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Postmortem Alcohol Production in Fatal Aircraft Accidents

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16. Abstract

During 1989 and 1990, the Civil Aeromedical Institute (CAMI) received specimens from 975 victims of fatal aircraft accidents. The maximum concentration of ethanol allowed under FAA regulations (0.04%, 40mg/dL) was exceeded in 79 of these cases (8%). It was determined based on the distribution of ethanol in urine, vitreous, blood, and tissue that 21 of the positive cases (27%) were from postmortem alcohol production. Twenty-two of the positive cases (28%) were found to be from the ingestion of ethanol. In 36 cases (45%) no determination could be made in regards to the origin of the ethanol. In two cases, postmortem alcohol production exceeded 0.15 percent (150mg/dL).

The opinion held by some toxicologists that postmortem alcohol production can be inferred from the presence of acetaldehyde, acetone, butanol, and other volatiles was found to be incorrect. Several cases with postmortem ethanol had no other volatiles. Volatile compounds were found in several cases where no ethanol was present. In addition, a case was found where the relative ethanol concentrations in blood, bile, and vitreous humor were solely consistent with the ingestion of ethanol, but acetaldehyde, acetone, and 2-butanol were also found in blood. This clearly indicates that the presence or absence of other volatiles does not establish postmortem ethanol production.

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POSTMORTEM ALCOHOL PRODUCTION IN FATAL AIRCRAFT ACCIDENTS

INTRODUCTION

Ethanol found in the blood of a pilot is a significant factor in determining the possible cause of an aircraft accident. However, the interpretation of ethanol in postmortem specimens is complicated by the presence of endogenous ethanol. Previous authors (1,6) have pointed out the dangers of interpreting ethanol in postmortem samples. Corry (1) warns the forensic scientist to "bear in mind that specimens of human tissue containing microorganisms, particularly specimens taken from corpses, may contain ethanol produced by microbial fermentation, and that extreme caution should be exercised when assessing the significance of postmortem ethanol."

Many papers have been published on postmortem ethanol production (1-15). In these papers procedures for determining postmortem ethanol production have been proposed. The presence of volatiles other than ethanol has been suggested (2) as an indicator of postmortem ethanol. The ratio of ethanol in blood to other specimens has been proposed (5,6) as another way of differentiating between ingested and postmortem ethanol. Several investigators (5,6,12) have shown that vitreous and urine do not suffer from postmortem ethanol production to any significant extent. Therefore, finding ethanol in urine or vitreous would generally indicate the ingestion of ethanol. Vitreous will normally have about 12% more ethanol than blood if the system is in the postabsorptive phase. Ethanol in urine will normally be about 25% or greater than the level of ethanol found in blood assuming no ethanol ingestion during the last 20 minutes. Levels of ethanol above certain concentrations have been used by some to infer the presence of ingested ethanol. In several cases concentrations such as 0.02% (20mg/dL), 0.15% (150mg/dL) and 0.20% (200mg/dL) have been suggested (1,8,9) as maximum levels of ethanol for postmortem ethanol production.

The following study addresses the determination of the presence or absence of postmortem ethanol in civil aviation fatalities.

The Forensic Toxicology Research Section (FTRS) at the Civil Aeromedical Institute (CAMI) receives specimens from most of the fatal aircraft accidents that occur in the United States. Collection and shipment of specimens from these accidents are sometimes delayed and the possibility of postmortem ethanol production does exist. Severe damage to the body often exposes specimens to microorganisms that can produce ethanol under the proper circumstances (temperature, time, and nutrients). A study was undertaken to determine the incidents of postmortem ethanol in specimens received by the laboratory.

METHOD

Specimens were collected by local pathologists and placed in evidence containers provided by the FAA Forensic Toxicology Research Section. These samples were refrigerated and shipped to CAMI by overnight air. Upon receipt the specimens were inventoried and prepared for analysis by a contract laboratory, the Armed Forces Institute of Pathology. The results of these tests were sent to the FTRS, the data were scanned with a SCANTRON optical card reader into a computer program developed by the Forensic Toxicology Research Section for storing, retrieving, and analyzing toxicology data. Of the various recommendations in the literature, we postulated postmortem ethanol was optimally inferred from the absence of ethanol in urine and/or vitreous coupled with a positive ethanol in blood or tissue. All cases with a blood ethanol concentration equal to or more than 0.04% (40mg/dL) were considered positive, as defined by Federal Aviation Regulation 14 CFR 91.11.

In 1989 and 1990, the Forensic Toxicology Research Section reviewed ethanol test results from 975 aviation fatalities to determine the extent of postmortem ethanol production.

RESULTS

The maximum concentration of ethanol allowed under FAA regulations 0.04% (40mg/dL) was exceeded in 79 of the 975 cases (8%). Twenty-one of the 79 cases (27%) were determined to be from postmortem ethanol production. In two of these cases, postmortem ethanol production exceeded 0.15% (150mg/dL). Twenty-two of the positive cases (28%) were found to be from the

TABLE I. Analysis of source of postmortem acohol in 975 cases.

Description	1989	1990	Total
Total cases	461	514	975
Total cases ≥0.4%(40mg/dL)	39 (8%)	40 (8%)	79 (8%)
Postmortem Ethanol	13 (33%)	8 (20%)	21 (27%)
Ingested Ethanol	8 (21%)	14 (35%)	22 (28%)
Unknown origin for Ethanol	18 (46%)	18 (45%)	36 (45%)

TABLE II. Relationship of ethanol origin and presence of other volatiles.

Description	1989	1990	Total
EPV	10	3	13
EIV	6	3	9
EUV	23	10	33
NEV	3	11	14
NEV	3	11	14

EPV = Postmortem ethanol & other volatiles
EIV = Ingested ethanol & other volatiles
EUV = Unknown origin of ethanol & other volatiles
NEV = Other volatiles and no ethanol

ingestion of ethanol. In 36 cases (45%), no determination could be made regarding the origin of the ethanol (Table I).

Volatiles other than ethanol were found in 13 cases with postmortem ethanol, 9 case with ingestion of ethanol, 33 cases with ethanol of an unknown origin, and 14 cases without any ethanol (Table II).

DISCUSSION AND CONCLUSIONS

Vitreous and urine were submitted in only 55% of the positive cases. Therefor, only 28% of these cases could be clearly identified as containing ingested ethanol. This is a much smaller number than was expected. We must increase the awareness of local pathologists and investigators to the need for collecting and submitting urine, vitreous, and other specimens to aid in differentiating between postmortem and ingested ethanol.

The presence or absence of volatiles, other than ethanol, does not of itself provide sufficient information needed to determine the origin of ethanol found in most postmortem samples. Table II shows that other volatiles can be found when there is no postmortem ethanol production. Postmortem ethanol can be found in cases where no other volatiles were found.

It has been suggested by some that one can assume the ingestion of ethanol when the ethanol concentration exceeds certain levels, such as 0.020% (20mg/dL), 0.150% (150mg/dL), or 0.200% (200mg/dL). The data collected in this study show that postmortem ethanol concentrations occasionally exceed these values. One can not determine with any degree of certainty the presence of postmortem ethanol based solely on the level of ethanol found in the analysis of postmortem specimens. The number of unknown variables in the production of postmortem ethanol makes it difficult to state unequivocally that the ethanol level in a specimen is above that which would be expected from a postmortem specimen. Specimens from 1989 and 1990 showed postmortem ethanol ranging in concentration from our cutoff of 0.01% (10mg/dL) to 0.18% (180mg/dL). In 1991 this laboratory analyzed a case with postmortem ethanol in excess of 0.30% (300mg/dL).

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