Prototype Detects Cyanide Poisoning

By: Brian Logue, Ph.D.

A victim of cyanide poisoning can die within 5-30 minutes, depending on dose, but the current clinical test to determine cyanide exposure takes 24 hours. Researchers at South Dakota State University have developed a portable test, which can detect cyanide poisoning in 70 seconds.

Cyanide as a Terrorist Agent
The most well-known use of cyanide as a terrorist agent occurred in 1982, when compounds of cyanide were used as adulterants in packages of Tylenol® in the Chicago area, leading to seven deaths. [1] There have also been a number of thwarted uses of cyanide as a terror agent. For example, in 1995, cyanide was placed in several subway restrooms during the Sarin subway attacks in Tokyo [2] and in 2002, Joseph Konopka was indicted by a U.S. grand jury on counts of collecting cyanide in a large quantity in the Chicago subway. [3]

Cyanide from Smoke Inhalation
More than 1.5 million tons of hydrogen cyanide are produced worldwide, according to the United Nations [4,5]. Nearly 20 percent goes to extract gold, silver and other precious metals from ore, while the remainder is used to manufacture paper, textiles and plastics, as well as for electroplating and etching metals. When a building fire occurs, people can be exposed to cyanide. In fact around 23,000 smoke inhalation incidences occur each year [6] and, in aggregate, nearly 60 percent of the people with smoke inhalation likely have potentially lethal cyanide exposure. [7-11]

Symptoms of Cyanide Exposure
Early symptoms of cyanide poisoning are nondescript and generally include dizziness, headache, shortness of breath and rapid heart rate as well as nausea and vomiting. [12] These symptoms can be indicative of a number of ailments, making the accurate diagnosis of cyanide exposure from its symptoms difficult. The lack of a rapid cyanide diagnostic and the difficulty in diagnosing cyanide exposure from its symptoms, leaves emergency medical personnel in a difficult position. They must either treat everyone with these symptoms with cyanide antidotes, which can be expensive and essentially impossible for a mass casualty situation, or risk withholding potentially life-saving treatment for cyanide exposed individuals. [13]

Associate Professor Brian Logue of the South Dakota State University Department of Chemistry and Biochemistry has developed a solution—a portable cyanide diagnostic that can detect exposure to cyanide within 70 seconds. During the last 10 years, Logue has developed techniques to analyze cyanide, its metabolites, and countermeasures for cyanide exposure. Using this experience, Dr. Logue and his team developed the simple sensor for diagnosis of cyanide exposure from 50 μL (around two drops) of blood. The diagnostic uses a two-stage process—the first converts the cyanide in the sample into a gas and the second traps it in a base. [13] The cyanide then undergoes a reaction to become fluorescent when exposed to light. The fluorescence is measured by the sensor to determine analytical concentration of cyanide and tests performed so far on rabbits were 100 percent accurate at diagnosing exposure to cyanide, even at levels 20 times lower than the lethal amount. [13]

The researchers have updated the design, which is in its fourth iteration, and decreased the diagnostic time from 2 minutes to 70 seconds. Current optimization will likely decrease that time to under a minute. Speed is essential when faced with a catastrophic situation, such as a large fire or terrorist attack, in which many victims need to be assessed quickly. In such a scenario, a blood sample from a finger prick, like a diabetic would use to measure blood sugar, could be used to determine if a person has been exposed to cyanide.

Ultimately, the researchers would like to

Researchers have developed a prototype for identifying cyanide poisoning in 70 seconds. (Photo courtesy of Brian Logue)
Spotlight

be able to test saliva or breath (for those who are normally breathing), because they are non-invasive and cyanide exposure typically occurs through the mouth or nose. However, thus far a quantitative link between saliva or breath cyanide concentrations and cyanide exposure has not been definitively established. In addition, the researchers will tap engineering expertise to miniaturize the device and will optimize the replaceable cartridge that contains the reactive chemicals. Currently, the device is being transitioned out of the laboratory, and more work is being done towards approval by Federal Drug Administration for rapid cyanide diagnosis.

About the Author:
Brian Logue, Ph.D. is an associate professor in the department of chemistry and biochemistry at South Dakota State University. He is also the associate director for the Center for Security Printing and Anti-counterfeiting Technology at SDSU.

References:

HDIAC publishes short articles (spotlights) every two weeks on www.hdiac.org. Spotlights are high-level, short summaries of technologies, research, or events in our eight focus areas. They are typically one to two pages in length and include at least one picture for the homepage slider. Additional pictures are not required but are recommended, should support the text, and will be placed in the spotlight. All pictures must be high resolution, approved and released for publication to HDIAC, and credited. Any references should be fully cited at the end of the spotlight in APA format. Spotlights must be free of political opinion/positions, refrain from promoting a specific product or company, and not editorialize. The spotlight and any associated references will be added to the HDIAC collection.

The spotlights are published on hdiac.org along with a downloadable PDF versions and are posted to HDIAC’s twitter and LinkedIn accounts. Authors are encouraged to visit the HDIAC website to download and display the pdf. The spotlights can be re-published after they have been taken off the HDIAC website, and we appreciate citing HDIAC as the original source.

To submit a spotlight, you can send a complete spotlight to Jessica Hill (jhill@hdiac.org). If you have an idea for a spotlight and would like to check that it falls within our focus areas, you can also email the idea to the same address.

Read the HDIAC Journal * Subscribe to the HDIAC Journal * HDIAC Spotlight Archive

This content was published on July 6, 2015 as an HDIAC Spotlight at the following URL: https://www.hdiac.org/node/1778