Regular Articles

Toward a Clinical Model of Suicidal Behavior in Psychiatric Patients

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Objective: Risk factors for suicide attempts have rarely been studied comprehensively in more than one psychiatric disorder, preventing estimation of the relative importance and the generalizability of different putative risk factors across psychiatric diagnoses. The authors conducted a study of suicide attempts in patients with mood disorders, psychoses, and other diagnoses. Their goal was to determine the generalizability and relative importance of risk factors for suicidal acts across diagnostic boundaries and to develop a hypothetical, explanatory, and predictive model of suicidal behavior that can subsequently be tested in a prospective study. **Method:** Following admission to a university psychiatric hospital, 347 consecutive patients who were 14–72 years old (51% were male and 68% were Caucasian) were recruited for study. Structured clinical interviews generated axis I and axis II diagnoses. Lifetime suicidal acts, traits of aggression and impulsivity, objective and subjective severity of acute psychopathology, developmental and family history, and past substance abuse or alcoholism were assessed. **Results:** Objective severity of current depression or psychosis did not distinguish the 184 patients who had attempted suicide from those who had never attempted suicide. However, higher scores on subjective depression, higher scores on suicidal ideation, and fewer reasons for living were reported by suicide attempters. Rates of lifetime aggression and impulsivity were also greater in attempters. Comorbid borderline personality disorder, smoking, past substance use disorder or alcoholism, family history of suicidal acts, head injury, and childhood abuse history were more frequent in suicide attempters. **Conclusions:** The authors propose a stress-diathesis model in which the risk for suicidal acts is determined not merely by a psychiatric illness (the stressor) but also by a diathesis. This diathesis may be reflected in tendencies to experience more suicidal ideation and to be more impulsive and, therefore, more likely to act on suicidal feelings. Prospective studies are proposed to test this model.

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There are more than 30,000 suicide victims each year in the United States (1). Over 90% of suicide victims have a psychiatric disorder at the time of death (2–8). However, most psychiatric patients do not commit suicide (9–12). Therefore, a psychiatric disorder is generally a necessary but insufficient condition for suicide. To identify suicide risk factors, it is necessary to look beyond the presence of a major psychiatric syndrome.

A previous suicide attempt is the best predictor of a future suicide or suicide attempt (13). However, since only 20%–30% of those who commit suicide have made a previous suicide attempt, it is necessary to identify other indicators of risk for either a suicide attempt or suicide completion.

Most studies of suicide or suicide attempts are restricted to one domain of possible risk factors, e.g., social (7, 14–18), psychiatric (4, 8, 19–45), psychological (46–48), or familial (49–53). Such studies are too nar-

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rowly focused to estimate the relative importance of different types of risk factors or their interrelationship by using multivariate techniques.

A related difficulty is that many studies have ignored the diagnosis of those who commit suicide (15, 16, 54) or studied only one diagnostic group, such as those with major depression (8, 21, 27, 28, 55–57), schizophrenia (10, 24), borderline personality disorder (25), mania (20), panic disorder (22), or alcoholism (11, 23). Such a design cannot determine whether risk factors are specific to a single diagnosis or allow generalizations across diagnostic boundaries. This distinction is critical in the effort to construct a general model of suicidal behavior.

Despite the importance of a psychiatric diagnosis, the quality of diagnostic methods in studies of suicide attempts varies greatly. Studies have used hospital charts, general clinical interviews (16, 21, 24–28, 36, 38, 46, 47), or a structured clinical interview for an axis I diagnosis (8, 19, 20, 22, 23, 29, 56). Few studies included axis II diagnoses (22, 25), mostly generated from a clinical interview in combination with research diagnostic criteria such as DSM-III or DSM-III-R (26, 27, 31, 36, 38). Studies of completed suicides have similar diagnostic deficiencies (48, 58–60).

Accurate diagnosis is important because, like completed suicides, suicide attempts usually occur in the context of a psychiatric illness (16, 26, 30, 36, 38). Moreover, 82% of suicide attempters have comorbid psychiatric diagnoses (61), and this is probably an underestimate because the investigators did not systematically diagnose axis II disorders.

Personality traits, particularly cluster B traits and disorders (62, 63), correlate with extent of suicidal behavior (age at first attempt, number of lifetime attempts) (62). Despite the need for evaluation of both axis I and axis II disorders, to our knowledge, no published study of suicide attempts has prospectively employed DSM-III-R or DSM-IV criteria and used structured clinical interview methods for both axis I and axis II disorders in multiple diagnostic groups. Nor have studies combined such assessments with measurement of relevant personality traits, family history, demographics, and psychosocial factors.

The present study involved 347 patients with major affective disorders, psychoses (schizophrenia, schizoaffective disorder, or schizophreniform psychosis), or personality disorders. Our goal was to determine the generalizability and relative importance of risk factors for suicidal acts across diagnostic boundaries. Structured clinical interviews generated axis I and axis II diagnoses, and we measured key personality characteristics such as aggression and impulsivity, recent life events, and a variety of clinical and demographic variables. The goal of this study was to develop a hypothetical, explanatory, and predictive model of suicidal behavior that can subsequently be tested in a prospective study.

METHOD

Following admission to a university psychiatric hospital for evaluation and psychiatric treatment, 347 consecutive patients were recruited. These patients were 14–72 years old, 51% were male, 68% were Caucasian, and they all had IQs greater than 80. All patients gave written informed consent for the protocol as approved by our institutional review board.

Clinical Assessment and Psychiatric Diagnosis

DSM-III-R axis I psychiatric disorders were diagnosed by using the Structured Clinical Interview for DSM-III-R (SCID) (64). Axis II diagnoses were obtained by using the structured Personality Disorder Examination (65). Psychiatric symptoms were assessed with the Brief Psychiatric Rating Scale (BPRS) (66), the Scale for the Assessment of Positive Symptoms (SAPS) (67), the Scale for the Assessment of Negative Symptoms (SANS) (68), the 24-item Hamilton Depression Rating Scale (69), the Beck Depression Inventory (70), and the Beck Hopelessness Scale (71). Lifetime aggression and impulsivity history were rated with the Brown-Goodwin Aggression Inventory (72), Buss-Durkee Hostility Inventory (73), and Barratt Impulsivity Scale (74). Life events were assessed with the St. Paul-Ramsey Scale, and potential protective factors were assessed with the Reasons for Living Inventory (75).

A suicide attempt was defined as a self-destructive act that was sufficiently serious to require medical evaluation and carried out with the intent to end one's life. The Scale for Suicide Ideation (76) measured suicidal ideation during the week preceding hospitalization, and suicide intent was assessed with the Suicide Intent Scale (77).

Raters were nurses or social workers with a master's degree or Ph.D. Interrater agreement kappa scores were >0.80 for axis I and >0.65 for axis II diagnoses (78). Intraclass coefficients (ICC) were greater than 0.70 for scales such as the Hamilton depression scale (ICC=0.93), BPRS (ICC=0.80), SANS (ICC=0.87), SAPS (ICC=0.71), and Scale for Suicide Ideation (ICC=0.97).

A history of childhood physical or sexual abuse or a head injury with loss of consciousness were recorded as present or absent. Assessment of past alcoholism or substance abuse was based on the SCID. Cigarette smokers were defined by asking if patients had ever smoked cigarettes regularly.

One hundred eighty-four (53%) of the 347 patients had made a previous suicide attempt; 118 (64%) of these patients had made multiple suicide attempts. Attempters and nonattempters were comparable in terms of axis I diagnoses: 176 (51%) of the 347 patients had a major depressive episode (93 attempters and 83 nonattempters); 126 (36%) had schizophrenia, schizoaffective disorder, or schizophreniform disorder (65 attempters and 61 nonattempters); and 45 (13%) had another diagnosis (26 attempters; 19 nonattempters). Seventy-four patients (21%) had comorbid borderline personality disorders. The mean Hamilton depression scale score of the 347 patients was 25.7 (SD=10.2), mean Beck Depression Inventory score was 21.2 (SD=13.1), and mean BPRS score was 43.5 (SD=12.1).

Statistical Methods

Differences between attempters and nonattempters on state and trait variables were tested by the two-sample t test (with equal or unequal variances as appropriate) or the Wilcoxon test for quantitative variables. For two-by-two tables, we used the chi-square statistic with Yates's correction for continuity. The odds ratio was also determined to show the strength of the relationship between attempter status and dichotomous (yes/no) variables. Interpretation of an odds ratio with a quantitative scale is not possible. For the purpose of data reduction, we performed two principal component factor analyses with no rotation, one for state-dependent rating scales and one for measures of aggression and impulsivity. Factors of the correlation matrix with eigenvalues greater than 1 were retained as significant. Logistic regression models were used to study the multivariate relationships of potential predictors with attempter status and their relative importance. Predictors in these models were selected a priori on the basis of previous research.

TABLE 1. Scores of Psychiatric Inpatients With or Without a History of Attempting Suicide on Measures of Potential Triggers or Stressors

Measure	Attempters			Nonattempters			Analysis		
	N	Mean	SD	N	Mean	SD	t or χ^2	df	p[a]
Hamilton Depression Rating Scale	177	26.3	9.8	159	24.9	10.5	1.25[b]	334	0.21
Beck Depression Inventory	135	23.4	13.2	120	18.6	12.6	2.95[b]	253	0.004[c]
Brief Psychiatric Rating Scale	176	42.6	12.4	157	44.5	11.6	–1.50[b]	331	0.14
Scale for the Assessment of Positive Symptoms	166	5.0	5.0	152	5.6	5.1	1.46[d]	1	0.23
Scale for the Assessment of Negative Symptoms	164	10.6	3.5	149	10.9	3.4	–0.74[b]	311	0.46
Length of current episode (weeks)	168	25.7	56.0	148	41.5	96.7	4.35[d]	1	0.04
St. Paul-Ramsey Scale (life events)	149	3.9	1.0	130	3.8	1.1	1.04[b]	277	0.30
Reasons for Living Inventory	97	164.1	48.9	86	191.3	44.6	–3.92[b]	181	0.0001[c]
Beck Hopelessness Scale	141	9.2	6.6	121	7.4	5.8	2.33[b]	260	0.02
Scale for Suicidal Ideation	169	18.1	11.9	148	6.7	9.3	9.60[e]	311	0.0001[c]

[a] Most of these p values are not corrected for multiple comparisons. If Bonferroni's method is applied, statistically significant tests are those having p values less than 0.005 (alpha=0.05÷10=0.005).
[b] Two-sample t test with equal variances.
[c] Significant after Bonferroni correction.
[d] Chi-square approximation for the two-sample Kruskal-Wallis/Wilcoxon nonparametric test.
[e] Two-sample t test with unequal variances.

RESULTS

Patients who had attempted suicide recently or in the past did not significantly differ from nonattempters in age (mean=32.0, SD=9.5, versus mean=32.7, SD=11.1) (t=–0.65, df=321.1, p=0.52), percentage of males (51% versus 52%), percentage married (14% versus 17%) (χ^2=0.40, df=1, p=0.53), percentage Caucasian (66% versus 71%) (χ^2=0.71, df=1, p=0.40), height (mean=67.3 cm, SD=4.2, versus mean=67.2 cm, SD=4.1), or number of children (mean=1.2, SD=1.5, versus mean=1.4, SD=1.7) (t=–0.67, df=264, p=0.50). Attempters had significantly fewer years of education (mean=12.7, SD=2.6, versus mean=14.0, SD=3.0) (t=–3.93, df=317, p=0.0001). However, this difference was not substantial enough to be clinically significant. The median personal income in the previous year was low in both groups, but for attempters it was 25% lower than for nonattempters ($6,000 versus $8,000) ($\chi^2$=8.03, df=1, p=0.005). Fewer attempters were Catholic (27% versus 41%) (χ^2=6.6, df=1, p=0.01).

Table 1 shows that attempters and nonattempters did not differ significantly on objective severity measures of acute psychopathology, such as major depression (Hamilton depression scale), psychosis (SAPS and SANS), and general psychopathology (BPRS), In contrast, subjective ratings of depression (Beck Depression Inventory), hopelessness (Beck Hopelessness Scale), and severity of suicidal ideation were all significantly greater in suicide attempters. Duration of current episode, another measure of severity of depression, was longer in nonattempters, indicating that attempters had shorter exposure to depression during the current episode. Attempters had more lifetime episodes of major depression or psychosis (median=3 in attempters versus 2 in nonattempters) (χ^2=4.18, df=1, p=0.04) and a younger age at onset of illness (median=23 years in attempters versus 27 years in nonattempters) (χ^2=13.8, df=1, p=0.0002). Although the level of stress associated with life events (St. Paul-Ramsey Scale) did not appear to differ significantly between the two groups, the suicide attempters reported significantly fewer reasons for living (table 1).

Table 2 addresses traits or stable characteristics and chronic conditions that have been implicated in suicidal behavior. In contrast to the findings in table 1, many differences were found between attempters and nonattempters. Attempters had significantly higher scores for lifetime aggression and impulsivity as well as higher rates of comorbid cluster B personality disorders, comorbid past alcoholism or substance abuse or dependence, smoking, head injury, and a family history of a first-degree relative who had attempted or completed suicide. Most of these differences were highly significant, even when Bonferroni's method for multiple comparisons was applied (table 2).

Detailed results of the factor analyses of the state-dependent and trait-dependent psychopathology rating scale scores, including scoring coefficients that indicate how the factor scores were computed from the rating scales, are available on request. Two state factors (total variance explained: 75%) and one trait factor (total variance explained: 64%) were generated. We called the state factors the psychosis factor (derived from BPRS, SAPS, and SANS) and the depression factor (derived from the Hamilton depression scale, Beck Depression Inventory, and Beck Hopelessness Scale) because of correlations with state-dependent measures of these components of psychopathology. We called the trait factor the aggression/impulsivity factor (derived from Brown-Goodwin, Buss-Durkee, and Barratt scales).

A logistic regression model in which suicide attempter status was the dependent variable and the three factors were the independent variables indicated that only the aggression/impulsivity factor was strongly associated with lifetime suicide attempt (odds ratio=3.30, 95% confidence interval=1.99–5.47, p=0.0001). The psychosis factor (odds ratio=1.17, 95% confidence interval=0.78–1.75, p=0.45) and the depression

TABLE 2. Potential Traits and Scores on Measures of Potential Traits Related to Suicidal Threshold or Diathesis of Psychiatric Inpatients With or Without a History of Attempting Suicide

Trait or Measure of Trait	Attempters			Nonattempters			Analysis				
	N	Patients With Trait		N	Patients With Trait						
		N	*%*		*N*	*%*	χ^2	*df*	*p*[a]	*Odds Ratio*	*95% CI*
Trait											
Comorbid borderline personality disorder	107	64	60	65	10	15	30.77	1	<0.0001[b]	8.19	3.77–17.80
Comorbid cluster A or C personality disorder	107	37	35	65	23	35	0.00	1	1.0	0.97	0.51–1.84
Childhood history of abuse	132	64	48	129	28	22	19.34	1	0.0001[b]	3.40	1.98–5.83
Past head injury	166	76	46	153	44	29	9.12	1	0.003[b]	2.09	1.32–3.33
Comorbid past alcoholism or substance abuse	183	128	70	159	74	47	18.31	1	<0.0001[b]	2.67	1.72–4.17
Cigarette smoking	181	125	69	156	68	44	21.18	1	<0.0001[b]	2.89	1.85–4.52
Male sex	184	93	51	163	84	52	0.006	1	0.94	0.96	0.63–1.47
First-degree relative who had attempted/completed suicide	180	36	20	158	14	9	7.42	1	0.006	2.57	1.33–4.97
		Mean	*SD*		*Mean*	*SD*	*t*	*df*	*p*[a]		
Measure of trait											
Brown-Goodwin Aggression	151	22.0	6.6	131	17.4	5.5	6.34[c]	279.5	0.0001[b]		
Buss-Durkee Hostility Inventory	94	38.0	13.2	93	32.3	12.5	2.99[d]	185	0.003[b]		
Barratt Impulsivity Scale	106	54.0	16.1	97	44.8	15.0	4.18	201	<0.0001[b]		

[a] Some of these p values are not corrected for multiple comparisons. If Bonferroni's method is applied, statistically significant tests are those having p values less than 0.004 (alpha=0.05÷12=0.004).
[b] Significant after Bonferroni correction.
[c] Two-sample t test with unequal variances.
[d] Two-sample t test with equal variances.

factor (odds ratio=0.98, 95% confidence interval= 0.66–1.46, p=0.94) were not significant predictors.

The addition of other independent variables, such as comorbid borderline personality disorder, past head injury, abuse in childhood, and a positive family history for suicidal behavior, did not alter the finding that the two state factors did not appear to predict attempter status. The addition of the score for severity of suicidal ideation to the logistic regression with the three factors did not alter the finding that the aggression/impulsivity factor is an important predictor of attempter status (odds ratio=3.10, 95% confidence interval=1.73–5.57, p=0.0001 for the factor versus odds ratio=1.10, 95% confidence interval=1.05–1.16, p= 0.0001 for suicidal ideation).

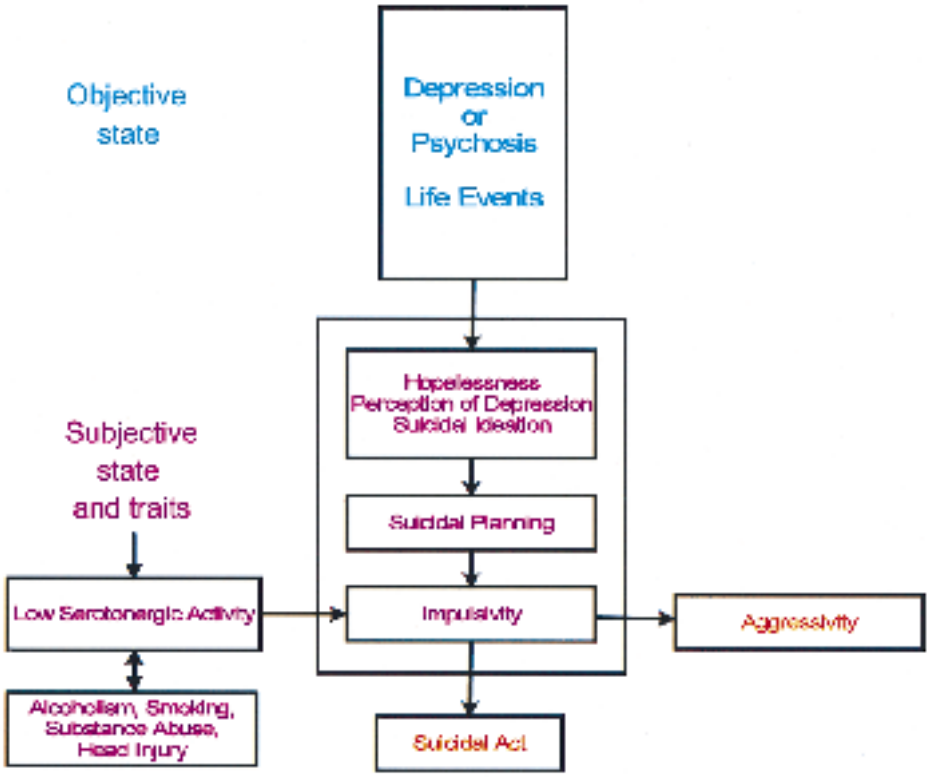
Because about 41% of attempters had attempted suicide within 30 days of hospitalization, we also ran the logistic regression model including only these recent attempters to address the possibility that, since the psychosis and depression factors reflected current acute state, they were more likely to be associated with suicidal behavior that occurred more recently. The results were unchanged. The aggression/impulsivity factor was a significant predictor of recent attempter status. Suicidal ideation is also an important predictor (according to the logistic regression described earlier) and is correlated with the aggression/impulsivity factor (r= 0.28, N=137, p=0.001).

Missing data did not explain the findings of the logistic regression model with the three factors (complete data were required for all items of all nine rating scales for each subject included). We compared subjects included in the multivariate analysis (N=126) with those who were dropped (N=221). No significant differences were found in any demographic or clinical variable except for slightly higher personal income, higher percentage Caucasian (78% versus 62%), and more lethal lifetime suicide attempts (3.8 versus 3.1) (t=2.44, df= 181, p=0.02) in the group included in the logistic regression models with the three factors.

DISCUSSION

A trait factor, aggression/impulsivity, assessing lifetime externally directed aggression and impulsivity, was highly significant in distinguishing past suicide attempters from nonattempters. Individuals with a past history of attempting suicide exhibited greater lifetime aggression and impulsivity than nonattempters with the same psychiatric illness. Hostility in association with major depression and other psychiatric conditions has been reported to be linked to suicidal behavior (28, 79) but not defined on the basis of lifetime behavior or stable trait-like features. A more pronounced impulsive-aggressive trait characterizes individuals at risk for suicide attempts regardless of psychiatric diagnosis. Most previous studies could not specifically address this point because they either examined one diagnostic group (8, 11, 20–25, 27, 28, 55–57, 80, 81), had too few cases to separate diagnostic groups (79), or did not specify diagnoses (15, 16, 54).

FIGURE 1. A Model of Suicidal Behavior



Externally directed aggression, suicidal acts, and other manifestations of impulsivity are all highly related (79, 82, 83). Our scales cannot separate impulsivity from its manifestations, such as aggression or borderline personality disorder. For example, the aggression/impulsivity factor comprises scores from the aggression and impulsivity scales, features also found in borderline personality disorder. A diagnosis of borderline personality disorder and the aggression/impulsivity factor were both robust predictors of attempter status but were strongly interdependent. Patients with a diagnosis of borderline personality disorder scored much higher on the aggression/impulsivity factor than those without borderline personality disorder (0.54 versus –0.16) ($t=3.09$, $df=83$, $p=0.003$). The component of borderline personality disorder that best correlated with suicidal behavior was impulsivity, highlighting the importance of impulsivity in determining risk of suicidal acts (64). Greater impulsivity or impaired decision making may underlie a generalized propensity to suicidal and aggressive acts. Impulsivity is measurable by neuropsychological tests that ultimately may prove to be more sensitive than a clinical history.

Clinicians intuitively rely on objective measures of severity of psychiatric illness as a guide to the risk for suicidal acts. Our findings and those of others indicate that objective severity of illness does not distinguish patients with a history of suicide attempts (47, 83–85). Given the cumulative evidence that a history of suicide attempt elevates the risk for future suicidal acts (13), objective severity of illness is also unlikely to predict future suicide attempts. This observation emphasizes the importance of the diathesis or trait-like predisposition, relative to severity of the illness, in predicting suicidal acts.

Patients with recurrent major depression or schizophrenia, who have a history of suicide attempt(s), make the attempt(s) relatively early in the course of illness (10, 83). In our study, the attempters had made an average of 2.5 lifetime suicide attempts, evidence that suicide attempters have a predisposition to suicidal acts. The predisposition to suicidal acts appears to be part of a more fundamental predisposition to both externally and self-directed aggression.

The model shown in figure 1 summarizes our results. Subjective depression, hopelessness, and suicidal ideation were greater in suicide attempters than in nonattempters, despite comparable rates of objective severity for depression or psychosis. Conversely, suicide attempters scored lower on the Reasons for Living Inventory—a scale that has been considered to measure the protective effect of having more reasons for living (75). The Reasons for Living Inventory score correlated negatively with hopelessness, providing further support for the notion that the Reasons for Living Inventory is an index of deterrents to suicide. There was no significant difference in life events between attempters and nonattempters; therefore, life events do not appear to explain the perception of fewer reasons for living. The more pronounced adverse response of suicide

attempters to depression or psychosis implies some degree of state-trait interaction (figure 1). Hopelessness is greater in suicide attempters than in nonattempters during an acute depression (83), after successful treatment (86), and intermorbidly (87). Hopelessness can predict future suicide (47, 87, 88). These observations suggest that the degree of hopelessness is determined by both state and trait, and it may have predictive properties.

Genetic or familial factors contribute to suicide risk (51, 52, 89). Aggression, impulsivity, and borderline personality disorder may also be results of genetic factors (90–94) or early life experiences, including a history of physical or sexual abuse (95, 96). A common underlying genetic or familial factor, therefore, may explain the association of suicidal behavior with the aggression/impulsivity factor or borderline personality disorder. An indicator of genetic or familial risk is a history of suicidal behavior in a first-degree relative (51). As evidence of this association, a higher rate of a positive family history of a suicide attempt or completion was associated with the presence of comorbid cluster B personality disorder (χ^2=5.08, df=1, p=0.02). This hypothesis of familial (perhaps genetic) transmission of a propensity for externally directed aggression and suicidal behavior, independent of transmission of major depression or psychosis, is consistent with evidence that suicidal behavior is transmitted in families independently of psychopathology but not independently of impulsive aggression (97); it is also consistent with adoption studies reporting that transmission of a genetic risk factor for suicide that is independent of psychopathology (50).

Suicide risk was also related to past head injury, as previously reported by others (98–101), and to a history of abuse in childhood (95, 96) (table 2). Both head injury and abuse in childhood were independent predictors of suicide status, and both were associated with the aggression/impulsivity factor. Higher scores on the aggression/impulsivity factor were found in patients with a past head injury (0.28 versus –0.19) (t=2.64, df=131, p=0.009) and in those with a history of abuse in childhood (0.33 versus –0.28) (t=3.20, df=106, p=0.002). In terms of causality, aggressive, impulsive children and adults are more likely to sustain a head injury, and head injuries can cause disinhibition and aggressive behavior (see reference 102 for review). Alternatively, mothers of abused children have an elevated suicide attempt rate and may transmit the risk for suicidal behavior both genetically and by upbringing. Aggressive, impulsive children may provoke child abuse in vulnerable parents and thereby create a tendency for self-injurious behavior in adult life (95, 96).

Alcoholism and substance abuse are associated with suicidal acts and may be causal factors by increasing the probability of a head injury due to acute intoxication. Fifty percent of head injuries, which result in disinhibition and a greater probability of suicidal behavior (103, 104), are sustained while using alcohol (105). Alcoholism and substance abuse are related to the aggression/impulsivity factor and comorbid borderline personality disorder (which, in turn, can increase the risk for head injury as well as be aggravated by a head injury). Comorbid past alcoholism or substance abuse are associated with head injury (χ^2=11.96, df=1, p=0.001), with borderline personality disorder (χ^2=7.57, df=1, p=0.006), and with higher scores on the aggression/impulsivity factor (0.26 versus –0.44) (t=4.42, df=141, p<0.0001). This constellation of aggression, alcoholism, substance abuse, and impulsivity resembles a syndrome called "disinhibitory" psychopathology described by Gorenstein and Newman (106) in a review of relevant clinical and animal studies of brain injury written almost 20 years ago.

Given the evidence linking low serotonergic activity separately to suicidal behavior (107–109), aggression, and alcoholism (see reference 82 for a review), it is conceivable that low serotonergic activity may, to some degree, underlie all three problems and that low serotonergic activity may mediate genetic and developmental effects on suicide, aggression, and alcoholism (110). Reports of increased aggression, impulsivity, and cocaine and alcohol consumption in mutant mice lacking the 5-HT_{1B} receptor (111, 112) indicate that a genetically mediated serotonin abnormality can result in increased impulsive aggression as well as alcoholism and substance abuse. Suicidal behavior is never observed in a rodent model, but the other elements of "disinhibitory" psychopathology are observed in this 5-HT_{1B} knockout mouse model.

Potentially related to the higher rate of substance abuse and alcoholism in the suicide attempters is our observation that cigarette smoking is more common in suicide attempters. Smoking is associated with elevated rates of suicide (113–117), and our study demonstrates that the association of smoking and suicidal acts is independent of any association of psychiatric illness with smoking. While this manuscript was under review, another study was published reporting an association of smoking and suicide attempts in patients with a variety of psychiatric diagnoses (118).

The coexistence of a greater propensity for suicidal ideation and for impulsive behaviors in suicide attempters can partly explain why suicide attempters are prone to attempt suicide. They feel more suicidal and are more likely to act on feelings. These results suggest that clinicians should carefully assess severity of suicidal ideation and lifetime impulsivity or aggression in order to estimate the risk for future suicidal acts. This study, like most previous studies, evaluated associations with past suicidal acts. A prospective study is underway to determine correlates of future suicidal acts in the same patient population as part of an effort to develop a predictive model of suicidal acts.

REFERENCES

1. Centers for Disease Control and Prevention: Advance report of final mortality statistics, 1990. Monthly Vital Statistics Report 1993; 41:1–52

2. Barraclough B, Bunch J, Nelson B, Sainsbury P: One hundred cases of suicide: clinical aspects. Br J Psychiatry 1974; 125: 355–373
3. Robins E, Murphy GE, Wilkinson RH Jr, Gassner S, Kayes J: Some clinical considerations in the prevention of suicide based on a study of 134 successful suicides. Am J Public Health 1979; 49:888–899
4. Rich CL, Runeson BS: Mental illness and youth suicide (letter). Am J Psychiatry 1995; 152:1239–1240
5. Dorpat TL, Ripley HS: A study of suicide in the Seattle area. Compr Psychiatry 1960; 1:349–359
6. Isometsä E, Henriksson M, Marttunen M, Heikkinen M, Aro H, Kuoppasalmi K, Lönnqvist J: Mental disorders in young and middle aged men who commit suicide. BMJ 1995; 310:1366–1367
7. Brent DA, Perper JA, Moritz G, Baugher M, Schweers J, Roth C: Firearms and adolescent suicide: a community case-control study. Am J Dis Child 1993; 147:1066–1071
8. Strakowski SM, McElroy SL, Keck PE Jr, West SA: Suicidality among patients with mixed and manic bipolar disorder. Am J Psychiatry 1996; 153:674–676
9. Jamison KR: Suicide and bipolar disorders. Ann NY Acad Sci 1986; 487:301–315
10. Johns CA, Stanley M, Stanley B: Suicide in schizophrenia. Ann NY Acad Sci 1986; 487:294–300
11. Roy A, Linnoila M: Alcoholism and suicide. Suicide Life Threat Behav 1986; 16:244–273
12. Frances A, Fyer M, Clarkin J: Personality and suicide. Ann NY Acad Sci 1986; 487:281–293
13. Leon AC, Friedman RA, Sweeney JA, Brown RP, Mann JJ: Statistical issues in the identification of risk factors for suicidal behavior: the application of survival analysis. Psychiatry Res 1990; 31:99–108
14. Durkheim E: Suicide. Translated by Spaulding JA, Simpson G. New York, Free Press, 1951
15. Chiles JA, Strosahl KD, Ping ZY, Michael MC, Hall K, Jemelka R, Senn B, Reto C: Depression, hopelessness, and suicidal behavior in Chinese and American psychiatric patients. Am J Psychiatry 1989; 146:339–344
16. Daly M, Conway M, Kelleher MJ: Social determinants of self-poisoning. Br J Psychiatry 1986; 148:406–413
17. Brent DA, Perper JA, Moritz G, Baugher M, Roth C, Balach L, Schweers J: Stressful life events, psychopathology, and adolescent suicide: a case control study. Suicide Life Threat Behav 1993; 23:179–187
18. Maris RW: Social and familial risk factors in suicidal behavior. Psychiatr Clin North Am 1997; 20:519–550
19. Kaplan KJ, Harrow M: Positive and negative symptoms as risk factors for later suicidal activity in schizophrenics versus depressives. Suicide Life Threat Behav 1996; 26:105–121
20. Dilsaver SC, Chen Y-W, Swann AC, Shoaib AM, Krajewski KJ: Suicidality in patients with pure and depressive mania. Am J Psychiatry 1994; 151:1312–1315
21. van Praag HM, Plutchik R: Depression type and depression severity in relation to risk of violent suicide attempt. Psychiatry Res 1984; 12:333–338
22. Weissman MM, Klerman GL, Markowitz JS, Ouellette R: Suicidal ideation and suicide attempts in panic disorder and attacks. N Engl J Med 1989; 321:1209–1214
23. Roy A, Lamparski D, DeJong J, Moore V, Linnoila M: Characteristics of alcoholics who attempt suicide. Am J Psychiatry 1990; 147:761–765
24. Roy A, Mazonson A, Pickar D: Attempted suicide in chronic schizophrenia. Br J Psychiatry 1984; 144:303–306
25. Shearer SL, Peters CP, Quaytman MS, Wadman BE: Intent and lethality of suicide attempts among female borderline inpatients. Am J Psychiatry 1988; 145:1424–1427
26. Morgan HG, Burns-Cox CJ, Pocock H, Pottle S: Deliberate self-harm: clinical and socio-economic characteristics of 368 patients. Br J Psychiatry 1975; 127:564–574
27. Friedman RC, Aronoff MS, Clarkin JF, Corn R, Hurt SW: History of suicidal behavior in depressed borderline inpatients. Am J Psychiatry 1983; 140:1023–1026
28. Weissman M, Fox K, Klerman GL: Hostility and depression associated with suicide attempts. Am J Psychiatry 1973; 130: 450–455
29. Duggan CF, Sham P, Lee AS, Murray RM: Can future suicidal behaviour in depressed patients be predicted? J Affect Disord 1991; 22:111–118
30. Hawton K, Fagg J, Platt S, Hawkins M: Factors associated with suicide after parasuicide in young people. BMJ 1993; 306:1641–1644
31. Motto JA, Heilbron DC, Juster RP: Development of a clinical instrument to estimate suicide risk. Am J Psychiatry 1985; 142:680–686
32. Cohen LJ, Test MA, Brown RL: Suicide and schizophrenia: data from a prospective community treatment study. Am J Psychiatry 1990; 147:602–607; correction, 147:1110
33. Sundqvist-Stensman UB: Suicides in close connection with psychiatric care: an analysis of 57 cases in a Swedish county. Acta Psychiatr Scand 1987; 76:15–20
34. Henriksson MM, Aro HM, Marttunen MJ, Heikkinen ME, Isometsä ET, Kuoppasalmi KI, Lönnqvist JK: Mental disorders and comorbidity in suicide. Am J Psychiatry 1993; 150:935–940
35. King EA, Barraclough BM: Suicide. Lancet 1993; 342:744–745
36. Apter A, Kotler M, Sevy S, Plutchik R, Brown S-L, Foster H, Hillbrand M, Korn ML, van Praag HM: Correlates of risk of suicide in violent and nonviolent psychiatric patients. Am J Psychiatry 1991; 148:883–887
37. Rich CL, Fowler RC, Fogarty LA, Young D: San Diego Suicide Study, III: relationships between diagnoses and stressors. Arch Gen Psychiatry 1988; 45:589–592
38. Beautrais AL, Joyce PR, Mulder RT, Fergusson DM, Deavoll BJ, Nightingale SK: Prevalence and comorbidity of mental disorders in persons making serious suicide attempts: a case-control study. Am J Psychiatry 1996; 153:1009–1014
39. Brent DA, Perper JA, Allman CJ: Alcohol, firearms, and suicide among youth: temporal trends in Allegheny County, Pennsylvania, 1960 to 1983. JAMA 1987; 257:3369–3372
40. Johnson J, Weissman MM, Klerman GL: Panic disorder, comorbidity, and suicide attempts. Arch Gen Psychiatry 1990; 47:805–808
41. Marttunen MJ, Aro HM, Henriksson MM, Lönnqvist JK: Mental disorders in adolescent suicide: DSM-III-R axes I and II diagnoses in suicides among 13- to 19-year-olds in Finland. Arch Gen Psychiatry 1991; 48:834–839
42. Runeson B: Mental disorder in youth suicide: DSM-III-R axes I and II. Acta Psychiatr Scand 1989; 79:490–497
43. Shaffer D, Gould MS, Fisher P, Trautman P, Moreau D, Kleinman M, Flory M: Psychiatric diagnosis in child and adolescent suicide. Arch Gen Psychiatry 1996; 53:339–348
44. Barraclough BM, Pallis DJ: Depression followed by suicide: a comparison of depressed suicides with living depressives. Psychol Med 1975; 5:55–81
45. Black DW, Winokur G, Nasrallah A: Suicide in subtypes of major affective disorder: a comparison with general population suicide suicide mortality. Arch Gen Psychiatry 1987; 44:878–880
46. Nordström P, Schalling D, Åsberg M: Temperamental vulnerability in attempted suicide. Acta Psychiatr Scand 1995; 92: 155–160
47. Beck AT, Steer RA, Kovacs M, Garrison B: Hopelessness and eventual suicide: a 10-year prospective study of patients hospitalized with suicidal ideation. Am J Psychiatry 1985; 142: 559–563
48. Pokorny AD: Prediction of suicide in psychiatric patients: report of a prospective study. Arch Gen Psychiatry 1983; 40: 249–257
49. Kety SS: Genetic factors in suicide, in Suicide. Edited by Roy A. Baltimore, Williams & Wilkins, 1986, pp 41–45
50. Schulsinger F, Kety SS, Rosenthal D, Wender PH: A family study of suicide, in Origin, Prevention, and Treatment of Affective Disorders. Edited by Schou M, Stromgren E. New York, Academic Press, 1979, pp 277–287

51. Roy A: Family history of suicide in manic-depressive patients. J Affect Disord 1985; 8:187–189
52. Roy A, Segal NL, Centerwall BS, Robinette CD: Suicide in twins. Arch Gen Psychiatry 1991; 48:29–32
53. Roy A, Segal NL, Sarchiapone M: Attempted suicide among living co-twins of twin suicide victims. Am J Psychiatry 1995; 152:1075–1076
54. James IP, Levin S: Suicide following discharge from psychiatric hospital. Arch Gen Psychiatry 1964; 10:43–46
55. Fawcett J, Scheftner W, Clark D, Hedeker D, Gibbons R, Coryell W: Clinical predictors of suicide in patients with major affective disorders: a controlled prospective study. Am J Psychiatry 1987; 144:35–40
56. Bulik CM, Carpenter LL, Kupfer DJ, Frank E: Features associated with suicide attempts in recurrent major depression. J Affect Disord 1990; 18:29–37
57. Roose SP, Glassman AH, Walsh BT, Woodring S, Vital-Herne J: Depression, delusions, and suicide. Am J Psychiatry 1983; 140:1159–1162
58. Avery D, Winokur G: Mortality in depressed patients treated with electroconvulsive therapy and antidepressants. Arch Gen Psychiatry 1976; 33:1029–1037
59. Black DW, Winokur G, Nasrallah A: Effect of psychosis on suicide risk in 1,593 patients with unipolar and bipolar affective disorders. Am J Psychiatry 1988; 145:849–852
60. Coryell W, Tsuang MT: Primary unipolar depression and the prognostic importance of delusions. Arch Gen Psychiatry 1982; 39:1181–1184
61. Henriksson MM, Isometsä ET, Kuoppasalmi KI, Heikkinen ME, Marttunen MJ, Lönnqvist JK: Panic disorder in completed suicide. J Clin Psychiatry 1996; 57:275–281
62. Brodsky BS, Malone KM, Ellis SP, Dulit RA, Mann JJ: Characteristics of borderline personality disorder associated with suicidal behavior. Am J Psychiatry 1997; 154:1715–1719
63. Isometsä ET, Henriksson MM, Heikkinen ME, Aro HM, Marttunen MJ, Kuoppasalmi KI, Lönnqvist JK: Suicide among subjects with personality disorders. Am J Psychiatry 1996; 153: 667–673
64. Spitzer RL, Williams JBW, Gibbon M, First MB: Structured Clinical Interview for DSM-III-R, Version 1.0 (SCID). Washington, DC, American Psychiatric Press, 1990
65. Loranger AW, Susman VL, Oldham JM, Russakoff LM: The Personality Disorder Examination: a preliminary report. J Personality Disorders 1987; 1:1–13
66. Overall JE, Gorham DR: The Brief Psychiatric Rating Scale. Psychol Rep 1962; 10:799–812
67. Andreasen NC: Scale for the Assessment of Positive Symptoms (SAPS). Iowa City, University of Iowa, 1984
68. Andreasen NC: Modified Scale for the Assessment of Negative Symptoms (SANS). Iowa City, University of Iowa, 1984
69. Hamilton M: A rating scale for depression. J Neurol Neurosurg Psychiatry 1960; 23:56–62
70. Beck AT, Ward CH, Mendelson M, Mock J, Erbaugh J: An inventory for measuring depression. Arch Gen Psychiatry 1961; 4:561–571
71. Beck AT, Weissman A, Lester D, Trexler L: The measurement of pessimism: the Hopelessness Scale. J Consult Clin Psychol 1974; 42:861–865
72. Brown GL, Goodwin FK, Ballenger JC, Goyer PF, Major LF: Aggression in human correlates with cerebrospinal fluid amine metabolites. Psychiatry Res 1979; 1:131–139
73. Buss AH, Durkee A: An inventory for assessing different kinds of hostility. J Consult Psychol 1957; 21:343–349
74. Barratt ES: Factor analysis of some psychometric measures of impulsiveness and anxiety. Psychol Rep 1965; 16:547–554
75. Beck AT, Kovacs M, Weissman A: Assessment of suicidal intention: the Scale for Suicide Ideation. J Consult Clin Psychol 1979; 47:343–352
76. Linehan MM, Goodstein JL, Nielsen SL, Chiles JA: Reasons for staying alive when you are thinking of killing yourself: the Reasons for Living Inventory. J Consult Clin Psychol 1983; 51: 276–286
77. Beck AT, Beck R, Kovacs M: Classification of suicidal behaviors, I: quantifying intent and medical lethality. Am J Psychiatry 1975; 132:285–287
78. Kelly TM, Mann JJ: Validity of DSM-III-R diagnosis by psychological autopsy: a comparison with antemortem diagnosis. Acta Psychiatr Scand 1996; 94:337–343
79. Fulwiler C, Grossman H, Forbes C, Ruthazer R: Early-onset substance abuse and community violence by outpatients with chronic mental illness. Psychiatr Serv 1997; 48:1181–1185
80. Fenton WS, McGlashan TH, Victor BJ, Blyler CR: Symptoms, subtype, and suicidality in patients with schizophrenia spectrum disorders. Am J Psychiatry 1997; 154:199–204
81. Favaro A, Santonastaso P: Purging behaviors, suicide attempts, and psychiatric symptoms in 398 eating disordered subjects. Int J Eating Disorder 1996; 20:99–103
82. Mann JJ: Violence and aggression, in Psychopharmacology: The Fourth Generation of Progress. Edited by Bloom FE, Kupfer DJ. New York, Raven Press, 1994, pp 1919–1928
83. Malone KM, Haas GL, Sweeney JA, Mann JJ: Major depression and the risk of attempted suicide. J Affect Disord 1995; 34:173–185
84. Beck AT, Brown G, Berchick RJ, Stewart BL, Steer RA: Relationship between hopelessness and ultimate suicide: a replication with psychiatric outpatients. Am J Psychiatry 1990; 147:190–195
85. Enns MW, Inayatulla M, Cox B, Cheyne L: Prediction of suicide intent in aboriginal and non-aboriginal adolescent inpatients: a research note. Suicide Life Threat Behav 1997; 27: 218–224
86. Rifai AH, George CJ, Stack JA, Mann JJ, Reynolds CF III: Hopelessness in suicide attempters after acute treatment of major depression in late life. Am J Psychiatry 1994; 151: 1687–1690
87. Young MA, Fogg LF, Scheftner WA, Fawcett JA: Interactions of risk factors in predicting suicide. Am J Psychiatry 1994; 151:434–435
88. Beck AT, Steer RA: Clinical predictors of eventual suicide: a 5- to 10-year prospective study of suicide attempters. J Affect Disord 1989; 17:203–209
89. Roy A: Genetics of suicide. Ann NY Acad Sci 1986; 487:97–105
90. Coccaro EF, Bergeman CS, Kavoussi RJ, Seroczynski AD: Heritability of aggression and irritability: a twin study of the Buss-Durkee aggression scales in adult male subjects. Biol Psychiatry 1997; 41:273–284
91. Coccaro EF, Silverman JM, Klar HM, Horvath TB, Siever LJ: Familial correlates of reduced central serotonergic system function in patients with personality disorders. Arch Gen Psychiatry 1994; 51:318–324
92. Christiansen KO: Threshold of tolerance in various population groups illustrated by results from Danish criminological twin study, in The Mentally Abnormal Offender. Edited by de Reuck AVS, Porter R. Boston, Little, Brown, 1968, pp 107–120
93. Mednick SA, Gabrielli WF, Hutchings B: Genetic influences in criminal convictions: evidence from an adoption cohort. Science 1984; 224:891–894
94. Carey G: Genetics and violence, in Understanding and Preventing Violence: Biobehavioral Influences on Violence. Edited by Reiss AJ Jr, Roth JA. Washington, DC, National Academy Press, 1994, pp 21–58
95. Farber EW, Herbert SE, Reviere SL: Childhood abuse and suicidality in obstetrics patients in a hospital-based urban prenatal clinic. Gen Hosp Psychiatry 1996; 18:56–60
96. Briere J, Runtz M: Differential adult symptomatology associated with three types of child abuse histories. Child Abuse Negl 1990; 14:357–364
97. Brent DA, Bridge J, Johnson BA, Connolly J: Suicidal behavior runs in families. Arch Gen Psychiatry 1996; 53:1145–1152
98. Lishman WA: Organic Psychiatry—The Psychological Consequences of Cerebral Disorder. Oxford, England, Blackwell Scientific, 1987
99. Lewin W, Marshall TFdeC, Roberts AH: Long-term outcome after severe head injury. BMJ 1979; 2:1533–1538

100. Achtè VKA, Anttinen EE: Suizide bei Hirngeschädigten des Krieges in Finnland. Fortschr Neurol Psychiatr 1963; 12:645–667
101. Vauhkonen K: Suicide among the male disabled with war injuries to the brain. Acta Psychiatr Scand 1959; 35:90–91
102. Elliott FA: Violence: the neurologic contribution: an overview. Arch Neurol 1992; 49:595–603
103. Clifton GL, Kreutzer JS, Choi SC, Devany CW, Eisenberg HM, Foulkes MA, Jane JA, Marmarou A, Marshall LF: Relationship between Glasgow Outcome Scale and neuropsychological measures after brain injury. Neurosurgery 1993; 33:34–38
104. Frost EAM: Perioperative management of the head trauma patient. Ann Acad Med Singapore 1994; 23:497–502
105. McAllister TW: Neuropsychiatric sequelae of head injuries. Psychiatr Clin North Am 1992; 15:395–413
106. Gorenstein EE, Newman JP: Disinhibitory psychopathology: a new perspective and a model for research. Psychol Rev 1980; 87:301–315
107. Mann JJ, Malone KM: Cerebrospinal fluid amines and higher lethality suicide attempts in depressed inpatients. Biol Psychiatry 1997; 41:162–171
108. Mann JJ, Malone KM, Sweeney JA, Brown RP, Linnoila M, Stanley B, Stanley M: Attempted suicide characteristics and cerebrospinal fluid amine metabolites in depressed inpatients. Neuropsychopharmacology 1996; 15:576–586
109. Malone KM, Corbitt EM, Li S, Mann JJ: Prolactin response to fenfluramine and suicide attempt lethality in major depression. Br J Psychiatry 1996; 168:324–329
110. Mann JJ: The neurobiology of suicide. Nat Med 1998; 4:25–30
111. Crabbe JC, Phillips TJ, Feller DJ, Hen R, Wenger CD, Lessov CN, Schafer GL: Elevated alcohol consumption in null mutant mice lacking 5-HT1B serotonin receptors. Nat Genet 1996; 14:98–101
112. Saudou F, Amara DA, Dierich A, Lemeur M, Ramboz S, Segu L, Buhot M-C, Hen R: Enhanced aggressive behavior in mice lacking 5-HT1B receptor. Science 1994; 265:1875–1878
113. Doll R, Peto R: Mortality in relation to smoking: 20 years' observations on male British doctors. BMJ 1976; 2:1525–1536
114. Neaton JD, Kuller LH, Wentworth D, Borhani NO: Total and cardiovascular mortality in relation to cigarette smoking, serum cholesterol concentration, and diastolic blood pressure among black and white males followed up for five years. Am Heart J 1984; 108:759–769
115. Ross RK, Bernstein L, Trent L, Henderson BE, Paganini-Hill A: A prospective study of risk factors for traumatic deaths in a retirement community. Prev Med 1990; 19:323–334
116. Hemenway D, Solnick SJ, Colditz GA: Smoking and suicide among nurses. Am J Public Health 1993; 83:249–251
117. Davey Smith G, Phillips AN, Neaton JD: Smoking as "independent" risk factor for suicide: illustration of an artifact from observational epidemiology. Lancet 1992; 340:709–712
118. Tanskanen A, Viinamäki H, Hintikka J, Koivumaa-Honkanen H-T, Lehtonen J: Smoking and suicidality among psychiatric patients. Am J Psychiatry 1998; 155:129–130