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Research Preview

Jeremy Travis, Director

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Improved Postmortem Detection of Carbon Monoxide and Cyanide

A Summary of a Research Study by Barry K. Logan, Ph.D., Washington State Toxicology Laboratory

Traditional methods for detecting carbon monoxide and cyanide during postmortem examinations have proven cumbersome, time consuming, and prone to interference from putrefactive and other changes in the substances analyzed. Even relatively recent methods are often too expensive for routine use or too dependent on subjective interpretations.

Despite the foregoing difficulties, testing for the presence of carbon monoxide and cyanide in biological material is a critical task for forensic laboratories nationwide: knowledge of the presence or absence of those substances in the deceased often helps determine cause of death (murder, accident, natural causes, etc.)—or at least narrows the range of possibilities. For example, the absence of carbon monoxide in the charred remains of an apparent fire victim would suggest that death did not occur as the result of the fire—in which case the victim would likely have inhaled fire-generated carbon monoxide—but instead prior to it.

The importance and prevalence of testing for those substances motivated the National Institute of Justice (NIJ) to support development and evaluation of an improved postmortem method for detecting (1) hydrogen cyanide gas released from inorganic cyanide in biological material and (2) carbon monoxide gas found in fire gases or automobile exhaust.

Lethal effects of carbon monoxide and cyanide

A colorless, odorless gas produced in the combustion of fossil fuels, automobile exhaust vapors, and poorly ventilated gas heating equipment, carbon monoxide is the best known example of an agent that can decrease the oxygen transport capability of blood and prevent oxygen from reaching body tissues in sufficient quantity. Exposure to very high concentrations can result in enough hemoglobin saturation to produce death by asphyxiation in minutes with almost no warning signs.

Cyanide, a common poison, is also a byproduct of the burning of many synthetic polymers and plastics. Cyanide blocks tissue utilization of oxygen and results in abnormally rapid or deep breathing. Cardiac irregularities are often noted, but the heart invariably outlasts the respirations. Death is due to respiratory failure and can occur within seconds or minutes of the inhalation of high concentrations of hydrogen cyanide gas. Because of slower absorption, death may be delayed after the ingestion of cyanide salts but the critical events still occur within the first hour.

Development of an improved detection method

First proposed in 1988, a gas phase electrochemical (GPE) method for detecting and measuring carbon monoxide, although promising, permitted analysis of only a few samples per hour and required the full-time attention of the equipment operator. The NIJ-sponsored project improved the GPE method, which involves freeing a sample of either carbon monoxide or cyanide gas from the material examined and introducing the sample into a GPE detection system. Advantages of this alternative GPE method include:

• Automation of the technique allows speedy analysis so that large numbers of samples can be screened in a relatively short time. Rapid turnaround time (1 minute per sample versus several hours for other approaches) makes the method ideal for the analysis of numerous samples that accident and product-tampering investigations can generate.

• Tests demonstrated that the method was sensitive to concentrations in the range of interest for postmortem material and was free from interference by changes in the substances analyzed.

• Putrefaction of samples did not cause problems for the method, according to test results.

• The technique is applicable to a great variety of solid and semisolid materials that are incompatible with other methods.

Illustrations of method's utility and effectiveness

Two cases illustrate the utility and effectiveness of the improved GPE technique. In one instance, charred, decomposed remains of a suspected drug dealer were found in a burned trailer. The coroner wanted to determine whether the deceased had been dead before the fire started. Blood samples were not available. The only specimen available for testing was the victim's decomposed liver, which was unsuitable for spectroscopic testing for cyanide. However, the improved GPE method determined that the deceased had been breathing when the fire started, allowing the coroner to rule out foul play.

In another instance, the technology was applied to a wide variety of products suspected of having been targets of product tampering. Traditional testing methods would have required 4 hours for each product sample; the GPE method took minutes.

Such cases, among other evidence, indicate that the improved GPE methodology is a reliable and advantageous alternative to other techniques and promises to become even more so as the method is refined in the years ahead.

This project, supported by NIJ grant 91–IJ–CX–0022, was led by Barry K. Logan, Ph.D., Washington State Toxicology Laboratory, Department of Laboratory Medicine, University of Washington. A photocopy of the technical report, "Identification and Measurement of Carbon Monoxide and Inorganic Cyanide in Post Mortem Biological Material," is available through interlibrary loan or, for a small fee, through the National Criminal Justice Reference Service at 800–851–3420. Ask for NCJ 159312.

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