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Remission From Unhealthy Drinking Among Patients With an Alcohol Use Disorder: A Longitudinal Study Using Systematic, Primary Care–Based Alcohol Screening Data

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ABSTRACT. Objective: Using electronic health record (EHR) data from a systematic, primary care–based alcohol screening, brief intervention, and referral to treatment (SBIRT) initiative within a health system, we examined correlates of remission from unhealthy drinking among patients with an alcohol use disorder (AUD). **Method:** We conducted a longitudinal study of 4,078 adults with AUD who screened positive for unhealthy drinking between October 1, 2015, and September 30, 2016. We extracted EHR data up to 3 years after screening until October 1, 2018. We used survival analysis to examine associations between remission (i.e., reporting abstinence or low-risk drinking at a subsequent screening) and patient characteristics, comorbidities, and treatment utilization. **Results:** The median time to remission from unhealthy drinking was 1.7 years. Factors significantly associated with greater odds of remitting from unhealthy drinking during follow-up were female gender; older age (50–64 years); Black or Latino/Hispanic race/ethnicity; having more medical comorbidities; not having a comorbid drug use disorder; lower alcohol consumption levels; and receiving addiction medicine treatment before the index screening. In the first follow-up year, individuals with mental health comorbidities were more likely to remit, but those in psychiatric treatment were less likely. Receiving addiction treatment during follow-up was not associated with remission. **Conclusions:** Ethnic minorities and individuals with mental illness were more likely to remit, which is encouraging given the health disparities observed among these clinically important subgroups and warrants further research. Our findings may inform research on AUD recovery and clinical practice, as remission from unhealthy drinking is a crucial component of the early stages of recovery. (*J. Stud. Alcohol Drugs, 81,* 436–445, 2020)

GIVEN THE substantial public health burden of alcohol use disorders (AUDs) (Grant et al., 2017; McKay & Hiller-Sturmhöfel, 2011), it is essential to understand the recovery process, including both long-term and early stages. Although varying definitions of "recovery" have been used across studies, one common key component is reduced alcohol consumption, which has broadened to include both abstinence and low-risk drinking (i.e., drinking within recommended guidelines). Recent research among individuals with AUD has shown that those who achieved low-risk drinking were comparable to those who achieved abstinence in terms of health-related outcomes, including reduced alcohol-related consequences and improved psychosocial functioning (Dawson et al., 2012; Frischknecht et al., 2013; Kline-Simon et al., 2013, 2017; Witkiewitz et al., 2017, 2018). Accordingly, regulatory guidelines (Falk et al., 2010; U.S. Department of Health and Human Services et al., 2015) suggest that low-risk drinking without significant consequences may also be a treatment goal acceptable to clinicians and patients.

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Several prior studies with varying follow-up times have examined correlates of recovery defined as remission to abstinence or low-risk drinking, although with some limitations. A population-based study surveyed individuals with AUD over multiple waves spanning up to 3 years, but primarily assessed baseline characteristics (Dawson et al., 2012). Studies of treatment-seeking AUD patients included follow-up interviews up to 16 years later (Moos & Moos, 2007; Satre et al., 2012; Weisner et al., 2003); however, they may not be as generalizable to the entire AUD population, as many individuals with AUD never receive treatment (Grant et al., 2015; Witkiewitz & Tucker, 2020), and individuals who seek treatment differ in many ways from those who do not, including demographic characteristics, age at onset, symptom severity, and psychiatric comorbidities (Dawson et al., 2006; Grant, 1996; Rohn et al., 2017). More research that examines factors of recovery that may change over time beyond treatment-seeking populations is needed.

Primary care is well positioned to identify and address AUD and to track recovery longitudinally in a broad population (Berger & Bradley, 2015; Institute of Medicine, 2006). Given that chronic medical conditions are common among individuals with AUD (Mertens et al., 2003; Schuckit, 2009), primary care providers may be able to identify unhealthy drinking during routine care that may not otherwise be detected. Primary care providers can also facilitate treatment in a continuing care model, which is important for long-term

recovery (Chi et al., 2011). National guidelines recommend screening all adults for unhealthy drinking in primary care and providing brief interventions if necessary (Curry et al., 2018). As workflows for screening, brief intervention, and referral to treatment (SBIRT) become more widely implemented across health systems, alcohol use measures in the electronic health record (EHR) may be a useful way to track drinking over time and to study remission from unhealthy drinking as an early indicator of recovery from AUD.

To our knowledge, no published study has examined remission from unhealthy drinking among patients with AUD in the context of systematic alcohol screening. Using EHR-derived data from a health system, we examined factors associated with remission over a 3-year follow-up period, including patient characteristics, physical and mental health comorbidities, and specialty treatment.

Method

Study setting

The study was conducted within Kaiser Permanente Northern California (KPNC), a large integrated health care delivery system serving approximately four million members. KPNC members are similar to the statewide insured population, although they are less likely to have very low household incomes (Gordon, 2015). Study procedures were approved by the institutional review board at KPNC.

Systematic alcohol SBIRT at KPNC

In June 2013, KPNC incorporated a systematic alcohol SBIRT workflow (Alcohol as a Vital Sign) into adult primary care based on a National Institute on Alcohol Abuse and Alcoholism (NIAAA)-sponsored SBIRT implementation trial (Mertens et al., 2015). Since then, KPNC has had an 89% average screening rate, and approximately 3.9 million members have been screened. During pre-visit evaluation, medical assistants conduct screenings by asking patients the modified NIAAA single screening question ["How many times in the past 3 months have you had 5 or more drinks in a day?" (for men ages 18–65, and "4 or more drinks" for women and individuals ages 66 and older)], followed by questions on the typical number of drinking days per week and drinks per day (NIAAA, 2005), and record the answers in the EHR. Drinking that exceeds either the NIAAA recommended daily limit (≥4 or ≥5 drinks on a single day), weekly limit (>7 drinks/week for women and men ages 66 and older, or >14 drinks/week for men ages 18–65), or both limits is considered a positive screening result for unhealthy drinking. The EHR alerts medical assistants with a best practice reminder to screen patients during a primary care visit if it is their first visit or if 6 months has elapsed since their prior screening if it had a positive result—otherwise, annually.

Study design and cohort

We identified 6,071 adults with a recorded AUD diagnosis at an encounter with the health system between October 1, 2015, and September 30, 2016, using EHR data and defined the index date as the first positive alcohol screening date within this period. The alcohol screening rate was 70% among adults who had at least one primary care visit during this period. Within KPNC, AUD and other mental health diagnoses can be assigned by physicians or other qualified health providers directly evaluating patients in any clinic setting by using International Classification of Diseases (ICD) codes. To identify patients with an AUD, we used ICD, Tenth Revision, Clinical Modification (ICD-10-CM) codes of F10.1*, F10.9*, and F10.2* (where * indicates all codes with that prefix, except remission codes F10.11 and F10.21).

Of the 6,071 patients, we excluded those who had unknown weekly (n = 38) or daily (n = 665) drinking at the index screening; had an AUD diagnosis recorded exclusively outside of outpatient, inpatient, and emergency department encounters (an indication of lower diagnosis reliability; n = 105); or were not continuously enrolled at KPNC in the year before the index date (allowing 90-day gaps in coverage) (n = 1,357). The final analytical cohort consisted of 4,078 patients for whom we extracted EHR data through October 1, 2018, providing a maximum follow-up period of 3 years.

Primary outcome: Time to remission from unhealthy drinking

The primary outcome was time to remission from unhealthy drinking, defined as the number of days from the index positive alcohol screening to the first negative screening during follow-up when the patient reported abstinence or low-risk drinking (i.e., drinking within recommended daily and weekly limits), or until observation was no longer possible (i.e., censorship). All patients contributed person-time (days) until they met the remission definition or were censored (Huber & Patetta, 2016). The reasons for censoring include lost to follow-up due to death (n = 135) or disenrollment from KPNC (n = 613) or not having a subsequent negative screening before the end of the study follow-up period (October 1, 2018) (i.e., right-censored, n = 998). Of the 998 right-censored patients, there were 287 who did not have a subsequent alcohol screening, and we assumed that they did not meet the remission definition by the end of our follow-up period.

Predictors of remission from unhealthy drinking

We obtained patient demographic, comorbidity, and treatment utilization data from the EHR. Demographic variables included gender, race/ethnicity, age, and household income.

The median household income was estimated by geocoding patients' residential addresses in the year before their index date to census blocks (U.S. Census Bureau, 2020; Young-Wolff et al., 2017) and categorized based on tertiles of the overall distribution (low, middle, and high). We imputed one patient's unknown geocoded household income data as the middle-income group. Based on alcohol consumption levels at the index screening, we categorized patients into three groups: exceeding daily limit only, exceeding weekly limit only, or exceeding both daily and weekly limits.

Using ICD-9 and ICD-10-CM codes, we identified comorbidities for the cohort in the year before the index date. We counted the number of chronic medical comorbidities (Ornstein et al., 2013) that each patient had, including hypertension, hyperlipidemia, gastroesophageal reflux, diabetes mellitus, osteoarthritis, asthma, osteoporosis or osteopenia, migraine, coronary disease, atherosclerosis, chronic obstructive pulmonary disease, chronic kidney disease, atrial fibrillation, heart failure, peptic ulcer, chronic liver disease, epilepsy, rheumatoid arthritis, and Parkinson's disease or syndrome. We categorized mental health comorbidities as none, with serious mental illness (SMI), or with non-SMI. SMI included depression, bipolar disorder, schizophrenia, and schizoaffective disorder (Brunette et al., 2004; De Hert et al., 2011). Non-SMI included anxiety disorder, panic disorder, obsessive-compulsive disorder, pervasive developmental disorder or autism, anorexia nervosa, bulimia nervosa, and dementia. Last, we created an indicator variable for an active comorbid drug use disorder (cannabis, cocaine, hallucinogen, inhalant, opioid, sedative, stimulant, and other drug-related disorders) or tobacco-related disorder, together in the same variable, as they are all negatively associated with AUD recovery (Satre et al., 2012; Tsoh et al., 2011; Weinberger et al., 2015).

KPNC members have direct access to both outpatient addiction medicine and psychiatric treatment in specialty care clinics (Chi et al., 2006). Addiction treatment at KPNC is representative of treatment programs nationwide and predominantly based on abstinence; it has a group-based treatment approach, although individual counseling and pharmacotherapy are also available. Psychiatric treatment includes assessment, individual and group psychotherapy, and medication management (Lake & Turner, 2017). Patients do not need a referral to use specialty treatment, and there are no delays in getting treatment. We extracted treatment utilization data from the EHR and created separate indicator variables for whether treatment was received in the year before the index date or during follow-up based on whether patients had one or more visits in these settings.

Statistical analysis

We calculated unadjusted remission rates (per 100,000 person-days) and 95% confidence intervals (CIs) by patient characteristics, comorbidities, and treatment utilization, dividing the total number of patients who remitted from unhealthy drinking during follow-up by the total number of person-days at which patients had not yet remitted, within each stratum of the covariate. We converted the remission rates from 100,000 person-days to 100 person-years for ease of interpretability and clinical relevance. We used the Kaplan–Meier method to plot survival curves with Hall–Wellner confidence bands and estimated the median time to remission in days (Huber & Patetta, 2016). We tested for differences in survival curves using log-rank tests.

Multivariable Cox proportional hazards regression analysis was used to examine the associations between remission and patient characteristics, comorbidities, and treatment utilization. The Cox model uses longitudinal time-to-event data to estimate hazard ratios (HRs), which have similar properties to the odds ratio in logistic regression (Hosmer & Lemeshow, 1999; Huber & Patetta, 2016; Spruance et al., 2004). We first fit a model including all predictors of interest, including age, gender, race/ethnicity, household income, alcohol consumption at the index screening, number of comorbid medical conditions, having comorbid SMI or non-SMI, having a comorbid drug or tobacco-related disorder, and whether addiction or psychiatric treatment was used in the year before and during follow-up. Since the association between remission and receiving addiction medicine treatment during follow-up may vary by alcohol consumption level (Chi et al., 2011; Glass et al., 2015), we next assessed for an interaction between these variables using joint tests. We did not find evidence of an interaction ($p = .48$; data not shown); therefore, we dropped the interaction term from our model (Huber & Patetta, 2016).

We also evaluated whether each variable satisfied the Cox proportional hazards assumption by testing whether an interaction term between the predictor variable and time was significantly different from zero (in a model with all other predictor variables and time), which would indicate that the HR changed over time and was thus nonproportional (Hosmer & Lemeshow, 1999; Huber & Patetta, 2016). We found nonproportionality for mental health comorbidities ($p = .02$) and receiving psychiatric treatment during follow-up ($p < .001$; data not shown); thus, we used the piecewise method to estimate the HRs in four time intervals where the hazard functions were proportional (0–365 days, 366–730 days, 731–950 days, and ≥951 days) (Schemper, 1992). Tests of equivalence of the piecewise HRs confirmed nonproportionality (SMI vs. none, $p = .016$; non-SMI vs. none, $p = .004$; psychiatric treatment during follow-up, $p = .001$; data not shown) (Huber & Patetta, 2016).

All statistical analyses were conducted using SAS software, Version 9.4 of the SAS System for Unix (SAS Institute Inc., Cary, NC). Statistical significance was assessed at two-sided $p < .05$.

Results

Cohort characteristics

The study cohort of 4,078 adult patients with AUD was predominantly male (68%), White (66%), and age 50 years and older (56%) (Table 1). Approximately 31% had a comorbid drug or tobacco-related disorder, 27% had SMI, and 11% had non-SMI (Table 1). Within the year before their index positive alcohol screening, 14% received addiction medicine treatment, and 32% received it during follow-up (Table 1). Similarly, 16% of patients received psychiatric treatment within the year before the index screening, and 24% during follow-up. Among patients who visited primary care during follow-up (n = 3,673), visits occurred a median of two times per year (IQR = 3; data not shown). Among patients screened again for unhealthy drinking during follow-up (n = 3,238), screenings were conducted a median of one time per year (IQR = 1; data not shown).

Unadjusted rates of remission from unhealthy drinking and bivariate analysis

A total of 2,332 patients (57% of the entire cohort) with AUD remitted from unhealthy drinking during the follow-up period (Table 2). About 39 of every 100 patients remitted per year (95% CI [37, 41]; Table 2), and it took about 607 days (1.7 years) for half of the cohort to remit (Figure 1). In unadjusted analyses, subgroups with significantly higher remission rates were female (vs. male), were older (≥50 years vs. 18–34 years), exceeded the daily limit only at their index positive screening (vs. those who exceeded the weekly limit only or both limits), had two or more medical comorbidities (vs. one or less), had no comorbid drug or tobacco-related disorder (vs. yes), had SMI (vs. non-SMI only or none), had one or more addiction treatment visits in the year before the index screening (vs. no visits), and had one or more psychiatry visits in the year before the index screening (vs. no visits) (Table 2). Remission rates varied slightly by race/ethnicity (p = .05), with Black and Latino/Hispanic individuals having higher rates.

Multivariable analysis with Cox proportional hazards regression

Adjusting for all other covariates, we found that patients with significantly higher odds of remitting from unhealthy drinking at any time during follow-up (i.e., HR > 1) were female versus male (HR = 1.19; 95% CI [1.09, 1.30]), were ages 50–64 years versus 18–34 years (HR = 1.19; 95% CI [1.04, 1.37]), were Black or Latino/Hispanic versus White (HR = 1.22; 95% CI [1.03, 1.44]; HR = 1.24; 95% CI [1.10, 1.41]; respectively), and received addiction treatment within the year before the index screening versus no treatment (HR = 1.18; 95% CI [1.04, 1.34]) (Table 3). For each additional medical comorbidity, the odds of remission increased by 9% (HR = 1.09; 95% CI [1.06, 1.11]). Compared with patients without a mental health comorbidity, patients with non-SMI or SMI (HR = 1.30; 95% CI [1.07, 1.56]; HR = 1.24; 95% CI [1.06, 1.44]; respectively) had a higher relative likelihood of remitting in the first follow-up year only; however, patients with SMI had a lower relative likelihood of remitting during the first half of the third year (HR = 0.65; 95% CI [0.45, 0.94]). In contrast, patients in psychiatric treatment during follow-up had a lower relative likelihood of remitting compared with

Table 1. Demographic and clinical characteristics of the alcohol use disorder cohort, Kaiser Permanente Northern California, 2015–2018

Characteristic	Overall cohort (n = 4,078) n (%)
Gender	
Male	2,782 (68.2)
Female	1,296 (31.8)
Age group	
18–34 years	828 (20.3)
35–49 years	961 (23.6)
50–64 years	1,197 (29.4)
≥65 years	1,092 (26.7)
Race/ethnicity	
White	2,692 (66.0)
Asian, Hawaiian, or Pacific Islander	213 (5.2)
Black	267 (6.5)
Latino/Hispanic	575 (14.1)
Multi/other/unknown	331 (8.2)
Household income	
Low	1,295 (31.8)
Middle	1,347 (33.0)
High	1,436 (35.2)
Drinking pattern at index screening	
Exceeding daily limit only	1,157 (28.4)
Exceeding weekly limit only	1,557 (38.2)
Exceeding both daily and weekly limits	1,364 (33.4)
Number of medical comorbidities, median (IQR)	2.3 (2.3)
Any comorbid drug or tobacco-related disorder	1,243 (30.5)
Cannabis related	201 (4.9)
Cocaine related	70 (1.7)
Opioid related	65 (1.6)
Other drug related[a]	138 (3.4)
Sedative, hypnotic, or anxiolytic related	25 (0.6)
Stimulant related	80 (2.0)
Tobacco related	1,029 (25.2)
Mental health comorbidities	
None	2,506 (61.5)
Non–serious mental illness only[b]	454 (11.1)
Serious mental illness[c]	1,118 (27.4)
Health service utilization	
Addiction medicine treatment within year prior	588 (14.4)
Psychiatric treatment within year prior	638 (15.6)
Addiction medicine treatment during follow-up	1,295 (31.8)
Psychiatric treatment during follow-up	976 (23.9)

Notes: IQR = interquartile range. [a]Other drug-related disorders comprise hallucinogen related, inhalant related, other psychoactive substance related, and other/unspecified drug related disorders; [b]non–serious mental illness comprises anxiety and panic disorders, obsessive–compulsive disorder, pervasive developmental disorders, anorexia nervosa, bulimia nervosa, and dementia; [c]serious mental illness comprises depression, bipolar disorder, schizophrenia, and schizoaffective disorder.

TABLE 2. Unadjusted rates of remission from unhealthy drinking (per 100 person-years) by patient characteristics and treatment utilization, Kaiser Permanente Northern California

Characteristic	Patients remitted, *n* (%)[a]	Person-years[b]	Remission rate per 100 person-years [95% CI]
All	2,332 (57)	5,985	39 [37, 41]
Gender*			
Male	1,547 (56)	4,138	37 [36, 39]
Female	785 (61)	1,848	42 [40, 45]
Age group*			
18–34 years	406 (49)	1,249	33 [29, 36]
35–49 years	522 (54)	1,425	37 [33, 40]
50–64 years	715 (60)	1,715	42 [39, 45]
≥65 years	689 (63)	1,596	43 [40, 46]
Race/ethnicity			
White	1,528 (57)	4,040	38 [36, 40]
Asian, Hawaiian, or Pacific Islander	119 (56)	316	38 [31, 44]
Black	162 (61)	362	45 [38, 52]
Latino/Hispanic	333 (58)	789	42 [38, 47]
Multi/other/unknown	190 (57)	478	40 [34, 45]
Household income			
Low	740 (57)	1,880	39 [37, 42]
Middle	770 (57)	1,953	39 [37, 42]
High	822 (57)	2,153	38 [36, 41]
Drinking severity at index screening*			
Exceeding daily limit only	691 (60)	1,595	43 [40, 47]
Exceeding weekly limit only	938 (60)	2,283	41 [38, 44]
Exceeding both daily and weekly limits	703 (52)	2,107	33 [31, 36]
Medical comorbidities*			
1 or less	1,007 (51)	3,034	33 [31, 35]
≥2	1,325 (63)	2,951	45 [42, 47]
Comorbid drug or tobacco-related disorder*			
Yes	656 (53)	1,804	36 [34, 39]
No	1,676 (59)	4,182	40 [38, 42]
Mental health comorbidities*			
None	1,423 (57)	3,815	37 [35, 39]
Non–serious mental illness only[c]	256 (56)	629	41 [36, 46]
Serious mental illness[d]	653 (58)	1,542	42 [39, 46]
Addiction treatment within year prior*			
Yes	343 (58)	798	43 [38, 48]
No	1,989 (57)	5,187	38 [37, 40]
Psychiatric treatment within year prior*			
Yes	375 (59)	886	42 [38, 47]
No	1,957 (57)	5,099	38 [37, 40]
Addiction treatment during follow-up			
Yes	740 (57)	1,945	38 [35, 41]
No	1,592 (57)	4,040	39 [37, 41]
Psychiatric treatment during follow-up			
Yes	564 (58)	1,495	38 [35, 41]
No	1,768 (57)	4,490	39 [38, 41]

Notes: CI = confidence interval. [a]Percentage based on number of patients within the stratum; [b]person-years are cumulative time at which the patient had not remitted; [c]non–serious mental illness comprises anxiety and panic disorders, obsessive-compulsive disorder, pervasive developmental disorders, anorexia nervosa, bulimia nervosa, and dementia; [d]serious mental illness comprises depression, bipolar disorder, schizophrenia, and schizoaffective disorder.
*Log-rank test $p < .05$, indicating a significant group difference in Kaplan–Meier survival curves.

patients who were not in psychiatric treatment in the first follow-up year only (HR = 0.70; 95% CI [0.60, 0.82]). In addition, patients who exceeded the weekly drinking limit only (HR = 0.80; 95% CI [0.72, 0.89]) or both the daily and weekly drinking limits (HR = 0.69; 95% CI [0.62, 0.77]), compared with those who exceeded the daily limit only, and patients with a comorbid drug or tobacco-related disorder (HR = 0.87; 95% CI [0.79, 0.96]) had lower odds of remitting any time during follow-up. Last, household income, receiving psychiatric treatment within the year before the index screening, and receiving addiction treatment during follow-up were not associated with remission.

Unadjusted Kaplan–Meier survival curves for all covariates significantly associated with remission from the Cox proportional hazards model are in the Supplemental Material (Supplemental Figures A–I). (Supplemental material appears

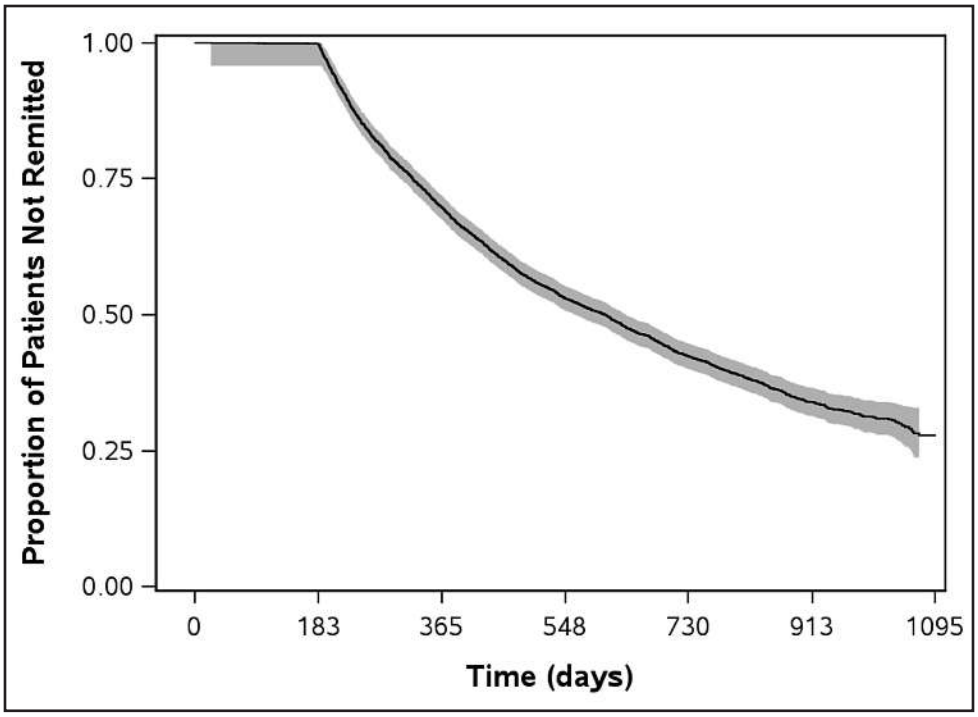

FIGURE 1. Kaplan-Meier survival curve of remission from unhealthy drinking and Hall–Wellner confidence bands (gray) of the Kaiser Permanente Northern California cohort of patients with AUD (n = 4,078), followed from their first positive alcohol screening until remission (i.e., a subsequent negative alcohol screening indicating abstinence or low-risk drinking), lost to follow-up because of death or disenrollment from Kaiser Permanente Northern California, or the end of the study follow-up period.

as an online-only addendum to this article on the journal's website.)

Discussion

To our knowledge, this is the first study to use comprehensive EHR data within the context of systematic alcohol SBIRT delivered in primary care to evaluate factors associated with remission from unhealthy drinking among patients with AUD, including patient characteristics, comorbid conditions, and specialty outpatient treatment. In a large cohort of patients with AUD, we found that patients had a median time to remission (i.e., abstinence or low-risk drinking) of 1.7 years. Although receiving addiction treatment during follow-up was not associated with remission, clinically important subgroups such as ethnic minorities and patients with mental health comorbidities had higher odds of remitting, particularly during the first follow-up year. Patients with more chronic medical comorbidities were more likely to remit during follow-up, providing further support for the "sick quitter" phenomenon (Sarich et al., 2019; Shaper et al., 1988). In contrast, patients with heavier drinking patterns and those with comorbid drug or tobacco-related disorders had lower odds of remitting during follow-up. In addition, patients who received psychiatric treatment during follow-up had lower odds of remitting in the first follow-up year only.

Although receiving addiction treatment in the year before the index screening was positively associated with remission, having any visits during follow-up was not. Prior research among treatment samples has found that receiving addiction treatment services after the initial treatment episode is related to positive long-term outcomes (McKay, 2009; Weisner et al., 2003); however, the mechanism is complicated, as having a treatment episode is associated with relapse, and effects may differ by problem severity and treatment needs. A recent analysis of nationally representative population survey data also found that treatment was more common among individuals with persistent AUD and those who achieved abstinent remission compared with symptomatic and asymptomatic individuals with high-risk or low-risk drinking (Fan et al., 2019). In addition, repeated treatment episodes may build on one another or be reinforced by other services, such as psychiatric treatment and primary care. Future research with sufficient sample size to properly examine these pathways with time-varying covariates is warranted.

Prior research on recovery has reported similar findings regarding demographic characteristics and drinking severity, but not mental health comorbidities. Consistent with our study, several studies have found that females and older individuals (i.e., ages ≥40 years) have better long-term recovery outcomes (i.e., 5–9 years) following treatment, such as maintaining abstinence (Satre et al., 2004; Weisner et al., 2003)

TABLE 3. Adjusted hazard ratios (HRs) and 95% confidence intervals (CIs) of remission from unhealthy drinking for patient characteristics and treatment utilization, Kaiser Permanente Northern California

Characteristic	HR[a] [95% CI]	*p*
Female gender (ref.: male)	1.19 [1.09, 1.30]	<.001
Age group (ref.: 18–34 years)		
35–49 years	1.12 [0.98, 1.28]	.098
50–64 years	1.19 [1.04, 1.37]	.011
≥65 years	1.13 [0.96, 1.34]	.145
Race/ethnicity (ref.: White)		
Asian, Native Hawaiian, or Pacific Islander	1.06 [0.88, 1.28]	.518
Black	1.22 [1.03, 1.44]	.019
Latino/Hispanic	1.24 [1.10, 1.41]	<.001
Other or unknown	1.08 [0.93, 1.26]	.317
Household income (ref.: middle)		
Low	0.98 [0.88, 1.08]	.647
High	0.96 [0.87, 1.06]	.440
Drinking pattern at index screening (ref.: exceeding daily limit only)		
Exceeding weekly limit only	0.80 [0.72, 0.89]	<.001
Exceeding both daily and weekly limits	0.69 [0.62, 0.77]	<.001
Number of medical comorbidities	1.09 [1.06, 1.11]	<.001
Comorbid drug or tobacco-related disorder	0.87 [0.79, 0.96]	.004
Mental health comorbidities (ref.: none), by time intervals[b]		
Non–serious mental illness only[c]		
0–365 days (first year)	1.30 [1.07, 1.56]	.006
366–730 days (second year)	0.87 [0.69, 1.10]	.254
731–950 days (first half of third year)	0.89 [0.56, 1.34]	.584
≥951 days (second half of third year)	2.33 [0.87, 5.61]	.072
Serious mental illness[d]		
0–365 days (first year)	1.24 [1.06, 1.44]	.005
366–730 days (second year)	1.10 [0.93, 1.30]	.274
731–950 days (first half of third year)	0.65 [0.45, 0.94]	.024
≥951 days (second half of third year)	0.39 [0.09, 1.21]	.144
Addiction medicine treatment within year prior	1.18 [1.04, 1.34]	.012
Psychiatric treatment within year prior	1.11 [0.96, 1.27]	.156
Addiction medicine treatment during follow-up	1.02 [0.93, 1.13]	.638
Psychiatric treatment during follow-up, by time intervals[b]		
0–365 days (first year)	0.70 [0.60, 0.82]	<.001
366–730 days (second year)	1.03 [0.87, 1.21]	.749
731–950 days (first half of third year)	1.24 [0.89, 1.70]	.192
≥951 days (second half of third year)	1.34 [0.55, 3.08]	.500

Notes: Ref. = reference. [a]An HR > 1 signifies that the group had greater odds of remitting at any time during follow-up compared with the reference group, whereas an HR < 1 signifies lower odds of remitting at any time during follow-up compared to the reference group; [b]piecewise Cox models were used to estimate the HR within time intervals that satisfied the proportional hazards assumption; [c]non–serious mental illness comprises anxiety and panic disorders, obsessive–compulsive disorder, pervasive developmental disorders, anorexia nervosa, bulimia nervosa, and dementia; [d]serious mental illness comprises depression, bipolar disorder, schizophrenia, and schizoaffective disorder.

and achieving AUD remission (Chi et al., 2011; Satre et al., 2012). Also consistent with our findings, one study found that lower past-year volume of alcohol use and Black/Asian/Hispanic race/ethnicity were associated with recovery after 3 years (Dawson et al., 2012). In contrast to our study, Dawson et al. (2012) did not find associations between mental health comorbidities (mood, anxiety, or personality disorders) and 3-year recovery, although other mental illnesses were not assessed. We found that individuals with mental health comorbidities had a higher relative likelihood of remitting in the first follow-up year, which might be because they were taking psychiatric medications, with clinicians encouraging lower alcohol intake, but the advantage did not persist over time. The co-occurrence of AUD among individuals with mental illness is well established (Kessler et al., 1996), and this subgroup should continue to be a focus of research on recovery.

We also found that Black and Latino/Hispanic individuals were more likely to remit during any time during follow-up, which is encouraging given the health disparities observed among these important subgroups in the United States (Chartier & Caetano, 2010; De Hert et al., 2011; National Center for Health Statistics (U.S.), 2016; Thornicroft, 2011). Although Native Americans and White individuals

are the ethnic groups at highest risk of developing an AUD (Grant et al., 2015), new research indicates that AUD nearly doubled in Blacks and increased by 52% in Hispanics from 2001–2002 to 2012–2013 (Grant et al., 2017). In addition, Black and Latino/Hispanic individuals experience the highest rates of recurrent or persistent dependence (Chartier & Caetano, 2010; Mulia et al., 2009) and have the highest risk for developing alcohol-related medical conditions, such as liver disease (Flores et al., 2008) and liver cirrhosis (Stinson et al., 2001; Yoon & Yi, 2008). Therefore, our results regarding race/ethnicity are hopeful, but continued attention to race/ethnic disparities in AUD clinical impact and treatment access is warranted.

Limitations

Although this study has notable strengths, including the ability to examine comorbid conditions using EHR-based data, there are limitations. Our longitudinal study design allowed us to evaluate remission rates among subgroups; however, interpretation is limited because our alcohol screening data depend on patient visits to primary care. Although patients visited primary care frequently, some patients (n = 287) were not screened again for unhealthy drinking during follow-up, and we assumed they did not remit. If we excluded these patients from the analysis, the associations we observed would become stronger rather than weaker (Leung et al., 1997); therefore, these results may be conservative.

Associations among medical severity, primary care visits, and alcohol screening results are complex and heterogeneous. We are unable to fully explore all the mechanisms underlying our findings with EHR-only data, and more research is needed. In addition, the delay in remission observed in the first 6 months of follow-up (Figure 1) is likely due to the EHR's best practice alert reminding medical assistants to screen patients when 6 months had elapsed after a positive alcohol screening (until a negative result). Similarly, the median time to remission could be influenced by this policy.

Our results may be biased by residual confounding because of unmeasured factors not included in our statistical model, such as marital status (Grant et al., 2017) and supportive friendships (Satre et al., 2012), which are related to recovery but were unavailable to us. We did not adjust for behavioral treatment that occurred outside of the health system, including Alcoholics Anonymous, which has been shown to be effective in sustaining remission from unhealthy drinking among individuals with an AUD (Kaskutas, 2009; Kelly et al., 2012; Ray et al., 2019). We used the piecewise method when a variable showed evidence of nonproportionality; however, HRs estimated for later follow-up intervals may be influenced by small sample sizes in the strata. Last, although KPNC members are representative of the insured population, our findings may not be generalizable to the wider AUD population in the United States.

Conclusion

In a health system that has implemented systematic SBIRT in adult primary care, we examined correlates of remission from unhealthy drinking using longitudinal alcohol screening data among a large cohort of individuals with AUD. We found that ethnic minorities and patients with mental illness had higher odds of remitting during follow-up, which warrants further research on whether other aspects of primary care–based alcohol SBIRT benefit these clinically important subgroups. Our findings may inform research on AUD recovery and clinical practice, as remission from unhealthy drinking is a crucial component of the early stages of recovery.

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Conflict-of-Interest Statement

The authors declare no conflicts of interest.

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