CDC's Laboratory Response to Toxins

Magnified image of Bacillus anthracis.

Aflatoxin in peanuts.
Source: Flickr user IITA Image Library

Death Cap Mushrooms.
Source: Flickr user Ressaure

Public Health Problem

Toxins are some of the most deadly chemicals known and represent an ongoing bioterrorism threat.[1] The Centers for Disease Control and Prevention (CDC) has developed specific and sensitive methods to help **diagnose, treat,** and **prevent diseases** caused by toxins and living things that make toxins.

Toxins from Bacteria

- **Anthrax Lethal toxin** is produced by *Bacillus anthracis*. The anthrax toxin proteins, including anthrax lethal factor, work together to disrupt a cell's defense system.
- **Botulinum toxin,** produced by *Clostridium botulinum*, is one of the most poisonous substances known. It causes botulism, a severe muscle-paralyzing disease, which affects an average of 200 persons living in the United States each year. The toxin enters the body through contaminated food, infected wounds, and bacteria in a child's digestive tract.[2]
- Anthrax Lethal and Botulinum toxin are two of the six mostly likely biological threat agents.[3]
- **Pertussis toxin** is produced by the *Bordetella pertussis* bacteria which causes whooping cough. Several states are reporting an increase in whooping cough cases, including a state-wide epidemic in California.[4]
- **Staphylococcal enterotoxin B (SEB)** is the toxin most often associated with food poisoning. SEB can be easily put into a fine mist (aerosolized), which makes it a serious biological threat agent.

Toxins from Fungi and Algae

- **Aflatoxins** are produced by many species of the fungus *Aspergillus*, which commonly contaminates corn (maize) and other types of crops during production, harvest, storage or processing. Aflatoxin is known to cause acute and chronic liver injury and cause liver cancer.[5] Aflatoxins are considered unavoidable contaminants in the U.S. food supply, especially in corn and peanuts. The U.S. Food and Drug and Administration and the U.S. Department of Agriculture monitor peanuts and field corn for aflatoxins and can remove food with unacceptable levels.
- **Saxitoxin** and **neosaxitoxin** are produced by several species of marine and fresh water algae and blue-green algae *(cyanobacteria)*. When these organisms are present in high concentrations, the toxins may build up in filter-feeding shellfish, such as clams and oysters. These toxins poison people when they eat contaminated shellfish. Paralytic Shellfish Poisoning (PSP) is one of the most severe forms of poisoning. PSP can cause paralysis and death if left untreated.
- **Amanitin toxins** are produced by the poisonous death cap mushroom *(Amanita phalloides)*. People are poisoned when they eat these mushrooms, which may look similar to non-harmful mushrooms. Health effects may include liver and kidney failure and death. Currently, there is no clinical test for amanitin poisoning.
- **Other toxins from fungi and algae** vomitoxin (deoxynivalenol), diacetoxyscirpenol, and T-2 and HT-2 toxins. These mycotoxins affect up to 25 percent of the world's grain supply. All of the mycotoxins are considered bioterrorism threat agents.

National Center for Environmental Health
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Ricin is a poison found in castor beans.
Source: Flickr user Museumdetoulouse

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Toxins from Plants

- **Abrin,** found in the seeds of the rosary pea, is one of the most poisonous plant toxins.
- **Ricin** is a poison found in castor beans. Each year, tons of castor beans are grown to produce castor oil. Both ricin and abrin work by entering human cells and preventing the cells from making the proteins they need. Without the proteins, cells die. This is harmful to the whole body, and the patient may die.[6]
- Although toxins are difficult to measure in human blood and urine, data on human exposures is critical to diagnose, treat, and prevent human disease.

CDC's Division of Laboratory Science Response to Toxins

In an emergency, CDC's advanced laboratory techniques allow scientists to

- **deliver test results sooner. Time is one of the most crucial factors in handling a public health emergency from a natural or terrorist source.** CDC's toxin methods are the most rapid tests available, allowing for definitive answers within hours of receiving the samples.
- **analyze more samples per day.** An equipped laboratory can measure hundreds, or even thousands, of samples each day. This high output was not possible with previous equipment and methods. In a recent exercise, the CDC laboratory successfully analyzed five thousand samples for ricinine, a stable marker for Ricin exposure.
- **quantify the toxin to track the course of infection.** Clinicians can use these methods to track the success of the treatment by looking at the decrease of toxins in the body. When clinically managing patients who are not getting better, identifying the difference between inefficient treatment and other illnesses (e.g., acute respiratory distress syndrome) is important.
- **characterize various toxin forms and subtypes.** CDC's method for botulinum toxin detects all forms and subtypes of the toxin. The ability to characterize toxins will allow scientists to confirm the likeliness of a common source of toxin in a natural or terrorist event.

What CDC Is Doing Now

CDC is continuing to do research on toxins. CDC's research involves

- **developing new test methods.** New methods are being developed for priority toxins including ricin, abrin, SEB, shiga toxins, gonyantoxins, and brevetoxins.
- **using their advanced technology** to diagnose, treat, and prevent toxin related diseases throughout the world, in particular, toxin methods have been used on aflatoxin, anthrax, botulism, ricin, saxitoxin and neosaxitoxin cases.
- **transferring technology.** CDC is working to transfer its methods to federal, state, and private laboratories to increase testing capacity during an emergency involving toxins.

References

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