

Predictors of a Suicide Attempt One Year After Entry Into Substance Use Disorder Treatment

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Background: The present study examined the patient intake and treatment-related risk factors associated with a suicide attempt in the 30 days before a 1-year posttreatment assessment.

Methods: A national sample of 8,807 patients presenting for treatment of substance use disorders (SUDs) in the Department of Veterans Affairs healthcare system were assessed at treatment intake and follow-up. Using the MacArthur Model, the risk and protective factors for suicide attempt were identified at baseline and during treatment.

Results: At follow-up, 4% (314/8,807) of the patients reported a suicide attempt within the past 30 days. Baseline predictors of a suicide attempt before follow-up included elevated suicidal/psychiatric symptoms, more recent problematic alcohol use, and longer duration of cocaine use. Contact with the criminal justice system was a protective factor that reduced the likelihood of a future suicide attempt. Greater engagement in SUD treatment was also associated with a reduction in suicide risk.

Conclusions: More involvement in SUD treatment reduced the likelihood of a future suicide attempt in high-risk patients. Substance use disorder treatment providers interested in reducing future suicidal behavior may want to concentrate their efforts on identifying at-risk individuals and actively engaging these patients in longer treatment episodes.

Key Words: Suicide, Alcohol, Addiction, Substance Use, Treatment.

SUBSTANCE USE DISORDERS (SUDs) are associated with an increased risk for completed suicide (Wilcox et al., 2004). In addition to eventual death by suicide, population surveys demonstrate that a high number of individuals with SUDs report a suicide attempt at some point in their lifetime (Kessler et al., 1999). Epidemiological research indicates that inhalant and heroin abuse and dependence are associated with an increased risk of suicidal behavior; however, the number of substances abused is generally more closely related to suicide attempts than the type of substance used (Borges et al., 2000). Consistent with the epidemiological evidence, previous suicidal behavior is common in patients who present for SUD treatment. In patients entering SUD treatment, anywhere from 8 to 45% report a lifetime attempt (Anderson et al.,

1995; Johnsson and Fridell, 1997) and approximately 3 to 4% (Ilgen et al., 2005; Moos et al., 1998) report an attempt within 30 days of treatment entry.

Despite the high prevalence of past suicide attempt in patients presenting for SUD treatment, risk factors for suicidal behavior in these patients are just beginning to be understood (Cornelius et al., 2004; Erinoff et al., 2004). The majority of research on suicide in treatment-seeking SUD patients is cross-sectional. Examinations of factors associated with a recent suicide attempt in SUD patients at treatment entry have identified several pretreatment factors, including previous suicide attempts, suicidal ideation, difficulty controlling violent behavior, depression, psychotic symptoms, past physical or sexual abuse, and severity of pretreatment alcohol or other substance use (Darke et al., 2004; Ilgen et al., 2004; Roy, 2002; Roy et al., 1990; Tiet et al., 2006b, 2006c).

Longitudinal research on predictors of suicide attempt in substance using patients is much less common. To the best of our knowledge, only 3 prior studies have examined patient characteristics as predictors of a subsequent suicide attempt in patients with SUDs. In individuals with problematic alcohol use, prior suicide attempt, younger age, unmarried status, dependence on other substances, and the presence of another substance-induced psychiatric disorder have been associated with a greater likelihood of a future suicide attempt (Preuss et al., 2003). In a sample of 470 patients treated in a detoxification facility, Wines et al. (2004) found that previous suicidality, more depression,

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Received for publication July 13, 2006; accepted January 2, 2007.

This work was funded by the Department of Veterans Affairs (VA) Health Services Research and Development Service and Mental Health Strategic Health Group.

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DOI: 10.1111/j.1530-0277.2007.00348.x

and more sedative and alcohol use predicted a suicide attempt in the 2 years following detoxification. Among 495 opiate-dependent patients, Darke et al. (2005) found that baseline suicidal ideation and attempt, more social isolation, and poly-drug use predicted suicide attempt in the 12 months after treatment entry. Additionally, these authors found that treatment for heroin dependence was not associated with an overall decline in suicide attempts despite the general improvements seen in substance use, depression, and suicidal ideation in the sample.

With the exception of Darke et al. (2005) research in opiate-dependent patients, the extent to which treatment reduces the risk for future suicidal behavior is essentially unknown (Cornelius et al., 2004; Erinoff et al., 2004). Understanding which patients may be at risk for posttreatment attempts and which aspects of treatment may be important for reducing this risk could help treatment providers better target interventions to reduce posttreatment suicidality.

RELATIONSHIPS AMONG RISK FACTORS

When considering multiple risk and preventive factors for suicide attempt, it is important to use longitudinal data to examine how individual risk factors are related not only to the outcome but also to each other. A clear framework is needed to properly identify and classify existing risk factors to minimize overlap and redundancy in our models and, in turn, simplify and maximize the prediction of risk for future suicide attempt. In the present study, we use a series of steps outlined by Kraemer et al. (2001) and described in further detail in Kraemer et al. (2005), often referred to as the MacArthur Model approach, to determine the relative importance of multiple risk factors. This strategy for examining risk is intended to identify the most relevant risk factors and to better understand how risk factors may work together in risk estimation. Another advantage of this strategy is that it allows us to examine whether treatment provided to SUD patients is protective independent of other risk factors, or whether treatment reflects the continuing influence of pretreatment variables. Our goal is to develop a concise model of risk and protective factors that will be useful in the clinical prediction of future suicide attempt.

Thus, the MacArthur Model approach was used to develop a model of risk for posttreatment suicide attempt based on baseline patient and treatment-related factors related to the index episode of care. This extends existing research through the use of a newer statistical technique in a large SUD treatment-seeking sample followed longitudinally for approximately 1 year after treatment. The study is intended to broaden our understanding of which pretreatment patient attributes identified in previous cross-sectional research relate to aspects of the treatment episode and ultimately impact risk for posttreatment suicidal behavior.

MATERIALS AND METHODS

Participants

Patients were drawn from an outcomes monitoring program conducted in the Department of Veterans Affairs (VA). The VA mandated that clinicians use the Addiction Severity Index (ASI; McLellan et al., 1992) to assess all patients at entry into SUD treatment programs; consequently, no exclusion criteria were used. This nationwide project was designed to monitor and improve the quality of care and treatment and, because the ASI was a mandated part of standard treatment practice, separate informed consent was not required. For the present study, the Stanford University Human Research Protection Program provided human subjects approval for the analysis of the data. Addiction treatment in the VA was provided in residential, intensive outpatient, and outpatient settings. Prevailing treatment orientations included cognitive-behavioral, 12-step, and eclectic interventions provided within the context of individual and/or group contact with clinicians and peers. The present study focuses on a cohort of 13,870 patients who received the ASI within 2 weeks of treatment entry into 1 of 149 psychosocial (nonmethadone) facilities across the United States. Approximately 64% ($N = 8,807$) of participants provided follow-up data on the ASI an average of 13 months after baseline assessment. Follow-up data were obtained from a combination of interview and self-report assessments. For more information about the assessments and follow-up procedures, see Moos et al. (2000).

On average, these 8,807 patients were 47 years old ($SD = 9.6$) and had 13 years ($SD = 2$) of education. The vast majority of the patients (96%) were male, 59% were Caucasian, 32% were African American, 5% were Hispanic/Latino, and 4% were of another ethnic group. A total of 21% were married and 38% reported stable full-time employment over the previous year. At baseline, the majority of patients reported that they were in treatment for either alcohol (49%) or combined alcohol and drug use (26%). The remaining patients reported that they were seeking treatment for cocaine (10%), poly-drug use (6%), heroin (3%), or marijuana (2%).

Comparisons of baseline measures of patients with and without follow-up data indicated that, on average, patients without follow-up data were 2 years younger [$F(1, 13,867) = 161.8, p < 0.01$], more likely to be non-Caucasian [$\chi^2(1, N = 13,867) = 23.3, p < 0.01$], less likely to be married [$\chi^2(1, N = 13,867) = 30.1, p < 0.01$], and less likely to have stable employment at baseline [$\chi^2(1, N = 13,867) = 91.5, p < 0.01$]. Of particular relevance to the present study, the rate of suicide attempts [$\chi^2(1, N = 13,867) = 0.2, NS$] and suicidal thoughts [$\chi^2(1, N = 13,867) = 0.2, NS$] in the 30 days before baseline was similar for patients with and without follow-up data. However, lifetime suicide attempts [$\chi^2(1, N = 13,867) = 17.7, p < 0.01$] and suicidal thoughts [$\chi^2(1, N = 13,867) = 33.7, p < 0.01$] were more common in patients with follow-up data than those without.

Measures

The ASI (McLellan et al., 1992) was selected by the VA as the assessment instrument because of its familiarity among clinicians and its reliability and validity as a measure of SUD treatment outcomes (McLellan et al., 1985, 1992). To increase the reliability of the ASI, the VA organized a nationwide program in a series of eight 2-day training sessions to train clinical staff who routinely provided treatment to patients with SUDs to conduct ASI interviews (Moos et al., 1998). Although the ASI items are often combined to create composite scores, disagreement exists about the optimal scoring methods (Alterman et al., 2001). Most importantly, for the clinical utility of results, the scoring methods are complicated and this may decrease the likelihood that the composite scores will be utilized by clinicians for treatment planning (Tiet et al., 2006c). Thus, we focused on individual ASI items as candidate risk factors, combining

or omitting them as guided by the MacArthur Model (described in greater detail in the data analysis section). These items fall within the following categories: demographic information, psychiatric, substance use, medical, family/social, legal, and employment. All items from the ASI were examined, including items related to lifetime, prior 30-day experiences, and previous treatment. Specific items within each domain are listed below.

Demographics. Patients provided basic demographic information, including gender, age in years, and race categorized as Caucasian versus other.

Psychiatric Symptoms. The ASI assessed the following psychiatric symptoms: depression, anxiety, hallucinations, trouble understanding information, difficulty controlling violent behavior (excluding self-harm), suicidal thoughts, and suicide attempts. All items were dichotomous (no/yes) and focused separately on (1) the past 30 days and (2) lifetime (excluding the past 30 days). Suicide attempt in the 30 days before the follow-up assessment was used as the primary outcome variable. The suicide-related items of the ASI did not include questions about the total number, method, severity, or level of suicide intent of suicide attempts. Within the psychiatric section of the ASI, patients also provided information about the number of past inpatient and outpatient treatment episodes, whether they received psychiatric medications in the last 30 days or in their lifetime, and the number of days of psychiatric problems out of the last 30.

Substance Use. Within the substance use section of the ASI, patients reported the number of days out of the past 30 in which they used alcohol, used alcohol to intoxication, and used heroin, recreational methadone, other opiates, barbiturates, sedatives, cocaine, methamphetamine, marijuana, hallucinogens, inhalants, and more than one of these drugs in combination. They also reported the number of years they used each of these substances in their lifetime. Patients reported the length and recency of their most recent time abstinent, and the number of times in their lifetime that they experienced delirium tremens, overdoses, attended alcohol treatment, drug treatment, alcohol detoxification, or drug detoxification. Additionally, patients reported the number of days out of the past 30 that they experienced alcohol problems or drug problems.

Medical. Patients reported the number of times they had been hospitalized for medical treatment in their lifetime, the time since their last hospitalization in years, and whether they had a chronic medical condition, took medication for a chronic medical problem, or were receiving a pension. They also noted the number of days out of the last 30 that they experienced a medical problem.

Family/Social. Patients reported the length of their marital status (in months), their typical living status (coded as alone vs with others), months in their usual living arrangement, whether they lived with a person with an alcohol or drug use disorder, whether they typically spent their free time alone or with others, how satisfied they were with how they spent free time (no vs yes or indifferent), and number of close friends. Next, patients reported whether they ever had a close relationship, and whether they experienced conflict in the past 30 days or their lifetime with the following people: mother, father, siblings, spouse, children, other family member, friend, coworker, or neighbor.

Legal. Patients reported whether their treatment was prompted by the criminal justice system and whether they were currently on probation/parole or were awaiting trial. They also reported the lifetime number of convictions and arrests, lifetime months incarcerated, months since their last arrest, days incarcerated in the past 30, and number of days in the last 30 in which they engaged in illegal activity.

Employment. Patients reported their years of education, and whether they had a profession, a drivers' license, and a car. Additionally, they noted the longest time they held a job (in months), their usual employment pattern (coded as employed full or part time vs not employed), the number of days they were paid for work out of

the past 30, amount of money from employment and from illegal income sources, and number of dependents.

Treatment

Nationwide VA databases were used to obtain information about treatment during the index episode of care. We obtained 2 individual-level measures of treatment: number of days of contact with a SUD treatment provider (median = 18 days) and number of days of contact with a psychiatric treatment provider (median = 4 days). Both treatment-related variables were highly skewed and square-root transformations were used for these predictors in subsequent analyses.

Analyses

Our goal was to develop a concise model of the risk factors for a follow-up suicide attempt based on baseline information from the ASI and information about treatment during the index episode of care. In response to concerns about how to handle multiple intercorrelated predictors, Kraemer and colleagues developed a strategy that provides a taxonomy for categorizing risk factors and a method of combining risk factors into integrated models of risk prediction. Thus, the analysis plan followed a series of steps described in Kraemer et al. (2001, 2005) and often referred to as the MacArthur Model. Within the addiction research field, Harris et al. (2006) provide guidance for applying the MacArthur Model to examine candidate risk factors in multisite trials in which participants are clustered within treatment sites. Risk factors are defined as variables that precede and are correlated with the outcome. For the remainder of the methods section, we use the general term *risk factor* to refer to predictors that are either risk or protective factors.

Using this previous work as our guide, the core of our analytical approach involved 3 basic steps: (1) sorting potential risk factors based on time precedence, (2) identifying which of these potential risk factors was correlated with the outcome (suicide attempt within 30 days of follow-up) and selecting a smaller pool of risk factors significantly associated with the outcome, and (3) further reducing the list of risk factors by identifying independent risk factors, proxy risk factors, overlapping risk factors, moderators, and mediators (see the definitions provided below).

Candidate risk factors belonged to either the baseline period or the treatment period. We then determined which of the baseline patient-level and treatment characteristics were associated with suicide attempt using mixed-model logistic regression analyses that controlled for clustering within treatment site. All potential risk factors were median centered. We chose $\alpha < 0.01$ as an indicator of a significant relationship because of our large sample size.

The third step required a series of analyses to identify a set of essentially uncorrelated risk factors. Any candidate risk factor that was associated with the outcome and not significantly correlated with another candidate risk factor was considered an independent risk factor and was included in our final model. The remaining steps apply to risk factors that were correlated with at least one other risk factor. For these correlated risk factors, the MacArthur Model approach involves conducting a series of regression (or, in our case, mixed-model logistic regression) analyses to predict the outcome (i.e., suicide attempt) that include the main effects of each pair of candidate risk factors and their interaction.

Depending on the results of these comparisons, the risk factors are classified as either proxy risk factors or overlapping risk factors. Proxy risk factors are defined as variables that, when combined with another correlated risk factor (the dominant risk factor), are no longer significantly related to the outcome. Thus, although they are correlated with both the outcome and another risk factor, it is the other risk factor that has the dominant association with the outcome. Proxy risk factors are dropped from subsequent analyses. Overlap-

ping risk factors are defined as risk factors that correlate with one another and both are important predictors of the outcome (i.e., either both main effects are still significantly associated with the outcome or their interaction is significantly associated with the outcome). Kraemer et al. (2005) recommend combining overlapping risk factors (e.g., summing, taking a factor score, etc.) into a single risk factor. This process results in the identification of a set of essentially uncorrelated risk factors that all significantly predict the outcome.

Finally, we examined whether the identified baseline risk factors moderated the effect of the treatment factors and whether any of the treatment factors mediated the effect of the baseline risk factors on the outcome. The result of this process is an integrated model predicting follow-up suicide attempt with a combination of largely independent risk factors. After developing this model, we focus on its clinical utility by examining the effect of treatment on the probability of suicide attempt in high-risk patients.

RESULTS

Approximately 4% (314/8,807) of patients reported a suicide attempt within 30 days of their follow-up assessment. A series of separate univariate mixed-model logistic regression analyses identified 33 items from the baseline ASI and one treatment factor as significantly ($p < 0.01$) associated with a suicide attempt within 30 days of the follow-up period. Candidate risk factors that were not associated with the outcome were not considered further. Many of the remaining risk factors were highly correlated with one another. The following steps describe how we further reduced and/or combined these risk factors.

The majority of the psychiatric symptoms measured by the ASI were significantly correlated with a lifetime suicide attempt, which was the strongest single-item predictor of a follow-up suicide attempt. These psychiatric symptoms included lifetime and 30-day depression, anxiety, hallucinations, trouble understanding information, difficulty controlling violent behavior, suicidal thoughts, and suicide attempt in the past 30 days. Of these variables, all but lifetime suicidal thoughts were determined to be proxy variables for a lifetime suicide attempt. Lifetime suicidal thoughts was an overlapping risk factor with lifetime suicide attempt and, therefore, these 2 variables were combined to create a single variable that classified patients as having no lifetime suicidal thoughts or attempts, suicidal thoughts but no attempt, or lifetime suicide attempt. Also positively correlated with this combined lifetime suicidality variable, and meeting the definition for overlapping risk factors, were the following 3 variables: number of psychiatric problems in the 30 days before baseline, number of previous inpatient psychiatric treatment episodes, and whether the patient reported being on psychiatric medications at baseline. These 4 variables were combined using a factor analysis (principal axis factoring) to derive a single measure of severity of suicidal/psychiatric symptoms at baseline. This variable was stronger than any of its component variables and was the strongest single independent predictor of follow-up suicide attempt of all the remaining risk factors.

Several variables were correlated with this composite suicidal/psychiatric severity variable and were examined in separate comparisons with this variable. These included employment status, years of continuous employment, the presence of a stable living environment, number of lifetime overdoses, lifetime physical abuse, pension for a psychiatric diagnosis, number of past outpatient treatment episodes, lifetime psychiatric medication, and the presence of a chronic medical condition. Analyses indicated that all of these variables were proxies for severity of suicidal/psychiatric symptoms and, therefore, these variables were subsequently dropped.

None of the remaining 5 risk factors at baseline correlated with suicidal/psychiatric severity. Age and number of years of cocaine use were highly correlated with one another and, when examined together, it was determined that they were overlapping. Consequently, these 2 variables were combined into a variable labeled *age-adjusted years of cocaine use* that was more positively associated with follow-up suicide attempt than its constituents. Two of the items related to legal problems were positively associated with one another and correlated with a lower risk of a suicide attempt: whether treatment was prompted by the legal system and whether or not the participant was on probation/parole at baseline. These were found to be overlapping and combined into a new variable that reflected whether patients reported that treatment was *either* prompted by the criminal justice system or that they were on probation/parole. This variable, referred to as *any baseline criminal justice involvement*, was a stronger predictor than its 2 components and was associated with a lower likelihood of a follow-up suicide attempt. Lastly, number of days out of 30 of alcohol problems before baseline was not correlated with any of the other remaining predictors and was associated with a higher likelihood of a suicide attempt at follow-up. Thus, the following 4 baseline indices were unique risk factors for a follow-up suicide attempt: (1) severity of suicidal/psychiatric symptoms, (2) number of days of alcohol problems, (3) age-adjusted years of cocaine use, and (4) involvement in the criminal justice system.

Next, we examined the treatment factors. Number of days of psychiatric treatment was not significantly correlated with follow-up suicide attempt. Number of days of SUD treatment was significantly associated with a lower risk of follow-up suicide attempt.

The final set of analyses showed that none of the 4 baseline indices were correlated with days of SUD treatment. Accordingly, SUD treatment did not mediate the effect of the baseline risk factors on follow-up suicide attempt. Finally, none of the 4 baseline risk factors interacted with days of SUD treatment, indicating that they did not moderate the effect of SUD treatment. Thus, we had all of the components of our final model. When entered together into a single mixed-model logistic regression analysis, all of the components were significantly predictive of a

Table 1. Risk and Protective Factors for a Suicide Attempt Following Substance Use Disorder Treatment

Predictor	Value	Standard error	df	t-Value	p<	r ²
Intercept	- 4.02	0.11	8460	35.11		
<i>Patients' baseline characteristics</i>						
Severity of suicidal/psychiatric symptoms	0.73	0.07	8460	10.62	0.001	0.034
Alcohol problems	0.02	0.00	8460	3.70	0.001	0.035
Cocaine-adjusted life years	0.02	0.00	8460	4.14	0.001	0.036
Criminal justice system involvement	- 0.60	0.17	8460	3.60	0.001	0.036
<i>Treatment</i>						
Substance use disorder treatment participation (# of days)	- 0.08	0.02	8460	5.36	0.001	0.039

follow-up suicide attempt with an r^2 of 0.04 (see Table 1). Thus, even after accounting for the baseline predictors of suicide attempt, the amount of SUD treatment received was associated with a reduction in the risk of suicide attempt.

A series of additional analyses were undertaken to examine the real-world implications of this model. First, patients were classified as being at the highest risk (>1 standard deviation above the mean) on each of the 4 patient risk factors that comprised our final model. Then, the number of patient-related risk factors was summed to give each patient a risk score that ranged from 0 to 4. Because of low numbers in the highest risk groups, patients with a score of 3 or 4 were combined into 1 group. Next, we examined whether high participation in treatment (more than 1 standard deviation above the mean) influenced the rate of suicide attempt in patients with differing levels of baseline risk. An increase in the number of risk factors was associated with an increased risk of follow-up suicide attempt and receiving more SUD treatment was associated with a substantial reduction in risk (Fig. 1). For patients in the highest risk group (i.e., with 3 or more baseline risk factors), more SUD treatment was associated with a drop in the likelihood of future suicide attempt from nearly 10 to 5%.

DISCUSSION

A suicide attempt approximately 1 year after entering SUD treatment is more likely in individuals with elevated suicidal/psychiatric symptoms, more days of recent problematic alcohol use, and longer lifetime cocaine use (adjusted for age). Contact with the criminal justice system at baseline was a protective factor and reduced the risk of future suicide attempt. Importantly, greater engagement in SUD treatment during the treatment episode was associated with a reduction in risk. Specifically, high participation in SUD treatment in high-risk patients cut the risk of future suicide attempt from 10 to 5%.

The patient factors we identified are broadly consistent with those noted in previous cross-sectional research and the limited number of longitudinal studies related to risk of suicide attempt. As shown previously, severity of substance use is an important risk factor for suicide attempt (Darke and Ross, 2002; Darke et al., 2004; Roy, 2002; Roy et al., 1990; Tiet et al., 2006c). Of the substance-related risk factors examined, number of days of alcohol problems and number of years of lifetime cocaine use (adjusted for age) emerged as distinct predictors of future suicidal behavior. Because the sample consisted of patients seeking treatment for SUDs, it represented a narrow range of patients on the high end of the continuum of problematic substance use. Nevertheless, the extent of past cocaine use and current alcohol problems were still associated with future suicide attempts.

Joiner et al. (2005) have highlighted the unique role of past suicidal behavior as a predictor of future suicidal behavior. As these authors note, previous suicidality is highly correlated with other risk factors (e.g., depression) and yet seems to be the strongest single predictor of future suicidal behavior. In our results, past suicide attempt was the best single item predictor of future suicide attempt and parsimonious models of future suicidal behavior may still want to rely on this item as a strong predictor of risk. Using the formal definitions provided by Kraemer et al. (2005), we found that past suicide attempt was an overlapping risk factor with several other variables, including suicidal thoughts, number of previous inpatient psychiatric treatment episodes, days in the past month of psychiatric problems, and current use of psychiatric med-

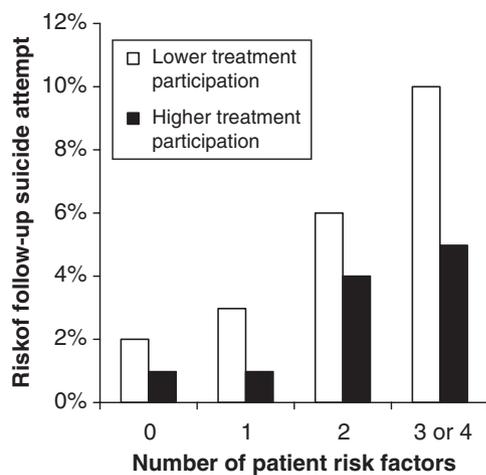


Fig. 1. Role of treatment participation in predicting future suicide attempt in patients with differing levels of baseline risk.

ications. Although past suicidality may be uniquely related to future suicide attempts (as hypothesized by Joiner et al., 2005) in other samples or when measured with other assessment instruments, our findings indicate that predictive risk models might be strengthened by including past suicidality as one aspect of a broader risk factor.

To the best of our knowledge, the role of the criminal justice system as a protective factor for future suicidal behavior has not been examined previously in the literature. However, patients who are court mandated to treatment tend to respond positively to SUD treatment (Kelly et al., 2005). Additionally, high levels of monitoring, such as the use of drug screening, are associated with a reduced likelihood of negative treatment outcomes in SUD patients (Moos, 2005). The ongoing monitoring of the legal system may have increased engagement in treatment, decreased future substance use and, consequently, reduced future suicidality in the present sample. Also, participants involved with the criminal justice system may have been placed in restrictive environments during the follow-up interval that reduced their access to alcohol and drugs, which, in turn, may have reduced their likelihood of suicidal behavior. More research is needed to better understand how the criminal justice system might influence patient substance use and suicidal behavior over the long term.

The present study extends the literature on suicide in treatment-seeking SUD patients because of the identification of treatment as a protective factor against risk of future attempt. To the best of our knowledge, only one other study (Darke et al., 2005) has explored the relationship between treatment and future suicide attempt. Darke et al. (2005) did not find that aspects of treatment for opiate dependence (including number of days of treatment) significantly reduced the risk of suicide attempt 12 months after treatment. The difference between our findings and those of Darke et al. (2005) may be due to the greater power to detect effects in the present sample and/or the unique characteristics of opiate-dependent patients. The present sample did not include patients receiving methadone maintenance treatment and, consequently, a relatively small portion of the sample (approximately 3%) identified heroin as their primary substance of abuse. Further research is needed to determine the characteristics that may make opiate-dependent patients less responsive to treatment (at least in risk for future suicide attempt) than other SUD patients. Also, our findings may be considered inconsistent with Preuss et al. (2003), who reported a positive association between suicide attempt and treatment participation in an initially nontreatment-seeking sample. This discrepancy in findings is likely due to the fact that all of the patients in the present sample were in treatment whereas in Preuss' sample, treatment participation may have served as a marker of patient severity.

Our results indicate that patients who averaged more SUD treatment during their treatment episode had a

reduced likelihood of attempting suicide at follow-up. High-risk patients who received a high amount of SUD treatment were half as likely to make a future attempt as those who received lesser amounts of SUD treatment. This could be a function of the monitoring and supervision provided by a longer duration of contact with SUD treatment providers during the index episode of care. Variations in sadness and depression may be more likely to be identified and treated more quickly when patients have more prolonged contact with their treatment providers during treatment. Patients who discontinue treatment contact early could more likely be isolated and experience unchecked symptom exacerbation.

In this sample of SUD patients, SUD treatment and not psychiatric treatment was important in reducing risk for future suicide attempt. One reason may have been the lack of intensity of psychiatric treatment, which was limited to 4 days or less for the majority of patients. It is possible that the coding of this information within the present dataset did not accurately capture the important aspects of psychiatric treatment that could reduce suicidal behavior. Specifically, our measure of psychiatric treatment (i.e., days of mental health treatment) did not quantify differences in the nature or timing of psychiatric treatment (e.g., early vs late in the SUD treatment episode). Additionally, it is possible that the unique nature of the relatively impaired, predominantly male VA sample may have made the effect of psychiatric treatment difficult to detect. Although psychiatric treatment is clearly an important part of treating suicidal behavior, these results highlight the need to focus on and treat substance use as a way to reduce future suicidal behavior (Cornelius et al., 2004; Erinoff et al., 2004).

Importantly, participation in SUD treatment did not mediate the effects of any of the baseline predictors and none of the predictors moderated the effect of length of stay on follow-up suicide attempt. The lack of mediation reflects the fact that baseline severity did not predict treatment participation, which may be due to the overall severity of this treatment-seeking sample. In addition, it is possible that unmeasured drug and alcohol problems between discharge and follow-up may explain why patients with greater baseline severity report higher rates of suicide at follow-up. Overall, the present model is additive, indicating that risk increases with each risk factor and that SUD treatment is a protective factor in patients with or without these risk factors.

An additional contribution of this study is that we present a structured way to identify risk factors in situations that yield a large number of highly intercorrelated predictors of the same outcome. This type of strategy is particularly relevant when working with a series of items from the same measure, such as the ASI. The MacArthur Model approach provides a clear methodology to identify distinct predictors and develop cleaner models without problems related to multicollinearity (Kraemer et al.,

2005). It also allows for the combination of risk factors in a manner that may not be apparent using other techniques. For example, we found that developing a combined risk factor of age-adjusted life years of cocaine use provided a stronger prediction of risk than either of its components individually.

However, the application of the MacArthur Model approach to characterize risk in our sample had several consequences. Specifically, adhering to the steps outlined by Kraemer et al. (2005) resulted in a model with multiple composite predictors. These composite predictors deviated from established models of suicidal behavior and may be difficult to translate into direct clinical practice. Moreover, the definitions of moderation and mediation differed somewhat from those frequently utilized in risk research (e.g., Baron and Kenny, 1986), leaving open the possibility that an alternative framework would yield different descriptions of relationships among predictors. However, at present, research on risk for suicide attempt relies primarily on the identification of multiple, individual predictors of suicidal behavior, with little guidance for understanding the interrelationships among these predictors. The present study reflects a first attempt to address this issue using the MacArthur Model approach as a guide. The modest level of model fit in the present data highlights the importance of developing stronger models of suicidal behavior. Hopefully, future research will test this model against other alternative combinations of predictors in other samples to better identify how these factors relate to one another to predict suicidality.

In clinical implications, treatment providers need to be aware of the high prevalence of suicide attempts in patients seeking SUD treatment (Anderson et al., 1995; Johnsson and Fridell, 1997), as well as the likelihood that a sizable minority of patients will attempt suicide in the year following treatment. Given the frequency of suicide attempt, careful screening and treatment planning in high-risk patients is particularly important for reducing the risk for subsequent suicidal behavior. In high-risk patients, our results indicate that treatment providers may want to consider a longer duration of care as a way to reduce the likelihood of a posttreatment suicide attempt.

The present findings should be considered with caution. First, because the follow-up rate was 64%, the data do not represent the full sample of patients who initially presented for treatment and our prediction of risk is limited to surviving patients who completed the follow-up interview. Comparisons of baseline characteristics of patients with and without follow-up data identified some demographic differences between these 2 groups; in addition, some differences (e.g., lifetime suicidality) were components of the predictors of future attempt identified in our analyses. Clearly, further research in samples with higher follow-up rates is needed to assess how missing data may have influenced the risk for a posttreatment suicide attempt. However, the study does have the benefit of providing

real-world data about a large national sample of patients seeking treatment for SUDs. Additionally, because there were no exclusion criteria, the findings are more likely to be generalizable to the full spectrum of patients that present for SUD treatment (see discussion in Tiet et al., 2006a).

The use of the ASI as the primary measure of baseline predictors and follow-up suicidality may diminish the generalizability of the findings in that the strength of our risk factors may have been influenced by the nature of the assessment. For example, the fact that variables such as depression were measured with a single item may have served to weaken their associations with suicide attempt. Moreover, we did not assess the construct of Major Depressive Disorder as defined by DSM-IV (American Psychiatric Association, 1994) criteria and the relationship between Major Depressive Disorder and the single ASI depression item is unknown. Similarly, the ASI items related to suicide attempt did not measure the severity or level of intent of each suicide attempt. Thus, the current measure of suicide attempt likely reflects a mixture of suicidal gestures and more serious suicide attempts. However, the ASI is able to assess multiple domains in a relatively short period of time, which allows for the efficient collection of routine clinical data. Some of the identified factors from domains outside of psychiatric and substance-related symptoms, such as the protective role of the criminal justice system, have received little attention in the literature. Although the stability and validity of the ASI are well established (see, Alterman et al., 2001; McLellan et al., 1985, 1992), these evaluations focused on composite scales of the ASI and specific data on the reliability of individual items, such as those related to suicidality, are yet to be established. Although the VA organized ASI training sessions for clinical staff, the low reliability of the ASI items, combined with the low base rate of post-treatment suicidal behavior may have limited the effect size of our model.

Another limitation is that follow-up suicide attempt was only measured within 30 days of the follow-up assessment. Thus, follow-up suicide attempt provides only a “snap shot” of posttreatment suicidal behavior and the extent of suicidal behavior during the entire interval between intake and follow-up is unknown. Similarly, the study only examines the impact of treatment received during the index episode of care, which represents only a portion of treatment provided to some patients. The role of the full combination of index and postdischarge treatment remains to be examined. Although we had a large sample, the low base rate of suicide attempt makes the detection of suicide attempts difficult and highlights the need to replicate our findings in other samples. Additionally, it is important to replicate the findings because our process of model development used a large number of tests of statistical significance and carries an increased risk of Type II error. Finally, the study was comprised primarily of men treated in VA SUD treatment programs and it is unclear

whether these findings would generalize to other treatment settings, particularly those with higher numbers of women.

Despite these limitations, this study provides a first attempt to understand the interrelationships between baseline and treatment factors in predicting posttreatment suicide attempt. The large sample collected at nearly 150 SUD treatment sites throughout the United States increases the generalizability of the findings. Overall, a combination of suicidal/psychiatric factors, past substance use, and current involvement in the criminal justice system influences the risk of posttreatment suicide attempt. Even after accounting for these factors, engagement in SUD treatment decreases the risk of a future attempt. Treatment providers could use these results to identify potential high-risk patients and increase efforts to keep these patients engaged in treatment with the goal of decreasing future suicidal behavior.

ACKNOWLEDGMENTS

This work was conducted, in part, under the auspices of the Substance Use Disorders Module of the Department of Veterans Affairs (VA) Quality Enhancement Research Initiative. Bernice Moos helped set up the original data files. The opinions expressed in this article are those of the authors and do not necessarily reflect those of the VA.

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