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## Alcohol-Associated Deaths in the District of Columbia—A Postmortem Study

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Accurate determination of the numbers and types of alcohol-associated<sup>2</sup> deaths in the community has proven almost as difficult as defining alcoholism itself. The major reason for this difficulty has been the lack of suitable methods for obtaining comprehensive information concerning the multifaceted relationship between alcohol and mortality [1]. Most epidemiological research on the subject has relied on data from death certificates, a notoriously unreliable measurement criterion. Investigations based on blood alcohol concentration have usually focused on a single type of fatality, traffic deaths for example, almost exclusively on victims of such events, or on the acute effects of alcohol. The bulk of other such research has been directed toward analyzing mortality rates and causes of death of persons defined, in a variety of ways, as alcoholics, on the chronic effects of alcohol abuse, and on the excess mortality of alcoholics over that of the general population [2].

The purpose of this study is to document the numbers and types of alcohol-associated fatalities in a well-defined sample representative of all types of deaths in the community. Use of medical examiner's office case material as a study sample offers distinct advantages for investigating the epidemiological relationship between alcohol and mortality by including persons in all age ranges dying both naturally and violently, and by employing systematic pathological, toxicological, and historical information to test both the acute and chronic effects of alcohol ingestion. Most particularly, comprehensive historical information regarding the circumstances surrounding traumatic deaths permits elucidation of the role of alcohol among perpetrators of violence. From these various data it was determined that 53% of the autopsied cases studied were alcohol-associated. Moreover, the analysis revealed that alcohol was a factor in 30% of all deaths in the District of Columbia of persons between 15 and 44 years of age.

### Materials and Methods

#### *The Sample*

The study sample consisted of 604 consecutive cases autopsied at the Office of the Chief Medical Examiner in the District of Columbia over a six-month interval between 26 Aug. 1974 and 25 Feb. 1975. During the study period 4949 deaths occurred in the District of Columbia, 1239 of which represented fatalities falling under the jurisdiction of the medical

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<sup>2</sup>The terms *ethyl alcohol* and *alcohol* are used synonymously throughout the paper.

examiner's office. The 604 study cases were selected from the latter group for complete autopsy and toxicological examination.

Criteria for case selection for autopsy were based largely on the circumstances surrounding death and included all known or suspected unnatural deaths and sudden, unexpected deaths of apparently healthy persons under 45 years of age. Circumstantial and historical information pertaining to medical examiner's office case material was provided by the Homicide Branch of the Metropolitan Police Department.

For reasons of case selection, the sample was biased to the extent that it contained a preponderance of deaths from trauma and disproportionate numbers of individuals in the younger age range. In addition, the sample was drawn, but not exclusively so, from lower socioeconomic strata.

### *Methods*

The general format for the study was analogous to an epidemiological model for infectious disease analysis. Alcohol was considered the agent. The victim represented the host, and the history and circumstances of the fatal event constituted the interaction between the agent and host and the environment. Criteria for inclusion of a case as being alcohol-associated were based on evidence of the presence of alcohol in the host or in the matrix of the situational environment at the time of the fatal event, or of alcohol having contributed to the disease or injury process leading to the victim's death.

The first criterion for inclusion of a case as being alcohol-associated was toxicological evidence of alcohol in the victim at the time of death. Blood alcohol analysis was performed in 482 of the 604 study cases. It is routine agency policy to perform toxicological screening analysis on all trauma fatalities surviving less than 24 h. Victims hospitalized longer than 24 h and children under 14 years of age are not usually so tested. Among natural deaths investigated, decision for drug analysis depends on many variables, but the majority of cases are screened. The headspace method using gas chromatography was employed in these analyses. A blood alcohol concentration equal to or greater than 0.03 g/100 ml was considered positive and was selected to obviate false positive alcohol levels derived from postmortem decomposition.

The second criterion for inclusion was historical information implicating the contribution of alcohol to the victim's death. Cases of documented alcohol abuse and of alcohol ingestion by the victim immediately preceding the lethal injury were, for obvious reasons, included. Particular attention was directed to ascertain the presence of alcohol in the immediate environment of the host at the time of injury; this environment was considered to include not only the victim but also the person "responsible" for the death, for example, the intoxicated driver who kills a pedestrian. All cases in which alcohol formed an integral part of the circumstances of death were included. In all types of fatalities investigated by the medical examiner's office, the homicide detective routinely questions witnesses regarding the use of alcohol by the victim or the assailant. Because the latter information often does not appear on the routine investigation report, for the purpose of this study, in addition to re-examining all the original death reports and other pertinent anamnestic data, the investigators reviewed police files of closed homicide cases including statements of all witnesses and defendants, surveyed all available information on traffic fatalities (particularly the results of toxicological analyses on living drivers), examined hospital charts on trauma victims, and consulted, where pertinent, attending physicians, families, and other informed persons.

The third criterion for inclusion was the presence at autopsy of a disease process known to be caused or exacerbated by alcohol in a person with a history of excessive alcohol usage. If pathological processes including alcoholic liver disease (fatty metamorphosis or Laennec's cirrhosis, or both), acute and chronic pancreatitis, alcoholic cardiomyopathy,

and alcohol-related seizure disorder appeared on the death certificate or in the anatomic diagnoses of the autopsy protocol, the case was included [3,4]. The presence of hepatic cirrhosis or pancreatitis was also pertinent to hospitalized trauma victims whose fatal outcome may have been affected by the underlying alcohol-related disease. All deaths of the latter type were also included.

Most of the cases included as being alcohol-associated met at least two of the three criteria noted above. In all of the natural deaths, there was pathological and either historical or toxicological evidence of alcohol having been one component of the cause of death. In deaths found to have occurred by unnatural means, there was either toxicological or historical evidence of alcohol in the host or his immediate environment at the time of death and, often, anatomic findings indicating its prolonged pathologic effect.

Several assumptions about the cause of disease, injury, and death form the theoretical underpinnings of the above criteria. The first premise is that the presence of alcohol in the victim or in the immediate environment of his death, including in some cases the person responsible for the death, contributed in some way to the death. The mortality coefficient of alcohol is not merely coincidental; in statistical terms, the null hypothesis is presumed not to hold true. (Pernanen [5] has written a lengthy discussion of the validity of using this assumption in violent deaths related to alcohol.) Second, alcohol cannot, except in a few cases, be considered the substantive cause of death, but it represents rather one component among several, which together "caused" the lethal injury or fatal disease [6]. All social and biological events have multiple causes, or multiple agents and factors may converge to cause the event noted. The death of an individual, being a social-biological event, is no different. In this study we document the frequency and types of cases in which alcohol formed a part of the substantive cause of death [7].

## Results

Of the total 604 cases analyzed, 320 (53%) were found to have been associated with alcohol. The overall results classified according to the manner of death and their criteria for inclusion are listed in Table 1. Numerical and percentage analyses of cases included because of a positive blood alcohol determination are outlined in Table 2. One hundred seventy-six victims were found to have positive blood alcohol levels on analysis. In six additional cases, surviving drivers responsible for a fatal traffic accident had elevated blood alcohol levels. The majority of the victims, 78%, had a blood alcohol content of 0.1 g/100 ml or above. Of the 39 victims with lower levels, 11 had been hospitalized for part of the 24 h following the injury, 20 (including 13 dying from natural causes) had an alcohol-related natural disease process, and 27 had a history of excessive alcohol intake.

TABLE 1—*Distribution of alcohol-associated deaths by manner of death and criteria for inclusion.*

Manner of Death	Total Cases	Positive BAC <sup>a</sup>	Positive Anatomic Findings	Positive Historical Data	Alcohol-Associated Deaths, <i>n</i>	Alcohol-Associated Deaths, %
Natural causes	212	43	111	105	111	52
Homicide	163	61	58	30	97	60
Suicide	47	12	12	9	16	34
Traffic accident	44	12	10	11	22	50
Nontraffic accident	80	21	29	34	44	55
Undetermined manner	58	27	22	16	30	52
Total	604	176	242	205	320	53

<sup>a</sup>BAC = blood alcohol concentration.

TABLE 2—*Distribution of alcohol-associated deaths by manner of death and blood alcohol content.*

Manner of Death	Total Cases	Cases Tested	Cases with Positive BAC <sup>a</sup>	Positive, %	Positive > 0.10 g/100 ml, % (Range, g/100 ml)
Natural causes	212	171	43	25	70 (0.03-0.69)
Homicide	163	128	61	48	85 (0.03-0.36)
Suicide	47	45	12	27	75 (0.03-0.33)
Traffic accident	44	39	18	46	89 (0.07-0.36)
Nontraffic accident	80	55	21	38	80 (0.03-0.70)
Undetermined manner	58	44	27	61	70 (0.03-0.31)
Total	604	482	182	38	78 (0.03-0.70)

<sup>a</sup>BAC = blood alcohol concentration.

### *Natural Deaths*

Of the 212 deaths attributed to natural causes, 111 (52%) were associated with alcohol. Numerical and percentage analyses of these cases are listed in Table 3 by the primary organ system affected in the immediate cause of death. All cases had histories of heavy alcohol intake. There were 40 deaths from alcoholic liver disease. The majority of those cases dying from gastrointestinal system disorders experienced a massive upper gastrointestinal hemorrhage secondary to alcoholic liver disease. This latter disease contributed to the seven deaths from cardiovascular system pathology; the others in this category had either alcoholic cardiomyopathy or organic heart disease, or both, with a positive blood alcohol content. Acute alcoholism, alcohol-related seizure disorders, and intracranial hemorrhage accounted for the cases in the central nervous system disease category. Pneumonia, tuberculosis, and asthma in persons with histories of alcohol abuse, positive blood alcohol content, and alcoholic liver disease are included in the respiratory disease system category.

TABLE 3—*Distribution of alcohol-associated natural deaths by organ system involved and criteria for inclusion.*

Organ System Involved	Total Cases	Positive BAC <sup>a</sup>	Positive Anatomic Findings	Positive Historical Data	Alcohol-Associated Deaths, <i>n</i>	Alcohol-Associated Deaths, %
Hepatobiliary	40	15	40	40	40	100
Gastrointestinal	28	6	25	25	25	89
Cardiovascular	68	5	14	14	14	21
Central nervous system/ acute alcoholism	31	13	20	15	20	65
Respiratory	22	3	9	8	9	41
Other	23	1	3	3	3	13
Total	212	43	111	105	111	52

<sup>a</sup>BAC = blood alcohol concentration.

### Homicide

During the six-month study period, 163 persons were homicide victims, and of these, 97 (60%) were associated with alcohol. A classification of these cases according to the mode of injury and the indexes for inclusion are listed in Table 4. Sixty-one (37%) of the victims had a positive blood alcohol, 54 in excess of 0.10 g/100 ml. The six hospitalized cases had alcoholic liver disease at autopsy and a history of having been drinking at the time of injury. According to statements given by the accused and witnesses, 16 assailants had been imbibing alcohol immediately prior to the fatal assault. In 14 additional cases, pertinent circumstantial information placed alcohol in the matrix of the death. For instance, four persons were killed during robberies of unlicensed liquor establishments; in five cases the victims were reported to have been incorrigible alcoholics.

### Suicides

Among the 47 suicides evaluated, 16 (34%) were associated with alcohol. Twelve victims had positive blood alcohol contents, and five of these were found at autopsy to have alcoholic liver disease. The other four cases had a long history of alcohol abuse, and two of these were found at autopsy to have cirrhosis of the liver. Data pertaining to the relationship between alcohol and suicide are shown in Table 5.

### Traffic Fatalities

Of 44 traffic fatalities, 22 (50%) were alcohol-associated, as noted in Table 6. Three drivers who survived for longer than 24 h were noted to have been clinically intoxicated at

TABLE 4—Distribution of alcohol-associated homicides by mode of injury and criteria for inclusion.

Mode of Injury	Total Cases	Positive BAC <sup>a</sup>	Positive Anatomic Findings	Positive Historical Data	Alcohol-Associated Deaths, <i>n</i>	Alcohol-Associated Deaths, %
Firearms	107	30	25	20	50	47
Cutting and stabbing	33	21	22	5	29	88
Blunt force	16	7	9	4	14	88
Asphyxia	5	3	2	1	4	80
Other	2	0	0	0	0	0
Total	163	61	58	30	97	60

<sup>a</sup>BAC = blood alcohol concentration.

TABLE 5—Distribution of alcohol-associated suicides by mode of injury and criteria for inclusion.

Mode of Injury	Total Cases	Positive BAC <sup>a</sup>	Positive Anatomic Findings	Positive Historical Data	Alcohol-Associated Deaths, <i>n</i>	Alcohol-Associated Deaths, %
Firearms	16	5	6	4	6	38
Ingestion of drugs	12	4	4	1	5	42
Jumping	9	0	1	1	1	11
Hanging	5	1	0	1	1	20
Drowning	2	1	1	1	1	50
Other	3	1	0	1	2	67
Total	47	12	12	9	16	34

<sup>a</sup>BAC = blood alcohol concentration.

TABLE 6—*Distribution of alcohol-associated traffic fatalities by category of case and criteria for inclusion.*

Category of Case	Total Cases	Positive BAC <sup>a</sup>	Positive Anatomic Findings	Positive Historical Data	Alcohol-Associated Deaths, <i>n</i>	Alcohol-Associated Deaths, %
Operator	15	7	6	3	10	67
Passenger	6	2	2	3	5	83
Pedestrian	23	3	2	5	7	30
Total	44	12	10	11	22	50

<sup>a</sup>BAC = blood alcohol concentration.

the time of hospital admission and all had fatty livers at autopsy. Both hospitalized pedestrians were found to have Laennec's cirrhosis, and both were alcoholics by history. In the other cases included as alcohol-associated, either the victim or the person responsible for the accident had a positive blood alcohol level.

#### *Nonvehicular Accidents*

Deaths by falling, drowning, thermal injury, firearms, and a miscellany of other accidents accounted for the 80 fatalities in this category and, of these, 44 (55%) were alcohol-associated. Table 7 lists the types of injuries sustained and the indexes for inclusion.

Of the 28 deaths from blunt-force injury, all but one were due to falls resulting in closed head trauma. Fourteen cases dying following hospital admission had a positive history of alcohol abuse and were found at autopsy to have alcoholic liver disease. The three choking deaths resulted from impaction of a bolus of food in the hypopharynx; each of these victims had a positive blood alcohol content. Seven persons died by accidental means because the person or persons responsible for their safety could not act appropriately because of their inebriated condition; for example, in one case the father of two small boys was so intoxicated that he could not rescue his sons from a fire at their residence.

#### *Undetermined Manner of Death*

Of the 58 cases in which the manner of death was classified as undetermined, 30 (52%) were associated with alcohol. The data on these cases are tabulated in Table 8.

TABLE 7—*Distribution of alcohol-associated nontraffic fatalities by mode of injury and criteria for inclusion.*

Mode of Injury	Total Cases	Positive BAC <sup>a</sup>	Positive Anatomic Findings	Positive Historical Data	Alcohol-Associated Deaths, <i>n</i>	Alcohol-Associated Deaths, %
Blunt force trauma	28	11	22	20	25	89
Fire	17	3	2	4	8	47
Drowning	6	2	1	3	5	83
Asphyxia/choking	3	3	2	3	3	100
Exposure to cold	2	1	2	2	2	100
Firearms	2	1	0	2	1	50
Other	22	0	0	0	0	0
Total	80	21	29	34	44	55

<sup>a</sup>BAC = blood alcohol concentration.

TABLE 8—*Distribution of alcohol-associated deaths from undetermined circumstances by mode of injury and criteria for inclusion.*

Mode of Injury	Total Cases	Positive BAC <sup>a</sup>	Positive Anatomic Findings	Positive Historical Data	Alcohol-Associated Deaths, <i>n</i>	Alcohol-Associated Deaths, %
Narcotism	14	10	6	2	10	71
Blunt force	11	2	5	4	5	45
Drowning	7	6	4	5	6	86
Other	26	9	7	5	9	35
Total	58	27	22	16	30	52

<sup>a</sup>BAC = blood alcohol concentration.

The 14 cases from acute narcotism represent a special subset of this group. In ten of these narcotism victims there was a positive blood alcohol content, conjointly with the toxicological finding of a morphine derivative or substitute. Six cases were found at autopsy to have fatty liver disease, and two had histories of alcohol abuse in addition to heroin addiction.

In the other 44 undetermined cases, the circumstances of death could not be fully elucidated. Twenty-one cases, all resulting from a variety of chemical and physical injuries, were associated with alcohol. All of the victims met at least two of the inclusion criteria specified above.

## Discussion

To our knowledge, no similar analysis of alcohol and mortality has been published. This uniqueness is, however, not peculiar to our work; no two studies concerning the relationship between alcohol and death are the same. As discussed by DeLint and Schmidt [2] in a review of the current research on the subject, the wide variation in access to pertinent data and in methodology necessarily leads to differing results. Moreover, the lack of uniform results precludes valid generalizations about the role of alcohol in mortality and hinders useful comparisons between mortality rates from alcohol in various communities and among different populations [2]. Access to and utilization of the combination of pathologic, toxicological, and historical data not only make this study original but also provide a firm foundation for our results. The three types of evidence complement one another. The autopsy findings of alcoholic liver disease tend to corroborate a history of alcohol abuse. In traumatic deaths, a positive blood alcohol concentration and fatty liver disease identified postmortem in the victim substantiate witnesses' statements that the parties involved in an altercation were chronic alcoholics and were drinking at the time of the fatal injury. People do die the way they live; death investigation would be chaos if the situation were otherwise.

That dictum reinforces our inclusion into the alcohol-associated category of most deaths classified here as having resulted from undetermined circumstances. Many persons addicted to alcohol live alone, and they die alone, unwitnessed, in a variety of ways. They are found in rivers in the cold of winter, and one cannot determine, for example, if they slipped on the ice and fell through, deliberately jumped, or were pushed into the water. So it is with many alcoholics dying from closed head trauma or from a combination of drugs including alcohol.

For purposes of providing perspective on our results and on the broader problem of alcohol and mortality, some comparisons between our findings and those of other studies are, despite the inherent difficulties, necessary. The most appropriate comparisons to be

made are those between our statistics and similar ones from other functional medical examiner's and coroner's systems. No reported study has addressed itself to all types of deaths, but rather most have focused on one of the major categories: homicide, accident, suicide, or natural death. In the latter category, Kuller et al [8] concluded that fatty liver disease resulting from chronic alcoholism was the leading cause of sudden death among black males and females between the ages of 20 and 39, in Baltimore, Maryland. In our cohort of the same age range, sudden deaths from cardiovascular disease and fatty liver disease are equal for black males, but fatty liver disease was the leading cause of death among black females. Many studies document the relationship between alcohol and cardiovascular, infectious, and neurological diseases, but no comparable investigation of the epidemiology in a medical examiner's system has been published.

Studies of the relationship between alcohol and fatal trauma investigated by medical examiners are more numerous. Our figure of 50% of traffic fatalities being alcohol-associated stands at the national average derived from many sources [9]. In a study of homicides in Philadelphia between 1948 and 1952, Wolfgang [10] stated that in 63.3% of cases examined either the victim or assailant, or both, had been drinking prior to the fatal event. A recent publication shows that alcohol was a factor in 64% of homicides in New Orleans [11]. These results are comparable to our 60% alcohol-associated homicide rate. With respect to homicide victims only, data from the Cuyahoga County (Cleveland) Coroner's Office indicate that during a 13-year span 58% of homicide victims whose blood was tested had measurable levels of alcohol [12]. The chief medical examiner's offices of North Carolina and New York City have reported that 50 and 42%, respectively, of homicide victims examined had a positive blood alcohol content [5,13]. In our study, 48% of homicide victims whose blood was analyzed had a positive blood alcohol content.

Among our nontraffic accidents, 38% of fatally injured persons tested had a positive blood alcohol content, 43% with exclusion of seven industrial deaths, only one of which was positive for alcohol. Although there is some variation in classification of cases, this figure is comparable to percentages of similar cases in the Sacramento, California (54%) [14] and Cuyahoga County (40%) [12] coroners' systems. Twenty-seven percent of the suicide victims analyzed here had a positive blood alcohol content, in the range of the 26.6% from the Cuyahoga County Coroner's Office and the 25.6% from the Office of the Chief Medical Examiner of New York City [12,13]. When data are drawn from jurisdictions having active medicolegal investigative capabilities, the numbers of victims having positive blood alcohol content are remarkably similar.

The only recent study of alcohol-associated deaths in a geographically defined population is that by Lowe et al [15] for Georgia in 1970. Using data from death certificates, they identified 581 cases among 40 000 deaths, a rate of 12.9 deaths per 100 000 population. The authors acknowledged that, with their methods, only two traffic fatalities could be associated with alcohol. All other deaths judged to be alcohol-related resulted from natural causes, primarily hepatic cirrhosis, their main criterion for inclusion. In our study there were 320 alcohol-associated fatalities out of 4949 total deaths in the District of Columbia during the six-month study period for an annual death rate of 88 per 100 000 population. Our inclusion of cases based on data not ordinarily found on the death certificate accounts for the disparity in rates noted.

The high rate of alcohol-associated mortality in the District of Columbia is even more apparent among those between 15 and 44 years of age, where a remarkable 30% of all such deaths were found to have been alcohol-associated. During the six months of this study, there was a total of 619 deaths of persons in this age group. Of these, 311 (50%) were autopsied at the medical examiner's office. One hundred eighty-eight (60%) of these 311 deaths were associated with alcohol for an age-specific death rate of 181 deaths per 100 000 population. And this is a minimal figure. A preliminary survey of cases



autopsied at hospitals in the District of Columbia has disclosed at least an additional 30 alcohol-related deaths in this age group.

### Summary

Ethyl alcohol and its lethal effects were present either in the victim or in the environment, including persons responsible for a given death, in 53% of the cases autopsied during a six-month period at the Office of the Chief Medical Examiner in the District of Columbia. The results of this small, admittedly biased, sample indicate that the acute and chronic effects of alcohol are a major public health problem in this jurisdiction. Comparative figures from other medical examiner's systems suggest the national prevalence of the problem and confirm the gross inadequacy of data from death certificates for such research. Only when the combination of accurate pathological, toxicological, and historical information concerning all types of deaths is available can reliable statistics regarding the numbers and types of deaths related to alcohol be obtained.

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