Biodetectors – What They Are and Why We Need Them

Do you remember where you were on September 11, 2001? Most Americans can provide vivid details of their thoughts and experiences on that world-changing day. The feeling of invincibility that engulfed the United States before 9-11 quickly gave way to a stifling fear of what might happen next. Fear of the catastrophic unknown quickly transformed most Americans into determined problem solvers constantly brainstorming for ideas to curtail the next attack. The harsh reality of a biological attack motivated the United States government to scour its resources for a defense against this seemingly unstoppable force. The most promising solution to emerge was the threat-terminating device called the biodetector.

Lethal pathogens are the primary agent in biological warfare. Biological warfare can be defined as the use of any pathogen, such as a bacterium, virus, or toxin, as a weapon of war. "A healthy person breathes in roughly six liters of air a minute, and certain pathogens can cause disease when as few as 10 organisms are inhaled." (Casagrande) The tactical dispersal of these biological agents is often colorless and odorless, and it can take days for physical symptoms to appear in the victims. Accordingly, Casagrande reports that a society might not know it is under attack until it is too late to respond. Through the use of a biodetector, these lethal pathogens can be recognized before they carry out their objective, thus saving the lives of many.

The biodetector is one of the most ingenious devices to be discovered in the past century. As documented by scientists at the Lawrence Livermore National Laboratory (LLNL), biodetectors depend on unique nucleic acid, antibody, or protein signatures to function. They scan the questionable item for one of these unique identifiers to indicate

whether lethal pathogens are present. As stated by Murray, these devices range from large, desktop units that can find lethal pathogens in the air, water or soil to handheld units that can detect such contaminants in blood or saliva. Hasson reminds us that twenty-first century biodetectors are a far cry from the past when World War I soldiers were issued primitive gas masks and brought pigeons into battle to help detect gas. If the birds died, it was a warning that the enemy had released toxins into the battlefield.

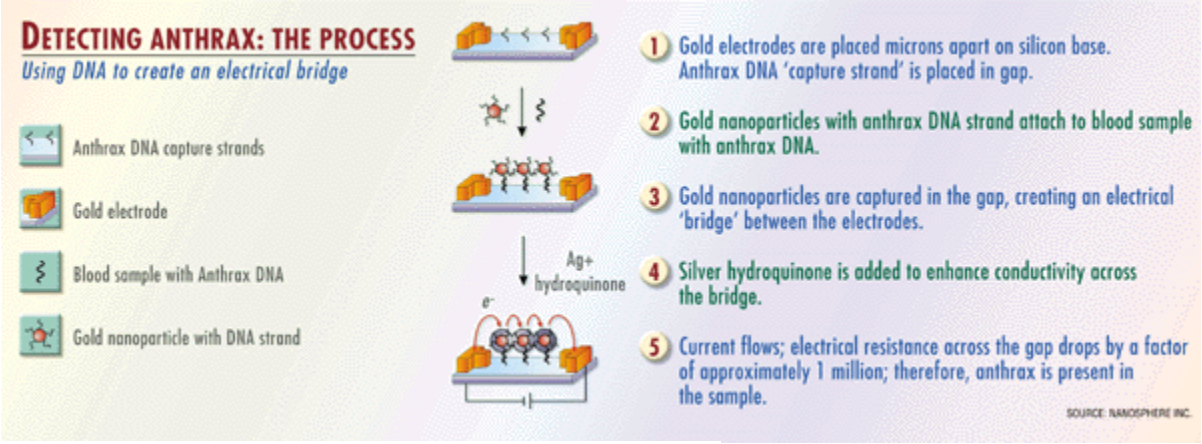

Exhibit A - Detecting anthrax: the process (Murray)

One of the most well known forms of biological warfare is anthrax. As defined by the Centers for Disease Control, anthrax is an acute infectious disease caused by the spore-forming bacterium *Bacillus anthracis*. According to the FBI Amerithrax investigation, in the weeks following 9-11, letters containing anthrax bacteria were mailed to several news media offices and two U.S. Senators. Five people were killed and 17 others became sick through anthrax skin contact and inhalation. The anthrax in these letters ranged in appearance from a coarse brown granular substance like dog chow to a more potent white powder like chalk, and was nearly impossible to detect without the services of a sophisticated laboratory. Dozens of buildings were contaminated with

anthrax as a result of these mailings, causing major disruption to the U.S. Postal Service and many government offices. According to the FBI, the cost of cleanup exceeded one billion dollars.

As Thayer reports in Chemical and Engineering News, the U.S. Postal Service has invested hundreds of millions of dollars to install biohazard detection systems in mail sorting facilities nationwide. These biodetectors are intended to protect mail sorting employees from exposure to lethal pathogens. A graphic depiction of the scientific process used to detect anthrax is provided in Exhibit A. A view of biodetectors in use in a mail sorting facility is shown in Exhibit B.

Exhibit B – View of biodetectors at mail sorting facility – (Thayer)

LLNL scientists had been researching biohazard detection systems before 9-11 and this biodetector research came into national prominence in the aftermath. Continued research has produced several improvements to biodetector capability since the introduction of the original devices. Biodetector portability has been especially helpful in military settings as soldiers can now carry devices into the war zone and identify hazards before they inflict damage. When biodetectors were only available in stationary form, all items were brought back to headquarters facilities to be scanned thereby wasting

Exhibit C – View of biodetector aboard a military aircraft (Casagrande)

valuable time in countering a potential biohazard. A view of a biodetector carried aboard a military helicopter is provided in Exhibit C.

Biodetectors have application beyond strengthening America's national security against bioterrorism, and can be very useful in the medical arena. As reported by Lerner and Thomson, biodetectors are being used in forensic medicine to assist in pinpointing the cause of death. During autopsies, the body is scanned for the presence of pathogens that could have contributed to the death. Researchers at LLNL are also investigating the viability of a biodetector that can scan for host-based, disease-causing signatures in the body. Once introduced to the medical marketplace, these devices will enable doctors to identify the existence of dangerous pathogens before the physical symptoms of disease materialize. According to Casagrande, scientists are also experimenting with devices that "sniff out" odors emitted by microbes or the additives used to make them into weapons. "Biological weapons reach the level of weapons of mass destruction—with a potential for human casualties rivaling that of nuclear weapons—only when they are disseminated through the air as a breathable aerosol of particles about one millionth of a meter in size." (Casagrande) If these weapons of mass destruction can be detected and defended against, our country will be a safer place to live.

In conclusion, the tragic events of 9-11 have drawn attention to the fact that our society is vulnerable to terrorist attack, and the threat of bioterrorism is a reality. In response, scientists have produced biohazard detection systems known as biodetectors that can identify the presence of lethal pathogens before the pathogens can inflict damage. Biodetectors have been installed in mail sorting facilities to protect employees from anthrax and other threats, and portable units can now be carried into a war zone to

alert soldiers to the presence of lethal pathogens. Biodetector research is also yielding benefit to the medical community as the devices are able to confirm the presence of pathogens during autopsies, leading to confirmation of cause of death. Future devices may be able to identify pathogens in the body before disease symptoms appear. Given the current cost to produce these devices, Murray predicts that it will be some time before biodetectors are installed in most business and residential settings, but it is at least comforting to know the technology exists and is available when required.

Reference List

2001 Anthrax Attacks. Wikipedia. http://en.wikipedia.org/wiki/2001_anthrax_attacks

Amerithrax Investigation. Federal Bureau of Investigation. http://www.fbi.gov/anthrax/amerithraxlinks.htm

Anthrax. Division of Bacterial and Mycotic Diseases. Centers for Disease Control and Prevention. Department of Health and Human Services. http://www.cdc.gov/ncidod/dbmd/diseaseinfo/anthrax_g.htm#What%20is%20anthrax

Biological Warfare. Wikipedia. http://en.wikipedia.org/wiki/Biological_warfare

Casagrande, Rocco. (2002). Technology Against Terror. Scientific American, October 2002, 82-87. http://www.resrchintl.com/pdf/Technology%20Against%20Terror.pdf

Defense Against Bioterrorism. Nonproliferation, Arms Control, and International Security. NAI at LLNL. http://www.llnl.gov/nai/Programs/Counterterrorism/Defense_Against_Bioterrorism.php

Dunn, M. W. "Assessing the Viability of Biodetectors in Providing Early Warning of an Impending Bioattack." http://lumen.georgetown.edu/projects/PosterTool/index.cfm?fuseaction=poster.display&posterID=856

Hasson, J. "Biodetectors Sniff Out Deadly Airborne Agents." (2003) http://www.fcw.com/fcw/articles/2003/0707/tec-sniff-07-07-03.asp

Lerner, Ed. K.L., Lerner, Brenda W., Thomson, Gale. (2006) "Biodetectors." World of Forensic Science. http://science.enotes.com/forensic-science/biodetectors

Murray, C. J. "Biodetectors Aim To Broaden Search for Anthrax Bacteria." (2001) http://www.eetimes.com/story/OEG20011012S0077

Osolin, C. (2005). Mariella Seeks Better Biodetector. Newsline. Vol. 30, (No. 34), 1-4. http://www.llnl.gov/PAO/employee/articles/2005/08-26-05-newsline.pdf

Paul, M.R., Cross, M.C., Radovitzky, R. "BioNEMS: The Design of a Nano-Biodetector." (2002) http://www.its.caltech.edu/~mpaul/dfd2002.pdf

Rennie, G. (2004) Radiation Detection on the Front Lines. Science and Technology Review, September 2004, 4-11.

Thayer, Ann. (2003). Postal Service Readies Defense. Chemical and Engineering News. Vol. 81, (No 21), 7.