

Health Consequences of Chemical and Biological Exposure

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Disclosure Statement

- ▶ I, Aaron Hilliard, do not have a vested interest in or affiliation with any corporate organization offering financial support or grant money for this continuing education program, or any affiliation with an organization whose philosophy could potentially bias my presentation.

Objectives

- ▶ Describe the health consequences and public health threats associated with exposures to chemical and biological agents
- ▶ Summarize the role of the pharmacist or health care provider during a chemical and/or biological emergency response

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Introduction

- ▶ Terrorism is the threat or implementation of violent means to undermine, destabilize, inflict harm, or cause panic in a society
- ▶ The induction of fear is a destabilizing force in a nation or state.
- ▶ September 11, 2001

Introduction

- ▶ Terrorist methods comprise the use of chemical, biological and radiological agents capable of widespread mass casualties and destruction.
- ▶ Ease of availability, the low cost of production and the facility for wide dissemination makes them very attractive weapons.
- ▶ The U.S FDA has prepared a series of working guidelines and information to help prepare against the threat of bioterrorism

Chemical Agents As Threats To Public Safety

- ▶ As early as 1990s, the U.S. chemical weapon stockpile included an estimated 25,000 tons of chemical warfare agents
- ▶ These included Organophosphorus nerve agents, vesicant (blister) agents as well as mustard gas
- ▶ Human experimentation was a significant part of the program to test protective clothing and respiratory mask
- ▶ Other experiments were designed to evaluate the operational readiness of military personnel
- ▶ Experiments involving human exposure were conducted until 1975
 - ▶ Information obtained from reports by National Research Council/National Academy of Sciences requested by Departments of Veterans Affairs and Defense

Chemical Agents As Threats To Public Safety

- ▶ During the Gulf War in 1991, Iraq was known to possess both chemical (Sarin and Cyclosarin) and biological weapons
- ▶ The weapons were not intentionally used by Iraqi forces during the Gulf War
- ▶ U.S. military service members used explosives to destroy a large ammunition depot (known as Khamisiyah) following the Gulf War cease-fire
- ▶ Department of Defense notified over 100,000 Gulf War veterans who had been in the vicinity of Khamisiyah at the time of the demolitions

Chemical Agents As Threats To Public Safety

- ▶ Nerve gases were developed during World War II as possible chemical warfare agents
- ▶ The first compound of which was tetraethyl pyrophosphate (TEPP).
- ▶ The biological action of the nerve gases, such as sarin (GB), tabun (GA), and soman (GD), Cyclosarin (GF) is similar to, but more toxic than the organophosphate (OP) insecticides
- ▶ The clear, colorless, tasteless liquids inhibit the action of acetylcholine esterase (AChE) by forming an irreversible OP-AChE complex, rendering it incapable of hydrolyzing acetylcholine (ACh).
- ▶ Inhibition of the enzyme results in accumulation and overstimulation of ACh at autonomic and somatic receptors.
- ▶ Excessive stimulation of nicotinic receptors is followed by skeletal muscle paralysis

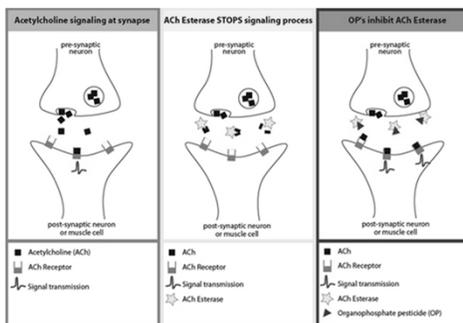
Chemical Agents As Threats To Public Safety

- ▶ Soman, a methylphosphonofluoridic acid ester
- ▶ Readily absorbed through skin
- ▶ VX (Methylphosphonothioic acid ester) has emerged as a more toxic nerve agent
- ▶ Its chemical and biological properties satisfy the requirements for VX as a chemical bioterrorist threat.

Chemical Agents As Threats To Public Safety

- ▶ Heating VX liquid renders it suitable for inhalation, dermal, or ocular contact with the airborne vapors.
- ▶ Contamination of food and water supplies
- ▶ Accumulation in physiological compartments
- ▶ Slow metabolic degradation
- ▶ High density, enabling it to spread throughout low-lying areas
- ▶ VX produces a severe cholinergic syndrome, terminating in convulsions, respiratory failure, and death with high doses
- ▶ Recovery from mild or moderate exposure to a nerve agent is possible.

Chemical Nerve Agents



Chemical Nerve Agents Organophosphates

- ▶ Used predominantly as pesticides.
- ▶ They are acetylcholinesterase (AChE) inhibitors.
- ▶ Exposure can be both accidental and deliberate, including occupational accidents and warfare (nerve agents), terrorist attacks, suicide attempts, homicides, etc.
- ▶ Onset of symptoms is fastest when inhaled (within seconds: Sarin gas), or by injected compounds.
- ▶ Slowest with dermal absorption, symptoms should occur within 6 hours

Chemical Nerve Agents Organophosphates

DIAGNOSIS:

Is made by symptoms and confirmed by laboratory tests indicating depressed levels of AChE activity.

TREATMENT: Is directed towards supportive care, decontamination, treatment of muscarinic signs and symptoms (Atropine) and antidotal therapy to regenerate AChE (Pralidoxime (2-PAM)).

GI decontamination: - Within 30-60 min by gastric lavage.

- Administer charcoal, unless emesis prevents it
- NO CATHARTICS (patient is suffering from diarrhea)

Dermal decontamination: Remove clothing, wash body with large amounts of water and soap. Health care workers wear protective barriers: glove, masks, eye shields, etc.

Organophosphates

Examples

Pesticides-Malathion, parathion, diazinon,
nerve gases – tabun, sarin, soman, cyclosarin, and
VX

Toxicity

Acute toxicity highly variable – Parathion, TPN,
sarin very toxic, malathion much less

Organophosphates

Mechanism of toxicity

Inhibition of acetylcholinesterase (AChE)
in nerve tissue

Symptoms

Over-stimulation of parasympathetic
nervous system --- salivation,
constricted pupils, diarrhea, sweating,
muscle twitching, CNS disturbances –
coma and death

Treatment

Reverse AChE inhibition effects – use
Atropine to block Ach receptors or AChE
inhibitor with Pralidoxime (2-PAM)

Organophosphates

Other Toxic Effects

- Delayed peripheral neuropathy (TOCP)
- Not a carcinogen or teratogen
- Possible long term neurological
consequences from repeated exposures

Chemical Nerve Agents Organophosphates

Acute Toxicity:

- ▶ The signs and symptoms of AChE inhibitions are related to:
 1. Muscarinic effects
 2. Nicotinic effects
 3. CNS effects
- ▶ Muscarinic effects can be remembered easily using the mnemonics:
- ▶ **SLUDGE** and **DUMBELS**

▶ S alivation	▶ D iarrrhea
▶ L acrimation	▶ U rinary incontinence
▶ U rinary incontinence	▶ M iosis, muscle twitch
▶ D iarrrhea	▶ B ronchorrhrea, bronchospasm, bradycardia
▶ G i distress	▶ E mesis
▶ E mesis	▶ L acrimation
	▶ S alivation

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Learning Assessment

- ▶ All of the following are components of Cholinergic Toxidrome clinical features except:
 - ▶ A. GI distress
 - ▶ B. Lacrimation
 - ▶ C. Defecation
 - ▶ D. Decreased bowel motility
 - ▶ E. Emesis

Chemical Nerve Agents Organophosphates

- ▶ Nicotinic effects can be remembered easily using the mnemonics:
- ▶ **MTWHF**
- ▶ Mydriasis, Tachycardia, Weakness, Hypertension, Hyperglycemia, Fasciculations
- ▶ CNS effects include anxiety, restlessness, headache, slurred speech, tremors, psychosis, seizures and death. Often characterized by 3 C's
- ▶ Confusion, Convulsions and Coma

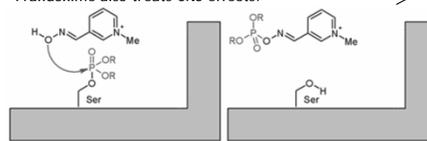
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Chemical Nerve Agents Organophosphates

TREATMENT (continued):

Establish airways: Treatment involves the use of **Atropine**: a competitive acetylcholine antagonist at postsynaptic muscarinic nerve membrane.

Antidotal therapy involves the use of **Pralidoxime**, which removes the phosphate from the acyl pocket of AChE and scavenges for additional non-bound organophosphates. Pralidoxime also treats CNS effects.



Gulf War Veterans' Medically Unexplained Illnesses

- ▶ A cluster of medically unexplained chronic symptoms that can include:
 - ▶ Fatigue
 - ▶ Headaches
 - ▶ Joint pain
 - ▶ Indigestion
 - ▶ Insomnia
 - ▶ Dizziness
 - ▶ Respiratory disorders
 - ▶ Memory problems

Military Service Connection VA: Chronic Multi-symptom Illness

- ▶ VA presumes certain chronic, unexplained symptoms existing for 6 months or more are related to Gulf War service without regard to cause
- ▶ Presumptive illnesses must have appeared during active duty or by December 31, 2021, and be at least 10 percent disabling
 - ▶ Chronic Fatigue Syndrome
 - ▶ Fibromyalgia
 - ▶ Functional gastrointestinal disorders
 - ▶ Undiagnosed illnesses
 - ▶ Veterans are eligible for medical and disability compensation

Vesicants, chemical asphyxiants, pulmonary irritants

- ▶ Nitrogen mustards are cytotoxic chemotherapy agents similar to mustard gas
- ▶ Nonspecific DNA alkylating agents
- ▶ Nitrogen mustard gas was stockpiled by several nations during World War II
- ▶ Dr. Alfred Gilman and Louis Goodman did research at Yale School of Medicine
- ▶ Performed clinical trials and classified nitrogen mustards for treatment of lymphoma i.e. cyclophosphamide

Vesicants, chemical asphyxiants, pulmonary irritants

- ▶ Vesicants, such as nitrogen mustard compounds, are capable of causing tissue necrosis
- ▶ These alkylating agents have a delayed onset of action (about 6 to 8 h), although cellular necrosis ensues immediately
- ▶ Inhalation produces a typical pulmonary irritation
- ▶ Lacrimating agents (benzyl bromide), simple asphyxiants (inert gases), chemical asphyxiants (carbon monoxide, cyanide), and pulmonary irritants (carbon disulfide, phosgene) are now recognized as potential chemical bioterrorist threats

Learning Assessment

- ▶ Which one of the following agents is cytotoxic
 - ▶ A. Soman
 - ▶ B. Nitrogen mustard
 - ▶ C. Tabun
 - ▶ D. Sarin
 - ▶ E. Cyclosarin

Ricin (Ricinus Communis)

- ▶ Ricin is derived from the processing of the castor bean and its seeds (Euphorbiaceae) in the extraction of castor oil.
- ▶ The seeds, plant, fruit, and constituents are stable in extreme hot or cold temperatures
- ▶ Ricin is composed of two lectins found in the seeds, ricin I and II
- ▶ The compounds, especially ricin II, bind to and inactivate the 60S ribosomal subunit in somatic cells, thus blocking protein synthesis
- ▶ It is one of the most potent of plant toxins

Ricin (Ricinus Communis)

- Inhalation of ricin powder likely produces a cough, dyspnea, nausea, and vomiting within a few hours
- Pulmonary congestion and cyanosis could soon follow.
- Injection of a lethal amount of ricin (estimated to be about 500 mg) at first would cause local muscle paralysis and lymph node necrosis near the injection site.
- Massive stomach and intestinal hemorrhaging would ensue, followed by multiple organ failure.
- Death occurs within 36 to 48 h and is due to focal necrosis of liver, spleen, lymph nodes, intestine, and stomach.

Introduction to Biological Agents

- ▶ Category A: High priority agents and pathogens rarely seen in the U.S that pose a risk to national security
- ▶ Highly infectious and easy to disseminate
- ▶ Clinical effects from exposure result in high mortality rates
- ▶ Capable of inciting public panic and disruption
- ▶ Require special action for public health preparedness

Introduction to Biological Agents

- Category A includes: Anthrax, Botulism, Plague, Smallpox, Tularemia, and organisms that induce viral hemorrhagic fevers,
- Category B: Lists the second highest priority agents
- Moderately easy to disseminate
- Moderate morbidity and low mortality rates
- Enhanced disease surveillance

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TABLE 32.1
Chemical and Biological Agents with High Risk to National Security

Category	Category Description	Toxin or Disease	Causative Agent	Classification
A	Highly infectious, easily disseminated, high mortality rate	Anthrax	<i>Bacillus anthracis</i>	Spore-forming bacteria
		Botulism	<i>Clostridium botulinum</i>	Spore-forming bacteria
		Plague	<i>Yersinia pestis</i>	Enterobacteria
		Smallpox	Variola, vaccinia*	Poxvirus
		Tularemia	<i>Francisella tularensis</i>	Coccobacillus
B	Moderate rates of infection, dissemination, morbidity and mortality	Hemorrhagic fever	Lassa, Junin, Machupo	Arenavirus
		Brucellosis	<i>Brucella</i> sp.	Coccobacillus
		Epsilon toxin	<i>Clostridium perfringens</i>	Spore-forming bacteria
		Acute gastroenteritis	<i>Salmonella</i> sp., <i>Shigella</i> sp., <i>E. coli</i>	Enterobacteria
		Q fever	<i>Coxiella burnetii</i>	Obligate intracellular bacillus
C	Highly infectious, ease of dissemination unknown	Ricin toxin	<i>Ricinus communis</i>	Castor beans
		Hemorrhagic fever, ARDS	Hantavirus	Bunyaviridae
		Encephalitis	Bunyavirus	
		Encephalitis	Nipah virus	Paramyxoviridae

Note: ARDS = adult respiratory distress syndrome.

* Variola is the extinct human virus; vaccinia is the laboratory product used for smallpox vaccinations.

Biological Pathogenic Toxins as Threats to Public Safety

- ▶ Human exposure to these agents may occur through inhalation, skin (cutaneous) exposure, or ingestion of contaminated food or water
- ▶ Physical symptoms may be delayed and sometimes confused with naturally occurring illnesses
- ▶ Biological warfare agents may persist in the environment and cause problems long after their release.
- ▶ Three major classes of microorganisms: bacteria rickettsia, and viruses.
- ▶ Hazardous bacterial toxins are produced as by-products of their pathogenic metabolism

TABLE 34.2 Biological Features of Category A Agents

Disease	Causative agent	Bacterial/viral features	Biological characteristics	Mode of transmission
Anthrax	<i>B. anthracis</i>	Spore-forming bacteria	Obligate aerobic; facultative anaerobe	Cutaneous; GI; inhalation
Botulism	<i>C. botulinum</i>	Spore-forming bacteria	Gram-positive anaerobic rod	GI
Plague	<i>Y. pestis</i>	Enterobacteria	Bubonic plague; Pneumonic plague	Bite of infected flea; Inhalation
Smallpox	Variola, vaccinia*	Poxvirus	Largest viral family	Inhalation, salivary route (person-to-person)
Tularemia	<i>F. tularensis</i>	Coccobacillus	Gram-negative spherical/rod	GI, inhalation; bite of arthropods
Hemorrhagic fever	Lassa, Junin, Machupo	Arenavirus	RNA viruses	Inhalation, (person-to-person)
	Ebola, Marburg	Filovirus		

*Variola is the extinct human virus; vaccinia is the laboratory product used for smallpox vaccinations.

Abbreviations: ARDS, adult respiratory distress syndrome; GI, gastrointestinal.

Anthrax (Bacillus anthracis)

- ▶ Anthrax is an infectious disease caused by the spore-forming bacterium B.anthraxis
- ▶ The highly resistant, prominent polypeptide capsule of the endospore renders B. anthracis immune to most methods of disinfection or natural processes of inactivation
- ▶ May be present in the soil for decades, occasionally infecting grazing goats, sheep, and cattle.
- ▶ Human infection occurs by three routes of exposure to anthrax spores: cutaneous, gastrointestinal, and inhalation
- ▶ Biological terrorist threat because of its high resistance and ease of communicability through air.

Anthrax (Bacillus anthracis)

- ▶ Fever, pulmonary edema, and lymphadenopathy. Shock and death occur within 3 to 7 days of initial signs and symptoms.
- ▶ The mortality rates from anthrax vary, depending on exposure and age
- ▶ Approximately 20% for cutaneous anthrax without antibiotics and 25–75% for gastrointestinal anthrax.
- ▶ Inhalation anthrax has a fatality rate that is 80% or higher.
- ▶ Anthrax is susceptible to an early antibiotic course of treatment with penicillin, doxycycline, and fluoroquinolones

Anthrax (Bacillus anthracis)

- The anthrax vaccine is an effective control measure and was developed from an attenuated strain of B. anthracis
- Clinical studies have calculated the efficacy level of the vaccine at about 92.5%
- Vaccination is not available to the general public and is not recommended to prevent disease.

Botulism

- Botulism is caused by clostridium botulinum, a gram-positive, pore forming anaerobic rod.
- Lives in soil and intestines of animals
- Cause by the release of botulinum toxin secreted by the organism in contaminated food.
- The heat resistant spores survive food processing and canning in sufficient numbers to cause toxicity on release of the toxin
- The botulinum toxin is a neurotoxin capable of preventing the release of acetylcholine at peripheral cholinergic synapses

Botulism

- Clinically, the disease has an onset of 12 to 36 hours.
- Signs and symptoms are related to inhibition of skeletal muscle innervation and include: flaccid muscular paralysis, blurred vision, difficulty swallowing, and respiratory paralysis.
- Supportive care and maintenance of vital functions, especially respiration, is of utmost importance in treatment. Specific antitoxin is available for some of the neurotoxin types

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Plague (Yersinia Pestis)

- ▶ Plague is an infectious disease of animals and humans caused by the bacterium *Y. pestis*
- ▶ All *Yersinia* infections are zoonotic, capable of spreading from rodents and their fleas (**urban plague**), as well as from squirrels, rabbits, field rats, and cats (**sylvatic plague**)
- ▶ Pandemics resulting from *Yersinia* infections have devastated human populations.
- ▶ The first of three urban plagues started in Egypt (541AD) and spread through the Middle East, North Africa, Asia, and Europe, killing over 100 million persons

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Plague (Yersinia Pestis)

- 25 Million deaths in Europe
- The recognition of public health and maintenance of hygienic standards has essentially eradicated urban plague from most communities
- The bite of the infected flea starts the incubation period of about seven days for *Y. Pestis*
- ▶ Aerosolized transmission of *Y. pestis* characterizes the highly infectious pneumonic plague.

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Plague (Yersinia Pestis)

- ▶ A shorter incubation period results in fever, headache, malaise, and a cough accompanied by blood and mucus.
- ▶ Without early antibiotic intervention, the pneumonia progresses rapidly over 2 to 4 days to septic shock and death.
- ▶ Early treatment with streptomycin, tetracycline, and chloramphenicol is effective in treating pneumonic plague.
- ▶ Prophylactic antibiotic treatment for 7 days will protect persons at risk for close (face-to-face) contact with infected patients.

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Small Pox

- ▶ Naturally occurring smallpox (*variola major*) is a member of the orthopoxvirus family, the largest and most complex family of viruses.
- ▶ It is easily transmissible via close person-to-person contact. The virus accounted for 7% to 12% of all deaths in eighteenth-century England.
- ▶ The last case of smallpox in the U.S. occurred in 1949, and in the world, in Somalia in 1977.
- ▶ Routine vaccination in the U.S. was stopped in 1971
- ▶ the World Health Organization (WHO) determined in 1980 that smallpox had been successfully eradicated from the world.

Small Pox

- ▶ Smallpox virus was inhaled and replicated in the respiratory tract.
- ▶ Dissemination occurred via lymphatics, resulting in viremia.
- ▶ The lymphatic vessels provide the pathways for the virus to spread to the spleen, bone marrow, liver, and skin (characteristic rash).
- ▶ The incubation period for variola was about 7 to 17 days.
- ▶ Initial symptoms included high fever, fatigue, headache, and backache

Small Pox

- ▶ Smallpox is very contagious through the respiratory/salivary route and infects humans only through accidental or occupational exposure.
- ▶ Individuals are most contagious during the first week of signs and symptoms
- ▶ The threat that smallpox could be used as a weapon of bioterrorism has prompted the development of new vaccination strategies for both military personnel and civilians.
- ▶ Vaccinia, a form of cowpox, is used for the production of smallpox vaccine
- ▶ In (2007) the FDA approved a new 100-dose kit for small pox vaccine ACAM2000

Salmonellosis (*Salmonella* sp.)

- ▶ Salmonellosis is caused by infection with *Salmonella* sp. a Gram-negative bacillus.
- ▶ It is a member of the Enterobacteriaceae family that colonizes the GI tracts of many species of animals, including chickens, cattle, and reptiles
- ▶ serogroups have been classified into three pathological categories. 1. *Salmonella* that are highly adapted to human hosts, such as *S. typhi* (Group D salmonella) and *S. paratyphi*
- ▶ (Group A), that produce typhoid fever and paratyphoid fever,

Salmonellosis (Salmonella sp.)

- Infection with species of *S. enteritidis* accounts for 85% of all salmonella infections in the United States
- An increasing number of isolates show resistance to multiple antimicrobial drugs
- ▶ Approximately 1.4 million cases of salmonellosis infections occur in the U.S. annually, most of which are diagnosed as **gastroenteritis**
- ▶ Gastroenteritis usually starts 12 to 48 h after ingestion of the organisms, with nausea, mild to severe abdominal pain, followed by watery diarrhea, sudden fever, and sometimes vomiting and dehydration

Salmonellosis (Salmonella sp.)

- Food handlers pose a serious epidemic risk
- Once ingested, the organisms that successfully escape the acidic stomach contents penetrate and pass through to the ileum and colon
- The resulting pathology is mostly due to damage within the GI tract

Salmonellosis (Salmonella sp.)

- Long term consequences: enteric fever, focal (localized) infections, and bacteremia.
- ▶ Focal infections of infected organs start in the GI tract and disseminate to the liver, gall bladder, and appendix. The organisms can proliferate to cause cardiac murmurs, pericarditis, pneumonia, rheumatoid-like arthritis, and osteomyelitis.
- ▶ **Bacteremia** characterized by sustained septicemia with *S. typhi*, *S. paratyphi*, *S. choleraesuis*, and *S. enteritidis*

Salmonellosis (Salmonella sp.)

- Poorly cooked meat and handling of raw, infected meat
- Unsuspected ingestion of contaminated poorly cooked poultry, raw milk or eggs, and egg products, are often the perpetrators
- Eggs may be contaminated both on their surface and within
- Outbreaks are more common in summer months and are often related to contaminated egg or chicken salads

Salmonellosis (Salmonella sp.)

- ▶ Isolation of the organism from the stools, blood, pus, vomitus, and urine aids in the presumptive diagnosis.
- ▶ Identification is based on initial growth of the organism on appropriate culture media, followed by biochemical and serological confirmation.
- ▶ There is no acceptable antibiotic cure for uncomplicated non typhoidal salmonellosis.
- ▶ Gastroenteritis is treated symptomatically with fluids, electrolytes, and a bland diet (for dehydration and continuous fever).

Salmonellosis (Salmonella sp.)

- ▶ Antibiotics prolong excretion of the organism and are unwarranted in uncomplicated cases.
- ▶ Antibiotic resistance is more common with nontyphoidal salmonella than with *S. typhi*.
- ▶ Antibiotics can prolong the shedding of organisms in the stools after the drug has been discontinued
- ▶ Infections with *S. typhi* and *S. paratyphi* are treated with fluoroquinolones (e.g. ciprofloxacin), chloramphenicol, gentamicin, trimethoprim/sulfamethoxazole, or broad-spectrum cephalosporins.

Salmonellosis (Salmonella sp.)

- ▶ As with brucellosis, the lack of an effective vaccine warrants concern that salmonella can be used as a possible bioterrorist tool.
- ▶ Epidemiologically, preventing contamination of foodstuffs by infected humans is paramount
- ▶ Contaminated raw eggs may pass unrecognized in some foods

Typhoid Fever

- ▶ Less common but life-threatening
- ▶ 70% acquired through international travel
- ▶ Responsible for enteric fever
- ▶ Gradually increasing nonspecific fever, headache, myalgias, malaise, and anorexia ensue and persist for about 1 week.
- ▶ Gastrointestinal symptoms resume
- ▶ The cycle continues with bacteremia and colonization of the gallbladder, and with reinfection of the intestinal tract

Typhoid Fever

- ▶ 1% to 5% of those who recover from the infection (carriers), maintain chronic colonization of the organism
- ▶ Can carry organism for more than one year after symptomatic disease
- ▶ Gallbladder acts as incubator
- ▶ S. typhi is acquired through fecal-oral transmission
- ▶ Preventable by avoiding ingestion of poorly cooked, raw or unwashed foods
- ▶ Usually treated with antibiotics
- ▶ Ampicillin, trimethoprim-sulfamethoxazole, and fluoroquinolones, but vaccination is recommended especially for travelers to endemic areas

Shigellosis (Shigella sp.)

- Shigellosis is caused by infection with shigella sp., a
- The organism colonize the GI tract of many species of animals
- Divided into 45 serogroups
- Over 150 million cases occur annually worldwide
- Fecal-oral transmission of contaminated food is the major route of transmission
- Children account for 70% of shigellosis cases
- Abdominal cramps, diarrhea, fever and stomach cramps.
- Ampicillin, trimethoprim/ sulfamethoxazole, nalidixic acid, fluoroquinolones are indicated

Escherichia coli O157:H7

- ▶ Gram-negative enteropathogenic bacteria is an emerging cause of food borne illness
- ▶ Possesses a broad range of virulence factors, exotoxins, and adhesion molecules allowing the organisms to attach to the GI and urinary tracts
- ▶ Most strains are part of the normal human bacterial flora.
- ▶ E. Coli serotype O157:H7 is not
- ▶ Virulent strain responsible for producing fatal enterotoxins
- ▶ The most common microorganism responsible for sepsis and urinary tract infections
- ▶ Neonatal meningitis and gastroenteritis in developing nations

Escherichia coli O157:H7

- ▶ Enterotoxigenic, enteropathogenic, enteroinvasive, enterohemorrhagic, enteroaggregative, and diffuse aggregative
- ▶ Each is responsible for a variety of diseases, including traveler's and infant diarrhea, dysentery, intra-abdominal infections, hemolytic uremic syndrome (HUS), and hemorrhagic colitis
- ▶ Infection is acquired through ingestion of poorly cooked ground beef, consumption of unpasteurized milk and juice, sprouts, lettuce, salami, and contact with cattle.

Escherichia coli O157:H7

- ▶ Waterborne transmission occurs through swimming in contaminated lakes, pools, or drinking inadequately chlorinated water.
- ▶ The organism is easily transmitted from person to person and has been difficult to control in child day-care centers.
- ▶ Stool cultures and serology confirm the presence of E. coli O157:H7 in suspected infections.
- ▶ Antibiotic treatment is unwarranted and may actually precipitate kidney infections

Cholera (Vibrio Cholerae)

- ▶ Acute diarrheal illness caused by intestinal infection with the gram-negative, facultative, anaerobic bacterium V. cholera
- ▶ V. cholera serogroup O1 or O139 is responsible for classic epidemic cholera and it produces cholera toxin
- ▶ Within 2 to 3 days of ingestion, copious watery diarrhea, vomiting, rapid loss of body fluids, and leg cramps develop.
- ▶ The symptoms eventually progress to dehydration, metabolic acidosis, shock, and cardiovascular collapse. The condition is fatal (25 to 50%) if untreated

Cholera (Vibrio Cholerae)

- ▶ Large epidemic outbreaks are related to fecal contamination of water supplies or street-vended foods.
- ▶ Eating raw or undercooked shellfish
- ▶ It is a major cause of epidemic diarrhea
- ▶ Responsible for global pandemic in Asia, Africa and Latin America for the last four decades.
- ▶ Doxycycline, trimethoprim-sulfamethoxazole, and furazolidone reduce the bacterial burden and toxin production

Cholera (Vibrio Cholerae)

- ▶ Currently available killed parenteral vaccines offer incomplete protection of relatively short duration and have been discontinued

Learning Assessment

- ▶ Which one of the following agents are considered a Category A Biological Warfare Agent?
 - ▶ A. Anthrax
 - ▶ B. Botulism
 - ▶ C. Plague
 - ▶ D. Smallpox
 - ▶ E. All of the above

What is the role of the pharmacist or health care provider during a chemical and/or biological emergency response?

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Federal Disaster Response Organizations

- ▶ Federal Emergency Management Agency (FEMA)
- ▶ National Response Plan (NRP)
- ▶ National Disaster Medical System (NDMS)
- ▶ Disaster Medical Assistance Teams (DMATs)
- ▶ Metropolitan Medical Response System (MMRS)
- ▶ National Pharmacy Response Team (NPRT)
- ▶ Centers for Disease Control and Prevention (CDC)
- ▶ Strategic National Stockpile (SNS)



Centers for Disease Control and Prevention



- ▶ Prepare and respond to public health emergencies
- ▶ Conduct investigations into health effects and medical consequences
- ▶ Assess health and medical needs of disaster victims
- ▶ Develop and maintain national systems for acute environmental hazard surveillance
- ▶ Provide epidemiologic, laboratory and other scientific services to agencies involved in disaster planning and response

<http://www.cdc.gov/nnd/DisasterResponse/DisasterResponse.aspx>

Disaster Medical Assistance Teams (DMATs)

- ▶ State-based teams
 - ▶ Medical and support personnel: physicians, nurses, pharmacists, paramedics
 - ▶ Process 200-250 patients in 24 hour period
- ▶ Must meet three requirements
 - ▶ Be adequately trained and equipped
 - ▶ Be able to care for themselves
 - ▶ Be fully prepared going into disaster to not add to burden of overwhelming infrastructure

Disaster Medical Assistance Teams (DMATs)

- ▶ Provide four services
 - ▶ Search and rescue
 - ▶ Triage and initial stabilization
 - ▶ Provide definitive medical care
 - ▶ Evacuation



Gandini R, Schmitzer, George F, Briggs SM. Lessons Learned from the September 11th World Trade Center Disaster: Pharmacy Preparedness and Participation in an International Medical and Surgical Response Team. *Pharmotherapy*. 2012;22(5):271-81.

National Pharmacy Response Team (NPRT)

- ▶ Includes pharmacists, pharmacy technicians, pharmacy students
- ▶ Goal: assist in chemoprophylaxis or mass vaccination
- ▶ Become temporary federal employee
 - ▶ Paid salary
 - ▶ Reimbursed for travel and per diem expenses
 - ▶ Liability coverage outside of state of licensure
 - ▶ Deployed for no longer than 2 weeks
- ▶ Required to complete web-based training program, be current with treatment recommendations

Strategic National Stockpile (SNS)

- ▶ Previously known as National Pharmaceutical Stockpile (NPS) established in 1999
- ▶ Managed by CDC
- ▶ National repository of antibiotics, chemical antidotes, antitoxins, life-support medications, medical/surgical supplies
- ▶ Goal: Ensure rapid delivery within 12 hours
- ▶ 3 main components
 - ▶ 12 hour push packages
 - ▶ Enough drugs per packet to treat >100,000 people
 - ▶ Vendor-managed inventory
 - ▶ CDC maintains supply of chemical antidotes

SNS

- ▶ Can be requested by the state and shipment begin within 12 hours pending federal government approval
- ▶ State responsible to provide manpower to disassemble packaging and transport pharmaceuticals
- ▶ Must factor in time to distribute
- ▶ Role of pharmacy personnel
 - ▶ Ensure proper storage
 - ▶ Provide recommendations for therapeutic alternatives
 - ▶ Patient screening and triage
 - ▶ Dispensing of pharmaceuticals
 - ▶ Immunizations
 - ▶ Patient counseling and compliance
- ▶ May extend expiration date



<http://www.fda.gov/oc/ohrt/ohrt.html>

ASHP Statement on the Role of Health-System Pharmacists in Emergency Preparedness

- ▶ Pharmacists should play a key role in planning and execution of
 - ▶ Pharmaceutical distribution and control
 - ▶ Drug therapy management of patients
- ▶ Be involved in the following
 - ▶ Development of guidelines
 - ▶ Selection of pharmaceuticals and supplies for national, regional and local emergency inventories
 - ▶ Ensure proper packaging, storage, handling, labeling and dispensing of emergency supplies
 - ▶ Ensure proper deployment of emergency supply of pharmaceuticals
 - ▶ Ensure appropriate education and counseling
- ▶ Advise public health officials on appropriate messages to convey to the public
- ▶ Collaborate with physicians in managing drug therapy

Commitments made by ASHP

- ▶ Maintain electronic communications network
- ▶ Disseminate prompt information to ASHP members
- ▶ Disseminate timely evidence-based information about pharmaceuticals
- ▶ Meet with government officials and others regarding involvement of health-system pharmacists in emergency preparedness and counterterrorism

Key Roles of a Pharmacist in Bioterrorism

- ▶ Surveillance
- ▶ Information
- ▶ Patient education and counseling
- ▶ Distribution of pharmaceuticals and medical supplies
- ▶ Administration of vaccines
- ▶ Evaluation/Triage
- ▶ Community planning and preparation

Surveillance

- ▶ Observe patients and their health needs
- ▶ Monitor and report any identified increases in purchases of over-the-counter products for fever, pain or diarrhea

Information

- ▶ Remain calm and provide reassurance
- ▶ Be assertive
- ▶ Educate public, media and health professionals
- ▶ Prevent irrational behavior
- ▶ Obtain medication history and allergies

Patient Education and Counseling

- ▶ Ensure appropriate use and safety
- ▶ Prevent toxicities and side effects
- ▶ Enable identification of other medical and psychological conditions
- ▶ Monitor for safety, efficacy and adherence
- ▶ Monitor for side effects

Distribution of Pharmaceutical and Medical Supplies

- ▶ Obtain extra pharmaceuticals from wholesalers
- ▶ Keep medications organized and under close supervision
- ▶ Maintain security of controlled substances
- ▶ Package and label appropriately
- ▶ Prepare drugs onsite
- ▶ Monitor usage of drugs and predict which drugs need to be ordered

Administration of Vaccines

- ▶ Role of pharmacist is moving from distributor of vaccines to administrator of vaccines
- ▶ Growing number of pharmacists who are certified to immunize
- ▶ Target vaccines associated with bioterrorism:
 - ▶ Smallpox
 - ▶ Anthrax

Evaluation and Triage

- ▶ Triage disaster victims
- ▶ Trauma management
- ▶ Prevent communicable diseases
- ▶ Assist in transporting patients to shelters or homes

Community Planning and Preparation

- ▶ Contact local and state public health and emergency medical officials to become part of emergency response team
- ▶ Coordinate actions with state board of pharmacy
- ▶ Contact prescription drug benefit plans regarding protocols for emergency re-fills
- ▶ Set up a handbook of contact information
 - ▶ Wholesalers, distributors, manufacturers, communications companies

Community Planning and Preparation

- ▶ Develop list of drugs, biologicals, supplies, nutritionals for emergency shelters
- ▶ Contact list of company representatives to assist in obtaining drugs/supplies
- ▶ Create a list of pharmacists you can call upon for assistance
- ▶ Prepare an emergency kit
- ▶ Have bioterrorism resources readily available (Internet, PDA)

Pharmacy Emergency Response Team (PERT)

- ▶ Trained to respond to chemical, biological, radiological, and nuclear agents
- ▶ Identify a lead pharmacist and set responsibilities for team members
- ▶ Involvement of pharmacy director, administrative support, clinical pharmacists
- ▶ Establish collaboration and coordination of the role pharmacy has in disaster management
- ▶ Set procedures for emergency cart fills
- ▶ Resources are provided for efficient communication and protection
- ▶ Provide staff education
- ▶ Conduct drills to optimize functioning of the team

How to Prepare

- ▶ Develop an extensive emergency plan
- ▶ Know federal and local disaster management plans
- ▶ Enhance the link between pharmacy and first responders, medical and mental health services, public health officials, law enforcement officers
 - ▶ Develop a local network of pharmacists, EMS, physicians
 - ▶ Regional poison control center
 - ▶ State and local agencies
 - ▶ Local and state professional associations
 - ▶ State emergency management groups

How to Prepare: Be Educated and Trained

- ▶ Become familiar with agents of concern, their treatment, prophylaxis and epidemiology
- ▶ Take training classes in emergency preparedness
- ▶ Learn first aid and become certified in cardiopulmonary resuscitation (CPR) and advanced cardiac life support (ACLS)

How to Prepare: Get Involved

- ▶ Develop the following
 - ▶ Antibiotic selection guidelines
 - ▶ Dosing charts for pediatric patients
 - ▶ Counseling information
 - ▶ Immunization guidelines (especially for high risk patients)
 - ▶ Post exposure prophylaxis recommendations both primary and secondary exposure
- ▶ Assist in writing pharmaceutical distribution plans
- ▶ Take part in development of guidelines or treatment algorithms in management of patients exposed to bioterrorism
- ▶ Work with wholesalers to develop plans to obtain emergency pharmaceuticals

How to Prepare: Get Involved

- ▶ Teach other pharmacists, nurses, and medical professionals
- ▶ Become certified to administer vaccines
- ▶ Develop programs for mass prophylaxis focusing on issues of drug security, triage of patients, and counseling
- ▶ Take part in practice drills or training exercises
 - ▶ Federal government can send training, education and demonstration (TED) packages

Learning Assessment

- ▶ Which organizations can Pharmacist or Health Care professionals play a vital role?
 - ▶ A. National Pharmacy Response Team
 - ▶ B. Strategic National Stockpile
 - ▶ C. Disaster Medical Assistance Teams
 - ▶ D. Centers for Disease Control
 - ▶ E. None of the above

Learning Assessment

- ▶ All of the following agencies are involved in Chemical or Biological Health Consequences except:
 - ▶ A. FEMA
 - ▶ B. CDC
 - ▶ C. DOH
 - ▶ D. DCBA
 - ▶ E. All of the above