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Trajectories of Remission and Mortality over 13 Years after Intake to Substance Use Treatment

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Abstract

Background.—Little is known about the relationships between long-term patterns of substance use and mortality risk among substance use disorder (SUD) patients.

Objective.—To determine distinct patterns of remission and relapse of SUD over time and examine their relationship with mortality.

Methods.—The study site was Kaiser Permanente of Northern California. Data for 997 adults who entered substance use treatment between 1994 and 1996 and 4241 non-SUD patients with similar demographic distributions (35% women in both groups) were analyzed. Latent class growth analysis identified distinct remission trajectory groups over 13 years among SUD patients and survival analyses were conducted to examine the risk of death between remission trajectory groups, and SUD and non-SUD patients within each remission trajectory group.

Results.—Three distinct remission trajectory groups were identified among SUD patients: 1) *early relapse*- low remission probabilities; 2) *declining*- decreasing remission probabilities; and 3) *stable remission*- stable remission probabilities across all time points. Among the SUD patients, the early relapse group had a higher risk of death than those stably remitted; stable and declining remission groups did not differ. Comparisons within each remission trajectory group showed that SUD patients in the early relapse and stable remission groups had higher risks of death compared with non-SUD patients; there were no differences within the declining group.

Conclusions.—SUD patients in the stable remission group had lower survival rates compared with non-SUD patients. These findings underline the importance of continuously addressing healthcare needs of individuals with SUD, even in the presence of long-term remission.

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INTRODUCTION

Previous research has found that substance use disorders (SUDs) are associated with a high prevalence of medical problems and an increased mortality rate (1–5), but little is known about the relationship between long-term patterns of substance use and mortality. Most studies examining these long-term relationships focus on general population samples which are often less severe. For example, a 20-year general population study of older adults examined the association between late-life alcohol consumption and all-cause mortality, and found that heavy drinkers had a three-fold increased mortality risk compared with abstainers and light drinkers (6). Another 20-year general population study in Russia examining substance use and cause-specific mortality found that alcohol was a main cause in mortality fluctuations (7). These findings are significant, but are focused on less severe general population samples. The mortality rates of patients with SUDs who enter treatment is of interest, because these individuals are likely to have more severe disorders and obtaining treatment may temper their health problems and thereby, subsequent mortality risk despite the severity of their diagnosis at treatment entry.

Furthermore, few studies have examined a multidimensional remission measure which considers reduced, non-problem drug use and drinking (in addition to abstinence). Post-treatment recovery has traditionally focused on abstinence; however, lower risk or non-problem use is increasingly considered an acceptable and realistic outcome (8–10). Studies find that reduced risk drinkers and drug users have positive psychosocial outcomes comparable to those who abstain, and are able to maintain a reduced risk or non-problem use status over time (11). As researchers and clinicians become more interested in harm reduction as a way to encourage people to enter treatment, research is needed to evaluate remission in addition to abstinence (or as an alternative to abstinence), including its long-term trajectories and associated patient factors.

This study adds to the literature by examining the relationship between remission trajectories and mortality over a 13-year period among patients who entered private, outpatient substance use treatment. We identify latent remission trajectory groups over 13 years and examine the risk of mortality among these groups to determine whether those with stable remission trajectories have higher survival rates than those in other trajectory groups (Aim 1). We then compare, within each remission trajectory group, the mortality risk between the SUD patients and non-SUD patients to determine if known differences in mortality rates between these groups hold across all remission patterns, or if only patients who were able to attain stable remission over time were able to attain similar mortality rates as to those without SUDs (Aim 2).

METHOD

Participants and setting

This study analyzed data drawn from a large randomized study conducted at Kaiser Permanente Northern California (KPNC) which is a large, private non-profit, integrated health care delivery system providing health care to over 3.8 million members. The substance use treatment program provides group-based outpatient and day treatment

modalities that include supportive group therapy, education, relapse prevention, family therapy and individual counseling in a model similar to other abstinence-based, group-format private and public programs. The original study sample consisted of 1204 adult substance use patients (aged 18 and older) who were recruited for a study comparing day hospital treatment to lower intensity outpatient treatment in the index episode between 1994 and 1996 (12). Participants were interviewed by trained interviewers at intake to the index treatment, then at 6 months, 1, 5, 7, 9, 11 and 13 years after intake, with high follow-up rates (82.7% at 6 months, 84.6% at 12 months, 83.8% at 5 years, 80.3% at 7 years, 79.7% at 9 years, 72.2% at 11 years, and 74.1% at 13 years). Institutional review board approval was obtained from the Kaiser Foundation Research Institute and University of California, San Francisco. Each SUD patient was assigned up to 5 health plan members with the same demographic characteristics (age, gender, length of membership) and no SUD diagnoses in the year prior to identification using KPNC's electronic health record (EHR) data; these patients are referred to as "non-SUD patients" (13,14). For Aim 1, the analytic sample included patients with a SUD who had a substance use treatment intake interview and at least two follow-up interviews over the 13 year period (SUD patients) (N=997). Aim 2 analyses compared the SUD patients from aim 1 (N=997) with non-SUD patients (N=4241) with similar demographic (ie., age and sex) distributions.

Measures

Interview data (SUD patients only):

Patient Characteristics.: The intake interview included measures of annual household income (reporting \$40,000 or more annually versus other), ethnicity (white versus other), marital status (married/living as married versus other), medical and psychiatric Addiction Severity Index (ASI) (15) composites, and smoking status in the prior 30 days.

Remission.: Data on alcohol and drug using days, use frequency and associated problems (e.g., conflicts, behavioral problems, and suicidal ideations) were collected at baseline and at each follow-up time point for the SUD patients. Past-year remission status was identified *for interview respondents* at each follow-up, allowing a patient's status to vary over the 13-year study period. Remission status was coded as missing for patients with missing interview data at each follow-up due to either interview non-response or death. As in previous work, remitted individuals were defined as abstainers who reported abstaining from alcohol and drugs in the prior year, or non-problem users who: used alcohol but indicated no days of drinking 5 or more drinks in a day and drank 4 or fewer times per month or less in the past year; used marijuana no more than once per month in the past year; did not use drugs other than alcohol or marijuana in the past year; and reported that they did not have suicidal ideations, violent behavior, or serious conflicts with family/friends/co-workers in the month prior to the interview (16,17).

EHR data (SUD and non-SUD patients):

Patient characteristics.: Gender and age were extracted from KPNC's EHR for the SUD and non- SUD patients. Age was classified into 4 categories: 18–29, 30–39, 40–49, and 50+ years.

Mortality.: Mortality data were obtained from KPNC hospitalization records, membership files, California State death certificates and Social Security Administration databases. For the SUD and non-SUD patients, an indicator variable for death status (1=death, 0=else) was created at each follow-up time point in the 13-year time window of study.

Analysis

All analyses were performed using SAS© software, version 9.3 (SAS Institute Inc., Cary, NC); statistical significance was defined at $p < 0.05$. To identify the latent classes of distinct data-based remission trajectories, we conducted a series of latent class growth analyses (LCGA) to fit 2-, 3-, 4-, and 5-class models using the SAS procedure PROC TRAJ. The final number of trajectory classes was determined based on the following criteria: (1) the Bayesian Information Criterion (BIC), commonly used as a fit statistic for LCGA models (18–21); (2) the average posterior probabilities of group membership, as a measure of classification quality (22); and (3) the interpretability of the classes identified (18,23). PROC TRAJ assumes missing at random, which allows missingness to be related to variables included in the analysis (24). This allows all subjects with at least one observation to be included in the analyses. However, in the current study patients were required to have at least 2 follow-ups during the 13 year period. Indicators of time (1, 5, 7, 9, 11 and 13 years) and dichotomous indicators of remission status (yes/no) at each time point were used to estimate the latent remission trajectories. After determining the distinct remission trajectory groups, standard summary statistics including percentages, means, and standard deviations, were used to describe the sample. Chi-square tests were used to compare the difference between the trajectory groups for the categorical variables, and ANOVA was used for continuous measures.

All-cause mortality over 13 years was examined with the Kaplan–Meier (log-rank test) and Cox proportional hazards models. For Aim 1, we first examined the risk of death among the SUD patients ($n=997$) to determine differences in survival rates across the remission trajectory groups. Demographic, medical and psychiatric Addiction Severity Index (ASI) (McLellan et al. 1992) composites and smoking status at intake were adjusted for in the model. Effects of the initial treatment (day hospital versus outpatient) and randomization (randomized versus not) were also included. These measures did not significantly ($p>0.05$) predict death and their inclusion did not change the pattern of results, so they were not included in the final models.

For aim 2, we examined differences in the risk of death between the SUD and non-SUD patients separately within each remission trajectory group to determine if differences in mortality rates between these groups held across all remission patterns, or if only patients in a stable remission group were able to attain similar mortality rates as to those without SUDs. Survival analysis was used as described above, however these models only controlled for age and gender as interview data were not available for the non-SUD patients.

RESULTS

Remission trajectories

We first conducted a series of latent class growth analyses to fit 2-, 3-, 4-, and 5-class models using a cubic fit for all trajectories; comparison of BIC across models suggested a 3-class model as the best model fit for the data (table 1). Posterior probabilities for the three class model suggests good classification of the final trajectories identified (i.e., average posterior probabilities of group membership $>.80$) (22) (table 2). After determining the optimal number of classes, we examined the shape (linear, quadratic and cubic) of the classes by conducting a series of models in which we varied the shape of the trajectory curves and compared the model fit index (BIC value). The final model with the best model fit had entropy of 0.673,(25) and suggested a cubic model for two of the trajectories and a linear model for one trajectory. The three remission trajectory groups identified were: 1) *early relapse* ($n=358/997[35.9\%]$) - those with low probabilities of remaining remitted after the 12-month follow-up; 2) *declining remission* ($n=333/997[33.4\%]$) - those whose probabilities of remission steadily decreased over time; and 3) *stable remission* ($n=306/997[30.7\%]$) - those with stable probabilities of remission across all time points (Figure 1). The stable remission group had more patients with only alcohol dependence at baseline and fewer patients with only other drug dependence compared to the other two groups ($p<.05$) (not shown).

Of the 997 patients in the sample, 179 (18%) did not have complete data at all follow-up time points (drop-outs), including 92 deaths (9%) and 87 (9%) survivors. Compared with surviving participants and surviving drop-outs, the deceased had a higher proportion of older participants aged 50+ at baseline (37% in the deceased versus 8% in each of the other two groups, $p<.001$). The deceased also had higher baseline medical ASI (mean/SD=0.52/0.43 versus 0.35/0.40 for the surviving drop-outs and 0.36/0.40 for the surviving participants, $p<.001$). These findings are consistent with the literature (26); no other significant differences across the 3 attrition pattern groups were found in other demographic measures or psychiatric ASI (not shown). We note that age group and baseline medical ASI were included in the Cox proportional hazards model examining mortality risk across remission trajectory groups.

Demographic characteristics of SUD patients

Of the 997 SUD patients, 35% were women, 74% were white, 44% reported annual household income over \$40,000 and 45% were married. Twenty-five percent were aged 18–29, 37% aged 30–39, 27% aged 40–49 and 11% were 50+, 24% did not smoke, 40% were smokers, and 36% refused to answer or their smoking status was unknown (not shown). Comparisons across remission trajectory groups showed that those in the stable remission group were more likely to be female married at baseline and aged 50 and older compared with those in the other remission trajectory groups (all $p<.05$) (Table 3).

Mortality risk among SUD patients

There were 92 deaths among the SUD patients over the 13-year period ($n=39/358$ [11%] in the early relapse group, $n=22/333$ [7%] in the declining remission group, and $n=31/306$

[10%] in the stable remission group); the percentage of deaths did not significantly differ across the remission groups ($p=0.1215$).

Adjusting for demographic and patient characteristics, the early relapse group had a higher risk of death compared with the stable remission group (adjusted hazards ratio [aHR] =1.73, 95% CI=1.02, 2.93); risk of death did not significantly differ between the stable and the declining remission groups. White participants (aHR=1.80, 95% CI=1.01, 3.22) had a higher mortality risk than non-White patients; older participants aged 40–49 (aHR=3.76, 95% CI=1.60, 8.85) and 50+ (aHR=13.58, 95% CI=3.87, 22.13) had higher mortality risk than those aged 18–30. All other variables in the model were not significantly associated with mortality risk over 13 years. (Table 4)

Mortality risk between SUD and non-SUD patients

Overall there was a higher mortality rate among SUD patients ($n=92/997$ [9.2%]) than the non-SUD patients ($n=221/4241$ [5.2%]; $p<.0001$). The mortality rates were significantly higher among SUD patients than non-SUD patients within the early relapse ($n=39/358$ [10.9%] deaths among SUD patients, $n=79/1513$ [5.2%] deaths among non-SUD patients; $p<.0001$) and stable remission ($n=31/306$ [10.1%] deaths among SUD patients, $n=63/1360$ [4.6%] deaths among non-SUD patients; $p=0.0002$) groups, but the difference between the SUD and non-SUD patients within the declining remission group was not significant ($n=22/333$ [6.6%] deaths among SUD patients and $n=79/1368$ [4.6%] deaths among non-SUD patients; $p=0.5646$). There were no differences in gender ($p=0.8034$) or age ($p=0.3825$) distribution between the SUD and non-SUD patients as a whole, or within each trajectory group. There were more deaths among the SUD patients ($n=92$ [9.2%]) than among the non-SUD patients ($n=221$ [5.2%]) over the 13-year period ($p<.0001$). As expected, SUD patients in the early relapse group (aHR=1.65, 95% CI=1.11, 2.44) had a higher risk of death during the 13-year period than the non-SUD patients. However, the SUD patients in the stable remission group also had a higher risk of death compared with non-SUD patients (aHR=1.73, 95% CI=1.11, 2.70). Risk of death for the SUD patients in the declining remission group did not significantly differ from non-SUD patients. (Table 5)

DISCUSSION

We found three distinct trajectories of substance use remission status over 13 years among patients with SUDs (defining remission as both abstinence and non-problem use). Similar to findings in the literature on long-term outcomes (27,28), stably remitted individuals were more likely to be women, over 50, and have a college education. ASI medical and psychiatric problem severity and smoking status at intake did not significantly differ across groups. However, the stably remitted group contained more patients with only alcohol dependence and fewer patients with only other drug dependence at baseline, while the early relapse group contained more individuals with both drug and alcohol dependence. This suggests that individuals without drug problems may be more likely to be stably remitted over time.

As expected, participants in the early relapse group had higher odds of mortality versus those in the stable remission group. Patients who are able to maintain abstinence or reduce

to non-problem use are known to have better short-term psychosocial outcomes and medium term cost outcomes than those who continue to use at high or risky levels (9,11,29,30). Prior analysis of data from the current study combined with another study found that having yearly primary care and specialty care based on need was associated with higher odds of remission over 9 years (16) and lower costs (13). It is possible that those with proper continuing care after the initial treatment episode may have more opportunities to address other medical issues (whether substance use-related or not). In addition, they may be more motivated or have better self-management skills in maintaining long-term substance use and general health outcomes. In accordance with the literature, being white and older were associated with higher mortality risk among SUD patients. Mortality risk did not differ between the declining remission and stable remission groups. However, when comparing attrition patterns across the three remission trajectory groups, the declining remission group had a higher proportion of surviving participants (87% versus 82% for the stable remission group and 78% for the early relapse group, $p=0.0447$). This may partly explain the null finding of mortality risk between the declining remission and stable remission groups.

SUD patients with early relapse had higher rates of mortality compared with the non-SUD patients. However, even though SUD patients in the stable remission group had higher survival rates than their relapsing peers, they still had lower survival rates than the non-SUD counterparts. Many studies comparing mortality rates of SUD patients and the general population found the standardized mortality ratio to be at least 4 times higher for the SUD patients (31–34). Our sample is from an integrated health care plan which may temper mortality differences, as these patients have consistent access to medical services. However, we note that the findings between substance use trajectory and mortality, which was not as strong as expected, may be due to the fact that all participants were receiving health care, and those with co-occurring medical conditions were perhaps receiving more health care. We also found that as compared to the other two trajectory groups, the declining group had highest proportions of ages 30–39, which could partly explain the relatively lower mortality rates for the SUD and non-SUD patients in the declining remission group.

The study has several limitations. As with all observational studies, our results cannot be interpreted as causal. All substance use outcomes were based on self-report, which may underestimate the actual frequency of alcohol and drug use. Particularly, individuals in the stable remission group may have been misclassified based on their self-report, which in part may account for the higher mortality risk observed for them compared with the non-SUD patients. The Addiction Severity Index's medical severity score was used as an indicator of medical severity at intake, although this did not allow us to account for specific pre-existing medical conditions. The SUD and non-SUD comparison models only adjusted for age and gender due to limited available data on the non-SUD sample. Future research should examine potential confounders related to these analyses. The current analysis uses the classical three-step approach to create the trajectory groups, which is a limitation of the software. This may underestimate the associations between the latent classes and observed covariates (35). Also, SAS Proc Traj did not provide model fit indexes other than BIC. Future research applying modern methods of either single-step or new three-step approaches to examine the research questions is needed. Drinking outcomes for those who died were not missing at random as assumed by Proc Traj. Analyses comparing individuals who completed

all follow-ups with those who did not have complete data at all follow-up time points (drop-outs), including the deceased drop-outs and the surviving drop-outs, found differences in age and baseline medical ASI. Further, trajectories analyses were conducted among individuals with at least 2 follow-ups; therefore, all individuals included in the analyses survived to at least 5 years post treatment entry, and mortality occurred at some time after the 5 year follow-up. This should be put into consideration when interpreting the generalizability of the results.

The findings of increased mortality risk in the early relapse group suggest increased and ongoing health risks of continued alcohol and other drug misuse. Patients in the stable remission group had lower survival rates than non-SUD patients, which has critical policy implications. It underlines the importance of continuously addressing healthcare needs of SUD patients post treatment entry, including physicians conducting screening and early intervention for individuals who are risky substance users. Findings further suggest that long-term stable remission following treatment may temper the health risks of those with SUDs, but reducing to non-problem use or even maintaining abstinence post treatment may still be insufficient to temper the health risks of prior substance use.

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REFERENCES

1. Cornelius JR, Reynolds M, Martz BM, et al. Premature mortality among males with substance use disorders. *Addict Behav.* 2008;33(1):156–160. [PubMed: 17553623]
2. Hser Y-I, Hoffman V, Grella CE, Anglin MD. A 33-year follow-up of narcotics addicts. *Arch Gen Psychiatry.* 2001;58(5):503–508. [PubMed: 11343531]
3. Hurt RD, Offord KP, Croghan IT, et al. Mortality following inpatient addictions treatment. Role of tobacco use in a community-based cohort. *JAMA.* 1996;275(14):1097–1103. [PubMed: 8601929]
4. Liskow BI, Powell BJ, Penick EC, et al. Mortality in male alcoholics after ten to fourteen years. *J Stud Alcohol.* 2000;61(6):853–861. [PubMed: 11188491]
5. Rehm J, Gmel G. Average volume of alcohol consumption, patterns of drinking and mortality among young Europeans in 1999. *Addiction.* 2002;97(1):105–109. [PubMed: 11895264]
6. Holahan CJ, Schutte KK, Brennan PL, Holahan CK, Moos BS, Moos RH. Late-life alcohol consumption and 20-year mortality. *Alcohol Clin Exp Res.* 2010;34(11):1961–1971. [PubMed: 20735372]
7. Zaridze D, Brennan P, Boreham J, et al. Alcohol and cause-specific mortality in Russia: a retrospective case-control study of 48,557 adult deaths. *Lancet.* 2009;373(9682):2201–2214. [PubMed: 19560602]
8. Mertens JR, Kline-Simon AH, Delucchi KL, Moore C, Weisner CM. Ten-year stability of remission in private alcohol and drug outpatient treatment: non-problem users versus abstainers. *Drug Alcohol Depend.* 2012;125(1–2):67–74. [PubMed: 22542217]
9. Kline-Simon AH, Falk DE, Litten RZ, et al. Posttreatment low-risk drinking as a predictor of future drinking and problem outcomes among individuals with alcohol use disorders. *Alcohol Clin Exp Res.* 2013;37(Suppl 1):E373–380. [PubMed: 22827502]

10. Falk D, Wang XQ, Liu L, et al. Percentage of subjects with no heavy drinking days: evaluation as an efficacy endpoint for alcohol clinical trials. *Alcohol Clin Exp Res*. 2010;34(12):2022–2034. [PubMed: 20659066]
11. 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. [PubMed: 18034696]
12. Weisner C, Mertens J, Parthasarathy S, et al. The outcome and cost of alcohol and drug treatment in an HMO: day hospital versus traditional outpatient regimens. *Health Serv Res*. 2000;35(4):791–812. [PubMed: 11055449]
13. Parthasarathy S, Chi FW, Mertens JR, Weisner C. The role of continuing care on 9-year cost trajectories of patients with intakes into an outpatient alcohol and drug treatment program. *Med Care*. 2012;50(6):540–546. [PubMed: 22584889]
14. Parthasarathy S, Weisner C, Hu TW, Moore C. Association of outpatient alcohol and drug treatment with health care utilization and cost: revisiting the offset hypothesis. *J Stud Alcohol Drugs*. 2001;62(1):89–97.
15. McLellan AT, Kushner H, Metzger D, et al. The Fifth Edition of the Addiction Severity Index. *J Subst Abuse Treat*. 1992;9(3):199–213. [PubMed: 1334156]
16. Chi FW, Parthasarathy S, Mertens JR, Weisner CM. Continuing care and long-term substance use outcomes in managed care: early evidence for a primary care based model. *Psychiatr Serv*. 2011;62(10):1194–2000. [PubMed: 21969646]
17. Mertens JR, Flisher AJ, Satre DD, Weisner CM. The role of medical conditions and primary care services in 5-year substance use outcomes among chemical dependency treatment patients. *Drug Alcohol Depend*. 2008;98(1–2):45–53. [PubMed: 18571875]
18. Nagin D Group-Based Modeling of Development. Cambridge, MA: Harvard University Press; 2005.
19. Yang CC. Evaluating latent class analysis models in qualitative phenotype identification. *Comput Stat Data Anal*. 2006;50(4):1090–1104.
20. Tofighi D, Enders CK. Identifying the correct number of classes in growth mixture models In: Hancock GR, Samuelsen KM, eds. *Advances in Latent Variable Mixture Models*. Greenwich, CT: Information Age; 2008:317–341.
21. Nylund KL, Asparouhov T, Muthén BO. Deciding on the number of classes in latent class analysis and growth mixture modeling: A Monte Carlo simulation study. *Struct Equ Modeling*. 2007;14(4):535–569.
22. Andruff H, Carraro N, Thompson A, Gaudreau P, Louvet B. Latent class growth modeling: a tutorial. *Tutor Quant Methods Psychol*. 2009;5(1):11–24.
23. Jung T, Wickrama KAS. An introduction to latent class growth analysis and growth mixture modeling. *Soc Personal Psychol Compass*. 2008;2(1):302–317.
24. Little RJ, Rubin DB. *Statistical Analysis with Missing Data*. 2nd ed. Hoboken, NJ: John Wiley & Sons; 2002.
25. Clark SL, Muthén B. Relating latent class analysis results to variables not included in the analysis. Unpublished manuscript. 2009 <https://www.statmodel.com/download/relatinglca.pdf>. [Last accessed 26 September 2016].
26. Scott CK, Dennis ML, Laudet A, Funk RR, Simeone RS. Surviving drug addiction: the effect of treatment and abstinence on mortality. *Am J Public Health*. 2011;101(4):737–744. [PubMed: 21330586]
27. Satre DD, Chi FW, Mertens JR, Weisner CM. Effects of age and life transitions on alcohol and drug treatment outcome over nine years *J Stud Alcohol Drugs*. 2012;73(3):459–468. [PubMed: 22456251]
28. Dawson DA, Goldstein RB, Ruan WJ, Grant BF. Correlates of recovery from alcohol dependence: a prospective study over a 3-year follow-up interval. *Alcohol Clin Exp Res*. 2012;36(7):1268–1277. [PubMed: 22309217]
29. Kline-Simon AH, Weisner CM, Parthasarathy S, Falk DE, Litten RZ, Mertens JR. Five-year healthcare utilization and costs among lower-risk drinkers following alcohol treatment. *Alcohol Clin Exp Res*. 2014;38(2):579–586. [PubMed: 24117604]

30. Schutte KK, Byrne FE, Brennan PL, Moos RH. Successful remission of late-life drinking problems: a 10-year follow- up. *J Stud Alcohol*. 2001;62(3):322–334. [PubMed: 11414342]
31. Pierce M, Bird SM, Hickman M, Millar T. National record linkage study of mortality for a large cohort of opioid users ascertained by drug treatment or criminal justice sources in England, 2005–2009. *Drug Alcohol Depend*. 2015;146:17–23. [PubMed: 25454405]
32. Nambiar D, Weir A, Aspinall EJ, et al. Mortality and cause of death in a cohort of people who had ever injected drugs in Glasgow: 1982–2012. *Drug Alcohol Depend*. 2015;147:215–221. [PubMed: 25497590]
33. Bogdanowicz KM, Stewart R, Broadbent M, et al. Double trouble: Psychiatric comorbidity and opioid addiction-all-cause and cause-specific mortality. *Drug Alcohol Depend*. 2015;148:85–92. [PubMed: 25578253]
34. Baggett TP, Chang Y, Singer DE, et al. Tobacco-, alcohol-, and drug-attributable deaths and their contribution to mortality disparities in a cohort of homeless adults in Boston. *Am J Public Health*. 2015;105(6):1189–1197. [PubMed: 25521869]
35. Feingold A, Tiberio SS, Capaldi DM. New approaches for examining associations with latent categorical variables: applications to substance abuse and aggression. *Psychol Addict Behav*. 2014;28(1):257–267. [PubMed: 23772759]

Figure 1.
Past-Year Remission Trajectories for the Substance Use Treatment Sample (n=997)

Table 1.

Model fit criterion for remission trajectories over time (N=997)

number of groups	BIC	2(BIC _t -BIC _{t-1})
2	-2815.82	—
3	-2779.11	65.32
4	-2783.29	-16.42
5	-2795.73	-32.96
6 *	-2807.75	-32.1

Note: Among those with 2+ follow-ups between 1 and 13 years; BIC=Bayesian Information Criteria;

* ERROR: Singular convergence

Table 2.

Mean Posterior probability of remission trajectory group membership (row) by remission trajectory group assignment (column)

	<u>Early Relapse</u>	<u>Declining Remission</u>	<u>Stable Remission</u>
Group 1	0.85	0.08	<0.01
Group 2	0.14	0.83	0.14
Group 3	<0.01	0.09	0.86

Table 3.

Patient demographics at intake for the substance use disorder sample by remission trajectory group (n=997)

	Remission Trajectory Groups			p-value
	Early relapse (n=358)	Declining remission (n=333)	Stable remission (n=306)	
Women (%)	29.1	33.6	41.8	<.01
Age Group (%)				
18–29	34.6	24.3	14.4	
30–39	33.5	42.6	35.0	
40–49	23.5	24.9	35.0	
≥50	8.4	8.1	15.7	<.0001
White (%)	75.1	73.8	72.6	ns
\$40,000+ annual income (%)	41.9	45.3	46.0	ns
Married (%)	39.9	45.7	51.2	<.05
Smoker at intake (%)	42.7	40.2	35.3	ns
Medical ASI at intake, mean(SD)	0.34 (0.38)	0.39(0.41)	0.40(0.41)	ns
Psychiatric ASI at intake, mean(SD)	0.41(0.26)	0.42(0.27)	0.40(0.26)	ns

ASI = Addiction Severity Index.

Table 4.

Risk of death by remission trajectory group for the substance use disorder sample (n=997)

	Hazard Ratio	95% CI		p-Value
Early relapse group (vs stable remission)	1.73	1.02	2.93	<0.05
Declining remission group (vs stable remission)	0.85	0.47	1.56	ns
Women (vs. men)	1.13	0.70	1.81	ns
Age 50+ (vs. 18–29)	9.25	3.87	22.13	<.01
Age 40–49 (vs. 18–29)	3.76	1.60	8.85	<.01
Age 30–39 (vs. 18–29)	1.42	0.58	3.49	ns
White (vs. other)	1.80	1.01	3.22	<.01
Annual Income \$40,000+ (vs. <\$40,000)	1.14	0.71	1.81	ns
Married (vs. other)	0.82	0.52	1.31	ns
Smoker at intake (vs. other)	0.76	0.48	1.20	ns
Medical ASI severity at intake	1.64	0.98	2.76	ns
Psychiatric ASI severity at intake	1.28	0.52	3.17	ns

ASI = Addiction Severity Index. CI = Confidence Interval.

Table 5.

Risk of death between substance use (n=997) and non-substance use (n=4241) disorder patients by remission trajectory group

	Hazard Ratio	95% CI		p-Value
Early relapse group SUD vs. non-SUD patients	1.65	1.11	2.44	<.05
Declining remission group SUD vs. non-SUD patients	1.04	0.63	1.70	ns
Stable remission group SUD vs. non-SUD patients	1.73	1.11	2.70	<.05

All models control for age and gender. CI = Confidence Interval. SUD = Substance Use Disorder