Testing the Drug Substitution Switching-Addictions Hypothesis: A Prospective Study in a Nationally Representative Sample

Carlos Blanco, MD, PhD; Mayumi Okuda, MD; Shuai Wang, PhD; Shang-Min Liu, MS; Mark Olfson, MD, MPH

**IMPORTANCE** Adults who remit from a substance use disorder (SUD) are often thought to be at increased risk for developing another SUD. A greater understanding of the prevalence and risk factors for drug substitution would inform clinical monitoring and management.

**OBJECTIVE** To determine whether remission from an SUD increases the risk of onset of a new SUD after a 3-year follow-up compared with lack of remission from an SUD and whether sociodemographic characteristics and psychiatric disorders, including personality disorders, independently predict a new-onset SUD.

**DESIGN, SETTING, AND PARTICIPANTS** A prospective cohort study where data were drawn from a nationally representative sample of 34,653 adults from the National Epidemiologic Survey on Alcohol and Related Conditions. Participants were interviewed twice, 3 years apart (wave 1, 2001–2002; wave 2, 2004–2005).

**MAIN OUTCOMES AND MEASURES** We compared new-onset SUDs among individuals with at least one current SUD at wave 1 who did not remit from any SUDs at wave 2 (n = 3275) and among individuals with at least one current SUD at wave 1 who remitted at wave 2 (n = 2741).

**RESULTS** Approximately one-fifth (n = 2741) of the total sample had developed a new-onset SUD at the wave 2 assessment. Individuals who remitted from 1 SUD during this period were significantly less likely than those who did not remit to develop a new SUD (13.1% vs 27.2%, P < .001). Results were robust to sample specification. An exception was that remission from a drug use disorder increased the odds of a new SUD (odds ratio [OR] = 1.46; 95% CI, 1.11-1.92). However, after adjusting for the number of SUDs at baseline, remission from drug use disorders decreased the odds of a new-onset SUD (OR = 0.66; 95% CI, 0.46-0.95) whereas the number of baseline SUDs increased those odds (OR=1.68; 95% CI, 1.43-1.98). Being male, younger in age, never married, having an earlier age at substance use onset, and psychiatric comorbidity significantly increased the odds of a new-onset SUD during the follow-up period.

**CONCLUSIONS AND RELEVANCE** As compared with those who do not remit from an SUD, remitters have less than half the risk of developing a new SUD. Contrary to clinical lore, achieving remission does not typically lead to drug substitution but rather is associated with a lower risk of new SUD onsets.
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ubstance use disorders (SUDs) are highly prevalent, often comorbid with other psychiatric disorders,1,2 and are associated with substantial individual suffering and societal cost.3 Remission from SUDs contributes to short-term and long-term reduction of criminal activity,4 improved medical status and social functioning,4 and a higher quality of life.5

Adults who recover from an SUD are often thought to be at increased risk for developing another SUD.6 Drug addiction is commonly viewed as a unitary syndrome with multiple expressions7 and drug substitution is of clinical concern.8,9 Yet rigorous empirical support for this clinical concept remains mixed.8,9 A greater understanding of the prevalence and risk factors for drug substitution would inform clinical monitoring and management.

Most studies on the drug substitution hypothesis have been conducted in clinical samples, constraining the generalizability of their results. To our knowledge, no epidemiological study has examined whether remission of an SUD predicts new onset of another SUD. It is also understudied whether co-occurring psychiatric disorders increase the risk of a new SUD after remission from 1 SUD. The goals of the present study were to help fill these gaps in knowledge using data from the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC). We hypothesized that remission from an SUD would increase the probability of new onset of an SUD and that sociodemographic characteristics and co-occurring psychiatric disorders would constitute independent risk factors for a new-onset SUD.

Methods

Sample
All procedures in this study received full review and approval from the US Census Bureau and US Office of Management and Budget. Participants provided written informed consent. Data were drawn from waves 1 and 2 of the NESARC.11 The target population of the NESARC was the civilian noninstitutionalized population 18 years and older residing in households and group quarters. Black and Hispanic individuals and adults aged 18 to 24 years were oversampled, with data adjusted for oversampling and household-level and person-level nonresponse. Excluding respondents who were ineligible for the wave 2 interview (eg, deceased), the wave 2 response rate was 86.7%, resulting in 34 653 completed interviews.11 Sample weights were developed to adjust for wave 2 nonresponse. The mean interval between wave 1 and 2 interviews was 36 (SE = 2.6) months.

We divided the study sample into 2 mutually exclusive groups by SUD status at each wave. The first group comprised all individuals with at least 1 current SUD (within the past 12 months) at wave 1 who did not remit from any SUD at wave 2 (n = 3275), whereas the second group included all individuals with at least 1 current SUD at wave 1 who had remitted at wave 2 (n = 2741).

Remission of an SUD and New-Onset SUD
Individuals were considered to have remitted from an SUD (alcohol abuse/dependence, drug abuse/dependence, or nicotine dependence) by the time of the wave 2 assessment if they met DSM-IV criteria for that disorder in wave 1 but not in wave 2. Having a new SUD was defined as having an SUD at wave 2 among individuals who had no lifetime history of that SUD at wave 1. Individuals who met criteria for abuse of 1 substance at wave 1 and criteria for dependence on that substance at wave 2 were considered to have a new-onset SUD, whereas individuals who met criteria for dependence at wave 1 and abuse but not dependence on that substance at wave 2 were not considered to have remitted from dependence on that substance. Relapse was defined as a new episode of an SUD at wave

Assessment
Sociodemographic measures included sex, race/ethnicity, nativity, marital status, education, and family history of SUDs and were measured as categorical variables. Age at the time of the wave 1 interview and age at the onset of substance use were measured as continuous variables.

The Alcohol Use Disorder and Associated Disabilities Interview Schedule DSM-IV Version (AUDADIS-IV),12 a structured diagnostic interview, was used to generate current (12-month) DSM-IV SUD diagnoses (ie, abuse and dependence) based on computer algorithms. Extensive AUDADIS-IV questions covered DSM-IV abuse and dependence criteria for sedatives, tranquilizers, painkillers, stimulants, cannabis, cocaine/crack (collapsed in this report to increase the stability of estimates), hallucinogens, inhalants/solvents, heroin, alcohol, and nicotine (for this last one, only dependence). Substance use onset was determined by asking respondents the age at which they had at least 1 drink of any kind of alcohol (not counting small tastes or sips), used drugs for the first time, or smoked a first full cigarette. Good to excellent (k = 0.70-0.91) test-retest reliability and validity of AUDADIS-IV SUD variables have been documented in clinical and general population samples.12-13

In waves 1 and 2, mood disorders included DSM-IV major depressive disorder, dysthymia, and bipolar disorder. Anxiety disorders included DSM-IV panic disorder, social anxiety disorder, specific phobia, and generalized anxiety disorder. The AUDADIS-IV methods to diagnose these disorders are described in detail elsewhere.14 Past-year and prior-to-past-year diagnoses of attention-deficit/hyperactivity disorder (ADHD) were assessed in wave 2.15 Personality disorders assessed at wave 1 included avoidant, dependent, obsessive-compulsive, paranoid, schizoid, histrionic, and antisocial personality disorders.11 Borderline, schizotypal, and narcissistic personality disorders were measured at wave 2. To increase the stability of our estimates and increase statistical power, we grouped personality disorders in the 3 DSM-IV clusters. Test-retest reliabilities of AUDADIS-IV personality disorders compare favorably with those obtained in patient samples using semistructured personality interviews.11 Test-retest reliabilities for AUDADIS-IV mood, anxiety, ADHD, and personality disorders in the general population and clinical settings are fair to good.11,12

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Among individuals with a lifetime history of the SUD that was in remission at wave 1.

**Statistical Analyses**

Weighted means, frequencies, and odds ratios (ORs) of sociodemographic correlates and comorbid psychiatric disorders were computed. Odds ratios were considered significant if their 95% CIs did not include 1. Adjusted odds ratios derived from multiple logistic regressions indicated associations of sociodemographic correlates with each specific psychiatric disorder and SUD with a new-onset SUD as the outcome variable. All standard errors and 95% CIs were estimated using SUDAAN to adjust for design characteristics of the survey.16

We conducted a series of sensitivity analyses to examine the robustness of results and provide complementary information. To examine whether results were similar across each type of substance, we conducted a logistic regression with remission from nicotine dependence, alcohol use disorders, drug use disorders, and the number of SUDs at baseline as predictors and new onset of an SUD as the outcome variable. To guard against the possibility that differences between remitters and nonremitters were owing to differences in rates of new onset of nicotine dependence, the most prevalent SUD, we conducted analyses on the new onset of alcohol or drug disorders, excluding nicotine dependence. We also examined whether stratifying by number of SUDs at wave 1 (1 vs multiple SUDs) modified the results. To examine whether among remitters abstinence was associated with lower rates of new-onset SUDs, we conducted a χ² trend test comparing abstinence remitters, nonabstinence remitters, and nonremitters. We further examined whether seeking treatment was associated with remission at wave 2 and, if so, whether it was associated with lower rates of a new-onset SUD even after adjusting for the effect of remission. We tested whether the results held when the new onset of an SUD was defined as meeting no *DSM-IV* criteria for that SUD at wave 1 but meeting full *DSM-IV* criteria at wave 2; remission from an SUD was defined as not meeting any *DSM-IV* criteria for that SUD. We further examined whether there were differences between remitters and nonremitters in rates of relapse onto another SUD.

**Results**

**Characteristics of Adults With and Without SUD Remission**

Among individuals who did not remit from an SUD, 87.0% had 1 SUD, 11.8% had 2 SUDs, and 1.2% had 3 or more SUDs whereas among individuals who remitted from an SUD, 72.5% had 1 SUD, 19.9% had 2 SUDs, and 7.6% had 3 or more SUDs at baseline (χ² = 68.6, *P* < .001). Among individuals who remitted, 88.9% remitted from 1 SUD, 8.4% remitted from 2 SUDs, and 2.7% remitted from 3 or more SUDs. The highest percentage of remission was from nicotine dependence (51.2%) followed by alcohol use disorder (42.9%) and drug use disorder (16.5%). The proportion of individuals with 1 SUD who remitted was 41.1% whereas among individuals with 2 or more SUDs, 17.1% remitted from all of them, 46.9% from at least 1 of them, and 36.1% did not remit from any of them.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Remission of at Least 1 SUD (n = 2741)</th>
<th>No Remission (n = 3275)</th>
<th>Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>36.8 (36.1 to 37.5)</td>
<td>39.4 (38.8 to 40.0)</td>
<td>b</td>
</tr>
<tr>
<td>Age at substance use onset, y</td>
<td>15.1 (14.9 to 15.3)</td>
<td>14.8 (14.7 to 15.0)</td>
<td>c</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>39.3 (37.1 to 41.6)</td>
<td>43.0 (40.9 to 45.2)</td>
<td>1.0 (1.0 to 1.0)</td>
</tr>
<tr>
<td>Male</td>
<td>60.7 (58.4 to 62.9)</td>
<td>57.0 (54.8 to 59.2)</td>
<td>1.2 (1.0 to 1.3)</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>74.9 (71.7 to 77.8)</td>
<td>78.5 (75.8 to 81.0)</td>
<td>1.0 (1.0 to 1.0)</td>
</tr>
<tr>
<td>Black</td>
<td>9.7 (8.2 to 11.4)</td>
<td>8.3 (7.0 to 9.9)</td>
<td>1.2 (1.0 to 1.5)</td>
</tr>
<tr>
<td>Native American</td>
<td>3.5 (2.6 to 4.6)</td>
<td>3.7 (2.8 to 4.9)</td>
<td>1.0 (0.7 to 1.4)</td>
</tr>
<tr>
<td>Asian</td>
<td>2.1 (1.4 to 3.2)</td>
<td>1.9 (1.2 to 2.8)</td>
<td>1.2 (0.7 to 1.9)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>9.9 (7.9 to 12.3)</td>
<td>7.6 (5.9 to 9.8)</td>
<td>1.4 (1.1 to 1.7)</td>
</tr>
<tr>
<td>Born in the United States</td>
<td>92.0 (90.0 to 93.7)</td>
<td>94.9 (93.4 to 96.1)</td>
<td>0.6 (0.5 to 0.8)</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>51.4 (48.7 to 54.1)</td>
<td>55.2 (53.1 to 57.2)</td>
<td>1.0 (1.0 to 1.0)</td>
</tr>
<tr>
<td>Widowed/separated/divorced</td>
<td>16.7 (15.1 to 18.4)</td>
<td>19.8 (18.3 to 21.4)</td>
<td>0.9 (0.8 to 1.1)</td>
</tr>
<tr>
<td>Never married</td>
<td>32.0 (29.4 to 34.6)</td>
<td>25.0 (23.1 to 27.1)</td>
<td>1.4 (1.2 to 1.6)</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>College</td>
<td>52.3 (49.8 to 54.7)</td>
<td>51.2 (48.9 to 53.4)</td>
<td>1.0 (1.0 to 1.0)</td>
</tr>
<tr>
<td>High school</td>
<td>31.8 (29.6 to 34.1)</td>
<td>33.4 (31.4 to 35.4)</td>
<td>0.9 (0.8 to 1.1)</td>
</tr>
<tr>
<td>&lt;High school</td>
<td>15.9 (14.1 to 18.0)</td>
<td>15.5 (13.9 to 17.3)</td>
<td>1.0 (0.8 to 1.2)</td>
</tr>
</tbody>
</table>

Abbreviations: NESARC, the National Epidemiologic Survey on Alcohol and Related Conditions; SUD, substance use disorder.

a Reference group.

b t = −6.5 and *P* < .001.

c t = 2.0 and *P* < .05.

d Results are significant at *P* < .05.
Individuals who remitted from an SUD were significantly younger than those who did not remit (Table 1). Age at onset of substance use did not differ between those who remitted and those who did not. As compared with their nonremitting counterparts, individuals who remitted from an SUD were significantly more likely to be Hispanic and have never married and were significantly less likely to be born in the United States.

Individuals who remitted from at least 1 SUD had lower odds than those who did not remit of having an Axis I disorder specifically including an anxiety disorder, social anxiety disorder, specific phobia, ADHD, and clusters A and B personality disorders. They also had lower odds of having a family history of SUDs (Table 2).

### New-Onset SUD
Approximately one-fifth (20.8%) of the total study sample had a new-onset SUD (n = 1215). Individuals with an SUD remission were more likely than those with no lifetime history of SUD (13.1% vs 10.8%, P = .01) to have a new-onset SUD at wave 2 but not more likely than those with a lifetime but no current history of having an SUD (13.1% vs 12.6%, P = .60) to have such a new onset. By contrast, compared with individuals who did not remit from an SUD, a significantly smaller proportion of those with an SUD remission had a new-onset SUD (13.1% vs 27.2%, P < .001).

In univariate analyses, remission from nicotine dependence or an alcohol use disorder was associated with a lower odds (OR = 0.46; 95% CI, 0.37-0.57 and OR = 0.28; 95% CI, 0.21-0.38, respectively) of having a new-onset SUD, whereas remitting from a drug use disorder increased the odds (OR = 1.46, 95% CI, 1.11-1.92). However, after adjusting for the number of SUDs at baseline, remission from nicotine dependence (OR = 0.38; 95% CI, 0.31-0.48), an alcohol use disorder (OR = 0.23; 95% CI, 0.17-0.32), or a drug use disorder (OR = 0.66; 95% CI, 0.46-0.95) all decreased the odds of a new-onset SUD, whereas the number of SUDs at baseline increased the odds (OR = 1.68; 95% CI = 1.43-1.98).

Results were robust to sample specification. When nicotine dependence was excluded, remitters continued to have lower rates of a new-onset SUD than nonremitters (8.7% vs 43.3%, P < .001). Stratifying by the number of SUDs yielded a

### Table 3. Types of New-Onset SUDs Among Individuals With and Without Remission of at Least 1 SUD at Wave 2 of the NESARC

<table>
<thead>
<tr>
<th>SUD Type</th>
<th>Remission of at Least 1 SUD (n = 2741)</th>
<th>No Remission (n = 3275)*</th>
<th>Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol use disorder</td>
<td>7.6 (6.5-8.9)</td>
<td>19.2 (17.4-21.2)</td>
<td>0.3 (0.3-0.4)*</td>
</tr>
<tr>
<td>Cannabis use disorder</td>
<td>1.9 (1.3-2.7)</td>
<td>4.7 (3.9-5.8)</td>
<td>0.4 (0.3-0.6)*</td>
</tr>
<tr>
<td>Nicotine dependence</td>
<td>3.5 (2.7-4.5)</td>
<td>3.9 (3.1-4.8)</td>
<td>0.9 (0.6-1.3)</td>
</tr>
<tr>
<td>Opioid/heroin use disorder</td>
<td>1.1 (0.7-1.6)</td>
<td>2.6 (1.9-3.6)</td>
<td>0.4 (0.2-0.7)*</td>
</tr>
<tr>
<td>Cocaine use disorder</td>
<td>0.8 (0.5-1.4)</td>
<td>2.2 (1.6-3.1)</td>
<td>0.4 (0.2-0.7)*</td>
</tr>
<tr>
<td>Other drug use disorders</td>
<td>1.3 (0.9-2.0)</td>
<td>2.4 (1.8-3.1)</td>
<td>0.6 (0.3-0.9)*</td>
</tr>
</tbody>
</table>

Abbreviation: SUD, substance use disorder.

* Reference group.

Results are significant at P < .05.
similar pattern of results. Remitters who had only 1 SUD at baseline were less likely than nonremitters to have a new SUD at wave 2 (10.0% vs 24.3%, \( P < .001 \)). Remitters with multiple SUDs at baseline were less likely to have a new-onset SUD at wave 2 than nonremitters with multiple SUDs (21.4% vs 46.3%, \( P < .001 \)).

Individuals who sought treatment between waves 1 and 2 were significantly more likely to remit than those who did not (36.8% vs 19.2%, \( P < .001 \)). Furthermore, after adjusting for remission status (ie, remission vs nonremission), individuals who sought treatment had lower odds of a new-onset SUD at wave 2 (OR = 0.31; 95% CI, 0.22-0.43). The probability of a new-onset SUD was lowest for abstinent remitters (12.4%), intermediate for nonabstinent remitters (15.2%), and highest for nonremitters (27.2%; linear \( \chi^2 = 30.9, P < .001 \)).

When remission was defined as not meeting any DSM-IV criteria, remitters were still less likely than nonremitters to have a new-onset SUD at wave 2 (13.0% vs 23.3%, \( P < .001 \)). Remitters were also less likely than nonremitters to have a new-onset SUD when new onset was defined as meeting no DSM-IV criteria for that SUD at baseline but meeting full DSM-IV criteria for the new SUD at wave 2 (5.6% vs 10.3%, \( P < .001 \)). Furthermore, individuals with remission from 1 SUD were less than half as likely as nonremitters to relapse to another SUD at wave 2 (2.6% vs 4.3%, \( P = .006 \)).

When considering the substances separately, individuals with an SUD remission were significantly less likely than those with no SUD remission to have a new-onset alcohol use disorder, cannabis use disorder, opioid use disorder, cocaine use disorder, and other drug disorder whereas there was no significant difference in the new onset of nicotine dependence (Table 3).

### Predictors of a New Onset SUD

The odds of a new-onset SUD were lower for individuals who remitted from a SUD than for those who did not (Table 4). Being younger at the time of the survey and a younger age at onset of substance use increased the likelihood of having a new-onset SUD. In the unadjusted analyses, the odds of onset of a new SUD were greater for men, Asian individuals, Hispanic individuals, and those who were never married. The odds of onset of a new SUD were also greater for individuals with ADHD and cluster A and cluster B personality disorders.

After adjusting for sociodemographic characteristics and psychiatric comorbidity, the odds of a new-onset SUD remained significantly greater for men, Asian individuals, individuals who were never married, and those with a cluster B personality disorder. The odds of a new-onset SUD remained significantly lower for those who had remitted from a SUD.

### Discussion

In a large nationally representative sample of adults with SUDs, approximately 1 in 5 had developed a new-onset SUD during the course at the 3-year follow-up. Contrary to our first hypothesis, individuals who remitted from 1 SUD at wave 2 were significantly less likely than those who did not...
remit to develop a new SUD. These results were robust to sample specification, including exclusion of nicotine dependence, stratification by number of SUDs, and alternative definitions of remission and new-onset SUDs. We also found that men who were younger and/or never married as well as individuals with early-onset substance use and co-occurring psychiatric disorders were all at increased risk of developing a new SUD at wave 2.

Individuals who remitted from an SUD had less than half the risk of developing a new SUD than those who did not remit from any SUD. In univariate analyses, remission from drug use disorders was associated with increased odds of a new-onset SUD. However, after adjusting for the number of SUDs at baseline, remission from a drug use disorder was associated with decreased odds of a new-onset SUD. Our findings help reconcile clinical lore about drug substitution with apparently contradictory findings from previous research. They also converge with earlier findings in stressing the role of previous psychopathology in the course of SUDs. Taken together, our findings indicate that remission of an SUD is not associated with an increase but rather with a dramatic decrease in the risk of a new-onset SUD or relapse onto a previously remitted SUD.

Several mechanisms may contribute to the protective effects of SUD remission from new-onset SUDs. Remission may decrease external or interpersonal precipitants of drug use, such as drug-related cues and contact with drug-using peers, which often lead to relapses. Coping strategies, skills, and motivation of individuals who remit from an SUD may also protect them from the onset of a new SUD. Furthermore, remission from an SUD even if the person does not achieve abstinence can decrease the drug-associated behavioral disinhibition, which might otherwise facilitate use of additional substances. Remission from an SUD also decreases the possibility of pharmacological or acute psychological synergistic effects with other substances, perhaps making them less reinforcing. In addition, some pharmacological and psychological treatments may be efficacious for more than 1 drug and may thereby reduce the risk of drug substitution. Consistent with these findings, receiving treatment for an SUD was associated with increased probability of remission and with decreased odds of a new-onset SUD.

In accord with our second hypothesis and with earlier published research, we report a higher incidence of SUDs among men, unmarried individuals, and those who were younger at the onset of substance use. Age-related differences in the excitability and sensitivity of the midbrain dopaminergic system and age-specific vulnerabilities related to the level of maturation and substance use patterns in young individuals may contribute to a greater risk for the development of SUDs in adolescents.

Several psychiatric disorders and SUDs are also marked by impulsivity and impaired behavioral control and thus may share genetic susceptibility or other common etiological factors with new-onset SUDs. Individuals with psychiatric disorders and comorbid SUDs may have a heavier load of risk factors or familial influences. Psychoactive substances may be used to alleviate adverse emotional states (self-medication). Psychiatric disorders may also contribute to social and interpersonal contexts, such as increasing the odds of generating stressful events and reducing their social networks that facilitate the new onset of SUDs.

Exposure to other substances, even among individuals who achieve remission from 1 SUD, may increase the risk of a new-onset SUD or relapse. This pattern highlights the importance of abstaining from any substance use for individuals in remission of an SUD. Addictive substances engage a set of common molecular mechanisms involved in associative learning, including stimulation of dopamine D1 receptors, activation of the signal transduction pathways, altered gene expression, and synaptic rearrangements. Substance use may increase substance memories that can manifest in substance cravings and activation of reward circuitry, increasing the risk for another SUD. It can also lead to epigenetic changes that increase cross-addiction vulnerability, particularly given the complex interactions among receptors for different psychoactive substances.

Our study has several limitations. First, information was based on self-reporting and did not include objective measures of substance use, such as urinalysis. Second, to limit subject burden, the comorbidity assessments, although extensive, did not include all Axis I or Axis II diagnoses. Third, the follow-up period was limited to 3 years. Therefore, individuals in remission at wave 2 may have experienced future relapses.

Conclusions
Contrary to a common clinical perception, remission from an SUD decreases rather than increases the risk of onset of another SUD. Psychiatric comorbidity and the use of other substances increase the risk of new-onset SUDs. Achieving remission from 1 SUD and abstaining from substance use may have the added clinical benefit of helping to prevent the onset of new SUDs.
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