Recognizing and Treating Exposure to Anthrax, Smallpox, Nerve Gas, Radiation, and Other Likely Agents of Terrorist Attack

Matt Bolinger, MD

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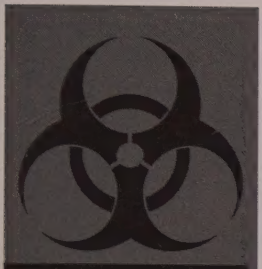

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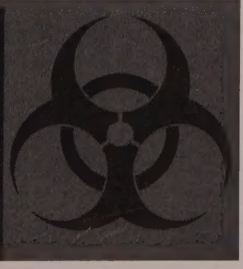

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For Wendy

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Warning

This book is intended to give the reader a general sense of chemical, biological, and radiological warfare agents, their symptoms and treatment, and methods of prevention. It is not intended to diagnose or treat disease.

Only qualified health care workers under appropriate supervision should carry out procedures and treatments for exposure to chemical and biological agents.

Special note: Many of these agents are so uncommon that there is no credible information on dosages for children. Unless otherwise specified, the dosages given are for adult patients.

Care has been taken to present accurate information in describing the agents and current accepted practices in treatment; however, the author, publisher, and distributors cannot accept any responsibility for errors or omissions or any consequences from application of the information in this book and make no warranty, express or implied, with respect to the contents of the book. *This book is for information purposes only.*

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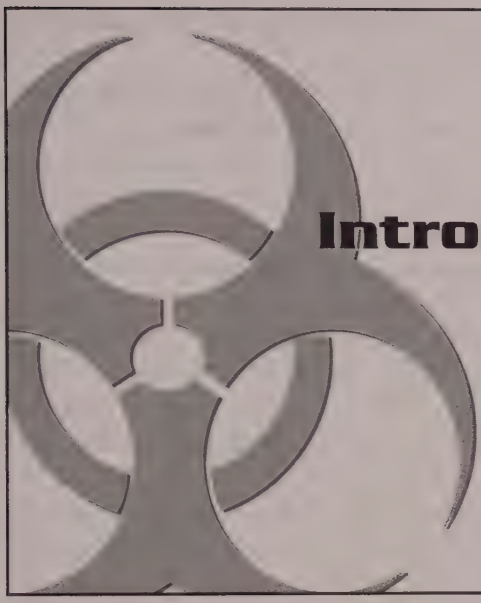


Introduction

In October 2001, a United States still reeling from the September 11 attacks faced the next challenge as news broke of anthrax being sent via the U.S. mail. Because the early symptoms of potentially fatal anthrax inhalation mimic those of the common cold, frightened people crowded their doctor's offices and hospital emergency rooms. Thousands were tested for exposure to the bacterial agent and thousands more were prescribed a 60-day course of the antibiotic ciprofloxacin.

The federal and state governments passed new laws, created new departments, and revamped old ones in response to the attacks. The U.S. Postal Service changed the way it handled mail. The economic effects alone could boggle the imagination. These attacks changed everything from meat inspection to foreign policy; these attacks changed the face of American culture.

One such change was in the American vocabulary. Anthrax became a household word, along with VX, sarin, and the term "dirty bomb." Our way of life changed before our very eyes. We

learned we must prepare ourselves for this brave new world, and preparation begins with knowledge.

At the root of fear is the unknown. This book combats fear by presenting relevant and useful facts on possible agents of terror. These facts include descriptions of the agents, the symptoms they produce, treatment options, and ways to prevent exposure and intoxication. Also included in this book are exam questions to help you test your comprehension and a chapter on vital signs.

Do you know what antibiotics should be used for anthrax exposure or plague outbreaks? What can be done in the event of a smallpox epidemic? How long cholera can persist in a water supply or on a metal object, such as a coin? How to disinfect water contaminated with botulinum toxin? This book will answer these questions and many more. The reality of today's world makes it imperative that citizens be informed about possible threats and, more importantly, a means of dealing with these threats. The information contained in this easy-to-understand book could save your life.

The following questions will allow you to test your knowledge of chemical and biological agents before reading this book. The answers are found at the end of the test.

Question 1: Which of the following diseases is treated with antibiotics?

A. Smallpox
B. Mustard poisoning
C. Yellow fever
D. Tularemia
E. Botulism

Question 2: Which of the following caused millions of deaths in the 14th century?

A. Anthrax
B. *Yersinia pestis*
C. Hantavirus
D. Lewisite
E. Sarin

Question 3: In which war was mustard gas first used?

A. Civil War
B. World War I
C. World War II
D. Vietnam
E. Revolutionary War

Question 4: Which toxin does the castor-bean plant produce?

A. SEB
B. T-2
C. Ricin
D. Castor nitrate
E. None of the above

Question 5: Which of the following has the faint odor of bitter almonds?

A. Mustard gas
B. Tabun nerve agent
C. T-2
D. Hydrogen cyanide
E. Both B and D

Question 6: Which of the following might your local law enforcement agency use to clear a street of rioting basketball fans?

A. CS
B. Mustard
C. Nerve gas
D. VX
E. Anthrax

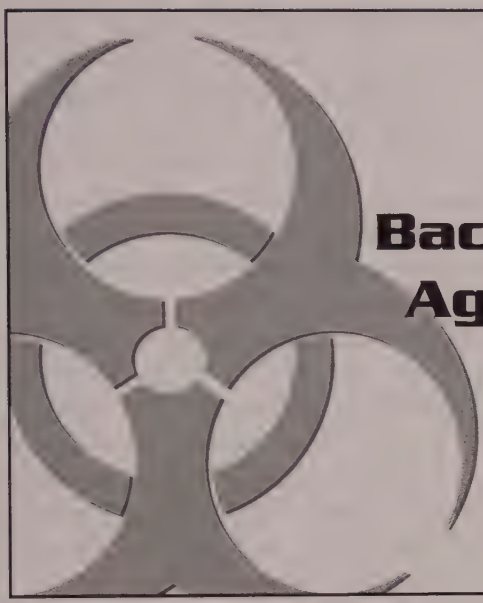
Question 7: Which of the following can be used in treating cholera?

A. Tetracycline
B. Doxycycline
C. Ciprofloxacin
D. Erythromycin
E. All of the above

Question 8: What are some symptoms of gamma radiation exposure?

A. Nausea
B. Vomiting
C. Anorexia (loss of appetite)
D. Fatigue
E. All of the above

Answers: 1: D; 2: B; 3: B; 4: C; 5: E; 6: A; 7: E; 8: E



Bacterial Agents

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Bacteria are one of the five agents of human infectious disease, along with viruses, fungi (such as yeast and mold), protozoa (including giardia and malaria), and helminths (intestinal worms). Bacteria are unicellular organisms and are classified by shape into four basic groups: cocci, bacilli, spirochetes, and pleomorphic (variable shapes).

Bacteria have cell walls and can be classified by the way they react to a gram stain, which allows the cells to be viewed under a microscope. In this technique, bacteria will stain according to the structure of their outer envelope: gram-negative bacteria have three layers in the outer envelope and stain red, and gram-positive bacteria have two layers in the outer envelope and stain blue. (The terms negative and positive here refer to the stain absorption of the bacterial cells, not the absence or presence of disease.) The ability to identify the type of bacteria is important in determining the treatment of an infection.

Some bacteria can form endospores in response to adverse conditions, such as depletion of nutrients. These spores form

inside the bacterial cell and contain bacterial genetic information; a "coat" forms around the genetic material and is responsible for its resistance to heat, dehydration, radiation, and chemicals. The spore has no metabolic activity of its own and can remain dormant for long periods of time. Like plant seeds, spores wait for the right conditions to germinate and grow.

Bacteria can be aerobic (use oxygen), anaerobic (can't grow in the presence of oxygen), or facultative anaerobic (prefer oxygen but can live without it). Bacteria generally range in size from 0.2 to about 5 micrometers (one micrometer is one-millionth of a meter).

Aerosol particles retained in the lungs are typically between 0.5 and 5 micrometers in diameter—particles smaller than 0.5 micrometers can be inhaled but are generally exhaled as well; particles larger than 5 micrometers are normally trapped in the nasal passages or trachea; particles larger than 15 micrometers generally do not remain in the air for extended periods.

ANTHRAX

Anthrax is the acute infection caused by the pathogen (disease-causing substance) *Bacillus anthracis. B. anthracis* is a spore-forming, aerobic, gram-positive bacteria that usually infects herbivores (e.g., cattle and sheep). Humans can become infected by coming into contact with the spores. In aerosolized form, the spores are colorless, odorless, and tasteless. The spores can be acquired by inhalation, skin contact (cutaneous), insect bites (cutaneous), and ingestion (gastrointestinal). *B. anthracis* is unique in that it has a protein capsule that makes it indestructible by the immune system. This organism produces toxins with three components: protective antigen, lethal factor, and edema factor. Once the bacteria enter the bloodstream, they multiply rapidly and kill the host quickly. Most cases in nature are cutaneous (95 percent). The onset of the disease can range from 1 to 60 days after exposure but usually occurs within 7 days. Anthrax is not likely to be spread person to person.

Symptoms

Cutaneous

Spores enter the skin through a cut, abrasion, or insect bite and germinate within hours. (Unbroken skin that comes in contact with spores will be unaffected.) Within days of exposure, a small, red, itchy bump resembling an insect bite appears. Within the next few days, the red spot progresses to an ulcer 1 to 3 centimeters (cm) in diameter. A characteristic black area develops in the center of the ulcer, and the perimeter of the ulcer is often swollen. A fully developed ulcer is painless. Lymph glands in the adjacent area may swell, and other lesions may appear near the original ulceration site. Spontaneous healing occurs in up to 80 percent of cases. In 20 percent of cases, bacteria become detectable in the bloodstream, and these patients experience high fever, shock, and possibly death.

Inhalation

Anthrax by inhalation is also known as woolsorter's disease because it often afflicted people that worked with wool from contaminated sheep. The first symptoms mimic the common viral cold, making the diagnosis difficult. Anthrax in the respiratory tract presents as fever, shortness of breath, and decreased blood oxygen. The 2001 attacks in the United States left patients with symptoms such as shortness of breath, tightening of the chest, headache, chills, fatigue, muscle aches, dry cough, nausea, and vomiting. Patients commonly had no nasal congestion, which could be an important clue in making a preliminary diagnosis since it would be expected to accompany the common cold. In the last stages of the disease, low blood pressure and respiratory distress are seen. Shock and death usually follow 24 hours after the onset of the last stage.

Gastrointestinal

Spores can be ingested and colonize in the gastrointestinal (GI) tract. Most GI cases are due to eating undercooked meat containing spores. Anthrax of the gastrointestinal tract presents as fever, nausea, vomiting, abdominal pain, and bloody diarrhea,

which is occasionally massive in volume. *B. anthracis* can colonize in the throat and present as fever, sore throat, and difficulty swallowing. The lesions can usually be seen on the tonsil. GI forms of anthrax can also lead to respiratory distress, shock, and death.

Treatment

Many antibiotics can be used to treat anthrax. Ciprofloxacin and doxycycline are the antibiotics of choice for treating anthrax that has been contracted through deliberate inoculation, such as acts of terror or biological warfare. (Biological agents engineered for warfare or terrorist acts are sometimes made to resist certain antibiotics. The same agents in nature probably don't contain the genetic mechanisms necessary to resist the antibiotic.) Penicillin, amoxicillin, and tetracycline have also been used in treating the disease. The strains of anthrax used in the September and October 2001 attacks in the United States were found to be susceptible to ciprofloxacin, tetracycline, doxycycline, penicillin, amoxicillin, and rifampin. The strains used in the attack were only intermediately susceptible to erythromycin. In severe infections, combinations of antibiotics may be appropriate. Treating inhaled anthrax is difficult once symptoms appear and leads to death in most, but not all cases.

In treating anthrax, the first phase of the antibiotic therapy should be done intravenously with the medicines listed in the chart and possibly one or two additional antibiotics. The 60 days of treatment include intravenous and oral antibiotics.

Prevention

The spores of *B. anthracis* can survive for years in dry earth. The spores can be destroyed by a number of oxidizing agents (e.g., 3 percent hydrogen peroxide, iodine, or chlorine bleach). Boiling water for 30 minutes with an added disinfectant (chlorine bleach or iodine) can deactivate anthrax and its spores. Dry heat above 320°F (160°C) will deactivate anthrax and its spores. Since the spores are microscopic, determining the area to decontaminated involves guesswork, and the amount of oxidizing agent to use depends on the area to be cleaned. For example, one part household bleach mixed with 10 parts water could be used to disinfect surfaces.

Anthrax

Treatment of Adults

USE ONE OF THE FOLLOWING:

Ciprofloxacin

400 to 500 mg orally every 8 to 12 hours for 60 days.

Doxycycline

100 mg orally every 12 hours for 60 days with a loading dose of 200 mg. (A loading dose is an initial dose of medication intended to bring the patient's blood levels up to a therapeutic range.)

Amoxicillin

500 mg orally every 8 hours for 60 days. Amoxicillin is not a treatment of choice; use only when ciprofloxacin and doxycycline are contraindicated (when it is inadvisable for the patient to take the medication).

Treatment of Children

USE ONE OF THE FOLLOWING:

Ciprofloxacin

6.8 mg orally per pound of body weight (*not to exceed 500 mg*) every 12 hours for 60 days.

Doxycycline

8 years old and up and greater than 100 lb., 100 mg orally every 12 hours for 60 days.

Younger than 8 years old and less than 100 lb., 1 mg orally per pound of body weight (*not to exceed 100 mg*) every 12 hours for 60 days.

Amoxicillin

36.3 mg orally per pound of body weight per day, divided into three doses and *not to exceed 500 mg per dose or 1,500 mg per day.* Amoxicillin is not a treatment of choice; use only when ciprofloxacin and doxycycline are contraindicated.

Anthrax

Prophylactic Treatment of Adults

USE ONE OF THE FOLLOWING:

Ciprofloxacin

500 mg orally every 12 hours for 60 days.

Doxycycline

100 mg orally every 12 hours for 60 days.

Amoxicillin

500 mg orally every 8 hours for 60 days (amoxicillin is not a treatment of choice; use only when ciprofloxacin and doxycycline are contraindicated).

Prophylactic Treatment of Children

USE ONE OF THE FOLLOWING:

Ciprofloxacin

6.8 mg orally per pound of body weight (*not to exceed 500 mg*) every 12 hours for 60 days.

Doxycycline

8 years old or older and greater than 100 lb., 100 mg orally every 12 hours for 60 days.

Younger than 8 years old or less than 100 lb., 1 mg orally per pound of body weight (*not to exceed 100 mg*) every 12 hours for 60 days.

Amoxicillin

36.3 mg orally per pound of body weight per day, divided into three doses and *not to exceed 500 mg per dose or 1,500 mg per day* (amoxicillin is not a treatment of choice; use only when ciprofloxacin and doxycycline are contraindicated).

Ciprofloxacin, doxycycline, and a number of other antibiotics can be given as a prophylactic (something that wards against or prevents disease). Cephalosporins should not be used for post-exposure prophylaxis or treatment of anthrax infections. Penicillin or amoxicillin may be used for post-exposure prophylaxis when ciprofloxacin and doxycycline are contraindicated.

There is a cell-free filtrate vaccine available that is reported to be 93 percent effective in protecting against anthrax. Three subcutaneous injections of the vaccine (0.5 ml) are given in 2-week intervals, then three additional injections are given at 6, 12, and 18 months. An annual booster injection is recommended thereafter. A mild reaction consisting of tenderness and redness at the injection site occurs in 30 percent of the recipients.

Handwashing, bandaging exposed skin lesions, proper food preparation, and air filtration (particulate filter efficiency of P100) are possible prevention methods. Gas masks are effective in preventing inhaled exposure to anthrax spores.

BRUCELLOSIS

Brucellosis, also known as undulant fever, is a disease normally transmitted to humans from infected animal products. Human brucellosis can be caused by any of four species of brucella. The brucella are small, aerobic, gram-negative bacilli and do not form spores. They enter the host and reside within the host's cells, which hinders an immune response. They can be deactivated by exposure to dry heat 320–340°F (160–170°C) for 1 hour but can withstand freezing for extended periods.

This organism can survive up to 40 days in dried soil and up to 125 days in damp soil. It can survive on a piece of paper for up to 32 days at room temperature. This organism can be aerosolized and inhaled or enter the body through cuts and abrasions. It is thought that as few as 10 organisms can cause disease in humans.

Brucella can be passed person to person through the placenta, breastfeeding, and sexual contact. The incubation period for this organism is 1 to 3 weeks but can be as long as a few

Brucellosis

Treatment

Use BOTH of the following:

Doxycycline

200 mg orally per day for 6 weeks. (Ofloxacin, at 400 mg per day, can be substituted for doxycycline but must also be coupled with rifampin.)

Rifampin

600 mg orally or IV per day for 6 weeks.

Prophylactic Treatment

Use BOTH of the following:

Doxycycline

200 mg orally per day for 6 weeks.

Rifampin

600 mg orally or IV per day for 6 weeks.

months. Chronic brucellosis can continue for years, but death is rare, even if left untreated.

Symptoms

The most common symptoms of brucellosis are fever, chills, excessive sweating, weakness, headaches, muscular pain, fatigue, anorexia, joint and lower back pain, sore throat, and dry cough. There are occasionally mental status changes. On occasion the infected person presents with enlarged lymph glands, enlarged liver and spleen, arthritis, skin rash, meningitis, cardiac irregularities, or pneumonia. The fever is often absent in the morning and gradually increases to peak in the evening.

Treatment

Treatment of brucellosis is difficult due to the nature of the offending organism. A combination of doxycycline and rifampin can be used for six weeks in acute cases. Supportive care in addition to antibiotics can give the patient added relief.

Prevention

Boiling and pasteurization can kill this organism. A vaccine has been created but is not available in the United States. Prophylactic treatment with doxycycline and rifampin for 6 weeks can prevent the disease in inoculated persons. Brucella contamination can be disinfected with chlorine bleach, 70 percent ethanol, or iodine. Placing infected instruments in an autoclave for 15 minutes deactivates brucella. Gas masks are effective in preventing inhaled brucella exposure.

CHOLERA

Cholera is a disease caused by the bacteria *Vibrio cholerae*. This organism has been responsible for seven global pandemics over the past two centuries. *V. cholerae* is a gram-negative, rod-shaped bacteria that is motile (capable of movement) and can live without oxygen. Its natural habitat is coastal seawater. This organism is passed via the fecal to oral route. Contaminated water is usually the culprit in spreading *V. cholerae*. The infectious dose is relatively high but is reduced in people with diminished stomach acid (e.g., people on antacids).

The bacteria can survive up to 16 days in dust, 50 days in feces, 7 days on metal coins, and 1 to 2 hours on the fingertips. This bacterium attaches itself to the wall of the small intestine. Once there, it produces an enterotoxin known as choleragen, which causes the cells lining the intestine to pump sodium chloride and water into the intestines. There is also a substantial loss of potassium and bicarbonate. Cholera causes massive watery diarrhea and quickly dehydrates the host.

Symptoms

Within 1 to 2 days after inoculation, the patient will present

Cholera

Treatment

USE ONE OF THE FOLLOWING:

Tetracycline
500 mg orally every 6 hours for 3 days.

Doxycycline
300 mg orally once or 100 mg every 12 hours for 3 days.

Ciprofloxacin
500 mg orally every 12 hours for 3 days.

Erythromycin
18.2 mg orally per pound of body weight daily (divided into 3 or 4 doses) for 3 days. Warning: *DO NOT exceed 4,000 mg per day.*

with a sudden onset of painless, watery diarrhea. The diarrhea will often become voluminous (up to 10 liters per day), and the patient can experience vomiting. There is seldom a fever associated with cholera. The disease is usually worse in older children and adults. The diarrhea associated with *V. cholerae* has been referred to as "rice water" because of its slightly cloudy color and inoffensive, sweet smell.

Treatment

The replacement of fluids, electrolytes, and bicarbonates is the most important aspect in treating cholera. Fluids can be given orally. Because of the loss of bicarbonate, intravenous fluid replacement with Ringer's lactate and oral potassium supplements are preferred. When an intravenous approach is not available, an oral rehydration solution can be administered: in 1 liter of clean water add a level half-teaspoon of table salt and 8 level teaspoons of sugar. This should be given with oral potassium.

Alternate between the rehydration solution and plain water, especially with small children and infants. Track the amount of fluid lost through diarrhea and vomiting and rehydrate with more than that amount.

Cholera is self-limiting, meaning that if the patient is kept hydrated, he or she will recover in time. Electrolytes are helpful, and the use of certain antibiotics can diminish the duration of the disease and the volume of fluids lost. Single-dose tetracycline or doxycycline is useful with adults but is not recommended for children under 8 years of age. Ciprofloxacin and erythromycin can also be given over three days. Erythromycin for three days is a good choice for children.

Prevention

Clean drinking water and proper disposal of feces play a major role in the prevention of cholera. In the event of an epidemic, sanitation is vital. Many disinfectants can be used to kill cholera (e.g., chlorine bleach, 70 percent ethanol, or iodine). There is a vaccine available, but it is only moderately effective for short periods.

LEGIONNAIRES' DISEASE AND PONTIAC FEVER

Bacteria of the genus *Legionellae* give two clinically important syndromes: Legionnaires' disease and Pontiac fever. In 1976 the American Legion held a convention in a Philadelphia hotel where an outbreak of pneumonia sickened 221 conventioneers; 34 people died of the illness. The CDC identified the causative bacteria and labeled it *Legionella pneumophila*.

Pontiac fever received its name when 95 percent of the employees of the Pontiac, Michigan, County Health Department suddenly came down with flulike symptoms. The causative agent was later found to be *Legionella* that had been distributed by the building's air-conditioning system. This organism is not on the CDC's list of bioterror threats but does deserve some consideration.

Legionnaires' Disease and Pontiac Fever

Treatment

Use ONE of the following:

Erythromycin
500 mg orally every 6 hours for 10 to 14 days.

Doxycycline
100 mg orally every 12 hours for 10 to 14 days.

Tetracycline
500 mg orally every 6 hours for 10 to 14 days.

Ciprofloxacin
750 mg orally every 12 hours for 10 to 14 days.

Rifampin
600 mg orally every 12 hours for 10 to 14 days.

Legionellae are gram-negative bacilli that are associated with environmental water sources such as air conditioners and water-cooling towers. They can survive for years in refrigerated water samples. Legionellae have been found in drinking water sources, and infections result from inhaling aerosolized contaminated water (e.g., showerhead spray and drinking fountain mist). Outbreaks have been associated with produce mist machines in supermarkets. Older people and those with compromised immune systems are the most at risk for infection.

Symptoms

Legionnaires' Disease

This is a severe form of pneumonia. The incubation period for this disease is 2 to 10 days. The patient presents with diarrhea, high fever (greater than 104°F/40°C), fatigue, anorexia,

chest pain, and shortness of breath. Abdominal pain, nausea, and vomiting have been reported in up to 20 percent of cases.

Pontiac Fever

Pontiac fever has an incubation period of 1 to 2 days. The patient presents with fever, chills, headache, fatigue, and other flulike symptoms. These symptoms are self-limiting after a few days. Some patients experience a type of weariness for many weeks after the infection.

Treatment

Pontiac fever is self-limiting and requires no antibiotic treatment. Legionnaires' disease can be treated with a variety of antibiotics. Erythromycin, tetracycline, doxycycline, rifampin, and ciprofloxacin are all indicated as therapy for the disease. Erythromycin is the treatment of choice for combating this organism. Treatments shown in the chart are for oral therapy.

Prevention

The best preventative measure against *Legionella* is disinfection of the water supply. Chlorine bleach and high heat will destroy this organism. There is no vaccine for *Legionella*. Prophylaxis for a known exposure to this organism would most likely be the same as the treatment. Gas masks provide effective protection against inhaled inoculation.

PLAGUE

Yersinia pestis is the organism responsible for the plague that killed one-third of the population of Europe in the 14th century. Also known as the black death, it is one of the most virulent bacteria known—as little as one organism can cause disease in humans. This gram-negative bacillus is normally carried by rodents and passed to humans by infected fleas. It survives in blood up to 100 days outside the body. *Y. pestis* can multiply within a wide range of temperatures (28.5 to 113°F or -2 to 45°C) and pH values (5.0 to 9.6). Plague has been the target of

Plague

Treatment

USE ONE OF THE FOLLOWING:

Streptomycin

6.8 mg per pound of body weight intramuscularly (IM) (*not to exceed 1,000 mg*) every 12 hours for 10 to 14 days.

Gentamicin

2.3 mg per pound of body weight intravenously (IV) per day for 10 to 14 days (in obese patients base dose on lean body mass).

Ciprofloxacin

400 mg IV every 12 hours until improvement, then 750 mg orally every 12 hours for a total of 10 to 14 days.

Doxycycline

100 mg orally every 12 hours for 10 to 14 days (a loading dose of 200 mg should be administered initially).

Prophylactic Treatment

USE ONE OF THE FOLLOWING:

Doxycycline

100 mg orally every 12 hours for 7 days after the last known exposure.

Tetracycline

500 mg orally every 6 hours for 7 days after the last known exposure.

Ciprofloxacin

500 mg orally every 12 hours for 7 days after the last known exposure.

many bioweapons programs, and an aerosolized form has been developed. This bacterium can be aspirated and passed from person to person through the air. Undercooked meat from infected animals can be a cause of infection. Plague can involve almost any organ or system and, if untreated, cause massive tissue destruction and death.

Symptoms

The plague presents in two forms, bubonic plague and pneumonic plague.

Bubonic Plague

This form has an incubation period of 2 to 6 days. It is contracted by means other than the respiratory tract. The patient presents with fever, chills, muscle aches and pains, headache, weakness, and tenderness in the lymph nodes near the site of infection. If untreated, the disease can progress to increased fever, rapid heart rate, weakness, confusion, shock, and death.

Pneumonic Plague

Pneumonic plague has an incubation period of 1 to 6 days. The patient generally presents on the first day with a rapid onset of fever, chills, muscle aches and pains, headache, weakness, and dizziness. On the second day of the disease, the patient experiences shortness of breath, cough, chest pain, and general respiratory distress. Death can occur in as little as three days after incubation. Plague can also present as pharyngitis, in which the patient will have a fever, sore throat, swollen cervical lymph nodes, and headache. Untreated, this will rapidly progress to systemic plague and death.

Treatment

Without treatment, plague is often fatal. The antibiotic streptomycin is the drug of choice for this infection. The antibiotics gentamicin, ciprofloxacin, and doxycycline can also be used to treat infections by *Y. pestis*. Penicillins, cephalosporins,

and macrolides (such as erythromycin) don't work as well in treating the plague and should not be used.

Prevention

Immediate prophylactic treatment with ciprofloxacin, tetracycline, or doxycycline during an outbreak can prevent infection. Prophylaxis should continue for 7 days following the last known exposure. Avoidance of known outbreak areas will diminish the risk of infection; the use of masks during an outbreak is advised. Use of protective clothing and repellents can diminish risk of infection by fleas.

A vaccine developed and licensed by the FDA is no longer available; it did not appear to provide protection against the primary pneumonic type. *Y. pestis* is susceptible to chlorine bleach, ethanol, and iodine. Gas masks will provide effective protection against aerosolized *Y. pestis*.

Q FEVER

Q fever is a disease caused by the gram-negative rickettsia bacteria *Coxiella burnetii*. This bacterium is able to survive in harsh environments through spore formation. *C. burnetii* can survive in dried spit for up to 30 days and dust for up to 120 days. The disease can present in two forms, acute and chronic. *C. burnetii* can be cultured and aerosolized as spores requiring as few as 10 inhaled organisms to cause disease. The spores have a resistance to heat and drying. They can survive for months in the soil and in milk products.

Symptoms

The incubation period for Q fever is from 3 to 30 days. The patient presents with fever, extreme fatigue, severe headaches, and general flulike symptoms. On occasion the patient will present with chills, nausea, vomiting, and diarrhea. When spores are inhaled, the pneumonic form of Q fever is seen. The patient presents with fever, soaking sweats, difficulty in breathing, chest pain, extreme weakness, and cough.

Q Fever

Treatment

Use ONE of the following:

Tetracycline
500 mg orally every 6 hours for 7 to 14 days.

Doxycycline
100 mg orally every 12 hours for 7 to 14 days.

Prophylactic Treatment

Use ONE of the following:

Tetracycline
500 mg orally every 6 hours for 5 to 7 days (beginning 8 to 12 days after exposure).

Doxycycline
100 mg orally every 12 hours for 5 to 7 days (beginning 8 to 12 days after exposure).

Treatment

Antibiotic therapy is effective in the treatment of Q fever. For the treatment of acute Q fever, tetracycline or doxycycline is given for 7 to 14 days. In chronic Q fever (when the disease persists after normal treatment) the patient is treated with a combination of antibiotics (doxycycline and rifampin) for a minimum of 3 years.

Prevention

A vaccine (IND 610) exists for this bacteria. It is only given to persons at high risk for the infection. The spores of *C. burnetii* can be killed by pasteurization at temperatures greater than 140°F

Tularemia

Treatment

USE ONE OF THE FOLLOWING:

Streptomycin

3.4 to 4.6 mg per pound of body weight IM twice a day for 10 to 15 days.

Gentamicin

1.4 to 2.3 mg per pound of body weight IV per day for 10 to 15 days (in obese patients, base dose on an estimate of what the patient's lean body mass would be).

Ciprofloxacin

400 mg IV every 12 hours until improvement, then 500 mg orally every 12 hours for a total of 10 to 15 days.

Ciprofloxacin

750 mg orally every 12 hours for 10 to 15 days.

Prophylactic Treatment

USE ONE OF THE FOLLOWING:

Streptomycin

3.4 to 4.6 mg per pound of body weight IM twice a day for 15 days.

Doxycycline

100 mg orally every 12 hours for 15 days.

Tetracycline

500 mg orally every 6 hours for 15 days.

Ciprofloxacin

500 mg orally every 12 hours for 15 days.

(60°C). Tetracycline and doxycycline can be given in prophylaxis on the 8th to 12th day after exposure. Prophylactic treatment is not effective and may prolong the onset of Q fever if administered early (1 to 7 days after exposure). *C. burnetii* is susceptible to chlorine bleach and ethanol as disinfectants. Gas masks are effective in preventing inhaled exposure to *C. burnetti.*

TULAREMIA

Tularemia is a disease caused by the gram-negative, non-spore-forming bacillus *Francisella tularensis.* This bacterium can survive for months in mud and water. It can survive for up to 190 days in straw. Many biting and bloodsucking insects serve as carriers for this bacterium. This organism is very infectious and could be "weaponized" by creating an aerosolized form. As few as five inhaled organisms can cause disease.

This organism was one of several biological weapons stockpiled by the U.S. military in the late 1960s. Until the early 1990s, the Soviet Union produced this organism in weapon labs and developed antibiotic- and vaccine-resistant strains. It can enter the human body through a variety of modes. Like *B. anthracis*, *F. tularensis* can cause cutaneous, inhaled, and gastrointestinal infections. The most common in nature is cutaneous. Gastrointestinal infection by this organism is rare due to the quantity of bacilli needed for GI inoculation.

Symptoms

After an incubation period of 2 to 10 days, patients with tularemia present with a sudden onset of fever, chills, headache, weakness, muscle aches, and joint pain.

Ulceroglandular Tularemia

In nature this is the most frequently seen form of tularemia. It is an infection that starts in the skin, with an ulcer developing at the site of inoculation. In 1 to 3 weeks, the ulcer develops a blackened base, and the local lymph nodes begin to swell and become painful. A fever is often present.

Pneumonic Tularemia

The pneumonic form of this disease presents with fever, shortness of breath, chest pain, and a nonproductive cough.

Typhoidal Tularemia

The typhoidal (gastrointestinal) form of tularemia presents with a high, continuous fever, abdominal pain, headache, weight loss, nonproductive cough, and possible delirium with shock.

Treatment

Many antibiotics are ineffective against this organism. Tetracycline has been successful but has been associated with higher relapse rates compared to streptomycin and gentamicin. Streptomycin and gentamicin are generally given intramuscularly (IM) and intravenously (IV) for 10 to 15 days.

Prevention

There is a vaccine available for this organism. If exposure has occurred, intramuscular injections of streptomycin or oral administration of other antibiotics can be helpful in avoiding the disease. This organism is destroyed by dry heat above 340°F (170°C) for 1 hour and is also susceptible to chlorine bleach and ethanol. Gas masks are effective in preventing inhaled exposure to *F. tularensis.*

Chapter 1 Self-Test

Question 1: Which of the following is NOT an agent of infectious disease?

A. Virus
B. Yeast
C. Giardia
D. Rifampin
E. Bacteria

Question 2: What size particle is generally retained in the lung?

A. Larger than 5 micrometers
B. Larger than 15 micrometers
C. Smaller than 5 micrometers
D. Larger than 0.5 micrometers
E. Both C and D

Question 3: Anthrax is caused by bacteria that:

A. Forms spores
B. Normally infects animals
C. Can be deactivated by chlorine bleach
D. Can be deactivated by ciprofloxacin
E. All of the above

Question 4: Which is the least likely symptom of cholera?

A. Fever
B. Vomiting
C. Rice-water feces
D. Dehydration
E. Diarrhea

Answers: 1: D; 2: E; 3: E; 4: A

REFERENCES

Note: The sources in this book were up to date at the time of publication. Due to the nature of Web sites, some material may no longer be accessible at the address listed.

Centers for Disease Control and Prevention. *Anthrax: Frequently Asked Questions.* http://www.cdc.gov/ncidod/dbmd/diseaseinfo/anthrax_g.htm#preventinf (accessed November 1, 2001).

_____. *Children and Anthrax: A Fact Sheet for Clinicians.* http://www.bt.cdc.gov/DocumentsApp/Anthrax/11072001/clinician.asp (accessed November 9, 2001).

_____. *Interim Recommendations for the Selection and Use of Protective Clothing and Respirators Against Biological Agents.* http://www.bt.cdc.gov/DocumentsApp/Anthrax/Protective/10242001Protect.asp (November 2, 2001).

_____. *Investigation of Bioterrorism Related Anthrax and Interim Guidelines for Exposure Management and Antimicrobial Therapy.* http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5042a1.htm (accessed November 1, 2001).

Fauci, A.S., et al. 1998. *Harrison's Principles of Internal Medicine,* 14th ed. New York: McGraw-Hill Companies, Inc.

Gladwin, M., B. Trattler. 1995. *Clinical Microbiology Made Ridiculously Simple*, 2nd ed. Florida: MedMaster, Inc.

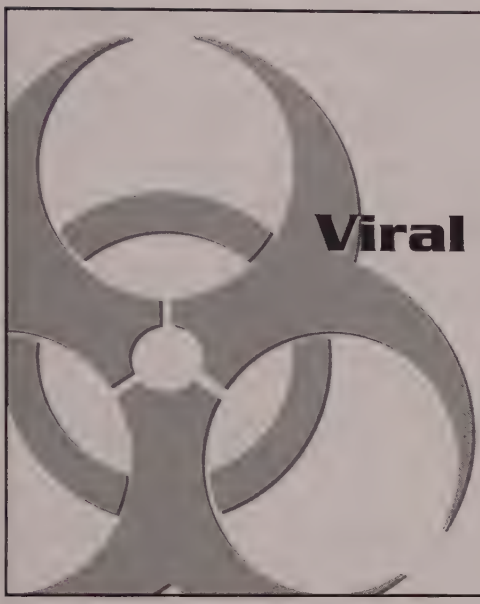
Levinson, W., E. Jawetz. 1998. *Medical Microbiology and Immunology,* 5th ed. Connecticut: Appleton and Lange.

Office of Laboratory Security/Health Canada. *Material Safety Data Sheet—Infectious Substances: Bacillus anthracis.* http://www.hc-sc.gc.ca/pphb-dgspsp/msds-ftss/msds12e.html (accessed November 9, 2001).

_____. *Material Safety Data Sheet—Infectious Substances: Brucella.* http://www.hc-sc.gc.ca/pphb-dgspsp/msds-ftss/msds23e.html (accessed November 9, 2001).

_____. *Material Safety Data Sheet—Infectious Substances: Coxiella burnetii.* http://www.hc-sc.gc.ca/pphb-dgspsp/

msds-ftss/msds43e.html (accessed November 9, 2001).
_____. *Material Safety Data Sheet—Infectious Substances: Francisella.* http://www.hc-sc.gc.ca/pphb-dgspsp/msds-ftss/msds68e.html (accessed November 9, 2001).
_____. *Material Safety Data Sheet—Infectious Substances: Legionella pneumophila.* http://www.hc-sc.gc.ca/pphb-dgspsp/msds-ftss/msds93e.html (accessed November 9, 2001).
_____. *Material Safety Data Sheet—Infectious Substances: Vibrio Cholera.* http://www.hc-sc.gc.ca/pphb-dgspsp/msds-ftss/msds164e.html (accessed November 9, 2001).
_____. *Material Safety Data Sheet—Infectious Substances: Yersinia Pestis.* http://www.hc-sc.gc.ca/pphb-dgspsp/msds-ftss/msds169e.html (accessed November 9, 2001).
University of Pittsburgh Medical Center. *Clinical Anthrax: Primer for Physicians.* http://www.upmc-biosecurity.org/pages/agents/anthrax_primer.html (accessed January 28, 2004).
_____. *Plague Fact Sheet.* http://www.upmc-biosecurity.org/pages/agents/plague_facts.html (accessed January 28, 2004).
U.S. Army Medical Research Institute. Kortepeter, M., G. Christopher, T. Cieslak, R. Culpepper, R. Darling, J. Pavlin, J. Rowe, K. McKee, E. Eitzen, ed. 2001. *USAMRIIDS's Medical Management of Biological Casualties Handbook*, 4th ed. Ft. Detrick, Maryland: U.S. Army Medical Research Institute of Infectious Diseases.
Werner, D., et al. 1992. *Where There Is No Doctor*; California: Hesperian Foundation.



Viral Agents

2

Viruses lack metabolic machinery and cannot replicate on their own. They are nothing more than DNA or RNA enclosed in a protein coat called a capsid. The virus invades the host cell by first binding to its outer membrane; then, depending on the type, the virus either injects its genetic information into the host cell or is completely internalized by the host cell. In either case, the genetic material is forced onto the host cell's machinery for reproduction.

Once infected, the host cell will no longer reproduce its own cells; it will synthesize and assemble the viral products. Once assembled, the virions (baby viruses) are released from the host cell through lysis (the eruption of the host cell) or budding (the virions bud off through the host cell's membrane). The new viruses are released and go hunting for the next host cell victim.

EBOLA AND MARBURG

Ebola and Marburg are both filoviruses known as viral hemorrhagic fever diseases. They contain single-stranded RNA.

Filoviruses replicate in the cytoplasm of the host cell. The surface nature of the filovirus inhibits destruction by the human immune system. Only low levels of neutralizing antibodies have been detected in infected individuals.

The filoviruses can cause severe outbreaks of infection due to person-to-person transmission. Direct contact with blood, sweat, vomit, urine, feces, or semen can all lead to infection; many outbreaks have occurred when hospital workers treated infected patients and became infected themselves. These viruses are stable at room temperature and remain infectious for long periods; Ebola can remain viable in a corpse for several weeks.

The most likely method of bioterror spread would be through aerosolizing the virus. There is an incubation period of 3 to 9 days for the filoviruses.

Symptoms

After the incubation period, the patient presents with a severe headache, fever, abdominal pain, weakness, muscle and joint pain (especially in the lower back), nausea, and vomiting. One to 3 days after the onset of the disease, the patient experiences severe diarrhea and difficulty swallowing. After about a week of these preliminary symptoms, the patient experiences a rash that spreads from the face and neck to the extremities. At this time, the patient also experiences severe bleeding in the gastrointestinal tract, urinary system, and possibly the eyes, ears, and nose. Patients who die usually do so between the 8th and 16th day after exposure due to multiple organ failure. Many patients who recover from the disease experience hair loss.

Treatment

The treatment for this infection consists of supportive measures. Fluid balances, electrolytes, oxygen status, and blood pressure should be maintained. Antibiotics can be given for any secondary bacterial infections. The filoviruses are not inhibited in vitro by ribavirin, an antiviral medication.

Prevention

Filoviruses are destroyed by heating to 140°F (60°C) for

longer than 30 minutes. They are also destroyed by lipid solvents. Laundry and other infected items must be incinerated or treated with a disinfectant (e.g., chlorine bleach). Corpses must be properly disposed of (placed in a sealed casket or cremated). Gas masks can provide protection against inhaled inoculation.

HANTAVIRUS PULMONARY SYNDROME

Hantavirus pulmonary syndrome is a disease caused by the hantavirus. It is an enveloped virus with single-stranded RNA. The virus is endemic in deer mice and acquired by humans through inhalation of aerosolized rodent urine and feces. This infection, with a mortality rate of nearly 80 percent, does not seem to be transmitted person to person. Hantavirus pulmonary syndrome, first discovered in 1993, should be considered in young adults who present with flulike symptoms and develop pulmonary edema (fluid in the lungs). Large quantities of infected rodent urine and feces could be aerosolized as a biological warfare agent.

Symptoms

The incubation period for hantavirus is 1 to 60 days. The patient first presents with a high fever, muscle aches, cough, nausea, and vomiting. The heart rate is elevated, and the blood pressure is slightly lower than normal. In the pulmonary phase of the disease, the patient's lungs begin to fill with fluid, and the patient has difficulty breathing. The patient can progress to hypotension (low blood pressure), shock, respiratory failure, and death without supportive care.

Treatment

There is no effective drug therapy for this illness. Ribavirin has been used but seems to be ineffective. Treatment consists of supportive measures (oxygen, intubation, and possible fluid administration).

Prevention

There is no vaccine available for this virus. Dust masks and air filtration may provide some protection in the event of

aerosolized infected mouse excrement. The hantavirus can be inactivated by chlorine bleach or ethanol. Gas masks provide protection against inhaled hantavirus.

SMALLPOX

In 1980 the World Health Organization (WHO) declared that the smallpox virus, also known as variola, had been eliminated worldwide. This by no means assures that the virus is extinct—it only means that the virus has not infected a human for a number of years. Governmental agencies still possess the smallpox virus in laboratories.

Smallpox is one of the most structurally complex viruses. This virus is highly contagious and is spread via the respiratory tract and direct contact. Once in the respiratory tract, smallpox invades the bloodstream and internal organs are infected. This occurs during the incubation period (7 to 17 days). Smallpox infects only humans, and it has a death rate of 20 to 50 percent.

Symptoms

After the incubation period, the patient presents with a sudden fever and weakness. Within 2 to 3 days after the fever, a rash begins on the face and spreads to the extremities. The rash evolves to small red bumps that eventually form into pustules (elevations of the skin containing pus). Within 2 to 3 weeks of the disease, crusts, or scabs, form over the pustules. The scabs generally fall off in the third or fourth week of the disease. The patient is most infectious in the first week of the disease and remains infectious until the scabs have fallen off.

Treatment

Patients with smallpox are treated with supportive care. Intravenous fluids, medication for fever and pain, and antibiotics for secondary bacterial infections are recommended. Rifampin may inhibit smallpox but has not been used clinically to treat this viral infection. Cidofovir has been shown to be effective against the virus in vitro and is being investigated as a treatment.

Prevention

There is a vaccine for smallpox, but it has not been used in the United States since 1972. More than half of the citizens in the United States have never been vaccinated for smallpox. People with pre-existing conditions of eczema, immune disorders, or pregnancy have a higher risk of complications with the vaccine. People exposed to smallpox can prevent or lessen the symptoms of the disease by receiving the vaccine within 4 days of exposure. The best results are seen when the vaccine is given within 24 hours of exposure. Immunity following vaccination only lasts 3 to 10 years; a booster should be given every 3 years. Lifelong immunity is achieved only after recovery from the disease itself.

The smallpox virus is very fragile, surviving only 1 to 2 days in the open environment. A number of disinfectants can be used to kill smallpox, including household bleach. Gas masks provide protection against inhaled smallpox.

VENEZUELAN EQUINE ENCEPHALITIS

Venezuelan equine encephalitis (VEE) is caused by a virus in the togaviridae family that is composed of single-stranded RNA. The natural carrier for the virus is the mosquito. VEE has an incubation period of 1 to 6 days and is very stable when aerosolized. Because of its virulence, a number of countries, including the United States, have investigated its use as a biological weapon. As little as one viral unit can constitute an infectious dose.

Symptoms

VEE presents with headache, high spiking fever, muscle pains, light sensitivity, altered level of consciousness, and possible neurologic deficits. Some patients also present further with a sore throat, nausea, cough, vomiting, and diarrhea. Care providers should take note that small children have a higher incidence of developing encephalitis (inflammation of the brain), which can lead to confusion, delirium, disorientation, convulsions, coma, and death.

Treatment

Patients with VEE are treated with supportive care. Intravenous fluids, medication for fever and pain, and antibiotics for secondary bacterial infections are recommended. When patients present with encephalitis, anticonvulsive medication may be needed. This disease is rarely fatal, and the patient usually recovers within 1 to 2 weeks.

Prevention

Vaccines TC-83 (initial dose vaccine) and C-84 (booster) exist for VEE. Person-to-person spread is not likely. VEE can cause encephalitis in unborn children if the mother is infected. During epidemics, mosquito bites should be prevented with screens, nets, mosquito repellents, and insecticides. Chlorine bleach, ethanol, and temperatures above 180°F (80°C) for 30 minutes deactivate VEE. Gas masks provide protection against inhaled VEE.

YELLOW FEVER

During the Panama Canal project, yellow fever made a name for itself by infecting thousands of canal workers. Yellow fever is spread by mosquitoes and is related to the virus that causes hepatitis C. These viruses are part of the flavivirus family and contain single-stranded RNA. The last time there was a yellow fever outbreak in the United States was in 1905, when New Orleans was hit with more than 3,000 cases with 452 deaths.

Symptoms

Yellow fever has an incubation period of about 7 days. The patient presents with jaundice (yellow appearance), hemorrhaging, fever, backache, nausea, black vomit (from gastrointestinal bleeding), a decrease in urine output, and delirium.

Treatment

The treatment for yellow fever is mainly supportive. Intravenous fluids and transfusions of blood or plasma may be needed to counter the loss of blood through hemorrhaging. The

administration of immune globulin will not interfere with the vaccine. Dialysis may be needed in the event of kidney failure.

Prevention

A vaccine is available and relatively safe. Immunity is provided within 10 days after vaccination and lasts for about 10 years. The vaccination is made with eggs, so people with allergies to eggs and egg products should be cautioned. Children under the age of 1 year should only be given the vaccine when there is a high risk of exposure. Chlorine bleach, ethanol, 3 percent peroxide, iodine, organic solvents, organic detergents, and temperatures above 140°F (60°C) for 10 minutes deactivate the virus that causes yellow fever. Protection from mosquito bites is essential during epidemics.

Chapter 2 Self-Test

Question 1: What is the name of the protein coat that encloses a virus?

A. RNA
B. Capsid
C. DNA
D. Prion
E. Deoxyribonucleic acid

Question 2: Which pathogen causes viral hemorrhagic fever?

A. Ebola
B. *Y. pestis*
C. Legionella
D. Anthrax
E. Yellow fever

Question 3: Which of the following should be suspected in a young person who presents with flulike symptoms and pulmonary edema?

A. Hantavirus
B. Ebola
C. Yellow fever
D. Smallpox
E. None of the above

Question 4: What is the best method for avoiding smallpox infections?

A. Prophylaxis with antibiotics
B. Vaccination
C. Activated charcoal
D. Rifampin
E. None of the above

Answers: 1: B; 2: A; 3: A; 4: B

REFERENCES

Centers for Disease Control and Prevention. *Interim Recommendations for the Selection and Use of Protective Clothing and Respirators Against Biological Agents.* http://www.bt.cdc.gov/DocumentsApp/Anthrax/Protective/10242001Protect.asp (accessed November 2, 2001).

_____. *Yellow Fever.* http://www.cdc.gov/ncidod/dvbid/yellowfever/index.htm (accessed November 3, 2001).

Fauci, A.S., et al. 1998. *Harrison's Principles of Internal Medicine*, 14th ed. New York: McGraw-Hill Companies, Inc.

Gladwin, M., B. Trattler. 1995. *Clinical Microbiology Made Ridiculously Simple*, 2nd ed. Florida: MedMaster, Inc.

Levinson, W., E. Jawetz. 1998. *Medical Microbiology and Immunology*, 5th ed. Connecticut: Appleton and Lange.

Office of Laboratory Security/Health Canada. *Material Safety Data Sheet—Infectious Substances: Ebola.* http://www.hc-sc.gc.ca/pphb-dgspsp/msds-ftss/msds53e.html (accessed November 9, 2001).

_____. *Material Safety Data Sheet—Infectious Substances: Hantavirus.* http://www.hc-sc.gc.ca/pphb-dgspsp/msds-ftss/msds74e.html (accessed November 9, 2001).

_____. *Material Safety Data Sheet—Infectious Substances: Vaccinia Virus.* http://www.hc-sc.gc.ca/pphb-dgspsp/msds-ftss/msds160e.html (accessed November 9, 2001).

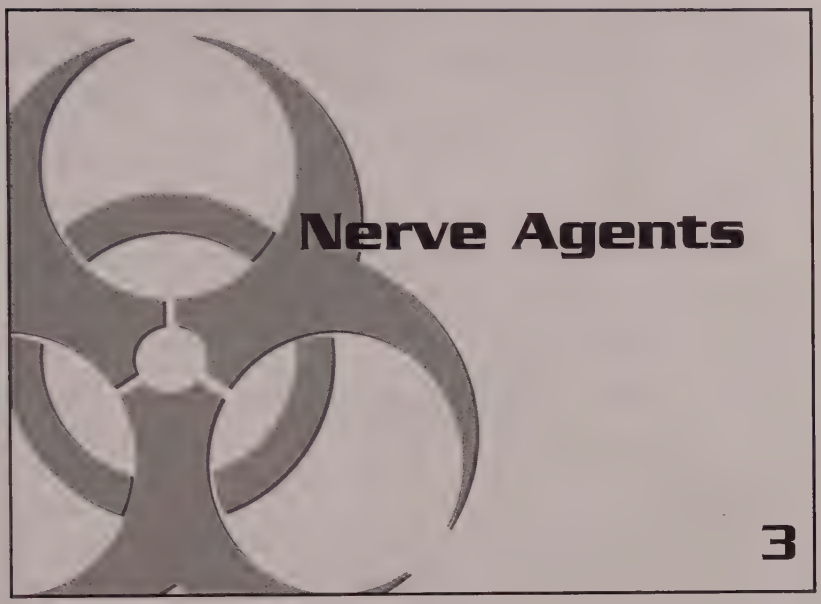
_____. *Material Safety Data Sheet—Infectious Substances: Venezuelan Equine Virus.* http://www.hc-sc.gc.ca/pphb-dgspsp/msds-ftss/msds162e.html (accessed November 9, 2001).

_____. *Material Safety Data Sheet—Infectious Substances: Yellow Fever Virus.* http://www.hc-sc.gc.ca/pphb-dgspsp/msds-ftss/msds167e.html (accessed November 9, 2001)

U.S. Army Medical Research Institute. Kortepeter, M., G. Christopher, T. Cieslak, R. Culpepper, R. Darling, J. Pavlin, J. Rowe, K. McKee, E. Eitzen, ed. 2001.

USAMRIIDS's Medical Management of Biological Casualties Handbook, 4th ed. Ft. Detrick, Maryland: U.S. Army Medical Research Institute of Infectious Diseases.

WebMD. http://my.webmd.com/content/article/61/67291.htm?lastselectedguid={5FE84E90-BC77-4056-A91C-9531713CA348} (accessed January 28, 2004).



Nerve Agents

3

Nerve agents work by binding and inhibiting the enzyme acetylcholinesterase, which is involved in stopping the transmission of nerve impulses. When acetylcholinesterase is inhibited, there is a constant flow of nerve impulses to the target organ.

Nerve agents are extremely toxic at low dosages and have a rapid effect on the human body. They can be used against a population in the form of a gas or liquid. They enter the body through the skin, lungs, or through ingestion. These agents work most rapidly when they are inhaled into the lungs, which move the agent directly into the bloodstream. Inhalation of high concentrations of a nerve agent may lead to death in a matter of minutes. Nerve agents are able to pass through the skin, leading to effects in less than 30 minutes.

SARIN

Sarin was developed in 1938. (The name sarin comes from the names of the chemists involved in its creation: Schrader,

Nerve Agents

Treatment

USE ALL THREE OF THE FOLLOWING:

Atropine sulfate

2 mg doses are given IV or IM every 10 to 15 minutes until the signs of nerve agent intoxication have disappeared. Atropine blocks the acetylcholine receptor and does not readily cross the blood-brain barrier.

Pralidoxime chloride

600 mg doses are given IV or IM every hour until respiration has improved. This drug blocks the binding of the nerve agent to acetylcholinesterase.

Diazepam

10 mg dose given orally, IV, or IM (multiple doses may be needed). Diazepam reduces convulsions and seizures.

Prophylactic Treatment

Pyridostigmine bromide

30 mg orally every 8 hours. This is given *pre-exposure* to enhance the effects of the atropine antidote. This drug should never be given to a patient who is already experiencing the symptoms of a nerve agent.

Ambrose, Rudiger, and van der LINde.) Iraq used sarin in the 1980–1988 war with Iran. Aum Shinrikyo, a Japanese religious sect, released sarin in 1994 and 1995, killing 19 and injuring thousands. Clothing releases the nerve agent for 30 minutes after it comes into contact with the vapor.

Sarin is, in pure form, colorless, odorless, and tasteless. It is 26 times more deadly than cyanide gas with a lethal dose of 0.5 milligrams (mg) for adults. The vapor is heavier than air and sinks to low-lying areas. Sarin degrades quickly under wet and humid weather conditions and is not as persistent as other nerve agents.

Sarin is dispersed as droplets or mist. Liquid sarin creates vapors that will penetrate the skin. Even a nonlethal dose of this agent can lead to permanent neurological damage without treatment.

SOMAN

After World War II, the Soviets incorporated soman into their arsenal of chemical warfare agents; many other countries are believed to possess it as well. Soman intoxication is more difficult to treat than intoxication by other nerve agents because it is the most potent acetylcholinesterase inhibitor. In a pure state, it is colorless and has an odor of rotting fruit. With impurities, it is amber or dark brown in color and has a camphor odor.

TABUN

From 1984 to 1988, the Iraqis used tabun against Iran. A colorless to brown liquid, pure tabun is odorless but has a faint fruity odor in its impure state. It is not as persistent as other nerve agents; clothing releases the nerve agent for 30 minutes after it comes into contact with tabun vapor. Industrial tabun, used in the chemical industry, is brownish and has an odor of bitter almonds. Tabun can persist in the environment for up to 3 months after it is released.

VX

VX is odorless and similar in appearance to motor oil. It persists for weeks or longer after it is released. It is released in areas

where enemy troops are expected to enter to stop or slow their progress. Decontamination of VX can be achieved with alcohol, ether, or acetate because of its oil-like properties. Clothing releases the nerve agent for 30 minutes after it comes into contact with the vapor.

Symptoms

Low-dose exposure to any of the above nerve agents leads to mild miosis (a contraction or narrowing of the pupil), short-range vision abnormalities, increased saliva production, increased nasal secretions, sweating, headache, nausea, and a feeling of pressure in the chest. A moderate dose leads to more pronounced miosis, with vision abnormalities, increased saliva and nasal secretions, sweating, and headache. The victim also experiences nausea and vomiting, severe tightening of the chest and difficulty breathing, muscular weakness, tremors and convulsions, and involuntary discharge of urine and feces. At high doses the victim will experience convulsions and unconsciousness. Respiratory muscles become paralyzed and the victim suffocates.

Treatment

The victim must be immediately moved to an uncontaminated area. Artificial respiration should be administered if the patient has stopped breathing. *Do not give mouth-to-mouth resuscitation if the victim's face is contaminated.* Immediately administer oxygen to patients who are short of breath or are having difficulty breathing. Exposed skin should be washed with a diluted solution of household bleach and water, then flushed with plain water. Contaminated eyes should be flushed with water for 10 to 15 minutes.

Do not induce vomiting when ingestion of a nerve agent has occurred. Activated charcoal should be administered immediately. Patients should not smoke until the signs of nerve agent poisoning have subsided. Patients with excessive bronchial secretions should be placed on their side and have their feet elevated, which can help drain the secretions. Assisted ventilation may be necessary even after atropine administration. Assisted ventilation

should be continued until the patient begins breathing on his or her own. Miosis alone does not warrant antidote therapy.

Prevention

Decontamination can be achieved with a solution of household bleach or a 10 percent solution of sodium carbonate. Pyridostigmine bromide tablets can be taken prophylactically. These tablets inhibit acetylcholinesterase and protects the enzyme against inhibitory effects of nerve agents. The acetylcholinesterase is released from pyridostigmine slowly and nerve impulses are maintained. A gas mask and protective clothing are effective in preventing intoxication by nerve agents.

Chapter 3 Self-Test

Question 1: Nerve agents work by inhibiting which of the following enzymes?

A. Acetylcholine
B. Acetylmethane
C. Acetylcholinesterase
D. Acetylene
E. A and C

Question 2: What is the average time of symptom onset for nerve agents?

A. Immediately
B. 2 to 4 hours
C. 24 hours
D. 2 to 4 days
E. 1 to 60 days

Question 3: Which of the following are common symptoms of nerve agent toxicity?

A. Miosis (narrowing of the pupil)
B. Sweating
C. Headache
D. Nausea
E. All of the above

Question 4: Which of the following should be conducted first in treating nerve agent toxicity?

A. Mouth-to-mouth resuscitation
B. Oxygen administration
C. Decontamination
D. Remove patient from contaminated area
E. None of the above

Question 5: Which of the following can be used to decontaminate nerve agents?

A. A solution of sodium bicarbonate and vinegar
B. A solution of activated charcoal and water
C. A solution of chlorine bleach and water
D. A solution of salt and water
E. A solution of uric acid

Question 6: Which of the following nerve agents resembles motor oil?

A. VX
B. Tabun
C. Soman
D. Sarin
E. None of the above

Question 7: When should vomiting be induced in patients with nerve agent intoxication?

A. Always
B. Sometimes
C. Seldom
D. Never
E. All of the above

Answers: 1: C; 2: A; 3: E; 4: D; 5: C; 6: A; 7: D

Centers for Disease Control and Prevention. *Sarin.* http://www.bt.cdc.gov/Agent/Nerve/Sarin/ctc0003.asp (accessed November 3, 2001).

_____. *Soman.* http://www.bt.cdc.gov/Agent/Nerve/Soman/ctc0004.asp (accessed November 5, 2001).

_____. *Tabun.* http://www.bt.cdc.gov/Agent/Nerve/Tabun/ctc0002.asp (accessed October 29, 2001).

_____. *VX.* http://www.bt.cdc.gov/Agent/Nerve/VX/ctc0006.asp (accessed November 2, 2001)

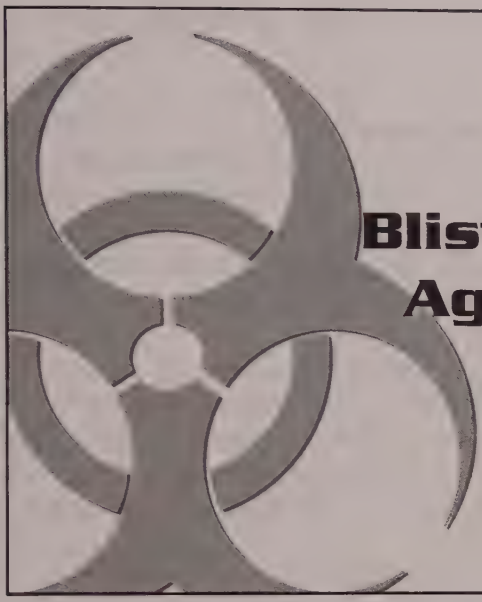
Departments of the Army, the Navy, and the Air Force, and Commandant, Marine Corps. *Field Manual FM8-285: Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries.* http://www.nbc-med.org/SiteContent/MedRef/OnlineRef/FieldManuals/fm8_285/index.htm (accessed November 3, 2001).

Organisation for the Prohibition of Chemical Weapons. *Nerve Agents.* http://www.opcw.nl/resp/html/nerve.html (accessed October 29, 2001).

Stockholm International Peace Research Institute. *Sarin.* http://projects.sipri.se/cbw/cbw-agents/Sarin.html (accessed October 29, 2001).

_____. *Soman.* http://www.sipri.se/cbw/cwb-agents/Soman.html (accessed November 1, 2001).

_____. *Tabun.* http://projects.sipri.se/cbw/cbw-agents/Tabun.html (accessed October 28, 2001).



Blistering Agents

4

Blistering agents cause severe damage to the skin, eyes, respiratory system, and internal organs. The term blistering agent, or vesicant, is derived from the blisters and vesicles it produces when in contact with skin. They have been used on battlefields since World War I. Many countries and paramilitary groups have blistering agents stockpiled and are eager to release them. Iraq used blistering agents extensively against Iran during the 1980s.

LEWISITE

The synthesis of lewisite is credited to U.S. Army Captain W.L. Lewis in 1918. Pure lewisite is colorless and odorless and has the appearance of an oily liquid. Industrial lewisite is amber to dark brown in color and has a geranium scent. Lewisite can produce vapor in cold climates, making it an ideal agent in winter warfare. It is persistent in the soil for days after its release. The freezing point of mustard can be lowered by the addition

of lewisite. There have been no verified uses of this agent on the battlefield.

Symptoms

Unlike mustard, lewisite exposure presents with immediate symptoms in the affected area. Inhalation exposure causes burning pain in the chest and throat, profuse nasal secretions, violent sneezing, cough, frothing mucus, lung edema, restlessness, weakness, subnormal temperature, low blood pressure, and shock and may lead to death.

Skin exposure causes immediate pain lasting 2 to 3 days, redness within 30 minutes, itching, and blister formation within 12 hours. Lewisite can cause deep skin burns that may lead to lung edema. Eye exposure causes instant pain and swollen eyelids; severe, permanent eye damage or blindness can occur within 1 minute after exposure.

Treatment

British anti-lewisite (BAL) is the antidote for lewisite. Rapid use of BAL (2,3-dimercaptopropanol) can prevent tissue destruction. This topical reacts with lewisite to form a stable product.

When BAL is not available, other methods of treatment must be used. The patient must quickly be decontaminated with a solution of chlorine bleach and water and then be washed with soap and water. If the decontamination is performed within 1 to 2 minutes after exposure, skin damage can be radically decreased. Small blisters less than 1 cm should be left alone as long as the area is clean. Large blisters should be opened and cleaned with saline two to four times a day. Antibiotic cream and sterile dressings should be applied.

Flush contaminated eyes with water for 15 minutes. Severely damaged eyes should be irrigated with saline two to three times daily to remove inflammatory debris. Topical antibiotics should be used three to four times daily to prevent infection and scarring. Topical atropine can be used to dilate the pupil. Petroleum jelly should be applied to the edges of the eyelids to keep them from sticking together.

Oxygen should be administered to patients who are experiencing difficulty in breathing. Fluid and electrolyte balances should be monitored. Administer artificial respiration if the patient's breathing has stopped. *Do not* give mouth-to-mouth resuscitation if the patient's face is contaminated. If the patient's hair is contaminated with lewisite, it must be shaved off. Treat secondary bacterial infections with antibiotics. If the agent is ingested, do not induce vomiting; activated charcoal may benefit patients who have ingested lewisite.

Prevention

Gas masks and protective clothing are effective in preventing lewisite poisoning. Lewisite vapor is much heavier than air, so people in contaminated areas should avoid low-lying areas when possible.

MUSTARD

Mustard was first produced in 1822, but its harmful effects were not discovered until 1860. It was first used as a warfare agent during World War I in 1917. Relatively simple to manufacture and stockpile, in its pure form mustard is colorless and almost odorless. It has a freezing point of about 57°F (14°C). This high freezing point makes delivery by aircraft difficult.

Mustard is often mixed with lewisite to lower the freezing point. In its agent grade it is yellow to dark brown, and its odor is described as similar to burning garlic or horseradish. It is an oily liquid and gives little vapor in cool weather. The chemical formula for basic mustard is bis(2-chloroethyl) sulfide. It has a density 5.4 times greater than air, causing it to sink to low-lying areas. Mustard is a known human carcinogen.

Symptoms

When the symptoms begin, 1 to 24 hours after exposure, the damage has already occurred at the cellular level. Mild exposure causes aching eyes, abundant tears and nasal secretions, skin

irritation and swelling, hoarseness, coughing, and sneezing. A patient presenting with these symptoms alone may not require medical treatment other than decontamination.

Moderate to severe exposure can lead to loss of sight, swollen eyelids, fluid-filled blisters, nausea, loss of appetite, fever, vomiting, diarrhea, respiratory distress, and lung edema. The most severe cases of toxicity occur when the victim is in contact with the liquid form of mustard. Skin injuries are more severe in warm and humid climates.

Treatment

The patient must quickly be decontaminated with a solution of chlorine bleach and water and then be washed with soap and water. If the decontamination is performed within 1 to 2 minutes after exposure, tissue damage can be radically decreased. Small blisters less than 1 cm should be left alone as long as the area is clean. Large blisters should be opened and cleaned with saline two to four times a day. Antibiotic cream and sterile dressings should be applied. Povidone iodine antiseptic applied to exposed skin within 10 to 20 minutes of contamination may lessen the effects of mustard gas.

Flush contaminated eyes with clean water for 15 minutes. Severely damaged eyes should be irrigated with saline two to three times daily to remove inflammatory debris. Topical antibiotics should be used three to four times daily to prevent infection and scarring. Topical atropine can be used to dilate the pupil. Petroleum jelly should be applied to the edges of the eyelids to keep them from sticking together.

Oxygen should be administered to patients who are experiencing difficulty in breathing. Fluid and electrolyte balances should be monitored. Administer artificial respiration if the patient's breathing has stopped. *Do not* give mouth-to-mouth resuscitation if the patient's face is contaminated. If the patient's hair is contaminated with mustard, it must be shaved off. Treat secondary bacterial infections with antibiotics. If the agent is ingested, do not induce vomiting. Activated charcoal may benefit patients who have ingested mustard.

Prevention

Gas masks and protective clothing are effective in preventing mustard toxicity. Mustard vapor is much heavier than air, so people in contaminated areas should avoid low-lying areas when possible. Large doses of vitamin E (1,200 i.u. per day) may give some protection against the damaging effects of mustard. Vitamin E is a fat-soluble vitamin, and caution should be used to prevent toxicity.

Look for exam questions in Chapter 9: Final Exam.

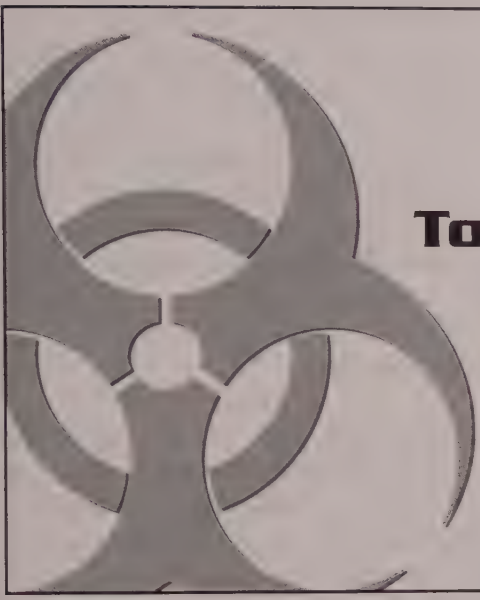
REFERENCES

Centers for Disease Control and Prevention. *Lewisite.* http://www.bt.cdc.gov/Agent/Blister/ctc0020.asp (accessed October 24, 2001).

_____. *Mustard.* http://www.bt.cdc.gov/Agent/Blister/ctc0021.asp (accessed October 24, 2001).

Organisation for the Prohibition of Chemical Weapons. *Mustard Agents.* http://www.opcw.nl/resp/html/mustard.html (accessed October 24, 2001).

Sidell, F.R., E.T. Takafuji, D.R. Franz, ed. 1997. *Medical Aspects of Chemical and Biological Warfare.* Washington, DC: U.S. Department of the Army, Office of The Surgeon General, and Borden Institute. Chapter 7: Vesicants.



Toxins

5

Toxins are poisons produced by living organisms such as plants, bacteria, fungi, and algae. They are not alive and cannot reproduce. Toxins can be grouped into two general categories of action against the body:

- Neurotoxins, which exert reversible effects on the nervous system
- Membrane-damaging toxins, which cause damage to tissues and organs

Toxins are more difficult to disperse than most other chemical and biologic warfare agents. If used, the most logical method of deployment would be in an aerosol form targeted to specific individuals or groups in confined spaces. Toxins can be delivered into a filtration or air-conditioning system or be used to poison food or water supplies. Reverse osmosis is effective in removing most toxins from water supplies. Chlorination of a water supply is generally not effective in destroying toxins other than botulinum toxin.

Toxins (except for trichothecene mycotoxins) do not readily penetrate the skin. The surfaces of the body that are most vulnerable to toxins are the respiratory and gastrointestinal tracts. Toxins are usually odorless and tasteless and are generally more potent than chemical agents. The immune system recognizes many toxins as foreign material and makes protective antibodies against them, which in turn makes it possible to create vaccines. The normal time needed for the body to make its own protective antibodies against a toxin is 4 to 15 weeks.

BOTULISM

Botulism is a disease caused by the toxin of the bacterium *Clostridium botulinum*. *C. botulinum* toxin enters the nervous system and prevents the release of acetylcholine, a nerve-impulse transmitter. This toxin paralyzes the muscles of the victim and is one of the most poisonous substances known. *C. botulinum* exists in soils around the world and could be cultured by small laboratories to produce lethal amounts of the toxin. It is relatively simple to produce and is a likely biological warfare agent. Eating toxin-contaminated food normally causes the disease. *C. botulinum* can infect an open wound and secrete its toxins. When the toxin is inhaled, it is estimated that less than 1 microgram can be lethal. Botulism is not spread from person to person.

Symptoms

The symptoms of ingested botulinum toxin appear hours to 3 days after exposure. Patients exposed to ingested toxins present as very ill with stomach pains, diarrhea, vision abnormalities, muscular weakness, and difficulty swallowing. The exposed patient later experiences paralyzed respiratory muscles leading to suffocation.

When the toxin is inhaled, the patient will likely present in 1 to 3 days with difficulty swallowing, mucus in the throat, cold-like symptoms without a fever, slowed eye movements and dilated pupils, slurred speech, and extreme weakness. Without treatment the patient may experience paralysis of the respiratory muscles and death by suffocation.

Treatment

There is an antitoxin available that is relatively safe and effective (a skin test for sensitivity must be performed before it is used), but it should be administered before the toxin enters the nervous system for optimal results; once the patient shows symptoms, the toxin has entered the nervous system and supportive care is needed. Intubation and mechanical ventilation should be part of supportive care when respiratory paralysis is experienced.

Prevention

A vaccine is available, and administration consists of three subcutaneous injections (0.5 ml) at weeks 0, 2, and 12. An annual booster is needed for continued protection. Side effects of the vaccine are most frequently soreness at the injection site for 2 to 4 days.

A gas mask can prevent inhaled botulinum poisoning, and the toxin can be removed from a water supply by reverse osmosis and deactivated by chlorination.

RICIN

Ricin is a plant toxin extracted from the seeds of the castor-oil plant, and its properties as a poison have been known since ancient times. It is one of the most deadly and easily produced plant toxins. Ricin blocks the body's ability to manufacture proteins, causing cellular and ultimately tissue destruction. It is present in castor meal after the oil has been extracted from the bean; castor beans contain between 1 and 5 percent ricin.

Symptoms

After ingestion, patients present in 1 to 2 hours with nausea, vomiting, and abdominal pain. This progresses into intestinal hemorrhaging and diarrhea. The patient experiences cramping, fever, sore throat, headaches, and dilation of the pupils. The patient ultimately moves toward vascular collapse, shock, and death.

Patients who have inhaled ricin will experience respiratory problems within 18 hours. The patient presents with low blood pressure and pneumonia-like symptoms. The lining of the respiratory tract is damaged, and fluid fills the lungs.

Treatment

Patients who have ingested ricin should be given a gastric lavage and activated charcoal. Intravenous fluid and electrolyte replacement may be necessary. Patients who have inhaled ricin should receive breathing support, intravenous fluid and electrolyte replacement, analgesics, and anti-inflammatory agents.

Prevention

Methods of treatment and immunization are under investigation. A gas mask can prevent inhalation. Reverse osmosis can be effective in removing ricin from water supplies. Chlorination will not deactivate it.

STAPHYLOCOCCAL ENTEROTOXIN B

Staphylococcal enterotoxin B (SEB) is an incapacitating agent. Produced by the bacteria staphylococcus aureus, SEB is the toxin that is most often the cause of food poisoning. The United States worked on weaponizing this toxin during the 1960s; a weaponized form of SEB would logically be an aerosol. SEB is soluble in water and could contaminate a water supply, although very large quantities would be required. It is relatively heat-stable and can withstand boiling for a few minutes. This toxin does not generally cause death.

Symptoms

Patients who are exposed to aerosols show symptoms 2 to 12 hours after exposure with a nonproductive cough, chest pain, shortness of breath, fever, muscle and joint pain, headache, stomach cramps, and vomiting. Patients who have ingested SEB present 2 to 12 hours after exposure with stomach cramps, vomiting, nausea, diarrhea, and occasionally fever.

Treatment

Most cases of SEB poisoning are self-limiting, and the patient will recover in less than 4 days. Supportive measures are the mainstay of treatment. Ventilation support and oxygen should be administered to patients with severe respiratory symptoms. Cool compresses, rest, fluids, and acetaminophen are helpful in keeping the patient comfortable. Antihistamines (diphenhydramine) have been used to control nausea. The ingested form of SEB is self-limiting after about 24 hours.

Prevention

A vaccine for SEB is being investigated. A gas mask is effective in preventing inhalation of SEB aerosols. Water should be boiled for 30 minutes after suspected contamination with SEB. Reverse osmosis can remove the toxin from drinking water; chlorination is not effective in deactivating SEB in a water supply.

TRICHOTHECENE MYCOTOXIN

Trichothecene mycotoxins are toxins produced by fungi. These agents are very stable in many environments. The fungi that produce trichothecene mycotoxins normally reside on plant material. When humans ingest the infected material (moldy grains or cereal), they develop mycotoxicosis. T-2 mycotoxin is the fungal toxin that is considered the most likely candidate for use as a biological agent. Evidence suggests that these toxins were used by the Soviets in Southeast Asia and Afghanistan in the "yellow rain" attacks.

Iraq has been suspected of experimenting with T-2, which can be delivered as dust, droplets, aerosols, or smoke by a number of methods. Producing large quantities of T-2 could be relatively simple using existing fermentation processes. When mycotoxins are extracted from fungal cultures, a yellow-brown oily liquid is produced that is almost 400 times more potent than mustard in producing injury to the skin. The agents can withstand tremendous amounts of heat: T-2 must be heated to

more than 500°F (260°C) for 30 minutes for inactivation. T-2 is rapidly absorbed through inhalation and ingestion but is slowly absorbed through the skin.

Symptoms

The symptoms of trichothecene mycotoxin exposure could present immediately as a burning sensation of the skin and eyes, blurred vision, nausea, vomiting, excessive nasal secretions, shortness of breath, and general weakness. As the toxin creates intestinal lesions, the patient presents with watery brown diarrhea and abdominal pain. In a short amount of time the patient may begin to experience chest pain, coughing, bleeding gums, fever, blisters, and low blood pressure and may vomit blood. Without treatment the patient may experience shock and possibly death.

Treatment

The patient should immediately be removed from the contaminated area and washed with soap and water. The eyes should be flushed with large amounts of saline. Washing the skin within 4 hours of exposure may reduce dermal damage by 80 percent. T-2 toxin can be inactivated by household bleach solutions. Activated charcoal should be administered to patients who have ingested T-2. Respiratory support should be administered to patients presenting with inhalation injury. Diphenhydramine (an antihistamine) has been shown to prolong survival times in animal experiments.

Prevention

There is not an available vaccine for this agent. Pre-exposure treatment with vitamin C, vitamin E, selenium, or diphenhydramine may give some protection against the effects of T-2 (this is under investigation). A gas mask and protective clothing are effective in preventing exposure. The only effective method of treatment for drinking water, at this time, is reverse osmosis. Chlorine bleach solutions will inactivate the toxin, but the degree of chlorination necessary to render the toxin inactive is very high and exceeds safe levels for drinking water.

Chapter 5 Self-Test

Question 1: Which of the following produce toxins?

A. Bacteria
B. Plants
C. Fungi
D. Algae
E. All of the above

Question 2: Which method of water treatment is effective for botulism toxin?

A. Chlorination
B. Reverse osmosis
C. Salting
D. A and B
E. None of the above

Answers: 1: E; 2: D

Levinson, W., E. Jawetz. 1998. *Medical Microbiology and Immunology*, 5th ed. Connecticut: Appleton and Lange.

Sidell, F.R., E.T. Takafuji, D.R. Franz, ed. 1997. *Medical Aspects of Chemical and Biological Warfare*. Washington, DC: U.S. Department of the Army, Office of The Surgeon General, and Borden Institute. Chapter 30: Defense Against Toxic Weapons. D.R. Franz.

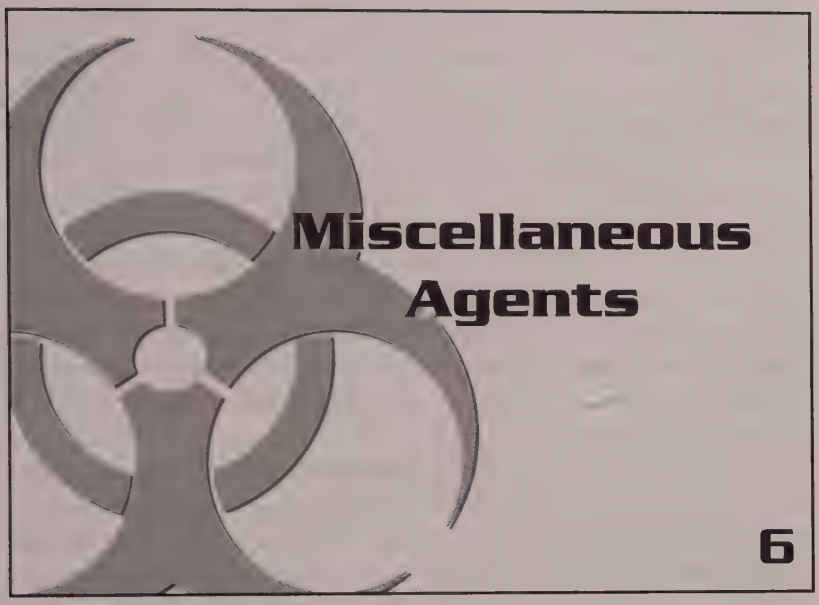
_____. 1997. *Medical Aspects of Chemical and Biological Warfare*. Washington, DC: U.S. Department of the Army, Office of The Surgeon General, and Borden Institute. Chapter 32: Ricin Toxin. D.R. Franz, N.K. Jaax.

_____. 1997. *Medical Aspects of Chemical and Biological Warfare*. Washington, DC: U.S. Department of the Army, Office of The Surgeon General, and Borden Institute. Chapter 33. Botulinum Toxins. J.L. Middlebrook, D.R. Franz.

_____. 1997. *Medical Aspects of Chemical and Biological Warfare*. Washington, DC: U.S. Department of the Army, Office of The Surgeon General, and Borden Institute. Chapter 31. Staphylococcal Enterotoxin B and Related Pyrogenic Toxins. R.G. Ulrich, et al.

_____. 1997. *Medical Aspects of Chemical and Biological Warfare*. Washington, DC: U.S. Department of the Army, Office of The Surgeon General, and Borden Institute. Chapter 34. Trichothecene Mycotoxins. R.W. Wannemacher, S.L.Wiener.

Organisation for the Prohibition of Chemical Weapons. *Toxins*. http://www.opcw.org/resp/html/toxins.html (accessed October 24, 2001).



Miscellaneous Agents

6

Miscellaneous agents include chlorine, hydrogen cyanide, phosgene, and tear gas. These have been placed under the miscellaneous heading because of their different mechanisms of action on the human body. They have all been used as chemical weapons, and many countries still manufacture them as such.

CHLORINE

Chlorine is a greenish-yellow gas with a pungent odor some describe as being similar to household bleach. Its vapor is heavier than air and tends to settle in low-lying areas. Chlorine is considered a choking agent because it causes lung damage in humans; 6,551 parts per million of chlorine vapor for 1 minute is considered a lethal dose.

Symptoms

Victims of inhaled chlorine exposure commonly complain of the inability to get enough air. Mild exposure to inhaled chlorine

cause an immediate burning sensation, cough, headache, labored breathing, nausea, shortness of breath, and sore throat. Moderate exposure causes the above with lung edema following a few hours later, which may lead to death if untreated. Exposure to the skin and eyes causes tearing, burning, pain, and possibly blurred vision.

Treatment

Victims of inhaled exposure should rapidly be moved to fresh air. The damaging effects of chlorine are magnified by physical exertion, so the patient should be made to sit in a half-upright position. Bronchospasms should be treated with bronchodilators. Oxygen therapy should be administered when hypoxia (low blood oxygen) is present.

Damage to the lung tissue can create an environment suitable for a number of bacteria. Secondary bacterial infection is commonly seen 3 to 5 days postexposure. Respiratory secretions other than clear or white in color could be an indication of a secondary bacterial infection and warrant antibiotic therapy.

Prevention

Removal of chlorine gas from the air can be accomplished with fine water mist. Chlorine vapor is heavier than air and travels along the ground, so people in contaminated areas should avoid low-lying spots when possible. A gas mask is effective in protecting against inhaled exposure to chlorine.

HYDROGEN CYANIDE

Cyanide is a respiratory chain poison that inhibits mitochondrial cytochrome oxidase, a protein involved in cellular respiration. Exposure results in a decrease in oxygen utilization. When cells in the body begin to function without oxygen, it causes lactic acidosis, a buildup of lactic acid in the body. Cyanide can be absorbed by and affect all tissues. Hydrogen cyanide has the faint odor of bitter almonds. During World War II, the Nazis used a form of hydrogen cyanide in gas chambers. In the 1980s it was reported that Iraq used hydrogen cyanide against Iran and the Kurds.

Symptoms

Cyanide poisoning presents in seconds as dryness and burning in the throat, shortness of breath, headache, faintness, vertigo, rapid, shallow breathing, increased heart rate, high blood pressure, vomiting, and convulsions. The above symptoms can be followed by lung edema, paralysis, coma, and death in severe cases. At high concentrations, cyanide can rapidly cause the victim to inhale deeply; this stimulation can be so strong that the victim cannot voluntarily hold his or her breath. Under high concentrations, the victim can go into convulsions and stop breathing within 30 seconds of inhalation. A bitter almond odor can be detected on the breath of intoxicated victims.

Treatment

The patient should be removed from the contaminated area immediately. Sit the patient in a half-upright position while preparing the antidote. Contaminated skin should be washed with soap and water. Administer oxygen to patients who show signs of labored breathing.

Adult patients who are unconscious should be treated with 10 to 15 milliliter (ml) (300 to 450 mg) of 3 percent solution of sodium nitrate, followed with 50 ml (12.5 gram) of 25 percent sodium thiosulfate. Sodium nitrate and sodium thiosulfate are both given intravenously. Following the sodium nitrate administration, the patient should not be allowed to get into an upright position because this could lead to severe low blood pressure and fainting. Break an ampule of amyl nitrate between two gauze pads and place over the airway 30 seconds of every minute while the patient breathes. A new ampule should be used every three minutes. Children are treated with lower dosages of the antidotes. Lactic acidosis can be treated by intravenous sodium bicarbonate.

Vitamin B12b (hydroxocobalamin) at high doses and EDTA may be helpful in treatment. Vitamin B12b is very expensive and is not the vitamin B12 available in many supplements; it may be available from chemical or pharmaceutical suppliers. Hyperbaric oxygen should be considered in patients who don't respond to antidotal therapy. Gastric lavage and

Hydrogen Cyanide

Treatment

USE ALL OF THE FOLLOWING:

Sodium nitrate (3 percent solution)
10 to 15 ml (300 to 450 mg) IV

Sodium thiosulfate (25 percent solution)
50 ml (12.5 g) IV

Amyl nitrate
1 ampule (vapor) 30 seconds of every minute with a new ampule every 3 minutes.

Vitamin B12b
4 grams (g) (at 1,346 g per mole) orally.

administration of activated charcoal should be administered to patients who have ingested cyanide.

Prevention

Removal of cyanide vapor from the air can be accomplished with fine water mist. A gas mask is effective in protecting against inhaled exposure to cyanide. This agent can penetrate unbroken skin. Protective clothing should be worn with the mask during cyanide release.

PHOSGENE

Phosgene was used during World War I and remains a possible chemical attack agent. It is considered a choking agent due to its damaging effects on the lungs. When aerosols are disseminated, a white cloud is formed, but this color will disappear as the agent sinks. Phosgene stays close to the ground because it is 3.4 times heavier than air. This agent has an odor of fresh-cut grass or hay at low concentrations.

Symptoms

Victims exposed to inhaled phosgene present with two separate periods of symptoms. There is usually an immediate onset of coughing, choking, headache, tearing, tightness in the chest, nausea, and occasional vomiting. These symptoms can subside, and the patient experiences no symptoms for 2 to 72 hours. After the symptom-free period, the patient will experience cough, shortness of breath, chest discomfort, shallow breathing, frothy sputum, severe lung edema, shock, and possibly death.

Treatment

Immediately remove the patient from any contaminated area. The patient should remain in a half-seated position until arrival at a medical facility. It is very important to keep the patient rested and warm. Oxygen should be administered to patients showing signs of hypoxia (low blood oxygen). Codeine (30 to 60 mg) can be given to suppress the cough. Steroids can be given to reduce the severity of lung edema. Diuretics may be of some value in reducing fluid loss into the lungs by reducing capillary pressure. A patient who shows no signs of recovery within 4 days should be evaluated for a secondary bacterial infection, which may be treated with antibiotics. Patients who survive phosgene contamination more than 48 hours usually recover without further complications.

Prevention

Phosgene vapor is heavier than air and travels along the ground, so people in contaminated areas should avoid low-lying spots when possible. A gas mask is effective in protecting against inhaled exposure to phosgene.

TEAR GAS

Tear gas is considered an incapacitating agent. Many forms exist, but two forms are the most common. CS (chlorobenzylidene malononitrile) is a white powder with a pungent odor. CN (chloracetophenon) is described as having the odor of apple blossoms and can be powder or liquid. They are both solid at

room temperature. Military and law enforcement agencies around the world use CS. CN is used in many personal protection devices. These agents can be heated to give vapors. Animals have a low sensitivity to tear gases.

Symptoms

Tear gas causes instant pain in the eyes. The victim experiences a flow of tears, saliva, and mucus. Skin exposure causes burning and swelling of the contaminated site. Victims experience a tightening in the chest, difficulty breathing, gagging, and possible vomiting. In exposure to extremely large doses, tear gas can cause serious damage to the respiratory system. Uncommonly, patients will present with respiratory damage 12 to 24 hours after exposure.

Treatment

The patient should be removed from the exposed area. The eyes should be irrigated with clean water. Washing the effected areas of skin with soap and water can possibly cause a momentary increase in symptoms but should bring relief sooner. CS can be inactivated by a 10 percent sodium bicarbonate and water solution. Bleach should *not* be used to decontaminate this agent. Tear-gas symptoms are usually self-limiting within 30 minutes. Any skin lesions caused by these agents should be treated with dressings and topical antibiotics. Antihistamines can be administered orally to control itching. Supportive care in a medical facility should be administered in the event of any respiratory damage.

Prevention

A gas mask and protective clothing are essential in preventing the effects of tear gas.

Chapter 6 Self-Test

Question 1: Which of the following most often presents as a greenish-yellow gas?

A. Chlorine
B. Phosgene
C. Hydrogen cyanide
D. Tear gas
E. All of the above

Question 2: Which of the following can be treated with Vitamin B12b?

A. Chlorine
B. Phosgene
C. Hydrogen cyanide
D. Tear gas
E. None of the above

Answers: 1: A; 2: C

REFERENCES

Centers for Disease Control and Prevention. *International Chemical Safety Cards—Chlorine.* http://www.bt.cdc.gov/Agent/Pulmonary/ipcs0126.asp (accessed October 25, 2001).

_____. *International Chemical Safety Cards—Hydrogen Cyanide.* http://www.bt.cdc.gov/Agent/Blood/ipcs0492.asp (accessed November 5, 2001).

_____. *International Chemical Safety Cards—Phosgene.* http://www.bt.cdc.gov/Agent/Pulmonary/ipcs0007.asp (accessed November 5, 2001).

Hu, Howard, MD, MPH; Jonathan Fine, MD; Paul Epstein, MD, MPH; Karl Kelsey, MD, MOH; Preston Reynolds, MD, PhD; Bailus Walker, PhD, MPH. "Tear Gas—Harassing Agent or Toxic Chemical Weapon?" August 4, 1989. *Journal of the American Medical Association* Vol. 262. Also available online: Physicians for Human Rights. http://www.phrusa.org/research/chemical_weapons/chemjama.html#6 (accessed January 29, 2004).

King County, Seattle, Washington. Toxic Hazards. *Riot Control Agents: Pepper Spray and Tear Gas.* http://www.metrokc.gov/health/hazard/riotcontrol.htm (accessed January 29, 2004).

Sidell, F.R., E.T. Takafuji, D.R. Franz, ed. 1997. *Medical Aspects of Chemical and Biological Warfare.* Washington, DC: U.S. Department of the Army, Office of The Surgeon General, and Borden Institute. Chapter 10. Cyanide Poisoning. S.I. Baskin, T.G. Brewer.

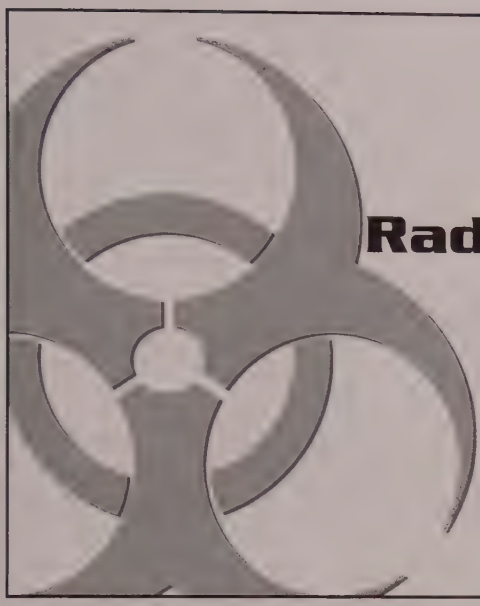
_____. 1997. *Medical Aspects of Chemical and Biological Warfare.* Washington, DC: U.S. Department of the Army, Office of The Surgeon General, and Borden Institute. Chapter 12. Riot Control Agents. F.R. Sidell.

_____. 1997. *Medical Aspects of Chemical and Biological Warfare.* Washington, DC: U.S. Department of the Army, Office of The Surgeon General, and Borden Institute. Chapter 9. Toxic Inhalation Injury. J.S. Urbanetti.

Organisation for the Prohibition of Chemical Weapons. Hydrogen Cyanide. http://www.opcw.nl/resp/html/hcn.html (accessed October 24, 2001).

Staten, C., Emergency Response and Research Institute. *Poison Warfare (Nerve) Gases.* http://www.emergency.com/nervgas.htm (accessed October 30, 2001).

U.S. Army Medical Research Institute. Kortepeter, M., G. Christopher, T. Cieslak, R. Culpepper, R. Darling, J. Pavlin, J. Rowe, K. McKee, E. Eitzen, ed. 2001. *USAMRIIDS's Medical Management of Biological Casualties Handbook*, 4th ed. Ft. Detrick, Maryland: U.S. Army Medical Research Institute of Infectious Diseases.



Radiation

7

Radiation is a form of energy that can travel through space and through many materials. Heat, light, and sound are all forms of radiation. This chapter covers ionizing radiation produced by unstable atoms.

When an atom has excess energy or mass, it is said to be unstable. These unstable atoms can emit electromagnetic and particulate radiation in the form of gamma and X-rays (electromagnetic) and alpha and beta radiation (particulate). Unstable substances can also release neutron radiation.

The amount of time unstable materials emit radiation depends on many factors, including the material in question and the rate of radioactive decay. Generally speaking, small fallout particles lose about 99 percent of their strength in roughly 2 weeks. The remaining 1 percent can still be fatal depending on the initial strength or energy.

Adverse health effects from radiation exposure range from skin burns and injury to organ failure and death. The effects are determined by the amount of radiation absorbed by the body

and the length of time the body is exposed. With high doses, effects can be seen almost immediately. Exposure to lower doses may only increase the risk of developing cancer or other chronic illness. This chapter will only cover the symptoms and treatment of the acute (immediate) effects of a nuclear incident.

TYPES OF RADIATION

Alpha Radiation

Alpha particles are emitted from radioactive materials. They have low penetrating power and have a very short range. Alpha particles are not normally able to penetrate unbroken skin. They are normally stopped by less than 4 inches of air or a single sheet of paper. Alpha particles only become a problem when the materials emitting them are inhaled, ingested, or enter the body by some other means.

Beta Radiation

Beta particles are also emitted from radioactive materials. They have moderate penetrating power and can travel for a few meters through the air. This form of radiation can penetrate intact skin and cause skin injury, as well as serious eye damage. If the materials emitting these particles are left on the skin, deposited in the nose, inhaled, or ingested, they can cause burns and internal damage.

Neutron Radiation

Neutrons are uncharged particles that react with the nuclei of atoms in target tissues. When neutrons bombard a target atom, they cause the atom to shift away from its orbital electrons. This normally occurs with lighter atoms such as hydrogen. Neutrons are more penetrating than alpha and beta radiation but not as penetrating as gamma radiation.

Gamma Radiation

Gamma radiation is an electromagnetic radiation of high energy. It is the most penetrating form of radiation and pres-

ents the greatest danger to humans. Gamma radiation is able to travel a few thousand meters through the air and penetrate human skin and tissues. It is so penetrating that a considerable amount can pass through the human body without a significant loss of energy. Persons exposed to materials emitting gamma radiation are in danger of severe radiation injury. A 3-foot thickness of earth or 2-foot thickness of concrete will stop almost all gamma rays.

Symptoms

Blast Injury

Blast wave overpressure and flying debris can cause serious injury to victims of a nuclear blast. Most blast injuries can be easily recognized due to trauma of the outer soft tissues (e.g. lacerations, bruising, and fractures). Some blast injuries could go unnoticed because of slow internal hemorrhaging. Patients with internal hemorrhaging could show signs of shock (low blood pressure, rapid heartbeat, confusion, decreased urine output, and cool, "clammy" skin).

Radiation Burns

The patient will present in as little as a few hours after exposure with skin that is red, swollen, and itchy. Hair loss on the exposed area can be seen in some cases. These symptoms can subside for a short time and the skin will seem to heal. This remission period is followed by a return of the symptoms. Thermal burns, classified as first, second, and third degree, would be seen following a nuclear blast.

- First degree: Characterized by red and painful skin. There is only slight damage to the first layer of skin (epidermis). Most sunburns are first-degree burns.
- Second degree: Characterized by red, painful, and blistered skin. There is destruction of the first layer of skin and slight damage to the second layer of skin (dermis).

- Third degree: Characterized by destruction of the first and second layers of skin. The underlying dermal appendages are also damaged. The skin often appears charred or blackened.

Early Transient Incapacitation (ETI)

When victims are exposed to high doses of radiation, they may experience early transient incapacitation, or ETI. This can occur within minutes to hours. The exposure causes the brain to lose its ability to regulate blood pressure, which causes the victim to become lethargic and confused. Acute radiation sickness generally follows ETI.

Acute Radiation Sickness

Radiation injury can occur following any release of radioactive material (e.g. nuclear blast, dirty bomb, or power-plant accident). Radiation sickness is a complex illness and can be complicated by injuries such as burns and blast injury. Acute radiation sickness is characterized by four phases: a prodromal phase, a latent phase, an illness phase, and a phase of recovery (or death). People who are exposed to radiation and remain symptom-free for more than 24 hours most likely received a low dose. They will generally require little or no immediate medical attention.

- Prodromal phase: The prodromal phase can start in the first few hours after exposure and is characterized by nausea, anorexia, vomiting, fatigue, possible diarrhea, and possible hyperthermia (rise in body temperature). With very high doses, the patient may experience the above along with respiratory distress and hyperexcitability. Nausea, anorexia, and vomiting can begin from 2 to 12 hours postexposure and usually subsides within 24 hours. Generally, the sooner the patient presents with nausea and vomiting, the greater the exposure to a radiation source. Hyperthermia (fever) is generally

associated with high doses of radiation. The symptoms of the prodromal phase may last only one to two days.

- Latent phase: During the latent phase, the symptoms resolve and the patient will appear to be recovering. The length of this phase varies with the dose of radiation received.
- Illness phase: Depending on the dose of radiation received, patients in the illness phase present with a suppressed immune system, infections, bleeding, diarrhea, electrolyte imbalances, cardiovascular collapse, and possible periods of unconsciousness.

Following the illness phase, the patient will either recover from or succumb to the illness. Future complications (i.e., cancer) can present due to the ionization.

Treatment

Blast Injury

Victims with blast injuries should be treated with emergency medical and supportive care. For unconscious patients, establish an airway and perform CPR when necessary. Fluid balance and blood pressure should be monitored and maintained. Care should be taken to evaluate the patient for signs of internal hemorrhaging.

Radiation Burns

The patient's skin should be gently decontaminated. Wash with a mild soap with a neutral pH and warm water. (Cold water closes the pores, trapping contaminated materials. Hot water causes more blood to flow to the area and increases the chance of internal contamination.) Sodium hypochlorite (bleach) solution, diluted 1:10 with water, can be used to decontaminate intact skin. Aggressive rubbing should be avoided. Contaminated hair should be shampooed, or removed if shampooing is ineffective. The burned skin should be dressed and kept clean. Topical ointments

(silver nitrate or antibiotic) can be applied to troubled areas to prevent bacterial infection.

Thermal Burns

First- and second-degree burns should be kept clean and dry. For extensive second-degree burns, some supportive care (fluids) may be necessary. Broken skin should be treated with topical antibiotics. Third-degree burns require aggressive wound management and possible supportive care (airway, fluids, IV antibiotics). Infection prevention is important when the skin is not intact or is badly damaged.

ETI and Acute Radiation Sickness

The patient should be decontaminated and treated for any nonradiological injuries first. For decontamination procedures, refer to treatment of radiation burns. The immediate management of patients who have received a serious (but not lethal) dose of radiation consists of combating infection and maintaining fluid balances.

Following a significant dose of radiation, the patient's bone marrow is damaged and his or her immune function diminishes. Antibiotics should be administered to prevent infection by both gram-negative and gram-positive bacteria (discussed in Chapter 1). A combination of antibiotics is used to fight these bacteria.

Patients who have been exposed to significant doses of radiation will require aggressive body-fluid maintenance due to the loss of fluid through vomiting and diarrhea. The vomiting can be controlled with antiemetics (antivomiting drugs). The diarrhea is usually caused by a destruction of the intestinal wall and can contain large amounts of blood. This lost fluid should be replaced with intravenous fluids including blood products.

Patients should be treated and held in a very clean environment. Their immune function will decrease rapidly with even median doses of radiation, and every effort should be made to keep them comfortable and hydrated.

ETI and Acute Radiation Sickness

Antibiotic Treatment

USE BOTH OF THE FOLLOWING:

Tobramycin

1.4 to 2.3 mg per pound of body weight per day IM (divided doses every 8 hours) for 14 days.

Ticarcillin

68 to 136 mg per pound of body weight per day IV (divided doses every 4 to 6 hours) for 14 days.

Antiemetic Treatment

USE ONE OF THE FOLLOWING:

Dolasetron

Adults: 100 mg per day orally for 2 days.

Children: 0.8 mg per pound of body weight per day (max 100 mg) for 2 days.

Granisetron

Adults: 2 mg per day orally for 2 days.

Prophylactic Treatment

USE ONE OF THE FOLLOWING:

Potassium iodide

Adults and children more than 150 lb.: 130 mg per day.
Children (3 to 18 years): 65 mg per day.
Children (1 month to 3 years): 32 mg per day.
Infants (birth to 1 month): 16 mg per day.

Potassium iodate

Adults and children more than 150 lb.: 85 mg per day.
Children (3 to 18 years): 42 mg per day.
Children (1 month to 3 years): 21 mg per day.
Infants (birth to 1 month): 10 mg per day.

Prevention

Distance and cover are essential in preventing illness from radiological incidents. Chemical suits and gas masks will provide some protection from alpha and beta fallout particles but offer little protection against gamma radiation. In the unlikely event of a nuclear incident, radioactive iodine will most likely be released and can cause serious health effects in its victims. Potassium iodide or potassium iodate can provide protection against the effects of radioactive iodine.

A number of types of nuclear incidents release radioactive iodine. The thyroid gland uptakes any iodine moving through the bloodstream and does not differentiate between radioactive and nonradioactive isotopes. Potassium iodide or potassium iodate given before or shortly after the nuclear incident works to block the absorption of radioactive iodine by filling the thyroid with nonradioactive iodine before a radioactive form is introduced. When the thyroid is filled with nonradioactive iodine, the harmful iodine will be eliminated.

Potassium iodine and potassium iodate produce the same results; however, it takes less potassium iodate to get a protective load of iodine into the thyroid.

The dosages given in the chart should be continued until the danger of radioactive iodine is no longer present. (Ideally, local authorities would advise you of when radioactive levels are safe. Aside from this, an instrument for measuring radioactivity would be needed.) Tablets containing the adult dosages can be purchased and stored for extended periods. Women who are pregnant or breastfeeding should take the adult dosage; the tablets can be cut for proper child and infant dosages.

There are a few alternatives to purchasing packaged tablets. Potassium iodide can be purchased in bulk from most chemical supply houses as potassium iodide USP. To make the solution, mix 24.5 grams of potassium iodide crystals into 1 quart of clean water. Five ml (1 teaspoon) of this solution will give the required iodine for one adult dose. This quart will provide about 190 adult doses at a fraction of the cost of packaged tablets. Iodized salt will NOT provide the necessary amount of iodine to block the thyroid gland, and iodine used for disinfect-

ing (tincture of iodine, water tablets, povidone iodine) can be fatal when ingested. *Do not* attempt to use these products for thyroid blocking.

Dirty bombs spread or release radioactive materials for terror purposes. It is unlikely that they will contain radioactive iodine. For this reason, potassium iodide will probably not be necessary in the event of a dirty bomb explosion.

REFERENCES

Centers for Disease Control and Prevention. *Acute Radiation Syndrome: Radiation Studies.* http://www.cdc.gov/nceh/radiation/ars.htm (accessed March 7, 2003).

_____. *Dirty Bombs: Radiation Studies.* http://www.cdc.gov/nceh/radiation/db.htm (accessed March 7, 2003).

_____. *Nuclear Terrorism and Health Effects: Radiation Studies.* http://www.cdc.gov/nceh/radiation/q&a.htm (accessed March 7, 2003).

_____. *Radiation and Health Effects: Radiation Studies.* http://www.cdc.gov/nceh/radiation/basicfacts.htm (accessed March 7, 2003).

_____. *Radiation Facts: Radiation Studies.* http://www.cdc.gov/nceh/radiation/facts.htm (accessed March 7, 2003).

Department of the Army, the Navy, and the Air Force. 1996. *FM8-9 NATO Handbook on the Medical Aspects of NBC Defensive Operations.* Washington, D.C.

Fauci, A.S., et al. 1998. *Harrison's Principles of Internal Medicine*, 14th ed. New York: McGraw-Hill Companies, Inc.

KI4U. *Potassium Iodide Anti-Radiation Pill FAQ.* http://www.ki4u.com (accessed March 25, 2003).

Spraycar, M., ed. 1995. *Stedman's Medical Dictionary*, 26th ed. Baltimore, Maryland: Williams and Wilkins.

Vital Signs

8

Vital signs are an important indicator of the human body's status. Throughout this book, references to vital signs have been made. Many of the sections on symptoms inform the reader to be alert for things such as fever, a rapid heart rate, increased blood pressure, or an increased rate of respiration. This brief chapter gives reference values for normal individuals.

TEMPERATURE

Normal body temperature, measured orally, is 98.6°F (37°C). This value can fluctuate during the day, being lower in the early morning and higher in the evening. Generally, oral temperatures above 99.1°F (37.3°C) are considered feverish. Temperatures above 102.2°F (39°C) are generally considered high fevers. Rectal temperatures are generally .9°F (.5°C) higher than oral temperatures.

NORMAL PULSE/HEARTBEAT

At rest adult: 60 to 80 beats per minute
At rest child: 80 to 100 beats per minute
At rest infant: 100 to 140 beats per minute

(Note: For each 1.8°F [1°C] of fever, the pulse normally increases 15 to 20 beats per minute.)

NORMAL RESPIRATION

At rest adult: 14 to 20 breaths per minute
At rest child: up to 30 breaths per minute
At rest infant: up to 44 breaths per minute

BLOOD PRESSURE

Normal blood pressure is 120/80. The first value (120) is the systolic pressure (the blood pressure when the heart is contracting) and the second value (80) is the diastolic pressure (referring to the time when the heart is in a period of relaxation and dilatation, or expansion).

REFERENCES

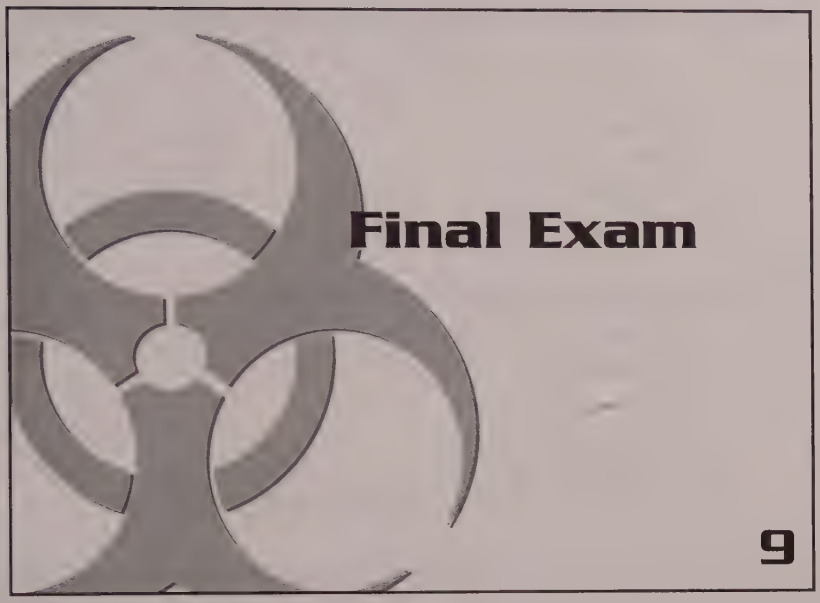
Bates, B., L. Bickley, R. Hoekelman. 1995. *A Guide To Physical Examination and History Taking*, 6th ed. Philadelphia: J.B. Lippincott Company.

Fauci, A.S., et al. 1998. *Harrison's Principles of Internal Medicine*, 14th ed. New York: McGraw-Hill Companies, Inc.

MedicineNet.com. *MedTerms Dictionary A-Z List.* http://www.medicinenet.com. (accessed February 25, 2004).

Spraycar, M., ed. 1995. *Stedman's Medical Dictionary*, 26th ed. Baltimore, Maryland: Williams and Wilkins.

Werner, D., et al. 1992. *Where There Is No Doctor.* California: Hesperian Foundation.



Question 1: Aerobic refers to a living organism that:

A. Can't grow in the presence of oxygen
B. Uses oxygen
C. Prefers oxygen but can live without it
D. Both B and C
E. None of the above

Question 2: Which of the following is not a component of anthrax toxin?

A. Lethal factor
B. Edema factor
C. Hemolytic factor
D. Protective antigen
E. None of the above

Question 3: Which of the following types of infection is not caused by anthrax?

A. Cutaneous
B. Ocular
C. Gastrointestinal
D. Pneumonic
E. None of the above

Question 4: Which of the following medications should not be used to treat anthrax?

A. Ciprofloxacin
B. Doxycycline
C. Amoxicillin
D. Cephalosporin
E. All of the above are effective

Question 5: Which of the following agents are capable of deactivating anthrax?

A. Chlorine bleach
B. 3 percent hydrogen peroxide
C. Iodine
D. A and C
E. All of the above

Question 6: What is a current method of prophylactic treatment for anthrax?

A. Ciprofloxacin 500 mg every 12 hours for 60 days
B. Erythromycin 250 mg every 6 hours for 60 days
C. Ciprofloxacin 500 mg every 6 hours for 60 days
D. Ciprofloxacin 500 mg every 12 hours for 14 days
E. None of the above

Question 7: What is the maximum time brucella can survive on a piece of paper at room temperature?

A. 3 days
B. 7 days
C. 12 days
D. 32 days
E. All of the above

Question 8: What is the maximum amount of time cholera can survive on a metal coin at room temperature?

A. 1 hour
B. 7 hours
C. 1 day
D. 7 days
E. None of the above

Question 9: After exposure, what is the normal time of onset for the symptoms of cholera?

A. 2 hours
B. 1 to 2 hours
C. 5 days
D. 1 to 2 days
E. Immediately

Question 10: Which disease presents with an onset of "rice-water" diarrhea?

A. Cholera
B. Anthrax
C. Q fever
D. Legionnaires' disease
E. Plague

Question 11: Which organism can survive in spit for up to 30 days?

A. Anthrax
B. *Y. pestis* (plague)
C. *C. burnetii* (Q fever)
D. Francisella (tularemia)
E. Legionella

Question 12: Which organism can survive in straw for up to 190 days?

A. Anthrax
B. *Y. pestis* (plague)
C. *C. burnetii* (Q fever)
D. Francisella (Tularemia)
E. Legionella

Question 13: Which organism was implicated in an outbreak at a convention in 1976?

A. Anthrax
B. *Y. pestis* (plague)
C. *C. burnetii* (Q fever)
D. Francisella (tularemia)
E. Legionella

Question 14: What is the treatment of choice for Legionnaires' disease?

A. Erythromycin
B. Ribavirin
C. Amyl nitrate
D. Penicillin
E. None of the above

Question 15: Which of the following organisms is most likely to be passed person to person through the air?

A. Anthrax
B. *Y. pestis* (plague)
C. *C. burnetii* (Q fever)
D. Francisella (tularemia)
E. Legionella

Question 16: What is enclosed in the protein coat of a virus?

A. RNA
B. Capsid
C. DNA
D. Prion
E. A or C

Question 17: Which of the following substances can transmit the Ebola virus?

A. Blood and semen
B. Sweat
C. Vomit
D. Feces and urine
E. All of the above

Question 18: How long can Ebola remain viable in a corpse?

A. 2 weeks
B. 2 years
C. 20 weeks
D. A and B
E. None of the above

Question 19: What is the treatment for infection with hantavirus?

A. Penicillin 500 mg every 6 hours for 14 days
B. Ciprofloxacin 500 mg every 12 hours for 60 days
C. Supportive measures
D. Enema with activated charcoal
E. All of the above

Question 20: How is hantavirus contracted in nature?

A. Mosquito bites
B. Inhalation of deer tick feces
C. Inhalation of dried rodent urine and feces
D. Eating undercooked meat
E. None of the above

Question 21: Which of the following diseases present with a rash that starts at the face and moves to the extremities?

A. VEE
B. Smallpox
C. Ebola
D. B and C
E. All of the above

Question 22: Which of the following is the natural carrier for VEE?

A. Tick
B. Deer mouse
C. Mosquito
D. Humans
E. All of the above

Question 23: Which of the following made a name for itself during the Panama Canal project?

A. Hantavirus
B. Syphilis
C. VEE
D. Yellow fever
E. Ebola

Question 24: Which of the following presents with black vomit?

A. Hantavirus
B. Yellow fever
C. VEE
D. B and C
E. All of the above

Question 25: When should emesis (vomiting) be induced in a patient who has ingested a nerve agent?

A. Immediately
B. 1 to 2 hours
C. After activated charcoal administration
D. Never
E. Within the first 5 minutes

Question 26: What is the function of diazepam in nerve agent treatment?

A. Reduce convulsions
B. Reduce seizures
C. Reduce urine output
D. Reduce nausea
E. A and B

Question 27: Which nerve agent was released by a Japanese religious sect in 1994?

A. VX
B. Tabun
C. Sarin
D. Soman
E. All of the above

Question 28: Which of the following is given pre-exposure for nerve agent antidote enhancement?

A. Pralidoxime chloride 600 mg every 8 hours
B. Pyridostigmine bromide 30 mg every 8 hours
C. Atropine sulfate 2 mg every 8 hours
D. Diazepam 10 mg every 8 hours
E. None of the above

Question 29: Which of the following nerve agents has an odor of rotting fruit?

A. Sarin
B. Soman
C. Tabun
D. VX
E. All of the above

Question 30: Which of the following has an odor of bitter almonds?

A. Sarin
B. VX
C. Tabun
D. Hydrogen cyanide
E. C and D

Question 31: Which of the following is likely to persist for weeks after it is released?

A. Sarin
B. Soman
C. Tabun
D. VX
E. A and D

Question 32: Which of the following blistering agents presents with immediate symptoms?

A. Mustard liquid
B. Mustard gas
C. Lewisite
D. B and C
E. All of the above

Question 33: Which of the following agents is better suited for winter warfare?

A. Mustard liquid
B. Mustard gas
C. Lewisite
D. B and C
E. All of the above

Question 34: Which of the following presents with a delayed onset of symptoms?

A. Mustard liquid
B. Mustard gas
C. Lewisite
D. A and B
E. All of the above

Question 35: Which of the following can be used to decontaminate blistering agent exposure?

A. A solution of sodium bicarbonate and vinegar
B. A solution of activated charcoal and water
C. A solution of chlorine bleach and water
D. A solution of salt and water
E. A solution of uric acid

Question 36: Which of the following can produce blisters on exposed areas of the victims?

A. Mustard
B. Lewisite
C. Tear gas
D. T-2
E. All of the above

Question 37: When do the symptoms of mustard exposure present?

A. Immediately
B. 1 to 24 hours
C. 2 to 3 days
D. 2 weeks
E. None of the above

Question 38: Which of the following can reduce the dermal effects of mustard if applied to the affected area within 10 to 20 minutes after exposure?

A. Chlorine bleach
B. Povidone iodine
C. Sodium bicarbonate
D. BAL
E. None of the above

Question 39: When a patient's hair is contaminated with mustard or lewisite it must be?

A. Washed with soap and water
B. Washed with chlorine bleach
C. Washed with sodium bicarbonate
D. Washed with lye
E. Shaved off

Question 40: Which of the following may give some protection against mustard effects?

A. Large doses of chlorine bleach
B. Large doses of vitamin B12b
C. Large doses of vitamin E
D. Small doses of arsenic
E. Adequate intake of protein

Question 41: What method of water treatment is effective in removing SEB toxins from a water supply?

A. Chlorination
B. Reverse osmosis
C. Boiling
D. Salting
E. All of the above

Question 42: Which of the following prevents the release of acetylcholine?

A. Sarin
B. Soman
C. Botulism toxin
D. VX
E. All of the above

Question 43: What is the most likely cause of death in botulism toxin poisoning?

A. Suffocation
B. Dehydration
C. Lung edema
D. Hemorrhage
E. All of the above

Question 44: Which of the following are symptoms presented with inhaled botulism toxin?

A. Difficulty swallowing
B. Mucus in the throat
C. Coldlike symptoms
D. Slurred speech
E. All of the above

Question 45: What is the ricin content in castor beans?

A. 1 to 5 percent
B. 5 to 10 percent
C. 15 to 20 percent
D. 35 percent
E. None of the above

Question 46: What effect does ricin have on the body at a cellular level?

A. Stops the utilization of oxygen
B. Stops the manufacture of proteins
C. Inhibits acetylcholinesterase
D. A and B
E. All of the above

Question 47: Which of the following toxins is the most common cause of food poisoning?

A. SEB
B. T-2
C. Botulism
D. Ricin
E. T-3

Question 48: Which of the following do fungi produce?

A. SEB toxin
B. Botulism toxin
C. Ricin
D. T-2
E. All of the above

Question 49: Pre-exposure treatment with which of the following is being investigated as protection against T-2?

A. Vitamin C
B. Vitamin E
C. Selenium
D. Diphenhydramine
E. All of the above

Question 50: Which of the following is heavier than air?

A. Chlorine gas
B. Phosgene
C. Lewisite
D. Sarin
E. All of the above

Question 51: Which of the following is the most dangerous effect of chlorine gas?

A. Burning sensation of the skin
B. Headache
C. Shortness of breath
D. Blurred vision
E. Lung edema

Question 52: What effect does hydrogen cyanide have on the body at a cellular level?

A. Stops the utilization of oxygen
B. Stops the manufacture of proteins
C. Inhibits acetylcholinesterase
D. A and B
E. All of the above

Question 53: Which of the following have the odor of bitter almonds?

A. Hydrogen cyanide
B. Chlorine
C. Industrial tabun
D. A and C
E. All of the above

Question 54: Which of the following should be treated with sodium nitrate?

A. Hydrogen cyanide
B. Chlorine
C. Sarin
D. Lewisite
E. Phosgene

Question 55: Which of the following can present as a white cloud when dispersed?

A. Tear gas
B. Phosgene
C. Mustard
D. A and B
E. A and C

Question 56: Which of the following should NEVER be used to decontaminate a tear-gas skin exposure?

A. Sodium bicarbonate solution
B. Chlorine bleach
C. Soap and water
D. A and B
E. B and C

Question 57: Which of the following is the normal body temperature in Celsius, measured with a rectal thermometer?

A. 98.6
B. 37.0
C. 36.5
D. 37.5
E. 99.4

Question 58: Which of the following would be considered a normal pulse for an adult at rest?

A. 100
B. 85
C. 80
D. 55
E. 120

Question 59: Which of the following would be considered a normal respiration rate per minute for an adult at rest?

A. 10
B. 17
C. 21
D. 30
E. 44

Question 60: In the blood pressure reading of 122/75, describe the two values.

A. 122 is the diastolic and 75 is the hystolic
B. 122 is the hystolic and 75 is the diastolic
C. 122 is the hystolic and 75 is the systolic
D. 122 is the systolic and 75 is the hystolic
E. 122 is the systolic and 75 is the diastolic

Answers to the Final Exam

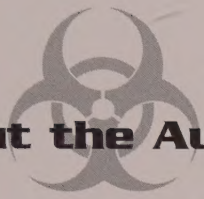
1: B	11: C	21: D	31: D	41: B	51: E
2: C	12: D	22: C	32: C	42: C	52: A
3: B	13: E	23: D	33: C	43: A	53: D
4: D	14: A	24: B	34: D	44: E	54: A
5: E	15: B	25: D	35: C	45: A	55: D
6: A	16: E	26: E	36: E	46: B	56: B
7: D	17: E	27: C	37: B	47: A	57: D
8: D	18: A	28: B	38: B	48: D	58: C
9: D	19: C	29: B	39: E	49: E	59: B
10: A	20: C	30: E	40: C	50: E	60: E

Appendix
Metric Conversions

Celsius to Fahrenheit: multiply by 9, divide by 5, add 32
Fahrenheit to Celsius: subtract 32, multiply by 5, divide by 9

Kilograms to pounds: multiply by 1,000, divide by 454
Pounds to kilograms: multiply by 454, divide by 1,000

Liters to gallons: multiply by 264, divide by 1,000
Gallons to liters: divide by 264, multiply by 1,000



About the Author

Matt Bolinger, MD, is an epidemiologist and conducts disease outbreak and field investigations for three counties in the southwestern United States. Most of his time is spent on disease surveillance (with an emphasis on bioterrorism) and analysis of population disease statistics. He has extensive training in symptomatic recognition and tracking of a bioterror agent release.

Terrorists have in recent years used deadly biological and chemical agents to attack civilian and government targets, and the ever-present threat of a nuclear incident is chilling to any sane person. Names such as anthrax, sarin, and ricin have become frighteningly familiar, but how many people know how to identify and treat the effects of these weapons of terror?

Matt Bolinger, MD, combats fear with knowledge, presenting relevant and useful facts on likely nuclear, biological, and chemical agents of terror. This book includes descriptions of 29 such agents, the symptoms they produce, treatment options, and ways to prevent exposure. Also included are exam questions to help you test your comprehension and a chapter on vital signs.

Do you know

- which antibiotics should be used for anthrax exposure or plague outbreaks?
- what can be done in the event of a smallpox epidemic?
- how long cholera can persist in a water supply or on a metal coin?
- how to prevent radiation poisoning?
- how to disinfect a water supply contaminated with botulinum toxin?

This book will answer these questions and many more.

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