Chapter 8

TOXINS

Summary

Signs and Symptoms: Vary among toxins. Botulinum toxins cause descending weakness and paralysis (including respiratory muscle paralysis) along with dry mouth and dilated pupils. Ricin and staphylococcal enterotoxin B (SEB) cause different presentations depending upon the route of exposure.

Detection: No field detectors are commonly available. Detection is mainly through a high index of suspicion and clinical recognition of signs and symptoms.

Decontamination: Clothing removal and skin cleansing using water (with or without soap) is generally sufficient.

Management: For almost all toxins, treatment is supportive only. This includes the potential necessity of ventilatory support for weeks following exposure to botulinum toxins, although a botulinum toxoid product is effective if given before signs and symptoms appear. Active immunization with botulinum toxoid is available only as a preexposure measure for those at demonstrated high risk.

Classification and Mechanisms of Action

The term "toxin" is sometimes used as a general synonym for poison; however, it is more strictly defined as a poisonous substance produced by a living organism. Unlike biological organisms, toxins do not replicate inside hosts or cause infection; rather, they produce "intoxication" or poisoning. Victims of toxins are not contagious.

There are hundreds of biological toxins, but most have not been developed for use as mass-casualty weapons. Toxins can be grouped according to source as bacterial, algal, fungal, plant, marine dinoflagellate, marine soft coral, arthropod, molluscan, or vertebrate. Additionally, they can be divided by mechanism of action into neurotoxins (toxins that affect neurotransmission), cell-damaging toxins, and superantigen toxins (which nonspecifically activate the immune system).

Detection

Laboratory detection of toxins in the environment or in biological samples is not generally available in the field. Detection will rest primarily upon a high index of suspicion and clinical recognition of signs and symptoms.

Physical Properties and Protection

Toxins can be dissolved in various other substances or spread as aerosols and may not be visible or irritating; exposure can occur without the knowledge of the victim. Aerosolized toxin can be inhaled or can settle on the skin, although only the T-2 mycotoxins are dermally active. Toxin can also be ingested or injected. Protection against inhalation and skin contact is provided by the protective mask and by any clothing that covers the skin.

Decontamination

Removal and laundering of clothing and skin cleansing using water (with or without soap) is all that is usually necessary. Because toxins are poisons rather than living organisms, disinfection and sterilization are not applicable.

Specific Toxins

- **Botulinum toxins**, a group of seven related neurotoxins produced by the bacterium *Clostridium botulinum*, are the most potent known poisons and cause botulism through ingestion

or toxin production in wounds. Victims exhibit descending skeletal muscle weakness (beginning with blurred vision, inability to fully open the eyelids, and difficulty swallowing) within 12 to 36 hours after inhalation of aerosol or up to several days after ingestion. The pupils dilate and the mouth is dry. Eventually, respiratory paralysis leads to death, unless ventilatory support can be established and maintained for several weeks. Intravascular and intramuscular administration of botulinum antitoxin is effective during the latent period, but rapidly becomes ineffective after signs and symptoms begin to appear. A toxoid is available for vaccinating laboratory workers at known risk of exposure.

- **Ricin** is a cell-damaging toxin extracted from the castor bean plant (*Ricin communis*). Ricin has been injected into victims in covert assassination attempts. The toxin binds to ribosomes and impairs protein synthesis. Ingestion produces mainly gastrointestinal effects; inhalation causes damage to both the central and peripheral compartments of the respiratory tract (leading to airway necrosis and pulmonary edema); and injection generally spares the respiratory tract, but leads to widespread organ necrosis and disseminated intravascular coagulation. No antitoxin (for passive immunization after exposure) or toxoid (to produce active immunization prior to exposure) is available for humans. Treatment is supportive.
- **SEB** is a superantigen toxin that causes self-limited incapacitating (seldom lethal), abrupt-onset abdominal pain, vomiting, and diarrhea after ingestion. Difficulty breathing, nonproductive coughing, fever, chills, and headache appear 3 to 12 hours after inhalation of aerosolized toxin. Treatment is supportive.
- **T-2 toxin** is one of the trichothecene mycotoxins (produced by fungi). Within 10 to 30 minutes after inhalation or ingestion, it can cause bloody vomiting and diarrhea, chest pain, and dizziness. Skin blisters can appear after skin contact. Death can follow weeks later from bone-marrow suppression, liver failure, or internal bleeding. Treatment is supportive.
- **Aflatoxins** are fungal toxins that are acutely toxic as well as being immunosuppressive, mutagenic, and carcinogenic. Acute effects include abdominal distress, pulmonary edema, and convulsions. Treatment is supportive.

- **Abrin** is a cell-damaging toxin found in jequirity beans. It is similar to ricin, but in mice is 75 times more toxic. Treatment is supportive.
- **Domoic acid** is an excitatory neurotoxin responsible for amnesic shellfish poisoning, which can cause seizures. Treatment is supportive.
- **Epsilon toxin** (from *Clostridium perfringens*) is a cell-damaging toxin. Ingestion increases the permeability of the small intestine and leads to increased absorption and damage to blood vessels, especially in the kidney, liver, and brain. Inhalation can cause damage to pulmonary vessels. The toxin is dermally active and can cause skin lesions. Treatment is supportive.
- **Epibatidine** (produced in the skin of poisonous frogs) and anatoxin-a (from cyanobacterial, or blue-green algae) produce the nicotinic effects of nerve agents; anatoxin-a(s), another cyanobacterial toxin, produces both the nicotinic and the muscarinic effects of nerve agents. Treatment is the same as for nerve agent poisoning.
- **Saxitoxins** are cyanobacterial (blue-green algal) toxins that cause paralytic shellfish poisoning. They can cause death within 10 seconds via paralysis. Treatment is supportive.
- **Tetrodotoxin** is an inhaled or ingested marine neurotoxin found in certain saltwater fish (such as puffer fish), crabs, starfish, blue-ringed octopi, newts, and salamanders. Death occurs from paralysis. Treatment is supportive.
- **Palytoxin** is a cyanobacterial (blue-green algal) toxin concentrated in corals. It is nearly as potent as botulinum toxins and causes vascular collapse and cardiotoxicity. Intracardiac injection of vasodilators may be the only recourse.