G90 An Analysis of 35 Ethylene Glycol Fatalities in Cook County, Illinois From 1993 Through 2003

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After attending this presentation the participant will understand that suicide is the most common manner of death from ethylene glycol intoxication in Cook County, Illinois, followed by accident, and rarely undetermined; understand the common death investigation circumstances surrounding death from ethylene glycol intoxication; and understand that toxicology values, although important in determining the cause of death, cannot replace a thorough death investigation when determining manner of death.

This presentation will impact the forensic community and/or humanity by providing realization that homicidal ethylene glycol intoxication is very rare, with suicidal ingestion by far the most common manner of death. Although homicidal poisoning is possible, the determination of the manner of death by the medical examiner or forensic pathologist should rely on the circumstances of the death after a thorough investigation, and not based on toxicology values alone, which overlap with accidental and intentional ingestions.

Introduction: A cluster of alleged and convicted homicidal ethylene glycol poisoning deaths has recently been reported in the media. In light of these reports, the authors sought to retrospectively review the experience of the Cook County Medical Examiner's Office investigating deaths occurring from ethylene glycol intoxication in an 11 year period from 1993 through 2003.

Background: Ethylene glycol is a relatively inexpensive and easily obtainable liquid used predominately as an antifreeze-antiboil additive in motor vehicles, but is also found in detergents, paints, cosmetics, and deicing products. It has a sweet taste, and is odorless and colorless, but commonly has fluorescent green or yellow dye added. It is an intoxicant with properties similar to ethanol when ingested, and is occasionally used as a substitute for ethanol when ethanol is not available. Several hours after ingestion, toxic effects of nausea, vomiting, convulsions, stupor, and coma can develop. Death usually occurs 24 to 48 hours later depending on the amount ingested, but can be delayed with medical intervention, as ethylene glycol causes metabolic acidosis, hyperosmolality, and tissue injury through its toxic metabolites.

Results and Analysis: During this 11 year period, 35 cases of fatal ethylene glycol intoxication were found in the Medical Examiner's Office computerized database. Retrospective analysis included review of the investigation and circumstances of the death; reports of follow-up investigations, including family interviews, autopsy reports, toxicology results; and any ancillary testing results. Temporally, one case occurred in 1993, no cases in 1994 or 1995, seven cases in 1996, eight cases in 1997, two in 1998, four in 1999, one in 2000, two in 2001, four in 2002, and six in 2003. Deaths were highest in October, April, and August, with only December having none. The average age was 43 years for both sexes, with a range of 25 to 73 years. There were 27 males and 8 females (ratio of 3.4 to 1). Twenty-eight were white and seven were black.

Manner of death was determined for the 35 deaths: 29 were suicides, 4 accidental, and 1 undetermined. There were no homicides. Of the suicidal determinations, ten left suicide notes or phone messages of intent. The four accidental determinations were related to chronic alcoholism and use of ethylene glycol as a substitute intoxicant. The one undetermined case could not be resolved between suicide and accident in a setting of chronic alcoholism and depression. Of the 29 suicide determinations, 14 had history of clinical depression, three had psychiatric diagnoses, and ten were going through a breakup in a long-standing relationship. Twenty-one had either commercial containers or cups of antifreeze at the scene. In examining where death or collapse from intoxication occurred, 28 were at their own home or apartment, 1 at work, 2 at their neighbor's home, 3 in motels, and one in a large department store. Of these 28 found at home, 11 were found in their bedroom, 4 in the basement, 1 in the kitchen, 1 inside a cabinet, 2 in the bathroom, and 7 had no specific location within the home noted.

Autopsy findings were nonspecific and consistent with drug ingestion with pulmonary and cerebral edema. Calcium oxalate crystals were found in renal tubules if death was not significantly delayed by treatment.

Ethylene glycol toxicology analysis was divided into three study groups: (1) those pronounced dead at the scene with postmortem analysis; (2) those found still alive and admitted to the hospital for a short period of time with postmortem toxicology; (3) those found still alive and admitted to the hospital, but subsequently died with antemortem hospital toxicology analysis only. There were 15 victims in the first group dead at the scene. The average blood ethylene glycol concentration on postmortem toxicology testing was 264 mg/dl (range 0 to 849 mg/dl). Average urine concentration was 1028 mg/dl (range 151 to 2193 mg/dl).

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The average ratio of blood to urine compared in individual cases was 0.31 (range 0.12 to 0.50). The manner of death for all members of this first group dead at the scene was suicide.

The second group was found alive and admitted to the hospital, but died after a short period of time, usually in the emergency room, and underwent autopsy with postmortem toxicology testing. All had metabolic acidosis and hyperosmolality while alive. Examples include two victims who both lived nine hours in the ER after a prior ingestion at unknown time. One had ethylene glycol in the blood of 626 mg/dl, bile 529 mg/dl, and vitreous 716 mg/dl. The second victim had ethylene glycol in the blood of 1141 mg/dl, bile 1134 mg/dl, and urine 561 mg/dl. In these two cases, bile seemed to parallel blood levels.

The third group was found alive and admitted to the hospital, but subsequently died, some after a long hospital course. This group tended to have large variable antemortem blood levels depending when testing was performed during the hospital course. The range of initial ethylene glycol in the blood was 143 to 864 mg/dl. All had documented metabolic acidosis and hyperosmolality, and all progressed to coma and death. Serial determinations of ethylene glycol blood levels were performed in many of the patients in this group and showed variable ethylene glycol metabolism rates. The half-life of ethylene glycol appeared to be less than 12 hours in this group where serial hospital blood measurements were taken.

Conclusion: In spite of the recent cluster of alleged and convicted ethylene glycol homicides reported in the media, none have been found in Cook County, Illinois, within the past 11 years. The majority of the Cook County deaths were from suicidal ingestion, with a few accidents in people using it as a substitute for alcohol. The results are similar to a prior reported cluster of non-fatal intentional ethylene glycol intoxications in Northeastern Illinois in 1996.[1] Toxicology values of ethylene glycol should not be used as a substitute for a thorough death investigation in determining manner of death.

[1] Leikin JB, Toerne T, Burda A, *et al*. Summertime cluster of intentional ethylene glycol ingestions. *JAMA*, Nov 5, 1997-vol 278, No. 17, p 1406.

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