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Acute Alcohol Use and Suicidal Behavior: A Review of the Literature

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Background: Both acute and chronic use of alcohol are associated with suicidal behavior. However, the differing relationship of each component of alcohol use and possible causal mechanisms remain unclear.

Methods: This article reviews and summarizes associations between acute alcohol consumption (with and without intoxication) and suicidal behavior (both completed suicide and suicide attempts) among adults 19 years and older, as presented in literature published between 1991 and 2001. Possible mechanisms and methodologic challenges for evaluating the association are also discussed. An application of a research design (the case-crossover study) that has the potential for addressing the effects of acute alcohol use over and above usual or chronic use is presented.

Results: The majority of articles reviewed were restricted to descriptive studies that documented the prevalence of suicide completers or attempters who tested positive for alcohol use. A wide range of alcohol-positive cases were found for both completed suicide (10-69%) and suicide attempts (10-73%). Common methodologic limitations included the lack of control groups (for evaluating risk conferred by alcohol use), selection and ascertainment bias, and small sample sizes. The results of the case-crossover pilot study indicated substantially higher risk of suicide during or shortly after use of alcohol compared with alcohol-free periods.

Conclusions: Although there is a substantial literature of published studies on acute alcohol use and suicidal behavior, the majority of studies focus on completed suicide and report prevalence estimates. Findings from such studies are subject to several possible sources of bias and have not advanced our knowledge of mechanisms in the association between acute alcohol use and suicidal behavior. The case-crossover design may help to overcome some limitations of these studies and facilitate evaluation of associations and possible causal mechanisms by which acute alcohol use is linked to suicidal behavior.

Key Words: Acute Alcohol Use, Suicide, Attempted Suicide, Risk Factors, Case-Crossover Study.

BEGINNING WITH THE work of Emile Durkheim in the late 1800s, there has been a long tradition of sociological and epidemiologic studies on suicidal behavior. Contrary to Durhkeim's belief that alcohol consumption was only an individual and psychopathological factor in suicide, it is now viewed as a sociological phenomenon that has a deep impact on the variation found in suicidal behavior (Durkheim, 1966; Skog, 1991). Today, it is well accepted that both acute and chronic alcohol use are associated with suicidal beHavior (Berglund and Ojehagen, 1998), and some consider this to be a_causal_re]atiojship (Brismar and Bergman, 1998). However, the causal mechanism for this relationship remains unclear (Hufford, 2001). This article addresses the association between acute alcohol consumption (with and without intoxication) and suicidal behavior, including both completed suicide and suicide attempts. We present a literature review of studies on the adult population (19 years and older) published during the years 1991 to 2001. The primary aims of this article are to assess what is known about th^jso^iation_betwe£D.. acute alcohol use .and suicidal behavior, discuss possible mechanisms of the association and methodological challenges, suggest implications for future research, and describe the application of a method that used cases as their own controls to minimize potential bias from traditional case-control studies.

Suicide is defined as "death arising from an act inflicted upon oneself with the intent to kill oneself (Rosenberg et al.$_3$ 1988), whereas suicide attempt is defined as a "behavior with_a nonfatal outcome, for which there is evidence (either explicit or implicit) thaUhe person intended to kill, himself/herself (O'Carroll et al., 1996). These definitions suggest that suicidal behavior implies a self-committed act carried outj#rih,,the intention toaieTWhen dealing with empirical studies, however, definitions become less stringent. In mor-

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tality studies, suicide is usually defined according to the underlying cause of death on death certificates. Countries, states, and regions within countries may differ in the quality of data_orj...death certificates and on the percentage~of autopsies performed to determine suicide as the underlying cause of death. This affects estimated rates of suicide. The definition and quantification of *suicide attempt* in empirical studies is also subject to variation. For example, in studies carried out in psychiatric facilities, cases tend to be defined more accurately than in community studies; suicide research among college students and general population surveys frequently relies on the response to a single (yes/no) question (Kessler et al., 1994). These issues should be kept in mind when considering differences in findings across studies.

Definitions and the quantification of acute alcohol use also vary from study to study-. For example, estimates of blood alcphql_concentration (BAC) on the basis of toxicology screening for completed suicides, or blood, breath, or urine screening for suicide attempts will vary in relation to the length of time between the suicidal behavior and BAC estimation. Definitions of intoxication vary in relation to the legal level in a given jurisdiction, an individual's self-report, quantity consume37~body mass, and tolerance (alcohol dependence). Self-reported alcohol consumption before the attempt has been relied on in studies of the association of acute alcohol consumption with suicide attempts, but the "window of effect" has been found to vary across studies from <3 hr (Kresnow et al., 2001) to 12 hr or more (Merrill et al., 1992). Confounding factors must also be considered in examining the effect of acute alcohol consumption, with or without intoxication, on suicidal behavior. These factors include the effect of usual consumption (or alcohol dependence), concurrent use of other substances, and comorbid psychiatric disorders, with or without alcohol dependence.

MATERIALS AND METHODS

The English language literature on MEDLINE, PsycINFO, and the National Institute on Alcohol Abuse and Alcoholism (NIAAA) Alcohol and Alcohol Problems Science Database (ETOH) was searched for articles on acute alcohol use (intoxication) and suicide (attempts and completed). A total of 37^ studies on completed suicide and JJJ^&judies on suicide attempts published over a 10-year period (1991-2001) were obtained from computer-based bibliographic databases and by hand-searching reference lists of four review articles (Brismar and Bergman, 1998; Hufford, 2001; Rossow, 2000; Smith et al., 1999). Articles from the same research group using the same sample were counted as only one entry.

Abstracts that did not explicitly mention suicide and acute alcohol use, articles that did not provide levels/measures of alcohol use specifically for suicides, and aggregate/ecological level studies were excluded. Ecological studies were excluded because most focused on variation in per-capita alcohol consumption and suicide rates, and it was not possible to isolate chronic from acute alcohol use and draw inferences about acute use. Two recent ecological studies of suicide and alcohol have extensive reviews for the interested reader (Ramstedt, 2001; Stack, 2000). _Dissertations_were not included because they are in limited circulation.

The following limits were set for the MEDLINE search: all Adult: 19 + years, publication date from 1991 to 2001, only articles with abstracts, English language, and human. A variety of strategies were used to narrow the search while increasing efficiency. The most efficient search strategy was as follows: (suicide OR suicide attempt NOT ideation) AND (alcohol use OR alcohol intoxication OR alcohol drinking NOT chronic alcohol NOT alcoholism NOT alcohol use disorder NOT alcohol dependent) NOT (case study) NOT (cholesterol). To ensure that relevant publications were not missed, using the same limits specified earlier, each of the following terms was searched individually with "AND suicide": acute alcohol use, alcohol intoxication, drunkenness, inebriation, ethjm_ol, and alcohol consumption. The NIAAA ETOH database (a database accessible through the NIAAA web site: www.niaaa.hih.gov) was searched for "suicide" and "alcohol" followed by a search on "suicide attempt" and "alcohol," using the same limits as the MEDLINE search. PsycINFO was also searched using the same limits mentioned above. Duplicate articles were removed. Two articles that could not be obtained were excluded. A more detailed description of the search strategy can be obtained from the authors.

Tables were compiled indicating the investigator(s), publication year, a description of the population, sample size, study design, measure of alcohol use, the findings/mechanisms, and limitations. This was done separately for studies of completed suicide and suicide attempt (Appendixes 1 and 2). In these appendixes, blood alcohol levels greater than zero were considered positive.

RESULTS

Suicide Studies

Published research on suicide and acute alcohol use includes two primary data sources, coroner's case-series studies and psychological autopsy studies.

Coroner's Case-Series Studies. These studies usually include toxicology screening and BAC measurements. The presence of any alcohol or prevalence within or above a certain level is reported. Usually the BAC level considered illegal for driving a motor vehicle in the specific jurisdiction is used as the cut point for intoxication. Rarely is there an attempt to provide an outside control group for comparison with the prevalence of alcohol present in the suicide series. A noteworthy exception is the article by Nordrum et al. (2000) that includes a series of natural deaths tested for BAC as a reference with which to compare suicide cases. Occasionally, series of suicide cases are compared, such as suicide cases with and without cancer (Pukkila et al., 2000).

Psychological Autopsy Studies. In these studies, data from coroner reports or other public records and interviews with the suicide victim's family members and close friends are analyzed to create a psychiatric profile of the person before death. Precipitating and contributing factors such as psychiatric disorders (including alcohol disorders) and drunkenness and sociodemographic factors such as unemployment are assessed retrospectively (see Pirkola et al., 2000). In the adolescent literature, there are examples of such studies that compare suicide cases with neighborhood controls (Brent et al., 1996); however, similar case-control studies in the adult literature during the period of this review could not be found.

Acute Alcohol Use and Completed Suicide

We reviewed 37 studies that included data on acute alcohol use and completed suicide (see Appendix 1). The average acute alcohol use was 37%, the median was 36%, and the range was 10 to 69%. Countries that were represented in this review include the United States (12 studies); Finland (8 studies); Australia (4 studies); Sweden (3 studies); Canada and Scotland (2 studies each); and Brazil, England, Northern Ireland, Germany, Norway, and South Africa (1 study each). Some studies focused exclusively on one method of suicide (e.g., gunshot deaths, exhaust fume inhalation), but the majority of studies reported multiple methods of suicide. Although not all studies specified the percentage who were alcohol positive by method, among studies that did, the percentage was found to vary by method, as well as by sex and age. Table 1 illustrates the range of alcohol positives by method of suicide. As can be seen, percentages ranged from a low of 7 to 16% for suicides by stabbing, cutting, or piercing to a high of 43 to 67% for burns, self-immolation, and electrocution.

Studies of Suicide Attempts

The two basic data sources for current research on suicide attempt and acute alcohol use are hospital-based emergency department (ED) studies and, much less frequently, population-based studies. A description of these studies can be found in Appendix 2.

ED Studies. Hospital-based research performed in the ED, toxicology unit, or psychiatric unit provides the most common source of data on the relationship between acute alcohol use and suicide attempts. In these studies, patients who are admitted to a medical service, usually an ED within a general hospital, a trauma center, or a psychiatric ward, are interviewed to obtain a self-report of alcohol use before the attempt, and BAC is estimated (usually through a breath test) as a measure of alcohol involvement. Most of these studies are cross-sectional and use probability samples of patients. We found only one example of a traditional case-control study that reported odds ratios for the association between acute alcohol and suicide attempt (Borges and Rosovsky, 1996).

Population-Based Studies. One study of alcohol use and nearly lethal suicide attempts included a general population sample as a control group (Kresnow et al., 2001). The distribution of the cases' self-reported alcohol consumption within 3 hr before the suicide attempts was compared with a similar distribution of drinking among community control subjects in time-matched periods. Control subjects had provided a 24-hr drinking history, which allowed evaluation of drinking during any 3-hr period. This approach allowed estimation of alcohol use status among control subjects at time periods corresponding to those 3 hr before the case events when control subjects lack a reference point and have not been individually matched to cases.

Analyses of data from the National Comorbidity Survey (Borges et al., 2000) used discrete-time survival analysis to study the effects of retrospectively reported temporally^ previous substance use, abuse, and dependence in predicting first onset of suicidal behavior. Current alcohol and drug use predicted subsequent suicide attempts after controlling for sociodemographic factors and comorbid mental disorders (including alcohol abuse/dependence), suggesting that the effects of substance use disorders on suicide at-. tempts were not entirely due to the effects of comorbid - mental disorders but to the intoxicating effects of substance use itself. These population-based studies support the feasibility and importance of studying the effects of current and/or acute alcohol use and suicidal behaviors.

Summary of Acute Alcohol Use and Suicide Attempts

For the 16 studies reviewed that included data on acute alcohol use and suicide attempt, the mean percentage of alcohol use was 40%, the median was 41%, and the range was 10 to 73%, based on self-report, BAC, toxicology, breath analysis/Alcometer, or medical or psychiatric chart review, depending on the study. This is strikingly similar to the percentages found for completed suicide. Studies from many countries are represented in this review, including England (three studies); the United States and Northern Ireland (two studies each); and Canada, Mexico, Scotland, the Netherlands, Bulgaria, Spain, Finland, Tanzania, and India (one study each)* Sf the 16 studies, 4 did not specify the methods used in suicide attempts. For the 12 studies that did report specific methods used, the vast majority were self-poisoning: 6 studies focused exclusively on self-poisoning, whereas for the remaining 6 studies, self-poisoning ranged from 63 to 96% of the samples. The range for acute alcohol use among victims of self-poisoning was 10 to 63% (mean, 43%; median, 49%). The next most common methods reported listed in order of frequency were self-laceration, hanging, and jumping from a height.

Table 1. Range of Alcohol Positives by Method of Suicide

Method	% Alcohol positive
Asphyxiation, hanging, strangulation, suffocation (5 studies)	10-38%
Bum, self-mutilation, electrocution (2 studies)	43-67%
Drowning (4 studies)	6-26%
Gunshot wound (8 studies)	20-62%
Jumping from a height (4 studies)	6-26%
Self-poisoning (by solid, liquid or gas; 8 studies)	7-51 %
Stabbing, cutting, piercing (3 studies)	7-16%
Railway, motor vehicle intentional accidents (6 studies)	3-65%

DISCUSSION

10-38%

The majority of articles reviewed were descriptive studies that evaluated the prevalence of alcohol-positive tests among samples of completed or attempted suicides. Acute alcohol use was associated with both suicide attempts and completions; however, a wide range of alcohol-positive gases was found: 10 to 69% for_ suicide and 10 to_73%_for attempts. These highly variable results make it difficult to

draw conclusions about the relationship between acute alcohol use and suicidal behaviors. The reasons for the variability are numerous.

The definition of suicidal behavior differed across studies. For example, some studies reported on "parasuicide," whereas others reported on "attempted suicide" or "self-harm" (or "deliberate self-harm") This variation resulted in differences in the definition of the outcome (e.g., parasuicide does not assume failed intent to produce a fatal outcome, which is inherent in suicide attempt).

The purposes of the studies also differed. Some focused on the demographic/social characteristics and clinical diagnosis of cases, whereas others focused on attempt trends over time or timing of attempt (day, night, weekly, weekend). Many of the articles did not primarily study acute alcohol use and suicidal behavior; consequently, measurement of acute alcohol use was not optimal in some studies.

Common methodological limitations for studies of completed suicide include the lack of control groups, retrospective design, reliance on proxy report via psychological autopsy studies, possible selection bias and ascertainment bias as a result of limited data and differing inclusion and exclusion criteria, small sample size, potential misclassification, differing testing procedures, no range of BAC provided, no specification of method of suicide attempt, and no report of BAC by method. Many of these limitations also apply to studies of suicide attempt.

Small Samples and Possible Selection Bias

Seven of the completed suicide studies and three of the attempted suicide studies had sample sizes of <50 people. Estimates are less precise for studies with smaller samples. Much of this research also suffers from potential selection bias as a result of nonresponse, missing data, inclusion/exclusion criteria, and misclassification. There is a lack of comparability between studies by medical examiner practices and toxicology and/or autopsy request practices. Among those who were intoxicated at the time of the suicidal behavior, in the absence of some indication of intent, an event (e.g., a fall from a height) must be classified as suicide, an accident, or unknown intent, and ambiguous cases may be misclassified.

Differences in Ascertainment Rates

Assessment of alcohol consumption is based on BAC, a breath test, or self-report, which are subject to possible inaccuracies in measurement and underreporting. Ascertainment bias in establishing suicide is also a problem; usually only suspected or certified suicide decedents are examined. Various studies reported time-dependent criteria for postmortem toxicology screening, which ranged from 2 to 6 hr for the time after which BAC was considered invalid. There are also differing criteria for intoxication across studies. Nordrum et al. (2000) noted that it is debatable which BAC is necessary before the influence of acute alcohol should be regarded as a contributory cause of death, and decisions may depend on the definition of legally intoxicated in a given jurisdiction.

In some studies, up to 60% of suicide decedents were not tested for BAC. Those who were hospitalized for up to 48 hr after the injury were often not screened. Those with deramposed (or charred or heavily mutilated) bodies were also~nbt screened. For suicide attempts, patients who left the ED before psychiatric review or patients who were severely injured were excluded from studies.

Limits Posed by Various Study Designs

ED and trauma center samples as well as autopsy cases drawn from medical examiners and coroner's offices do not represent random samples of all suicides in the general population, limiting generalizability (Brismar and Bergman, 1998). The majority of studies are cross-sectional and report the *prevalence* of BAC or self-reported alcohol consumption as a measure of alcohol involvement, causal interpretations of causation. The samples studied were often selected from EDs or coroner's reports, and no appropriate control group was available, limiting evaluation of risk associated with alcohol use. Only two studies tested the statistical association between acute alcohol consumption and suicide; other studies reported percentages of alcohol use or intoxication among suicide attempters or completers immediately before the event. Few data were provided regarding alcohol use by sex, age, or method used to commit suicide. In addition, little is known about whether this relationship differs by type of alcohol consumed or by drinking pattern. With incomplete data on method of suicide, whether alcohol intoxication predicts the use of more lethal methods of suicide cannot be tested.

Proposed Mechanisms

A state of intoxication may trigger self-inflicted injuries by promoting depressive thoughts and feelings of hopelessness while simultaneously removing inhibiting barriers to hurting oneself (Skog, 1991). Indirect mechanisms, including alcohol consumption as a form of self-medication for depression or alcohol use as a marker for other high-risk behaviors, have also been considered. Although we are far from understanding the relationships between acute alcohol use and suicidal behavior, a number of possible direct mechanisms for the association have been proposed. Sociological interpretations include acute alcohol use leading to increased social deterioration or ..anomy) (Skog, 1991), unemployment, debts, and social isolation (Magne-Ingvar et al., 1997; Merrill et al., 1992; Platt and Robinson, 1991). Biological interpretations of the association include impairing physical and mental functioning (Field et al., 2001) or interacting with other psychotropic drugs (Suokas and Lonnqvist, 1995). Disinhibition, in which alcohol acts to remove psychological and even physiologic barriers, leading to self-harm, has also been proposed (Kresnow et al., 2001). Huf-

ford （2001）summarized four psychological pathways for the proposed relationship between acute alcohol use and suicidal behavior that may be interactive: (1) increasing psychological distress, including hopelessness, loneliness and depression; (2) enhancing or facilitating aggressive behavior, including self-aggression; (3) changing an individual's expectations and help propel or trigger suicidal ideation into action; and (4) constricting attention and inhibiting effective coping strategies to avoid suicidal behavior. Rossow (1996) has also reviewed a number of possible mechanisms in individual- and aggregate-level studies. As these mechanisms are presented as post hoc interpretations of findings rather than hypotheses tested in carefully designed studies, the evidence supporting these proposed pathways is limited.

As apparent from this review, most studies report prevalence rates of alcohol involvement, and few provide risk estimates or test for specific mechanisms in the relationship between acute alcohol use and suicidal behavior. A recent report from the NIAAA advisory council recognized the need to "develop more innovative research designs to examine the causal role of alcohol in suicide, homicide, and other violent events" (NIAAA, 1999). We present here a new application of a method that addresses some of the limitations mentioned above and that could be used to advance our knowledge in this area.

Testing the Impact of Acute Alcohol Exposure in Case-Crossover Studies

In 1991, the epidemiologic case-crossover design was developed specifically to examine the role of the "immediate determinants of myocardial infarction" (Maclure, 1991), such as heavy physical exertion (Mittleman et al, 1993). In this design, an individual serves as his or her own control in studying the effect of a transient factor (e.g., acute alcohol consumption) on the risk of an acute event (e.g., suicidal behavior). This strategy was developed to circumvent previous limitations in the selection of appropriate control subjects in traditional case-control studies. It has been applied to a variety of public health problems, including illicit drug use (Maclure and Mittleman, 2000; Wu and Anthony, 2000). The method has also been used to study the association of alcohol use and injury in ED settings (Borges et al., 2004; Vinson et al., 1995).

In an application of this method, alcohol consumption is conceptualized as an exposure that has a time-limited physiolgic effect. When present in an organism, alcohol produces short-term biological, psychological, and behavioral changes until it is metabolized. The repeated use of alcohol may produce more broad and long-lasting impact (i.e., abuse and dependence). The case-crossover method can take into account the long-term effects of alcohol consumption, although it cannot provide a relative risk estimate for its effect. In brief, the case-crossover design provides estimates of intermittent alcohol use over and above the baseline risk associated with long-term alcohol use. This method minimizes control bias by comparing alcohol use before the suicidal behavior with alcohol use during some other predetermined time or times for the same individual (e.g., usual frequency of drinking, or alcohol consumption during the same time the previous day, or the previous week). Such "serf-matching" allows for better estimation of the association between acute alcohol use as well as the patterns of drinking (e.g., an unusually heavy drinking episode in an otherwise light drinker) and suicidal behavior. These data will be important in informing potential interventions that address factors related to risky drinking patterns.

The case-crossover method may be an ideal epidemiological strategy for the study of acute alcohol use and suicidal behavior. Qnly two distinct pieces of information are required: (1) an estimate of alcohol use at or around the time of the event (these data have already been collected in many of the studies reviewed here) and (2) an estimate of how unusual the exposure (acute alcohol consumption) is for the individual ' with the outcome of interest (Maclure and Mittleman, 2000). Three basic approaches are suggested for obtaining this information: (1) the usual frequency approach, (2) the pair-matched approach, and (3) the multiple intervals approach (Mittleman et al., 1995). The usual frequency approach requires an estimate of the usual (yearly) frequency and quantity of alcohol consumption. The pair-matched approach requires an estimate of alcohol consumption during the same time the previous day or during the same time on the same day of the previous week. Finally, the method of multiple intervals requires several estimates of alcohol consumption at varying time periods, a form of multiple matching.

A Working Example: An Exploratory Case-Crossover Study of Acute Alcohol Use and Suicide Attempt

The following is a brief description of a working example (Borges et al., 2002). Interested readers may contact the authors for a more comprehensive description of the analysis and Cherpitel (1989) for development of the data-collection method. Data were merged from seven ED studies that included probability samples of patients who were ■admitted for periods of at least 1 week, 24 hr/day. The merged sample consisted of 102 suicide attempters over the age of 18 from the United States, Australia, Canada, and Mexico, taken from the Emergency Room Collaborative Alcohol Analysis Project covering 30 ED sites across six countries (Cherpitel et al., 2003).

Whether the patient had been drinking alcohol within 6 hr before the event (suicide attempt), the length of time between the last drink and the event, and the usual quantity and frequency of alcohol consumption during the last 12 months were assessed. Patients were defined as exposed and nonexposed on the basis of reported alcohol use within 6 hr before the suicide attempt. The usual yearly frequency and quantity of alcohol consumption was used to define the person-time at risk. The amount of person-time exposed to

alcohol was estimated by multiplying the reported annual frequency and usual quantity of alcohol consumption (drinks) by the duration of its hypothesized physiologic effect (1 hr). Unexposed person-time was then calculated by subtracting the exposed person-time hours from the number of hours in 1 year. For example, a patient who drank once a year and had two drinks was exposed 2 for hr during the last 12 months and had 8764 unexposed hours. Further analyses were also performed under the assump-tion that each patient sleeps for at least 7 hr in 24, during which time he or she or she could not be considered at risk for a suicide attempt. A macro written in SAS (SAS Institute, 1990) was used to obtain relative risk estimates, based on the usual frequency approach for data analyses of case-crossover studies (Maclure, 1991).

Of the 102 suicide attempters, 48% were female, 59% were younger than 30 years, and 35% reported drinking alcohol within 6 hr before the suicide attempt. The estimated relative risk for those who reported drinking before the event was 13.0(95% CI, 7.5-22.3). Although 49% of the male and only 20% of the female subjects reported alcohol use before the attempt, there was little difference in the estimated relative risk.

In a case-crossover study using the usual frequency approach, person-time data are generated and the analysis estimates an average incidence rate-ratio. Because the time frame of this rate-ratio is short (several hours only), it is interpreted as a relative risk (Maclure, 1991). An odds ratio is not calculated in this particular approach (13.7 for males and 11.1 for females). The prevalence of reported alcohol consumption before the event was slightly higher for those younger than 30 (38%) compared with the older group (31%), but the relative risk also was slightly lower (12.5 and 14.0, respectively). In this example, it seems that any alcohol consumption greatly increases the risk of suicide attempt. Using the case-crossover method, prevalence rates of acute alcohol use can be obtained, and relative risk also can be estimated across samples and subgroups within samples. The case-crossover design has several limitations worth noting. This design is especially suited to explore the impact of an intermittent risk factor but cannot be used to estimate the risk of chronic alcohol use. The case-crossover study is well suited to control for between-person (i.e., time invariant) confounders, because it uses cases as their own controls, but the possibility of within-person (i.e., time varying) confounders still remains. Also, differences in recall may lead to an overestimation of the association between alcohol and injury if patients are more likely to remember and report alcohol use on a short period basis and/or before an injury event.

The case-crossover method has proved useful in the study of suicide attempts seen in an ED, as described, and could prove useful in the study of completed suicides as well. It is possible to estimate alcohol consumption before death through postmortem fluid analyses, which is a common practice. Obtaining data on usual drinking practices is more difficult in suicide studies but is feasible with some modifications to the current "psychological autopsy" methods, which obtain data from a collateral (usually a family member) through a complex series of questions that lead to estimates of psychiatric disorders (including alcohol use disorders). The same method could be used to gather information about the usual frequency and quantity of alcohol consumption of the suicide victim, and it also may be possible to obtain information on alcohol use during the same time of day or week before the suicide. The validity of this information is, of course, a matter of further inquiry, but the strategy seems feasible.

CONCLUSIONS

Between 1991 and 2001, a substantial number of studies on acute alcohol use and suicidal behavior were published. The majority were on completed suicide, with fewer on suicide attempts. Cross-sectional studies (of both attempts and completed suicides) were the most common method but resulted in simple prevalence estimates of acute alcohol involvement with suicidal behavior. The cross-sectional design is extremely limited, subject to several sources of bias, and has not advanced our knowledge of mechanisms in the association between acute alcohol use and suicidal behavior. In case-control studies, the possible bias in the selection of control subjects in research on acute alcohol consumption and suicidal behavior has hindered the field; the use of traditional case-control studies has been viewed with skepticism (Borges and Rosovsky, 1996; Shepherd, 1998)7"The case-crossover design may help to overcome some of these limitations by using cases as their own controls (Maclure, 1991) and by potentially improving relative risk estimates and evaluation of mechanisms by which alcohol use is linked to suicidal behavior. With few modifications of current data collection practices, traditional studies of suicidal behavior can take advantage of this newly developed study design.

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Appendix I. Acute Alcohol Use and Suicide

Year	Study population	Sample *N* (% male)	Study design[a]	Measure of alcohol use	Synopsis of findings of mechanisms	Study limitations[b]
1996	All gunshot deaths classified as suicide by coroners, Northern Ireland, 1989 and 1993; compares security force with civilian suicides.	104 (94)	1	Toxicology screen	41 (39%) consumed alcohol before fatal incident, 23 (51%) from security force; 18 (31%) from civilian population	1, 2
1994	All autopsies performed in which manner of death was determined as suicide and method listed as gunshot wound. Newfoundland, Canada, 1/1986–7/1993.	64 (95)	1	Blood alcohol test	29 (52%) positive with BAC 10–82 mmol/liter. Twenty-six had BAC >17.4 mmol/liter	1, 2; only 88% had a blood alcohol test performed
1994	Six-year study of consecutive completed suicides from exhaust fume inhalation, Lothian and Borders region of Scotland.	79 (90)	1	Toxicology screen	Ethanol was present in blood of 37 (51% of those tested) with levels ranging from 14–397 mg/dl	1, 2; results of blood COHb saturation were not available in 9% of the sample
2001	All suicides by drowning, Adelaide, South Australia, 4/1980 to 3/2000.	123 (62)	1	Toxicology screen	20% of cases tested positive for alcohol	1, 2
2000	Fatally injured victims ≥13 years, Sao Paulo, Brazil, 1994.	747 [c]	1	Toxicology screen	36% positive BAC (41% of males and 20% of females)	1, 2; only 39% of suicides had toxicological exams
1996	Fatality data compared from county coroner records between a "dry" area (Hinds County, Miss.), 2/1992–1/1993 and a "wet" area (Contra Costa County, CA), 12/1987–11/1988.	123 [c]	1	Toxicology screen	44% suicides alcohol positive in H.C. (17% ≥0.10); 33% positive in C.C. (17% ≥0.10)	1, 2; toxicology reports for alcohol were obtained from 96% of those in Contra Costa and only 48% of those in Hinds County
1994	Coroner's records of all cases in which an inquest was held into a violent suicide occurring, South Yorkshire (West) UK coroner's district, 1985–1991	246 (74)	1	Toxicology screen	Alcohol detected in blood samples from 38 (29%) of 130 cases tested; 32 (33%) of 96 males; 6 (18%) of 34 females; 24 (63%) had levels in excess of 100 mg/dl	1, 2; only 53% were BAC tested
2001 & 2001	Comparison of consecutive suicides in San Diego, CA, 1981–1982, and Mobile County, AL, 1990–1998	512 (76)	1	Toxicology screen	The most frequent substance detected in both samples was alcohol. Alcohol most frequent substance detected, ~30% of suicides in both samples.	1, 2; toxicological analysis was not performed on 12% of cases in San Diego, 4% of cases in Mobile
1994	Homicide-suicides between adult sexual intimates in Australia (National Homicide Monitoring Project) and public records from Australia's two most populous states	32 (97)	1	Surveillance data and public records	In the national sample, 6% of offenders committing suicide used alcohol; 56% in the public record data drank before suicide.	1, 2, 3; in the national sample, the influence of alcohol on the offender was known in only approximately 1/3 of cases
2001	All combined homicide-suicide events, Galveston County, Texas, 1980–1998	20 (95)	1	Toxicology screen	9 (64%) of 14 perpetrators with blood alcohol levels measured were positive; alcohol concentrations ranged from 20 to 285 mg/dl	1, 2, 3; only 65% were tested for BAC
2001	All deaths as a result of descent from a height that underwent autopsy, Manhattan, 1997–1999	77 (64)	1	Toxicology screen	Fourteen (19%) consumed alcohol before death; BAC range: 0.06–0.49 g/dl	1, 2, 3
1991	Fatal injuries in Oklahoma, 1978–1984	2175 (74)	1	Toxicology screen	Of those tested, 40% of suicides were positive for alcohol	1, 2; only 71% of suicides were tested for BAC
1994	Case records of firearm suicides during confrontations with police, Marion County, IN, and surrounding counties, 1984–1992	14 (100)	1	Toxicology screen	Of the 12 cases tested, 7 had BAC negative or trace levels; 2 >trace-100 mg/dl; 3 had >100 mg/dl (42% total used alcohol)	1, 2, 3; 14% of cases were not tested
1992	Three-year (1986–1988) cohort of consecutive suicides, Western Australia	515 (80)	1	Blood and urine alcohol levels	182 (36%) of suicides had positive blood alcohol, 25% were moderately to significantly impaired (alcohol level of 0.05% or more) at time of death	1, 2; 1% cases were not tested
1998	Fatal motor accidents, 1974–1992 in Finland	106 [c]	1	Post mortem and police examination records	22% of drivers in suicide group had used alcohol at time of accident	1, 2
1998	All homicidal and suicidal deaths as a result of sharp force violence were examined in Soedermanland, Gotland, Stockholm counties, Sweden, 1983–1992	105 (78)	1	Toxicology screen	16 (16%) of 102 tested suicides were under influence of alcohol at time of death	1, 2; 3% of cases were not BAC tested
2000	Coroner's reports, all suicide deaths by hanging, under age 25, Queensland, S. Australia, 1995 and 1996	137 (87)	1	Coroner's, police, and forensic pathology reports	At time of death, 38% of cases were recorded as having blood alcohol	1, 2
1991	All sudden, unexpected, and unnatural deaths, Hamburg Germany, 1989	265 (62)	2	BAC	36% of suicides had BAC >0.05%	1; only 26% of sample autopsied
1997	Railway-related deaths, Cape-Town, South Africa, 4/1/1992–9/30/1994	32 (78)	1	Autopsy (with BAC) and accident report data	3 (10%) of 30 tested had used alcohol before death	1, 2, 3

Appendix I. Continued

Investigator	Year	Study population	Sample *N* (% male)	Study design[a]	Measure of alcohol use	Synopsis of findings of mechanisms	Study limitations[b]
Lindeman et al.	1997	Suicides among Finnish physicians, 1986–1993	51 (69)	1	Toxicology screen	11 (31%) of the male physicians used alcohol, whereas 1 (6%) of females used alcohol as part of their suicide	1, 2, 3
Lunetta et al.	2001	Mortality and population data, accidents and violent deaths, Finland, 1987–1996	$n \approx 14053$[c]	1	Toxicology screen	Among 15- to 64-year-olds, 35% of male and 13% of female suicides were alcohol related (31% for sexes combined)	1, 2
Marttunen et al.	1997	All suicides, Finland 4/1/87–3/31/88; military and nonmilitary suicides compared, by age group	68 (100)	3	Toxicology screen	Two (29%) of seven military suicides occurred under the influence of alcohol compared with 44 (72%) of the other young male suicides	1, 2, 3; 7% of "other" male suicides not BAC tested
Marzuk et al.	1992	All certified suicides by the New York City medical examiner among New York residents during 1985	105 (83)	1	Toxicology screen	Ethanol detected conjointly with cocaine in approximately half of cases; OR = 1.79 for suicide given positive toxicology	1, 2
Mendelson and Rich	1993	Data from the San Diego Suicide Study of consecutive suicide victims, 1981–1983	204 (73)	3	Toxicology screen	Positive alcohol tissue levels were detected in 28% of cases examined toxicologically; Alcohol was found to be similar in men (29%) and women (26%)	1, 2; toxicological reports 8%
Mishara	1999	All suicide deaths, Montreal Canada, subway system, 3/1986–1996	129 (61)	1	Blood alcohol level	Alcohol found in 20 (25%) cases	1, 2; in ~39% of cases BAC not conducted; 120 suicides combined with 9 undetermined deaths
Moug et al.	2001	All gunshot deaths investigated, 1989–1998 in Forensic Medicine and Science files, Univ. Glasgow, Scotland	17 (94)	1	Toxicology screen	Alcohol detected in 5 (42%) of 12 suicide cases; blood alcohol levels were above the legal driving limit for the UK (80 mg/100 ml blood) in 25% of cases	1, 2, 3; 29% of cases were not BAC tested
Nordrum et al.	2000	Series of medicolegally autopsied deaths in two counties, Northern Norway 1973–1992	109[c]	1	Toxicology screen	38% had BAC ≥0.5%, compared with 17% of tested natural deaths	1, 2; ~5% were not autopsied
Ohberg et al.	1996	Nationwide suicide study (the National Suicide Prevention Project), Finland, 4/1/1987–3/31/1988	1348 (77)	3	Toxicology screen	In 36% of suicides, victim under the influence of alcohol; significantly higher in males (41%) than females (20%); Men significantly more often under heavy influence of alcohol	1, 2; ~4% of suicides were not screened for alcohol
Olson et al.	1999	All female suicide deaths, New Mexico, 1990–1994	313 (0)	1	Toxicology screen	A higher proportion of American Indians (53%) had alcohol present than Hispanic (39%) or non-Hispanic (31%) women	1, 2
Ostrom et al.	1996	All carbon monoxide suicides car exhaust autopsied in State Institutes of Forensic Medicine, Umea or Stockholm Sweden, 1984–1987	194 (88)	1	Toxicology screen	Alcohol was detected in 98 suicides (51%) with mean BAC 1.5 g/kg	1, 2
Partonen et al.	1994	All suicides among military draftees, Finland, 1981–1990; suicides committed during basic training compared with suicides committed later during service	50 (100)	1	Forensic records	Alcohol was detected in 20 (40%) cases; mean BAC was 1.3 promilles	1, 2, 3
Pirkola et al.	1997 & 2000	All suicide victims, Finland, 4/1/1987–3/31/1988; compares alcohol misusers with nonmisusers	1397 (77)	3	Toxicology screen	69% of alcohol misusers had alcohol in their blood (57% had a BAC ≥0.10); 23% of alcohol nonmisusers had alcohol in their blood (13% had a BAC ≥0.10)	1, 2; ~400 cases apparently excluded on the basis of missing, incomplete, or unreliable interviews
Pukkila et al.	2000	Completed suicides, province of Oulu, Finland, 1988–99; alcohol intoxication compared between cancer sufferers and noncancer suicides	1515 (82)	2	Medicolegal investigations including autopsy	Cancer patients committed suicide more rarely under the influence of alcohol than noncancer suicide victims (15% vs. 45%)	2
Rich et al.	1998	Consecutive suicides, San Diego, 11/1981–9/1982 and Mobile Alabama, 10/1990–9/1995, that had comprehensive toxicological exams	404 (78)	1	Toxicology screen	28–35% (depending on method) of those in San Diego were positive for alcohol; 14–32% of those in Mobile were positive for alcohol	1, 2; 12% in California did not have toxicology and 6% in Mobile
Rutledge and Messick	1992	All trauma deaths occurring <24 hr after injury, North Carolina, that were investigated by MEs, 1986–1988	1680[c]	1	Toxicology screen	Positive blood alcohol levels detected in 24% of suicide victims	1, 2; in 1988, blood alcohol level was available on only 80% of trauma victims; unclear what % of suicides were BAC tested
Shiang et al.	1997	Completed suicides, San Francisco, 1987–1994 comparing Asians with whites	922 (75)	1	Postmortem tissue specimens were tested for alcohol	31% of whites used alcohol at time of death; only 8% of all Asians used alcohol; using >0.08% BAC, 23% of whites compared to 6% of Asians were positive	1, 2
Sjogren et al.	2000 & 2000	All unnatural deaths autopsied with blood alcohol tested, Sweden, 1992–1996	6793 (70)	1	Toxicology screen	1964 (34%) of suicides were positive for alcohol, 37% males and 28% females	1, 2; 27% of cases in the entire sample of unnatural deaths were not autopsied, and 43% were not blood tested for alcohol

[a] Study designs: 1, retrospective case series; 2, prospective case series; 3, psychological autopsy.

[b] Limitations: 1, no control group; 2, retrospective; 3, small sample size.

[c] Percentage male not reported.

Appendix II. Acute Alcohol Use and Suicide Attempts

Investigator	Year	Population	Sample *N* (% male)	Study design[a]	Measure of alcohol use	Synopsis of findings of mechanisms	Limitations[b]
Baca-Garcia et al.	2001	All consecutively suicide attempt admissions to a general hospital ED, Madrid, Spain, 1996–1998; the relationship between impulsivity and lethality of attempts was examined	478 (36)	2	Self-report	In 117 (24%) who consumed alcohol before attempt, 41% reported no influence on attempt, 26% reported impaired judgment; 33% reported alcohol used to facilitate attempt; consistent with alcohol consumption related to impulsive suicides	1; only self-report of alcohol use
Bhugra et al.	1999	Asian women presenting to hospital services, West London, after attempted suicide were compared with Asian female surgery patients and white female suicide attempters to determine whether cultural and social factors play a role in the causation of deliberate self-harm	27 (0)	2	Self-report	White women (72%) more likely to have used alcohol in their attempt than Asian women (13%)	1; self-report only; 3; high nonparticipation rates for Asians (42% agreed to participate)
Bland et al.	1994	All records of parasuicide attending a hospital ED, Edmonton, Canada, 11/1990–5/1991	274 (38)	1	Information derived from medical and psychiatric records.	In 25% of all cases, alcohol was used as one of the methods and 1% used alcohol as the primary method	1, 2; whether alcohol use was based on self-report or another measure not reported
Blenkiron et al.	2000	All self-harm patients aged ∃16 referred to a hospital psychiatric service, North England, 3/1997–7/1997; timing of self-harm is primary interest	158 (45)	2	Self-report and record review	In 90 (57%) of study participants, alcohol was consumed around the time of the attempt	1; exclusion of excessive alcohol use cases and those lacking psychiatric review; 14% of patients not assessed
Borges and Rosovsky	1996	All suicide attempters ≥age 15, in an ED, Mexico City, during 1 week on a 24-hr basis in 1986	40 (53)	2	Breath analysis and self-report	Compared with abstinence, alcohol consumption substantially increased the risk of suicide attempt; alcohol use before suicide attempt more important risk factor than habitual consumption	3
Iliev et al.	2000	Representative sample of 311 of 2693 acute deliberate self-poisonings > age 14 admitted and treated in regional toxicology center, Plovdiv region of Bulgaria, 1/1/90–12/31/98	311 (33)	1	Unclear whether based on toxicological analysis or self-report	Thirty-two (10%) attempts were committed in a state of alcohol intoxication	1, 2; authors did not specify whether alcohol use is based on self-report or another measure
Kelly and Galloway	1992	Deliberate self-poisonings presenting to hospital in Craigavon area, Northern Ireland, comparing 1976 with 1986	265 in 1976 and 228 in 1986 (~40)	1	Information derived from medical and psychiatric records	Alcohol was taken (with another drug) in 36% of episodes classified as deliberate self-poisoning in 1976; 38% in 1986	1, 2; lack of specific information on alcohol use reporter; 10% of cases lacked accurate demographic and drug data
Kingma	1994	Trauma patients attending ED of a University hospital in the Netherlands, 1970–1993, for treatment of injuries as a result of suicide attempts or automutilation	2124 (72)	1	Not specified, most likely derived from medical and psychiatric records	20% of patients had consumed alcohol before their attempt; use highest in 20–39 age group; 75% of using alcohol before suicide attempt or automutilation	1, 2; lack of specific information on alcohol use reporter; attempts and automutilation grouped together
Kresnow et al.	2001	Population-based study of nearly lethal suicide attempts, Houston, Texas; cases were Houston residents aged 13–34 years seen at an ED, 11/9/1992–7/30/1995	153 cases 512 controls[c]	3	Self-report	41 (27%) of cases reported drinking at least one alcoholic beverage in the 3 hr before suicide attempt; odds ratios ranged from 6 to 15 in multiple replications after controlling for confounders	Self-report only; matching by day of week, not season; no seasonal/holiday effects could be evaluated
Latha et al.	1996	All consecutive suicide attempts admitted to general hospital ED, Manipal, India, during 3.5 years starting 8/1988	73 (62)	2	Self-report	Alcohol implicated in eight (11%) attempts in context of acute intoxication, habitual excessive drinking, and withdrawal	1, 2; ~23% of attempters did not consent or were not interviewed
McMahon and McGarry	2001	All patients admitted to an Irish county hospital, 1997, after self-poisoning	111 (38)	1	Toxicology reports	Alcohol consumed synchronously by 51%; 17% fulfilled criteria for alcohol dependency	1, 2; 11 accidental and 100 deliberate self-poisonings presentations were grouped together
Merrill et al.	1992	All consecutive attempted suicides admitted to West Midlands Poisons Unit, UK, from 1988	250 (41)	2	Self-report	Alcohol consumed by 46% of patients within 12 hr of self-poisoning (54% of males and 41% of females)	1; self-report only; no end date was specified for data collection
Ndosi and Waziri	1997	All consecutive suicide attempts admitted to an ED, Tanzania, Africa, 1/1/1991–6/30/1993	300 (31)	2	Self-report, as well as attendant relative and friends report	73% consumed various amounts of alcohol before attempting suicide; most smelled of alcohol at admission	1; self- and other's report only; 9% of patients originally recruited did not follow through
Platt and Robinson	1991	All interviewed patients age 16+ admitted to Regional Poison Treatment Center, Edinburgh, Scotland, 1968–1987	5218 (41)	1	Self-report	Virtually all alcoholics drank at the time of attempt compared with <62% (males) and <47% (females) nonalcohol dependents	1, 2; total sample size not directly stated; self-report only; 3% of the sample had missing data on alcohol use
Suokas and Lonnqvist	1991 & 1995	All consecutive self-poisoning patients treated during 1983 at ED, Helsinki Univ. Central Hospital	1018 patients/1207 attempts (47)	1	Alcometer or blood test	Almost 2/3 (63%) of the patients had taken some amounts of alcohol in addition to drugs; 55% had high (>1.5%) alcohol levels	1, 2; information on alcohol consumption was missing for 2% of sample
Waller et al.	1994	Assault and suicide-related injuries examined in a study of characteristics, costs, and effects of injury in Burlington, VT, random sample of days, 3/4/1991–3/3/1992	22 (36)	2	Blood alcohol tested in 52%	38% had positive BAC or had a note indicating long-standing problems with alcohol in their medical record	1, 3; 7 (21%) attempters declined participation; BAC not tested in 45% of suicide attempters

[a] Study designs: 1, retrospective case series; 2, prospective case series; 3, case-control.

[b] Limitations: 1, no control group; 2, retrospective design; 3, small sample size.

[c] Percentage male not reported.

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