; Wilkinson, C.W.; and Raskind, M.A. Chronic daily ethanol and withdrawal: 6. Effects on rat sympathoadrenal activity during "abstinence". *Alcohol* 38(3):173-177, 2006. PMID: 16905443

Rechlin, T.; Orbes, I.; Weis, M.; and Kaschka, W.P. Autonomic cardiac abnormalities in alcohol-dependent patients admitted to a psychiatric department. *Clinical Autonomic Research* 6(2):119–122, 1996. PMID: 8726098

Rehm, J.; Mathers, C.; and Popova, S.; et al. Global burden of disease and injury and economic cost attributable to alcohol use and alcohol-use disorders. *Lancet* 373(9682):2223–2233, 2009. PMID: 19560604

Richardson, H.N.; Lee, S.Y.; O'Dell, L.E.; et al. Alcohol self-administration acutely stimulates the hypothalamic-pituitary-adrenal axis, but alcohol dependence leads to a dampened neuroendocrine state. *European Journal of Neuroscience* 28(8):1641–1653, 2008. PMID: 18979677

Robinson, T.E., and Berridge, K.C. The neural basis of drug craving: An incentive-sensitization theory of addiction. *Brain Research. Brain Research Reviews* 18(3):247–291, 1993. PMID: 8401595

Robinson, T.E., and Berridge, K.C. The psychology and neurobiology of addiction: An incentive-sensitization view. *Addiction* 95(Suppl. 2):S91–S117, 2000. PMID: 11002906

Room, R.; Babor, T.; and Rehm, J. Alcohol and public health. *Lancet* 365(9458):519–530, 2005. PMID: 15705462

Rosenberg, H., and Mazzola, J. Relationships among self-report assessments of craving in binge-drinking university students. *Addictive Behaviors* 32(12):2811–2818, 2007. PMID: 17524566

Shively, C.A.; Mietus, J.E.; Grant, K.A.; et al. Effects of chronic moderate alcohol consumption and novel environment on heart rate variability in primates (Macaca fascicularis). *Psychopharmacology (Berlin)* 192(2): 183–191, 2007. PMID: 17297637

Sinha, R. How does stress increase risk of drug abuse and relapse? *Psychopharmacology (Berlin)* 158(4):343–359, 2001. PMID: 11797055

Sinha, R. The role of stress in addiction relapse. *Current Psychiatry Reports* 9(5):388–395, 2007. PMID: 17915078

Sinha, R. Chronic stress, drug use, and vulnerability to addiction. *Annals of the New York Academy of Sciences* 1141:105–130, 2008. PMID: 18991954

Sinha, R.; Talih, M.; Malison, R.; et al. Hypothalamic-pituitary-adrenal axis and sympatho-adreno-medullary responses during stress-induced and drug cue-induced cocaine craving states. *Psychopharmacology (Berlin)* 170(1):62–72, 2003. PMID: 12845411

Sinha, R.; Lacadie, C.; Skudlarski, P.; et al. Neural activity associated with stress-induced cocaine craving: A functional magnetic resonance imaging study. *Psychopharmacology (Berlin)* 183(2):171–180, 2005. PMID: 16163517

Sinha, R.; Fox, H.C.; Hong, K.A.; et al. Enhanced negative emotion and alcohol craving, and altered physiological responses following stress and cue exposure in alcohol dependent individuals. *Neuropsychopharmacology* 34(5):1198–1208, 2009. PMID: 18563062

Sinha, R.; Fuse, T.; Aubin, L.R.; and O'Malley, S.S. Psychological stress, drug-related cues and cocaine craving. *Psychopharmacology (Berlin)* 152(2):140–148, 2000. PMID: 11057517

Sinha, R.; Garcia, M.; Paliwal, P.; et al. Stress-induced cocaine craving and hypothalamic-pituitary-adrenal responses are predictive of cocaine relapse outcomes. *Archives of General Psychiatry* 63(3):324–331, 2006. PMID: 16520439

Sinha, R.; Fox, H.C.; Hong, K.I.; et al. Effects of adrenal sensitivity, stress- and cue-induced alcohol craving, and anxiety on subsequent alcohol relapse and treatment outcomes. *Archives of General Psychiatry,* 68(9):942-952, 2011*a*. PMID: 21536969

Sinha, R.; Shaham, Y.; and Heilig, M. Translational and reverse translational research on the role of stress in drug craving and relapse. *Psychopharmacology* (Berlin) 218(1):69-82, 2011*b*. PMID: 21494792

Sinha, R. New findings on biological factors predicting addiction relapse vulnerability. *Current Psychiatry Reports* 12(5):398-405, 2011. PMID: 21792580

Sinha, R. Modeling stress and drug craving in the laboratory: Implications for addiction treatment development. *Addiction Biology* 14(1):84–98, 2009. PMID: 18945295

Sinha, R., and Li, C.S. Imaging stress- and cue-induced drug and alcohol craving: Association with relapse and clinical implications. *Drug and Alcohol Review* 26(1):25–31, 2007. PMID: 17364833

Sinha, R., and O'Malley, S.S. Craving for alcohol: Findings from the clinic and the laboratory. *Alcohol and Alcoholism* 34(2):223–230, 1999. PMID: 10344782

Tapert, S.F.; Brown, G.G.; Kinderman, S.S.; et al. fMRI measurement of brain dysfunction in alcohol-dependent young women. *Alcoholism: Clinical and Experimental Research* 25(2):236–245, 2001. PMID: 11236838

Thayer, J.F., and Sternberg, E. Beyond heart rate variability: Vagal regulation of allostatic systems. *Annals of the New York Academy of Sciences* 1088:361–372, 2006. PMID: 17192580

Tiffany, S.T. A cognitive model of drug urges and drug-use behavior: Role of automatic and nonautomatic pro-

cesses. *Psychological Review* 97(2):147–168, 1990. PMID: 2186423

Volkow, N.D. Imaging the addicted brain: From molecules to behavior. *Journal of Nuclear Medicine* 45(11):13N–22N, 2004. PMID: 15584131

Volkow, N.D., and Fowler, J.S. Addiction, a disease of compulsion and drive: Involvement of the orbitofrontal cortex. *Cerebral Cortex* 10(3):318–325, 2000. PMID: 10731226

Volkow, N.D.; Wang, G.J.; Telang, F.; et al. Cocaine cues and dopamine in dorsal striatum: Mechanism of craving in cocaine addiction. *Journal of Neuroscience* 26(24):6583–6588, 2006. PMID: 16775146

Walker, B.M.; Rasmussen, D.D.; Raskind, M.A.; and Koob, G.F. alpha1-noradrenergic receptor antagonism blocks dependence-induced increases in responding for ethanol. *Alcohol* 42(2):91–97, 2008. PMID: 18358987

Wand, G.S., and Dobs, A.S. Alterations in the hypothalamic-pituitary-adrenal axis in actively drinking alcoholics. *Journal of Clincal Endocrinology and Metabolism* 72(6):1290–1295, 1991. PMID: 2026749

Weiss, F. Neurobiology of craving, conditioned reward and relapse. *Current Opinion in Pharmacology* 5(1):9–19, 2005. PMID: 15661620

Willner, P.; Field, M.; Pitts, K.; and Reeve, G. Mood, cue and gender influences on motivation, craving, and liking for alcohol in recreational drinkers. *Behavioural Pharmacology* 9(7):631–642, 1998. PMID: 9862088

Wong, D.F.; Kuwabara, H.; Schretlen, D.J.; et al. Increased occupancy of dopamine receptors in human striatum during cue-elicited cocaine craving. *Neuropsychopharmacology* 31(12):2716–2727, 2006. PMID: 16971900

Wrase, J.; Grusser, S.M.; Klein, S.; et al. Development of alcohol-associated cues and cue-induced brain activation in alcoholics. *European Psychiatry* 17(5):287–291, 2002. PMID: 12381499

Yoon, G.; Kim, S.W.; Thuras, P.; et al. Alcohol craving in outpatients with alcohol dependence: Rate and clinical correlates. *Journal of Studies on Alcohol* 67(5):770–777, 2006. PMID: 16847547

Zhou, Y.; Franck, J.; Spangler, R.; et al. Reduced hypothalamic POMC and anterior pituitary CRF1 receptor mRNA levels after acute, but not chronic, daily "binge" intragastric alcohol administration. *Alcoholism: Clinical and Experimental Research* 24(10):1575–1582, 2000. PMID: 11045867