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Drug Detection at Autopsy: A Prospective Study of 247 Cases

ABSTRACT: Comprehensive toxicology analyses using gas chromatography of blood for alcohol and acidic, basic, and neutral drugs were performed on 247 randomly selected medical examiner cases. Drugs or alcohol or both were found in 54% of this group. When considered by manner of death (natural, accident, homicide, and suicide), each of the groups had incidences of positive findings of 46 to 63%. Selection of cases for toxicologic study on the basis of manner of death does not seem to be feasible. It is the authors' opinion that comprehensive toxicology evaluation for drugs should be done on virtually all medical examiner cases. This approach ensures a thorough and complete evaluation in all cases. In addition, a comprehensive toxicology study will provide information in the event that questions concerning the absence or presence of drugs arise at some later date.

Toxicologic studies are now recognized as an integral part of the proper investigation and evaluation of most medical examiner cases. It is apparent to medical examiners and other death investigators that now, as never before, when comprehensive toxicologic examination is performed, a very high incidence of positive findings is obtained, regardless of the actual cause of death. In many cases, these findings indicate only that a small quantity of an alcoholic beverage had been imbibed or that a "sleeping pill" had been taken the night prior to death and perhaps be unrelated to the death. In other cases, the drug or toxic agent is the direct cause of death, such as by overdose, or may explain the actions of the deceased leading to his death, such as the acutely intoxicated motor vehicle driver who crashes into an abutment or the drowning victim found to have ingested phencyclidine.

Limitations on the manpower and financial resources of most laboratories make it impossible to perform complete toxicology screens on all postmortem cases investigated in most medical examiners' offices. Therefore, in order to better select those cases in which toxicologic examination would be of value, we determined the actual incidence of drugs and alcohol present in a random series of deaths investigated in this medical examiner system.

Methods

Blood samples were taken from 247 randomly selected medical examiners' cases investigated at the Southwestern Institute of Forensic Sciences over a three-month period from October to December 1978. These samples were routinely taken from the heart by inserting a 20-gauge needle through the chest wall and withdrawing about 30 mL of blood. The blood was then placed in three untreated Becton-Dickinson redtop Vacutainer® test tubes, which were transferred to the laboratory the same day and stored at 4°C until analysis. All of the blood samples were analyzed at the toxicology laboratory of the Institute by using three gas chromatographic procedures developed to detect and quantitate drugs in biologic samples:

1. An acidic and neutral drug screen uses direct extraction of blood with ether-toluene, evaporation of the solvent phase, and partitioning of the residue between hexane and ethanol prior to the injection of the ethanol phase on a gas chromatograph. This screen is described elsewhere [1] and detects over 120 drugs and other agents.

2. A basic drug screen uses n-butyl chloride extraction of blood with back extraction into weak acid and then partitioning of the basic drugs into a small volume of chloroform for gas chromatographic injection. This procedure, described by Foerster et al [2], is comprehensive for more than 80 basic drugs, metabolites, and alkaloids found in blood.

3. The analysis for lower alcohols consists of the direct blood injection method of Jain [3]. This procedure detects and quantitates ethyl alcohol, methyl alcohol, isopropyl alcohol, acetone, and n-propyl alcohol.

These three procedures are used routinely to perform a toxicology drug screen in clinical as well as in autopsy samples. When used conjunctively, the procedures detect virtually all drugs in the classes of sedative-hypnotics, tranquilizers, antihistamines, synthetic narcotics, anticonvulsants, and most other prescription and illicit medications in therapeutic or higher concentrations. Not detected are morphine, lysergic acid derivatives, cannabinoids, some antibiotics, steroids, digoxin, carbon monoxide, heavy metals, some volatiles (such as Freon® and toluene), and a few other miscellaneous substances. Such specific testing for those agents was done only in a few cases when indicated by historical circumstances, and these results are not reported in this study.

The 247 cases were divided into four categories by manner of death and further categorized according to the presence or absence of alcohol and other drugs.

Results

Natural death accounted for 48% of the population; accident, 23%; homicide, 19%; and suicide, 10%. This distribution corresponds fairly well with the total population seen every year at the Institute, except that the percentage of homicides was slightly higher in this sample. In this particular sample, no deaths were assigned to the "undetermined" category.

Forty-six percent (46%) of the total population had neither alcohol nor drugs detected at the time of death, 19% had only alcohol, and 26% had only drugs. Nine percent (9%) had alcohol and one or more other drugs in combination (Table 1).

The presence of alcohol alone occurred mostly in violent deaths (Table 2). Only 9% of the victims of natural disease showed the presence of alcohol alone, compared to 41% of the homicide victims, 22% of accident victims, and 16% of suicide victims. In contrast, examination of these same four groups for the presence of drugs revealed a complete reversal in the order of frequency (Table 2). Thirty-four percent (34%) of the natural deaths had drugs alone compared to 24% of suicides, 19% of accident victims, and 13% of homicide victims.

The high incidence of drugs alone in natural deaths is not unexpected since natural disease victims are older and more prone to be on drug therapy for a variety of medical problems. The high percentage of suicide victims having drugs alone might seem to be due to the

TABLE 1—*Distribution of cases as to presence or absence of drugs.*

Alcohol/Drugs	Cases	
	n	%
None	115	46
Alcohol alone	47	19
Drugs alone	63	26
Alcohol and drugs	22	9
Total	247	100

TABLE 2—*Relationship of toxicologic findings to manner of death.*

Manner of Death	Negative	Alcohol Alone	Drugs Alone	Alcohol and Drugs	Total Cases
Natural	64 (54)[a]	11 (9)	40 (34)	3 (2.5)	118
Suicide	11 (44)	4 (16)	6 (24)	4 (16)	25
Accident	23 (40)	13 (22)	11 (19)	11 (19)	58
Homicide	17 (37)	19 (41)	6 (13)	4 (9)	46

[a]Figures in parentheses are the percentages of the total number of cases in each manner of death category in which the specified groups of agents were detected.

use of drug overdose as a method of suicide. However, in our series only 3 of 25 such deaths were from drug overdose. It seems more likely that the higher incidence of drugs present in suicide victims is due to the fact that they seek medical help for the symptoms of mental disease or stress before finally resorting to suicide and that drugs are commonly prescribed to relieve these symptoms.

Cases in which there was a combination of drugs and alcohol were more frequent in the violent death categories (Table 2). Only 2.5% of natural disease victims showed the presence of alcohol plus drugs as compared to 9% of homicide victims, 16% of suicide victims, and 19% of accident victims.

The blood alcohol concentration at the time of death was also related to the manner of death. Of those who had positive blood alcohol, victims of violent death were much more likely to have concentrations above 100 mg/100 mL than were individuals dying of natural disease (Table 3). Almost three quarters of homicide victims with alcohol showed such a blood concentration compared to 58% of accident, 62% of suicide, and 36% of natural disease victims.

An expected trend was also discovered when the type of drug found was compared with the manner of death. The drugs were divided into three categories (psychoactive, pain relief, other) according to the predominant reason that a particular drug is prescribed by the aver-

TABLE 3—*Relationship of blood alcohol concentration to manner of death.*

Manner of Death	Less than 100 mg/dL	100 mg/dL or more
Natural	9 (64)[a]	5 (36)
Accident	11 (46)	13 (54)
Homicide	6 (26)	17 (74)
Suicide	3 (38)	5 (62)

[a]Figures in parentheses are the percentages of the total number of cases in each manner of death category in which alcohol was detected.

age physician. A drug was placed in the psychoactive category if it is primarily used for its mood-altering effect. Drugs such as propoxyphene, which have mood-altering effects in some individuals, were not included in this category because they are prescribed for relief of pain. On the other hand, phenobarbital was included in the psychoactive drug category since in most of our victims it was prescribed as a sedative rather than as an antiseizure medication. The third category, "other," included all drugs not in either the psychoactive or pain relief category, that is, medications for heart disease, antihistamines, antidiabetic agents, and so forth. Sixty percent (60%) of the drugs present in the total population fell into the psychoactive category, that is, tranquilizers, soporifics, and antidepressants (Table 4). Of those victims who had taken drugs, a higher percentage of victims of violent death had taken psychoactive drugs. The highest incidence was in the suicide group, apparently demonstrating a trend for suicide victims to seek medical relief for their problems and a tendency for physicians to treat these patients with psychoactive drugs.

Second only to alcohol in terms of incidence in the total population and incidence in every category of death was diazepam, detected in 13% of the total population (32 individuals). The incidence of diazepam in each group according to manner of death was as follows: 22% of accident victims, 16% of suicide victims, 11% of natural disease victims, and 4% of homicide victims. The next most frequently detected drugs were propoxyphene, 6% of the total population; phenobarbital, 3%; flurazepam, 2.5%; methaqualone, 1.5%; and amitriptyline, 1.5%. Two of the three drug-overdose suicides in this study were due to ingestion of the antidepressant amitriptyline. Subsequent observations have shown this agent to be the leading single drug cause of overdose deaths in this jurisdiction in the last two years (1979 and 1980) [4].

Discussion

The data obtained as the result of this study indicate an overall high incidence of positive drug findings in cases studied by the medical examiner. In more than half of all deaths (54%), drugs, alcohol, or both were detected in the blood. This did not include a certain number of drugs not detected by the screens used or certain other toxic agents such as carbon monoxide, cyanide, and volatile substances.

Although, as might have been expected, alcohol and other drugs were found most frequently in violent death categories (56 to 63%), even those determined to be death from natural causes were positive in 46% of cases.

The significance of the toxicology findings must, of course, be determined for each individual case in light of the historical data. For example, a very low level or negative finding of anticonvulsant medication in a known epileptic patient may be as significant as a very high level of the drug in a suspected acute overdose. In cases involving accidental or intentional trauma, when the cause of death is easily ascertained, the results of toxicologic analysis are often instrumental in explaining the circumstances and behavior leading to death. The forensic science expert called to court to testify on death circumstances in cases of motor vehicle accidents, industrial accidents, and homicide is almost uniformly asked whether the

TABLE 4—*Relationship of category of drug to manner of death.*

Category	Natural	Accident	Homicide	Suicide	Total
Psychoactive	32 (46)[a]	29 (66)	8 (67)	12 (86)	81 (51)
Pain relief	16 (23)	16 (8)	1 (8)	2 (14)	35 (22)
Other	32 (31)	8 (18)	3 (25)	0 (0)	43 (27)
Total					159 (100)

[a]Figures in parentheses are percentages of the total number of cases in each manner of death category in which drugs of the specified class were detected.

deceased had been intoxicated at the time of death or to explain the unusual behavior leading to death. The psychoactive drug phencyclidine, for example, is known to induce bizarre behavior, often leading to drowning and other forms of violent death [5]. The family of the suicide victim asks the pathologist whether their loved one may have been on drugs or intoxicants that might help explain the tragic circumstance. Thus, to answer such questions and to most accurately assign the cause and manner of death, it is essential to perform toxicology evaluations.

No clear pattern emerges from the study to assist in eliminating unnecessary toxicology analysis based on the manner of death. In contrast to the original tenet—to establish some guidelines for selectivity in toxicology screening—it would appear that from this study virtually all cases investigated should be screened for common therapeutic drugs and alcohols. Many individuals believe that this is not feasible because of insufficient laboratory resources, and they propose that selection of a case for toxicology requests be made on the basis of the circumstances surrounding each individual case. If this latter policy is used, it must be realized that this selection is open to serious error in that the medical examiner may not know at the time of initial investigation all the circumstances surrounding the death. For example, a family may attempt to conceal or may not know of a history of drug abuse or suicide threat. To prepare for this circumstance, blood should be obtained and retained for at least six months in virtually all medical examiner cases, even if there is no initial intent to perform toxicology screening.

Ideally, all medical examiner cases should have a toxicology evaluation similar to that herein described. With modern instrumentation and laboratory techniques, it is now possible to do so at a reasonable expense. Many drug-related and even drug-caused deaths that had not been suspected have been revealed by routine screening. Unusual drug abuse and death from at least one medication not previously thought to be a drug of abuse or to have a significant lethal potential have been detected in this manner [6].

Summary and Conclusion

Comprehensive screening for alcohol and other drugs was performed on 247 consecutive medical examiner cases. Drugs or alcohol or both were detected in 54% of the total study group. Alcohol was the most commonly encountered drug as well as the one most highly correlated with violent death. Homicide victims, in particular, had used alcohol alone much more than any other drug or combination of drugs. Blood alcohol concentrations were also related to violent death, with homicide victims having the highest levels. Of other drugs present in the population, the majority were psychoactive in nature and prescribed for tension reduction, sleep induction, or mood evaluation. The presence of psychoactive drugs was elevated in violent deaths in that a higher percentage of suicide, accident, and homicide victims had taken drugs in this group than had victims of natural disease. Diazepam was second only to alcohol as the drug found most commonly in both the total population and each individual category of death. It was detected in 13% of the 247 cases included in this study.

Each of the groups assigned by manner of death had high incidences of positive findings (46 to 63%). In view of this, no general guidelines concerning selectivity of cases by manner of death for toxicologic screening were formulated. It is concluded that comprehensive toxicologic screening is desirable in all postmortem cases investigated.

References

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