



**Healthcare Response to Weapons of Mass  
Destruction: Biological, Chemical and  
Radiological**

## **Current Approvals**

### **Physician**

Upon successful completion of this course, 7.4 AMA PRA Category 1 Credits are awarded.

**Access Continuing Education, Inc.** partners with the Institute for Medical and Nursing Education to provide CME credit.

### **Registered Nurse**

Nevada law requires that select healthcare professionals, including nurses, take four hours of continuing education “relating to the medical consequences of an act of terrorism that involves the use of a weapon of mass destruction”. Beginning January 1, 2005, all nurses renewing their licenses must have completed this four-hour bioterrorism course as part of their continuing education (CE) renewal requirement. The four hours may be counted as part of the 30-hour CE requirement for RN and LPN renewal, and as part of the 45-hour continuing education (CE) requirement for advanced practice nurse (APN) and certified registered nurse anesthetist (CRNA) renewal. While the legislature didn’t mandate the course for certified nursing assistants (CNAs), the Nevada State Board for Nursing highly encourages them to take it as part of their 24 hour in-service training renewal requirement.

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**Answer Sheet: Healthcare Response to Weapons of Mass Destruction:  
Biological, Chemical and Radiological**

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## Objectives

- Describe categories of weapons of mass destruction.
- Identify symptoms of select biological, chemical and radiological threats.
- Discuss treatment of select biological, chemical and radiological threats.
- Describe personal protective equipment (PPE) for biological, chemical and radiological threats.
- Discuss syndromic surveillance and reporting procedures for acts of terrorism involving biological agents.
- Identify how to use the Health Alert Network.

## Introduction

Terrorism is not a new problem; there have been countless examples throughout history. Biological, chemical and radiological threats, as well as more conventional explosives and arms have long been used against specific populations to further political, social and religious objectives.



Oklahoma City, OK, April 26, 1995 -- Search and Rescue crews work to save those trapped beneath the debris, following the Oklahoma City bombing. FEMA News Photo; courtesy of FEMA.

Despite the countless examples of terrorism throughout the world, including in the US, it was the attacks of September 11, 2001 that prompted Americans and the US government to focus on preparing for potential biological, chemical and radiological terrorism. In 2005 the State of Nevada issued The State of Nevada Hazardous Materials Emergency Response Plan that has plans for emergency response for biological, chemical and radiological emergencies. Healthcare organizations have responded by creating specific plans for how to respond to such emergencies and to make sure that their plans coordinate and integrate with local, state and federal public health and law enforcement agencies. Professionals are urged to seek out and follow such plans in their healthcare organizations.

In support the public's reliance on healthcare providers' knowledge about responding to acts of biological, chemical and radiological terrorism, the 2003 Nevada legislature passed Assembly Bill 250. This law requires that select healthcare professionals, including nurses, take four hours of continuing education "relating to the medical consequences of an act of terrorism that involves the use of a weapon of mass destruction."

**Beginning January 1, 2005, all nurses renewing their licenses must have completed this four-hour bioterrorism course as part of their CE renewal requirement. On that date, the Board's random CE audits began to include auditing for proof that renewing nurses have completed the bioterrorism course.**

The law specifies that the course of instruction must include:

- a. An overview of acts of terrorism and weapons of mass destruction;
- b. Personal protective equipment required for acts of terrorism;
- c. Common symptoms and methods of treatment associated with exposure to, or injuries caused by, chemical, biological, radioactive and nuclear agents;
- d. Syndromic surveillance and reporting procedures for acts of terrorism that involve biological agents; and
- e. An overview of the information available on, and the use of, the Health Alert Network.

Completing a bioterrorism course which meets the requirements of the law is a **one-time requirement** of all registered nurses (RNs) and licensed practical nurses (LPNs) with active Nevada licenses. Once the course is completed, it doesn't have to be taken again.

The required four hours may be counted as part of the 30-hour CE requirement for RN and LPN renewal, and as part of the 45-hour continuing education (CE) requirement for advanced practice nurse (APN) and certified registered nurse anesthetist (CRNA) renewal.

While the legislature didn't mandate the course for certified nursing assistants (CNAs), the Board for Nursing highly encourages them to take it as part of their 24 hour in-service training renewal requirement.

### **Healthcare Professionals Are a Critical Component of Response**

Because of the specialized knowledge and skill of healthcare professionals, their services are critical in the event of a biological, chemical or radiological attack. However, as humans, healthcare professionals are likely to experience many of the same fears and concerns as their patients. Fears related to one's own health and safety, as well as the welfare of loved ones, the condition of one's home and property, responsibilities to family versus responsibilities to one's patients are among conflicting feelings that may be experienced.

Being prepared for such possibilities may help healthcare professionals to manage and mitigate some of these fears. In addition to the emergency plans that healthcare organizations have developed to respond to potential emergency situations, each person and family in the US should prepare a plan for emergencies. Such plans would have to integrate with others' plans. For example, families with children would need to integrate the parents' workplace emergency plans with the plans of their children's schools and/or daycare providers. The welfare of pets and those who may be at home must be addressed. Identifying meeting places or contacts in distant locations with whom to coordinate should occur; for example, everyone in the family may know to contact a relative who lives in another state in the event that phone lines and cell towers in the local area are impacted. Families should create an emergency kit in the event of evacuation or the need to shelter in place. Evacuation and sheltering in place will be covered later in this course. For more information about the recommended contents of an emergency kit, go to <http://www.ready.gov/build-a-kit>.

Because a covert attack involving the release of a biological, chemical or radiological weapon may not be immediately detectable, healthcare providers should maintain a high degree of suspicion and be alert to patterns and diagnostic clues that might indicate unusual illness outbreaks.

Indications of intentional release of a biologic agent include (CDC, 2007):

- An unusual temporal or geographic clustering of illness or patients presenting with clinical signs and symptoms that suggest an infectious disease outbreak (e.g., persons who attended the same public event or gathering; >2 patients presenting with an unexplained febrile illness associated with sepsis, pneumonia, respiratory failure, or rash or a botulism-like syndrome with flaccid muscle paralysis, especially if occurring in otherwise healthy persons);
- An unusual age distribution for common diseases (e.g., an increase in what appears to be a chickenpox-like illness among adult patients, but which might be smallpox); and
- A pattern of large numbers of persons exhibiting similar symptoms of relatively rarely occurring illnesses, should raise suspicions among healthcare providers. For example, a large number of cases of acute flaccid paralysis with prominent bulbar palsies, suggestive of a release of *botulinum* toxin.

Awareness of and recognition of these patterns of illnesses, on the part of healthcare providers, is particularly important because biological agents, unlike chemical agents, may not be detectable until hours, days or weeks pass.

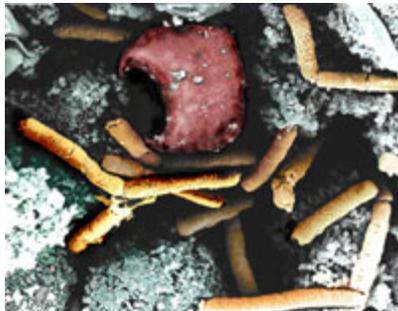
In addition to being alert to emerging signs and symptoms within the population, healthcare providers must also become knowledgeable about how to protect themselves in the event of a biological, chemical or radiological attack. The specifics of how healthcare providers must respond in different cases will vary depending on the nature of the attack, and will be covered in detail in later sections throughout this course.

## Biological Agents

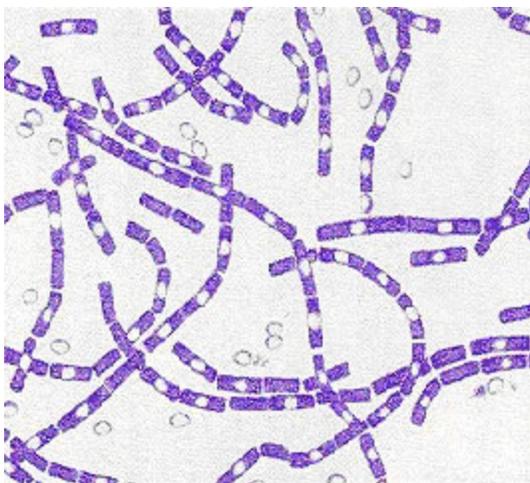
The US Centers for Disease Control and Prevention (CDC) defines three categories of biologic agents with potential to be used as weapons, based on ease of dissemination or transmission, potential for major public health impact due to high mortality, potential for public panic and social disruption, and special requirements for public health preparedness. Category A agents are of highest concern; they are (CDC, 2007; Siegel, et al., 2007):

- *Bacillus anthracis* (anthrax),
- *Yersinia pestis* (plague),
- *Variola major* (smallpox),
- *Clostridium botulinum* toxin (botulism),
- *Francisella tularensis* (tularemia),
- Viral Hemorrhagic Fevers (VHF): filoviruses (Ebola hemorrhagic fever, Marburg hemorrhagic fever); and arenaviruses (Lassa [Lassa fever], Junin [Argentine hemorrhagic fever], and related viruses).

### Anthrax



Color-enhanced scanning electron micrograph shows splenic tissue from a monkey with inhalational anthrax; featured are rod-shaped bacilli (yellow) and an erythrocyte (red). Photo courtesy of Arthur Friedlander, NIAID.



**Anthrax bacteria.** Courtesy of AVIPAnthrax Vaccine Immunization Program

Bacillus anthracis can cause inhalation anthrax, cutaneous anthrax, gastrointestinal anthrax and oropharyngeal anthrax (CDC, 2006e; CDC, 2001a):

*Cause: Bacillus anthracis*

- Encapsulated, aerobic, gram-positive, spore-forming, rod-shaped (*bacillus*) bacterium (CDC, 2006e).

*Systems Affected*

- Skin or cutaneous; the most common form.
- Respiratory tract or inhalation; occurs rarely.
- Gastrointestinal (GI) tract; occurs rarely.
- Oropharyngeal form; the least common form (CDC, 2006e).

*Transmission*

- Skin: direct skin contact with spores; in nature, contact with infected animals or animal products (usually related to occupational exposure); person-to-person transmission from contact with lesion of untreated patient possible, but extremely rare (Siegel, et al., 2007).
- Respiratory tract: inhalation of aerosolized spores (CDC, 2006e; CDC, 2001a).
- GI: consumption of undercooked or raw meat products or dairy products from infected animals (CDC, 2006e).
- NO person-to-person transmission of inhalation or GI anthrax (CDC, 2006e; CDC, 2001a).
- Spores can be inhaled into the lower respiratory tract. The infectious dose of *B. anthracis* in humans by any route is not precisely known. In primates, the LD50 (i.e., the dose required to kill 50% of animals) for an aerosol challenge with *B. anthracis* is estimated to be 8,000-50,000 spores; the infectious dose may be as low as 1-3 spores (Siegel, et al., 2007).

*Reporting*

Report suspected or confirmed anthrax cases immediately to your local health department or to

- **NV State Department of Emergency Management 24 hours per day at 775-687-0400;** or
- **CDC at 770.488.7100.**

## Cutaneous Anthrax



Ulcer and vesicle ring; black eschar, redness remains. Courtesy of CDC.

### *Incubation Period*

- Usually an immediate response up to 1 day (CDC, 2006e, CDC, 2001a); it can be from 1 to 12 days (Siegel, et al., 2007).

### *Typical Signs/Symptoms*

- Local skin involvement after direct contact with spores or bacilli.
- Localized itching followed by 1) painless, reddish papular lesion that develops a central vesicle or bulla in 1-2 days, the lesion become pustular during the next 3-7 days and 2) subsequently there is development of black eschar within 7-10 days of initial lesion. There can be extensive surrounding edema (Siegel, et al., 2007).

### *Diagnosis*

- Swabs of lesion (under eschar) for immunohistochemistry (IHC), polymerase chain reaction (PCR) and culture; punch biopsy for IHC, PCR and culture; vesicular fluid aspirate for Gram stain and culture; blood culture if systemic symptoms; acute and convalescent sera for ELISA serology (Siegel, et al., 2007).
- Obtain specimens for culture BEFORE initiating antimicrobial therapy (CDC, 2006e; CDC, 2001a).

### *Treatment*

- Do **NOT** use extended-spectrum cephalosporins or trimethoprim/sulfamethoxazole because anthrax may be resistant to these drugs (CDC, 2006e; CDC, 2001a).
- See Table 1. Cutaneous Anthrax Treatment Protocol for specific therapy.

### *Precautions*

- Standard contact precautions. Avoid direct contact with wound or wound drainage (CDC, 2006e; CDC, 2001a).
- Contact Precautions if uncontained copious drainage (Siegel, et al., 2007).
- For any aerosolized powder, environmental exposures: Respirator (N95 mask or powered air purifying respirators, or PAPRs), protective clothing; decontamination of persons with powder on them (CDC, 2006e; CDC, 2001a).

- Handwashing for 30-60 seconds with soap and water or 2% chlorhexidene gluconate after spore contact (alcohol handrubs inactive against spores) (CDC, 2006e; CDC, 2001a).

<b>Table 1. Cutaneous Anthrax Treatment Protocol* for the 2001 Bioterrorism Attack (CDC, 2001a)</b>		
<b>Category</b>	<b>Initial Therapy(oral)+</b>	<b>Duration</b>
Adults*	Ciprofloxacin 500 mg BID or doxycycline 100 mg BID	60 days++
Children*	Ciprofloxacin 10-15 mg/kg q 12 hours (not to exceed 1 Gm/day) or doxycycline§: >8 yrs & >45kg: 100 mg q 12 hours >8 yrs & $\geq$ 45kg: 2.2 mg/kg q 12 hours $\geq$ 8 yrs: 2.2 mg/kg q 12 hours	60 days++
Pregnant women***	Ciprofloxacin 500 mg BID or doxycycline 100 mg BID	60 days++
Immunocompromised persons*	Same as for non-immunocompromised adults and children	60 days++

\*Cutaneous anthrax with signs of systemic involvement, extensive edema, or lesions on the head or neck require intravenous therapy, and a multi-drug approach is recommended Table 1.

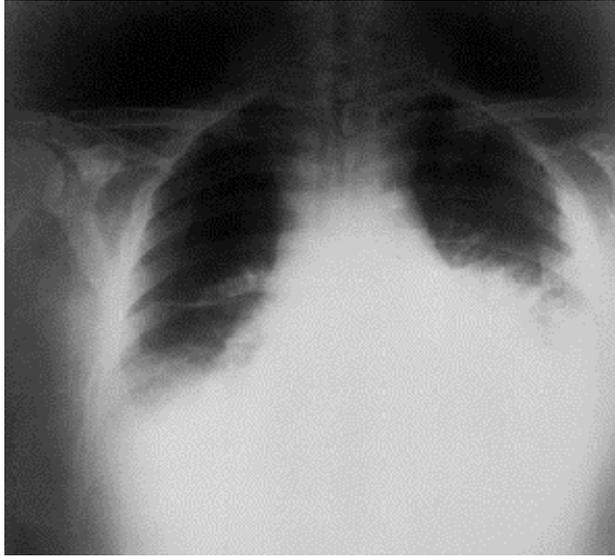
+Ciprofloxacin and doxycycline should be considered first line therapy. Amoxycillin 500 mg po TID for adults or 80 mg/kg/day divided every 8 hours for children is an option for completion of therapy after clinical improvement.

++Previous guidelines have suggested treating cutaneous anthrax for 7-10 days, but 60 days is recommended in the 2001 attack, given the likelihood of exposure to aerosolized B. anthracis.

§The American Academy of Pediatrics recommends treatment of young children with tetracyclines for serious infections (e.g., Rocky Mountain Spotted Fever).

\*\*\*Although tetracyclines or ciprofloxacin are not recommended during pregnancy, their use may be indicated for life-threatening illness. Adverse effects on developing teeth and bones are dose related; therefore doxycycline might be used for a short time (7-14 days) before 6 months of gestation.

## Inhalation Anthrax



Mediastinal widening and pleural effusion on Chest X-Ray in inhalation anthrax. Courtesy of CDC.

### *Incubation Period*

- Usually <1 week; may be prolonged for weeks (up to 2 months) (CDC, 2006e; CDC, 2001a).
- Usually 1 to 7 days but up to 43 days reported (Siegel, et al., 2007).

### *Typical Signs/Symptoms* (often biphasic, but symptoms may progress rapidly)

#### Initial phase

- Non-specific symptoms such as low-grade fever, nonproductive cough, malaise, fatigue, myalgias, profound sweats, chest discomfort (upper respiratory tract symptoms are rare) (CDC, 2006e).
- Maybe rhonchi on exam, otherwise normal (CDC, 2006e; CDC, 2001a).
- Chest X-ray or computerized tomography scan (CT) (Siegel, et al., 2007; CDC, 2006e; CDC, 2001a):
  - mediastinal widening
  - pleural effusion (often)
  - infiltrates (rare)
  - hilar abnormalities.

#### Subsequent phase

- 1-5 days after onset of initial symptoms (CDC, 2006e; CDC, 2001a).
- May be preceded by 1-3 days of improvement (CDC, 2006e; CDC, 2001a).
- Abrupt onset of high fever and severe respiratory distress (dyspnea, stridor, cyanosis) (CDC, 2006e; CDC, 2001a).
- Shock, death within 24-36 hours (CDC, 2006e; CDC, 2001a).
- If untreated, 85-90% fatal (Siegel, et al., 2007).
- Meningitis occurs in 50% of inhalation anthrax cases (Siegel, et al., 2007).

### Laboratory

- Coordinate all aspects of testing, packaging, and transporting with public health laboratory/Laboratory Response Network (LRN) (CDC, 2006e; CDC, 2001a).
- Obtain specimens appropriate to system affected (CDC, 2006e; CDC, 2001a):
  - blood (essential)
  - pleural fluid
  - cerebral spinal fluid (CSF).
  - skin lesion.
- blood for culture and PCR; pleural effusion for culture, PCR and IHC; CSF if meningeal signs present for IHC, PCR and culture; acute and convalescent sera for ELISA serology; pleural and/or bronchialbiopsies IHC (Siegel, et al., 2007).

### Clues to diagnosis

- Gram-positive bacilli on unspun peripheral blood smear or CSF (CDC, 2006e; CDC, 2001a).
- Aerobic blood culture growth of large, gram-positive bacilli provides preliminary identification of *Bacillus* species (CDC, 2006e; CDC, 2001a).

### Treatment

- Obtain specimens for culture BEFORE initiating antimicrobial therapy.
- Initiate antimicrobial therapy immediately upon suspicion.
- Do **NOT** use extended-spectrum cephalosporins or trimethoprim/sulfamethoxazole because anthrax may be resistant to these drugs.
- Supportive care including controlling pleural effusions.
- See Inhalational Anthrax Treatment Protocol in Table 2. below for specific therapy.

### Precautions

- Standard precautions (Siegel, et al., 2007; CDC, 2006e; CDC, 2001a).
- Aerosolized powder, environmental exposures: Respirator (N95 mask or PAPRs), protective clothing; decontamination of persons with powder on them (Siegel, et al., 2007; CDC, 2006e; CDC, 2001a).

Table 2. Inhalation Anthrax Treatment Protocol* for 2001 Bioterrorist Attack		
Category	Initial Therapy (intravenous)	Duration
Adults	Ciprofloxacin 400 mg every 12 hrs* <b>or</b> Doxycycline 100 mg every 12 hrs ** <b>and</b> One or two additional antimicrobials †	IV treatment initially**. Switch to oral antimicrobial therapy when clinically appropriate: Ciprofloxacin 500 mg po BID <b>or</b> Doxycycline 100 mg PO BID  Continue for 60 days (IV and PO combined)
Children	Ciprofloxacin 10-15 mg/kg q 12 hrs ** *** <b>or</b>	IV treatment initially**. Switch to oral antimicrobial therapy when clinically appropriate: Ciprofloxacin 10-15 mg/kg

	<p>Doxycycline<sup>†††</sup> <sup>††</sup>:</p> <p>&gt;8 yrs &amp; &gt;45kg: 100 mg every 12 hrs</p> <p>&gt;8 yrs &amp; <math>\geq</math> 45kg: 2.2 mg/kg every 12 hrs</p> <p><math>\geq</math> 8 yrs: 2.2 mg/kg every 12 hrs</p> <p><b>and</b></p> <p>One or two additional antimicrobials <sup>†</sup></p>	<p>PO every 12 hrs<sup>***</sup></p> <p><b>or</b></p> <p>Doxycycline<sup>†††</sup>:</p> <p>&gt;8 yrs &amp; &gt;45kg: 100 mg PO BID</p> <p>&gt;8 yrs &amp; <math>\geq</math> 45kg: 2.2 mg/kg PO BID</p> <p><math>\geq</math> 8 yrs: 2.2 mg/kg PO BID</p> <p><b>and</b></p> <p>Continue for 60 days (IV and PO combined) <sup>††</sup></p>
Pregnant Women <sup>†††</sup>	Same for nonpregnant adults (the high death rate from the infection outweighs the risk posed by the antimicrobial agent).	IV treatment initially. Switch to oral antimicrobial therapy when clinically appropriate. <sup>†</sup> Oral therapy regimens same for nonpregnant adults.
Immunocompromised Persons	Same as for non-immunocompromised adults and children	Same as for non-immunocompromised adults and children
<p>* For gastrointestinal and oropharyngeal anthrax, use regimens recommended for inhalational anthrax.</p> <p><sup>†</sup> Ciprofloxacin or doxycycline should be considered an essential part of first-line therapy for inhalational anthrax.</p> <p><sup>††</sup> Steroids may be considered as an adjunct therapy for patients with severe edema and for meningitis based on experience with bacterial meningitis of other etiologies.</p> <p><sup>†††</sup> Other agents with <i>in vitro</i> activity include rifampin, vancomycin, penicillin, ampicillin, chloramphenicol, imipenem, clindamycin, and clarithromycin. Because of concerns of constitutive and inducible beta-lactamases in <i>Bacillus anthracis</i>, penicillin and ampicillin should not be used alone. Consultation with an infectious disease specialist is advised.</p> <p><sup>††††</sup> Initial therapy may be altered based on clinical course of the patient; one or two antimicrobial agents (e.g., ciprofloxacin or doxycycline) may be adequate as the patient improves.</p> <p><sup>†††††</sup> If meningitis is suspected, doxycycline may be less optimal because of poor central nervous system penetration.</p> <p><sup>††††††</sup> Because of the potential persistence of spores after an aerosol exposure, antimicrobial therapy should be continued for 60 days.</p> <p><sup>†††††††</sup> If intravenous ciprofloxacin is not available, oral ciprofloxacin may be acceptable because it is rapidly and well absorbed from the gastrointestinal tract with no substantial loss by first-pass metabolism. Maximum serum concentrations are attained 1–2 hours after oral dosing but may not be achieved if vomiting or ileus are present.</p> <p><sup>††††††††</sup> In children, ciprofloxacin dosage should not exceed 1 g/day.</p> <p><sup>†††††††††</sup> The American Academy of Pediatrics recommends treatment of young children with tetracyclines for serious infections (e.g., Rocky Mountain spotted fever).</p> <p><sup>††††††††††</sup> Although tetracyclines are not recommended during pregnancy, their use may be indicated for life-threatening illness. Adverse effects on developing teeth and bones are dose related; therefore, doxycycline might be used for a short time (7–14 days) before 6 months of gestation.</p>		

### Gastrointestinal Anthrax

#### *Incubation Period*

- Usually 1-7 days (CDC, 2006e; CDC, 2001a);
- 15-72 hours (Siegel, et al., 2007).

## *Typical Signs/Symptoms*

### Initial phase

- Nausea, anorexia, vomiting, and fever progressing to severe abdominal pain, hematemesis, and bloody diarrhea (CDC, 2006e; CDC, 2001a).
- Acute abdomen picture with rebound tenderness may develop (CDC, 2006e; CDC, 2001a).
- Necrotic, ulcerated edematous lesions develop in intestines (Siegel, et al., 2007).
- Mesenteric adenopathy on computed tomography (CT) scan likely.
- Mediastinal widening on chest X-ray has been reported (Siegel, et al., 2007).

### Subsequent phase

- 2-4 days after onset of symptoms, ascites develops as abdominal pain decreases (CDC, 2006e; CDC, 2001a).
- Shock, death within 2-5 days of onset (CDC, 2006e; CDC, 2001a).
- 25-60% fatal if untreated (Siegel, et al., 2007).

### *Laboratory*

- Coordinate all aspects of testing, packaging, and transporting with public health laboratory/LRN.
- Obtain specimens appropriate to system affected (CDC, 2006e; CDC, 2001a):
  - blood (essential).
  - ascitic fluid.
- Rectal swabs and stool samples (Siegel, et al., 2007).

### *Clues to diagnosis*

- Gram-positive bacilli on unspun peripheral blood smear or ascitic fluid (CDC, 2006e; CDC, 2001a).
- Pharyngeal swab for pharyngeal form (CDC, 2006e; CDC, 2001a).
- Aerobic blood culture growth of large, gram-positive bacilli provides preliminary identification of *Bacillus* species (CDC, 2006e; CDC, 2001a).

### *Treatment*

- Obtain specimens for culture BEFORE initiating antimicrobial therapy.
- Early (during initial phase) antimicrobial therapy is critical.
- Do **NOT** use extended-spectrum cephalosporins or trimethoprim/sulfamethoxazole because anthrax may be resistant.
- Use Inhalation Anthrax treatment protocol; See Table 2 for specific treatment.

### *Precautions*

- Standard precautions (Siegel, et al., 2007; CDC, 2006e; CDC, 2001a).
- Aerosolized powder, environmental exposures: Respirator (N95 mask or PAPRs), protective clothing; decontamination of persons with powder on them (Siegel, et al., 2007; CDC, 2006e; CDC, 2001a).

Oropharyngeal Anthrax (CDC, 2006e; CDC, 2001a)

*Incubation Period*

- Usually 1-7 days

*Typical Signs/Symptoms*

Initial phase

- Fever and marked unilateral or bilateral neck swelling caused by regional lymphadenopathy.
- Severe throat pain and dysphagia.
- Ulcers at the base of the tongue, initially edematous and hyperemic.

Subsequent phase

- Ulcers may progress to necrosis.
- Swelling can be severe enough to compromise the airway.

*Laboratory*

- Coordinate all aspects of testing, packaging, and transporting with public health laboratory/LRN.
- Obtain specimens appropriate to system affected:
  - Blood (essential).
  - Throat.

*Clues to diagnosis*

- Aerobic blood culture growth of large, gram-positive bacilli provides preliminary identification of *Bacillus* species.

*Treatment*

- Obtain specimens for culture BEFORE initiating antimicrobial therapy.
- Do **NOT** use extended-spectrum cephalosporins or trimethoprim/sulfamethoxazole because anthrax may be resistant to these drugs.
- Supportive care including controlling ascites.
- Use Inhalation Anthrax Treatment Protocol; See Table 2. for specific therapy.

*Precautions*

- Standard contact precautions.

Botulism

*Agent*

The toxic agent in botulism is produced by *Clostridium botulinum*, an encapsulated, anaerobe, gram-positive, spore-forming, rod-shaped (bacillus) bacterium (CDC, 2006).

## *Disease*

Botulism is a neuroparalytic (muscle-paralyzing) disease. It is considered to be one of a major bioweapon threat because of its extreme potency and lethality and ease of production and transport, as well as the need for prolonged intensive care treatment among those infected (CDC, 2010; Arnon, et al., 2001).

There are three forms of naturally occurring botulism (CDC, 2010; CDC, 2006; Arnon, et al., 2001):

- **Foodborne botulism** occurs when a person ingests toxin, which leads to illness within a few hours to days. Outbreaks of foodborne botulism have potential to be a public health emergency because the contaminated food may be eaten by other people.
- **Infant botulism is caused** by ingestion of *C. botulinum* which produces toxin in the intestinal tract
- **Wound botulism** is a rare disease that occurs when wounds infected with *C. botulinum* secrete the toxin.
- **Adult intestinal botulism**, which is rare, and is caused when *C. botulinum* colonizes the intestinal tract of children or adults, usually with gastrointestinal abnormalities.

All forms of botulism account for approximately 200 cases in the US annually (Arnon, et al., 2001).

**Inhalational botulism** does not occur naturally. Aerosolized botulinum toxin is a possible mechanism for a bioterrorism attack (CDC, 2006; Arnon, et al., 2001).

- Inhalational botulism cannot be clinically differentiated from the 3 naturally occurring forms.
- Indications of intentional release of a biologic agent may include:
  - An unusual geographic clustering of illness (e.g., persons who attended the same public event or gathering).
  - A large number of cases of acute flaccid paralysis with prominent bulbar palsies, especially if occurring in otherwise healthy persons.

## *Transmission*

Botulism is not transmissible from person-to-person; exposure to toxin necessary for disease. It is absorbed into circulation from a mucosal surface or a wound (Arnon, et al., 2001).

## *Incubation*

Symptoms begin within 2 hours to 8 days after toxin ingestion (Arnon, et al, 2001); symptoms of inhalation botulism appear within 72 hours (CDC, 2006; Arnon, et al., 2001); 1-5 days (Siegel, et al., 2007).

## *Symptoms/Signs*

- Symmetrical cranial neuropathies (CDC, 2010):
  - Difficulty swallowing or speaking, dry mouth.
  - Diplopia (double vision), blurred vision, dilated or non-reactive pupils, ptosis (drooping eyelids).
  - Slurred speech, difficulty swallowing, dry mouth, muscle weakness (CDC, 2010).
- Symmetric descending weakness and respiratory dysfunction (requiring mechanical ventilation).
- Descending flaccid paralysis.
- Intact mental state.
- No sensory dysfunction.
- No fever.

### *Diagnosis/Lab*

- Diagnosis: history and clinical exam.
- Laboratory confirmation:
  - Identification of toxin in serum, stool, or food.
  - Culturing *C. botulinum* from stool, wound or food.

### *Differential Diagnoses*

Differential Diagnoses for Adults (Arnon, et al., 2001)

- Guillain-Barre syndrome.
- Miller-Fisher syndrome.
- Myasthenia gravis.
- Cerebrovascular accident (CVA).
- Bacterial and/or chemical food poisoning.
- Tick paralysis.
- Lambert-eaton syndrome.
- Chemical intoxication (e.g., organophosphates, carbon monoxide).
- Poliomyelitis.

### *Treatment*

- Prompt diagnosis is essential.
- Equine botulinum antitoxin (supplied by CDC through state health departments) can prevent progression of illness and shorten symptoms if administered early. Infant botulism can be treated with human-derived antitoxin (Baby-BIG) available from the California State Health Department (CDC, 2010).
- Meticulous intensive care should be exercised, including monitoring of respiratory function and when required, artificial ventilation.
- Recovery follows the regeneration of new neuromuscular connections.
- 2-8 weeks duration of ventilatory support may be required in more severe cases.

### *Reporting*

Report suspected or confirmed botulism cases immediately to your local health department or to:

- **NV State Department of Emergency Management 24 hours per day at 775-687-0400;** or
- **CDC at 770.488.7100.**

### *Control Measures*

- Standard precautions must be utilized.
- Patients with suspected botulism do not need to be isolated.
- If meningitis is suspected in a patient with flaccid paralysis, medical personnel should use droplet precautions.
- Heating to an internal temperature of 85°C for at least 5 minutes will detoxify contaminated food or drink.
- In contrast with mucosal surfaces, intact skin is impermeable to botulinum toxin.
- After exposure to botulinum toxin, clothing and skin should be washed with soap and water.
- Contaminated objects or surfaces should be cleaned with 0.1% hypochlorite bleach solution if they cannot be avoided for the hours to days required for natural degradation.

## Plague

### *Agent*

*Yersinia pestis* is a bacterium found in rodents and their fleas in many areas around the world (CDC, 2005d).

*Y. pestis* is easily destroyed by sunlight and drying. When released into air, the bacterium will survive for up to one hour, depending on conditions (CDC, 2005d).

### *Disease*

Plague can occur as bubonic plague or pneumonic plague.

### *Transmission*

Bubonic plague is transmitted through the bite of an infected flea or exposure to infected material through a break in the skin (CDC, 2005d).

Airborne transmission of *Y. pestis* can occur from either intentional aerosol release or from close and direct exposure to someone with pneumonic plague. Because of the delay between being exposed to the bacteria and becoming sick, people could travel over a large area before becoming contagious and possibly infecting others (CDC, 2005d).

A bioweapon carrying *Yersinia pestis*, the organism that causes plague, is possible because the bacterium occurs in nature and could be isolated and grown in quantity in a laboratory. The World Health Organization (WHO) reports 1,000 to 3,000 cases of plague worldwide every year. An average of 5 to 15 cases occur each year in the western US. These cases are usually scattered and occur in rural to semi-rural areas. Most cases are of the bubonic form of the disease. Naturally occurring pneumonic plague is uncommon, although small outbreaks do occur. In the United States, the last known cases of person to person transmission of pneumonic plague occurred in 1925 (Siegel, et al., 2007). Both types of plague are readily controlled by standard public health response measures. Even though *Y. pestis* can be grown in the laboratory from naturally occurring sources, manufacturing an effective weapon using *Y. pestis* would require advanced knowledge and technology (CDC, 2005d).

Pneumonic plague is most likely to occur if used as a biological weapon, but some cases of bubonic and primary septicemia may also occur. The infective dose is 100 to 500 bacteria (Siegel, et al., 2007).

Person-to-person transmission occurs via respiratory droplets; risk of transmission is low during first 20-24 hours of illness and requires close contact (Siegel, et al., 2007). However, the copious amounts of bloody sputum coughed by the victim at the end stage of the disease, contains large quantities of bacteria.

Antibiotics clear the sputum of plague bacilli rapidly, so that a patient generally is not infective within hours after initiation of effective antibiotic treatment (Siegel, et al., 2007).

So in modern times many patients will never reach a stage where they pose a significant risk to others. Even in the end stage of disease, transmission only occurs after close contact. Simple protective measures, such as wearing masks, good hygiene, and avoiding close contact, have been effective to interrupt transmission during many pneumonic plague outbreaks (Siegel, et al., 2007).

### *Incubation*

Symptoms generally develop within 1 to 6 days (CDC, 2005d); usually 2 to 3 days (Siegel, et al., 2007).



Scanning electron micrograph depicting a mass of *Yersinia pestis* bacteria (the cause of bubonic plague) in the foregut of the flea vector. Photo courtesy of Rocky Mountain Laboratories, NIAID, NIH.

### *Signs & Symptoms*

Symptoms include swollen, tender lymph glands called buboes. Buboes are not present in pneumonic plague. If bubonic plague is not treated, however, the bacteria can spread through the bloodstream and infect the lungs, causing a secondary case of pneumonic plague (CDC, 2005d).

Clinical features of pneumonic plague include fever, chills, headache, cough with muco-purulent sputum (gram-negative rods may be seen on gram stain), rapid progression of weakness. In a later stage hemoptysis, shortness of breath and chest pain can occur; a chest radiograph will show evidence of bronchopneumonia (CDC, 2001). Nausea, vomiting, and abdominal pain may also occur. Without early treatment, pneumonic plague usually leads to respiratory failure, shock, and rapid death (CDC, 2005d). It can also lead to circulatory collapse and bleeding diathesis (Siegel, et al., 2007).

### *Diagnoses/Labs*

If pneumonic plague is suspected, samples of the patient's blood, sputum, or lymph node aspirate are sent to a laboratory for testing. Preliminary results can be ready in less than two hours; confirmation occurs usually 24 to 48 hours (CDC, 2005d).

### *Reporting*

Report suspected or confirmed cases immediately to your local health department or to:

- **NV State Department of Emergency Management 24 hours per day at 775-687-0400;** or
- **CDC at 770.488.7100.**

### *Treatment*

Treatment beginning within 24 hours after the first symptoms can reduce the risk of death. Available oral medications are a tetracycline (such as doxycycline) or a fluoroquinolone (such as ciprofloxacin). For injection or intravenous use, streptomycin or gentamicin antibiotics are used. Early in the response to a bioterrorism attack, these drugs would be tested to determine which is most effective against the particular weapon that was used (CDC, 2005d).

### *Prophylaxis*

Currently, no plague vaccine is available in the United States although research is in progress (CDC, 2005d). Consider antibiotic prophylaxis for healthcare workers with close contact exposure (Siegel, et al. 2007).

## *Infection Control Measures*

Standard Precautions, Droplet Precautions until patients have received 48 hours of appropriate therapy (Siegel, et al., 2007).

### Smallpox

Smallpox is a serious, contagious, and sometimes fatal infectious disease. There is no specific treatment for smallpox disease, and the only prevention is vaccination (CDC, 2007a).

Smallpox outbreaks have occurred from time to time for thousands of years, but the disease has been eradicated due to the successful worldwide vaccination program. The last case of smallpox in the United States was in 1949. The last naturally occurring case in the world was in Somalia in 1977. Once the disease was eliminated, routine vaccination against smallpox among the general public was stopped because it was no longer necessary for prevention (CDC, 2007a). Because much of the world's population has is not vaccinated against smallpox, even a single case of smallpox is considered a public health emergency.

In the aftermath of the events of September and October, 2001, the US government has taken precautions to be ready to deal with a bioterrorist attack using smallpox as a weapon. As a result of these efforts (CDC, 2009):

- 1) There is a detailed nationwide smallpox response plan designed to quickly vaccinate people and contain a smallpox outbreak. This plan includes the creation of smallpox health care teams that would respond to a smallpox emergency and the vaccination of members of these teams; and
- 2) There is enough smallpox vaccine to vaccinate everyone who would need it in the event of an emergency.

Report suspected or confirmed smallpox cases immediately to your local health department or to:

- **NV State Department of Emergency Management 24 hours per day at 775-687-0400; or**
- **CDC at 770.488.7100.**

Smallpox is caused by the variola virus that emerged in human populations thousands of years ago. Except for laboratory stockpiles, the variola virus has been eliminated (CDC, 2007a).

There are two clinical forms of smallpox, variola minor and variola major. Illness associated with **variola minor** is milder with a sparse rash or a more rapid evolution of rash, over 6 to 7 days to crust stage. Secondary fevers are less frequently seen in variola minor. Outbreaks of variola minor had mortalities of ~1%. A milder form of disease is also seen among those who have residual immunity from prior smallpox vaccination (Inglesby, et al., 1999).

**Variola major** is the severe and most common form of smallpox, with a more extensive rash and higher fever. There are four types of variola major smallpox (CDC, 2007a):

- Ordinary (the most frequent type, accounting for 90% or more of cases);
- Modified (mild and occurring in previously vaccinated persons);
- Flat;
- Hemorrhagic (both rare and very severe).

Historically, variola major has an overall fatality rate of about 30%; however, flat and hemorrhagic smallpox usually are fatal (CDC, 2007a).

**Transmission** of smallpox occurs through inhalation of droplet or, rarely, aerosols, as well as through contact with skin lesions containing virus. If used as a biological weapon, natural disease, which has not occurred since 1977, will likely result (Siegel, et al., 2007). Direct and fairly prolonged face-to-face contact is required to spread smallpox from one person to another. Smallpox also can be spread through direct contact with infected bodily fluids or contaminated objects such as bedding or clothing. Rarely, smallpox has been spread by virus carried in the air in enclosed settings such as buildings, buses, and trains. Humans are the only natural hosts of variola. Smallpox is not known to be transmitted by insects or animals (CDC, 2007a).

**Clinical Symptoms:** A person with smallpox is sometimes contagious with onset of fever (prodrome phase), but the person becomes most contagious with the onset of rash. At this stage the infected person is usually very sick and not able to move around in the community. The infected person is contagious until the last smallpox scab falls off (CDC, 2007a).

The acute clinical symptoms of smallpox resemble other acute viral illnesses, such as influenza, beginning with a 2--4 day nonspecific prodrome of fever and myalgias before rash onset. Several clinical features can help clinicians differentiate varicella (chickenpox) from smallpox. The rash of varicella is most prominent on the trunk and develops in successive groups of lesions over several days, resulting in lesions in various stages of development and resolution. In comparison, the vesicular/pustular rash of smallpox is typically most prominent on the face and extremities, and lesions develop at the same time (CDC, 2007a).

### Smallpox Disease Progression (CDC, 2007a)

**Incubation Period**  
**(Duration: 7 to 17 days)**  
**Not contagious**

**Exposure to the virus** is followed by an incubation period during which people do not have any symptoms and may feel fine. This incubation period averages about 12 to 14 days but can range from 7 to 17 days. During this time, people are not contagious.

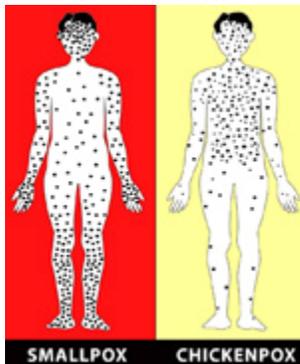
**Initial Symptoms**  
**(Prodrome)**  
**(Duration: 2 to 4 days)**  
**Sometimes contagious\***

**The first symptoms** of smallpox include fever, malaise, head and body aches, and sometimes vomiting. The fever is usually high, in the range of 101 to 104 degrees Fahrenheit. At this time, people are usually too sick to carry on their normal activities. This is the *prodrome* phase and may last for 2 to 4 days.

**Early Rash**  
**(Duration: about 4 days)**  
**Most contagious**

**A rash emerges** first as small red spots on the tongue and in the mouth.

**Rash distribution:**



These spots develop into sores that break open and spread large amounts of the virus into the mouth and throat. At this time, the person becomes **most contagious**.

Around the time the sores in the mouth break down, a rash appears on the skin, starting on the face and spreading to the arms and legs and then to the hands and feet. Usually the rash spreads to all parts of the body within 24 hours. As the rash appears, the fever usually falls and the person may start to feel better.

By the third day of the rash, the rash becomes raised bumps.

By the fourth day, the bumps fill with a thick, opaque fluid and often have a depression in the center that looks like a bellybutton. (This is a major distinguishing characteristic of

smallpox.)

Fever often will rise again at this time and remain high until scabs form over the bumps.

**Pustular Rash**  
**(Duration: about 5 days)**  
**Contagious**

The bumps become **pustules**-sharply raised, usually round and firm to the touch as if there's a small round object under the skin. People often say the bumps feel like BB pellets embedded in the skin.

**Pustules and Scabs**  
**(Duration: about 5 days)**  
**Contagious**

The pustules begin to form a crust and then **scab**.

By the end of the second week after the rash appears, most of the sores have scabbed over.

**Resolving Scabs**  
**(Duration: about 6 days)**  
**Contagious**

The scabs begin to fall off, leaving marks on the skin that eventually become pitted **scars**. Most scabs will have fallen off three weeks after the rash appears.

The person is contagious to others until all of the scabs have fallen off.

**Scabs resolved**  
**Not contagious**

Scabs have fallen off. Person is no longer contagious (CDC, 2007a).

\* Smallpox may be contagious during the *prodrome* phase, but is most infectious during the first 7 to 10 days following rash onset.

Diagnosis of smallpox is made electron microscopy of vesicular fluid or culture of vesicular fluid by a World Health Organization (WHO) approved laboratory (CDC); detection by PCR available only in select LRN labs, CDC and United States Army Medical Research Institute of Infectious Diseases (USAMRID).

Infection control measures include the combined use of Standard and Contact precautions until all lesions have crusted and separated (3-4 weeks). Transmission by the airborne route is rare, but airborne precautions are recommended when possible. In the event of a mass exposure, barrier precautions and containment within a designated area are the most important precautions. Only immune healthcare workers (those who have been recently vaccinated) should care for these patients; post-exposure vaccine can prevent or mitigate symptoms if provided within 4 days (Siegel, et al., 2007).



**Smallpox lesions on skin of trunk. Picture taken in Bangladesh, 1973.** Public Health Images Library (PHIL) ID # 284. Source: CDC/James Hicks.



**Face lesions on boy with smallpox.** Public Health Images Library (PHIL) ID # 3. Source: CDC/Cheryl Tyron.

### *Smallpox Vaccination*

Smallpox vaccine is made from live vaccinia virus, not variola virus (that causes smallpox). Vaccinia virus is a member of the orthopox virus family, which includes smallpox (variola), cowpox, monkeypox, gerbilpox,

camelpox among others (CDC, 2007d). When inoculated on the superficial layers of the skin, the virus grows and induces an immune reaction that serves to protect against smallpox (CDC, 2007d).

Dryvax, a stored calf-lymph vaccine manufactured in the 1970's by Wyeth Laboratories, is freeze dried (lyophilized) and must be reconstituted with a diluent before use. Dryvax contains antibiotics and preservatives. It is the vaccine that was used in 2003 to immunize public health and healthcare response teams, as was recommended by the Advisory Committee on Immunization Practice (ACIP). Dryvax is also used to immunize laboratory workers who conduct research involving vaccinia or other orthopoxviruses (CDC, 2007d).

### Contraindications for Vaccination

Because the vaccinia virus used in smallpox vaccine can be spread to others from the vaccine site of an immunized person, the contraindications below apply to **both potential vaccinees and their household contacts** ("household contacts" include persons with prolonged intimate contact with the potential vaccinee, including the potential for direct contact with the vaccination site, e.g., sexual contacts) (CDC, 2007d).

- **Eczema or atopic dermatitis and other acute, chronic, or exfoliative skin conditions.**

Any previous diagnosis of eczema or atopic dermatitis puts one at high risk of developing eczema vaccinatum, a potentially severe and sometimes fatal complication. Persons with household contacts that have a history of eczema or atopic dermatitis, irrespective of disease severity or activity, should not be vaccinated.

If the potential vaccinee or any of their household contacts have other acute, chronic, or exfoliative skin conditions (e.g., burns, impetigo, chicken pox, contact dermatitis, shingles, herpes, severe acne, severe diaper dermatitis with extensive areas of denuded skin, or psoriasis), they are at risk for inadvertent autoinoculation of the affected skin with vaccinia virus and should not be vaccinated until the condition(s) resolves.

Persons with Darier's disease can develop eczema vaccinatum and therefore should not be vaccinated.

- **Diseases or conditions which cause immunodeficiency or immunosuppression.**

Vaccinees or their household contacts who have conditions such as HIV/AIDS, solid organ or stem cell transplant, generalized malignancy, leukemia, lymphoma, or agammaglobulinemia, should not be vaccinated. People with these conditions are at greater risk of developing a serious adverse reaction resulting from unchecked replication of the vaccine virus (progressive vaccinia). It is also reported that some patients with severe clinical manifestations of some autoimmune diseases (e.g., systemic lupus erythematosus) may have some degree of immunocompromise as a component of the disease. These patients should not receive smallpox vaccine during the pre-event vaccination program.

HIV testing should be readily available to all persons considering smallpox vaccination. HIV testing is recommended for persons who have any history of a risk factor for HIV infection and who are not sure of their HIV infection status. Anyone who is concerned that they could have HIV infection also should be tested. HIV testing should be available in a confidential or, where permitted by law, anonymous setting with results communicated to the potential vaccinee before the planned date of vaccination. Persons with a positive test result should be told not to present to the vaccination clinic for immunization.

- **Treatments which cause immunodeficiency or immunosuppression.**

If a potential vaccinee or any of their household contacts are undergoing treatment with radiation, antimetabolites, alkylating agents, high-dose corticosteroids (i.e., > 2 mg/kg body weight or 20 mg/day

of prednisone for > 2 weeks), chemotherapy agents, or organ transplant medications, they should not be vaccinated.

People who are receiving these therapies are at greater risk of serious adverse reactions to the smallpox vaccine. People undergoing treatment with high dose corticosteroids, or who have household contacts undergoing such treatment, should not be vaccinated within one month of completing corticosteroid therapy. Persons undergoing other treatments which cause immunosuppression or who have household contacts undergoing such treatment should not receive smallpox vaccine until they or their household contact have been off immunosuppressive treatment for 3 months.

- **Pregnancy.**

Live virus vaccines are generally contraindicated during pregnancy. Pregnant women who receive the smallpox vaccine are at risk of fetal vaccinia. Although this is a very rare condition (fewer than 50 cases have ever been reported), it usually results in stillbirth or death of the infant shortly after delivery.

Before vaccination, people should be asked if they or any of their household contacts are pregnant or intend to become pregnant in the next 4 weeks; those who respond positively should not be vaccinated. In addition, women who are vaccinated should be counseled not to become pregnant during the 4 weeks after vaccination, and abstinence or highly effective contraceptive measures should be recommended to reduce the risk of pregnancy within four weeks of vaccination.

Routine pregnancy testing of women of child-bearing age is not recommended.

Any woman who thinks she could be pregnant or who wants additional assurance that she is not pregnant should perform a urine pregnancy test using a "first morning" void urine on the day scheduled for vaccination. However, women should be informed that a negative urine pregnancy test cannot exclude a very early pregnancy and therefore they and their healthcare providers should not base a decision about their pregnancy status solely upon a urine pregnancy test result.

If a pregnant woman is inadvertently vaccinated or if she becomes pregnant within 4 weeks after vaccinia vaccination, she should be counseled regarding the basis of concern for the fetus. However, vaccination during pregnancy should not ordinarily be a reason to terminate pregnancy.

The contraindications above apply to potential vaccinees and their household contacts. The following additional contraindications apply only to potential vaccinees:

- **Previous allergic reaction to smallpox vaccine or any of the vaccine's components.**

Vaccinia vaccine (Dryvax®) contains small amounts of polymyxin B sulfate, streptomycin sulfate, chlortetracycline hydrochloride, neomycin sulfate, and phenol.

Anyone who has experienced an anaphylactic reaction to these components should not be vaccinated. In addition, anyone who has experienced a previous allergic reaction to the smallpox vaccine should not be vaccinated.

- **Moderate or severe acute illness.**

Moderate or severe acute illness is generally a contraindication to vaccination. Vaccination should be deferred until the acute illness has resolved.

- **Infants and children.**

Smallpox vaccine is contraindicated for children under 12 months of age. The Advisory Committee on



## **Step-by-Step Instructions for Smallpox Immunization** (CDC, 2007c)

1. **Review patient history for contraindications.**
2. **Choose the site for vaccination.**  
The deltoid area on the upper arm is recommended.
3. **Skin preparation.**  
No skin preparation is required. Under no circumstances should alcohol be applied to the skin prior to vaccination as it has been shown to inactivate the vaccine virus.
4. **Dip needle.**  
The needle is dipped into the vaccine vial and withdrawn. The needle is designed to hold a tiny drop of vaccine of sufficient size and strength to ensure a take if properly administered. The same needle should never be dipped into the vaccine vial more than once, in order to avoid contamination of the vaccine vial.
5. **Make perpendicular insertions within a 5-mm diameter area.**  
The needle is held perpendicular to the site of insertion. The wrist of the vaccinator should be maintained in a firm position by resting on the arm of the vaccinee or another firm support.
  - A number of perpendicular insertions are made in rapid order in an area approximately 5 mm in diameter. The number of insertions should be in accordance with the package insert, using 3 insertions for primary vaccination and 15 insertions for revaccination with the Dryvax vaccine. A trace of blood should appear at the site of vaccination within 15-20 seconds. During primary vaccination, if no trace of blood is visible after 3 insertions, an additional 3 insertions should be made using the same bifurcated needle without reinserting the needle into the vaccine vial.
  - The bifurcated needle is for one-time use only and should be discarded in an appropriate biohazard container immediately after vaccinating each patient.
6. **Absorb Excess Vaccine**  
After vaccination, excess vaccine should be absorbed with sterile gauze. Discard the gauze in a safe manner (usually in an infection control receptacle) in order not to contaminate the site or infect others who may come in contact with it.
7. **Cover vaccination site.**  
It is important that the vaccination site be covered to prevent dissemination of virus. Recommended coverings include the following:
  - Gauze loosely secured by first aid adhesive tape (taking care to obtain history of tape sensitivity).
  - When working in a healthcare setting, vaccinees should keep their vaccination site covered with gauze or a similar absorbent material. This dressing should, in turn, be covered with a semipermeable dressing. Products combining an absorbent base with an overlying semipermeable layer also can be used to cover the vaccination site. Healthcare workers do not need to be placed on leave after receiving a smallpox vaccination.
  - Vaccinees in settings where close personal contact is likely (such as parents of infants and young children) should cover the vaccination site with gauze or a similar absorbent material, wear a shirt or other clothing that would cover the vaccination site, and also make sure to practice good hand hygiene.

Note: The use of semipermeable dressing alone could cause maceration of the vaccination site and increased, prolonged irritation and itching at the site, thereby increasing touching, scratching, and

contamination of the hands. Thus, only persons working in healthcare settings should use semipermeable dressings (over gauze or a similar absorbent material as described above).

**8. Educate vaccinee.**

To avoid contact transmission of the virus, vaccinees must be cautioned to do the following:

- Do not rub or scratch the vaccination site.
- Keep the site covered and change gauze-only dressings every 1-2 days or if wet. Change semipermeable dressings at least every 3-5 days.
- Keep the vaccination site dry, covering it with a water-proof bandage while bathing.
- Discard gauze carefully in plastic zip bags.
- Set aside a laundry hamper for clothes, towels, sheets and other items that may come into contact with the vaccination site.
- Wash clothing or other materials that come into contact with the vaccination site in hot water with detergent and/or bleach. Wash hands afterward.
- Wash hands thoroughly with soap and hot water or with alcohol-based hand rubs such as gels or foams after touching the vaccination site, or bandages, clothing, towels, or sheets that have come into contact with the vaccination site.
- When the scab falls off, throw it away in a plastic zip bag.
- Report any problems by calling the phone number provided on the "Post-Vaccination and Follow-Up Information" sheet, calling your health care provider, or visiting and emergency room.
- Return 7 days after vaccination for a "take" check (to see if the vaccination was successful).

**9. Record the vaccination.**

Record vaccination information as instructed by the CDC.

A normal primary vaccination appears as a papule in 3-4 days, and rapidly progresses to a vesicle with the surrounding erythema by the 5th-6th day. The vesicle center becomes depressed and progresses to a well-formed pustule by the 8th-9th day. By the twelfth day, or soon thereafter, the pustule crusts over forming a brown scab, which progresses from the center of the pustule to the periphery. After 2.5 to 3 weeks, the scab detaches and a well formed scar remains (CDC, nd).

Normal Reaction Time	
Day	Description
0	Vaccination
3-4	Papule
5-6	Vesicle with surrounding erythema → vesicle with depressed center
8-9	Well-formed pustule
12+	Pustule crusts over →scab
17-21	Scab detaches revealing scar

Rarely, in some first-time or distantly vaccinated individuals, seemingly appropriate vaccination techniques may result in no reaction. One should assume that the individual is **not** immune and repeat attempts should be made to achieve a major response or "take". At least one repeat vaccination with a different vaccine vial should be given, switching skin sites on the same arm or using the other arm. If the second vaccination is unsuccessful, consultation should be obtained to determine if the vaccination technique was flawed (primary or re-vaccinee), the vaccine was non-viable (first-time or re-vaccinee), or the vaccinee still had immunity from a previous vaccination (re-vaccinee).

Systemic symptoms are expected and usually occur between 8 -10 days after vaccination when the vaccine site reaction reaches the peak of the inflammatory response. These include:

- Soreness at the vaccination site.
- Intense erythema ringing the vaccination site.
- Malaise.
- Lymphadenopathy (local).
- Myalgia, headache, chills, nausea, fatigue.
- Fever.

Historically, the occurrence of these normal reactions varied considerably from study to study as shown in ranges demonstrated in the table below. They also varied between primary vaccinees (higher rates of symptoms) and re-vaccinees (lower rates of symptoms).

Lymphadenopathy	25.0 - 50.0 %
Myalgia, headache, chills, nausea, fatigue	0.3 - 37.0 %
Fever > 37.7° C	2.0 - 16.0 %

A recent NIH study, evaluating diluted and undiluted smallpox vaccine in adults receiving their first vaccination, reported the following symptom rates during the 14 days following vaccination:

- Lymphadenopathy
- Fatigue
- Headache
- Myalgia and chills
- Nausea
- Fever >37.7 degrees C

Adverse responses to vaccination can include: inadvertent autoinoculation, ocular lesions (blepharitis, conjunctivitis), generalized vaccinia, progressive vaccinia, eczema vaccinatum; bacterial superinfection also requires addition of contact precautions if exudates cannot be contained (Siegel, et al., 2007).

#### Identification of Priority Groups for Vaccination in a Smallpox Outbreak

The following are considered high risk groups and should be prioritized for vaccination in a smallpox outbreak (CDC, 2002):

1. Face-to-face close contacts ( $\leq 6.5$  feet or  $2$  meters) or household contacts to smallpox patients after the onset of the smallpox patient's fever.
2. Persons exposed to the initial release of the virus (if the release was discovered during the first generation of cases and vaccination may still provide benefit).
3. Household members (without contraindications to vaccination) of contacts to smallpox patients<sup>†</sup> to protect household contacts should smallpox case contacts develop disease while under fever surveillance at home).
4. Persons involved in the direct medical care, public health evaluation, or transportation of confirmed or suspected smallpox patients.
5. Laboratory personnel involved in the collection and/or processing of clinical specimens from suspected or confirmed smallpox patients.
6. Other persons who have a high likelihood of exposure to infectious materials (e.g., personnel responsible for hospital laundry, waste disposal, and disinfection).

7. Personnel involved in contact tracing and vaccination, or quarantine/isolation or enforcement, or law-enforcement interviews of suspected smallpox patients.
8. Persons permitted to enter any facilities designated for the evaluation, treatment, or isolation of confirmed or suspected smallpox patients<sup>‡</sup> (only essential personnel should be allowed to enter such facilities).
9. Persons present in a facility or conveyance with a smallpox case if fine-particle aerosol transmission was likely during the time the case was present (e.g. hemorrhagic smallpox case and/or case with active coughing)<sup>§</sup>.

<sup>¶</sup> Although individuals with smallpox are not infectious until the onset of rash, vaccinating contacts from the time of the onset of fever helps provide a buffer and assures that contacts who may have been exposed at the early onset of rash, when the rash may have been faint and unrecognized, have been vaccinated.

\* Includes personnel whose public health activities involve direct patient contact such as case interviewing

<sup>†</sup> Household members of contacts who have contraindications to vaccination should be housed separately from the other vaccinated household members until the vaccination site scab has separated (~ 2 weeks) to prevent inadvertent transmission of vaccinia virus. They should be housed separately from the contact until the incubation period for smallpox has passed and the contact is released from surveillance.

<sup>‡</sup> Only personnel without contraindications to vaccination should be chosen for activities that would require vaccination for their protection. Personnel with contraindications should not perform duties that would place them at risk for smallpox exposure and should otherwise only be vaccinated if an exposure has already occurred.

<sup>§</sup> Evaluation of the potential risk for aerosol transmission and initiation of vaccination for non-direct contacts will be done by CDC, state, and local public health personnel. The decision to offer vaccination to non-direct contacts of smallpox cases will be made jointly by federal and state health officials.

### *Treatment of Smallpox*

There is no specific treatment for smallpox disease, and the only prevention is vaccination (CDC, 2007a). Research is occurring to test the effectiveness of new antiviral agents.

### Tularemia

*Francisella tularensis* could be used as a biological weapon in a number of ways (through the skin, mucous membranes, and through the gastrointestinal tract), but an aerosol release would likely have the greatest adverse medical and public health consequences (CDC, 20011; CDC, 2005c).

Worldwide incidence of naturally occurring tularemia is unknown. It is likely that the disease is greatly under-recognized and under-reported. It occurs naturally throughout much of North America and Eurasia.

In the US, human cases have been reported from every state except Hawaii, with the majority occurring in south-central and western states (CDC, 2011; CDC, 2005c). In the US, reported cases have dropped sharply from several thousand/year prior to 1950 to fewer than 200/year in the 1990s. Between 1985 and 1992, 1409 cases and 20 deaths were reported in the US, a case fatality rate of 1.4%. Most US cases occur June-September, when arthropod-borne transmission is most common. Cases in winter most commonly occur among hunters and trappers who handle infected animal carcasses (CDC, 2011; CDC, 2005c).

### *Agent*

*Francisella tularensis*, a small, nonmotile, aerobic gram-negative coccobacillus, is one of the most infectious pathogenic bacteria known. It requires inoculation or inhalation of as few as 10 organisms to cause disease (CDC, 2011; CDC, 2005c). It has a thin lipopolysaccharide-containing envelope and is a hard, non-spore-

forming organism that survives for weeks at low temperatures in water, moist soil, hay, straw, and decaying animal carcasses (CDC, 2011; CDC, 2005c).

### *Disease*

Tularemia is a bacterial zoonosis, i.e., animal-borne.

### *Transmission*

*F. tularensis* is found in widely diverse animal hosts and habitats and can be recovered from contaminated water, soil, and vegetation. A variety of small mammals, including voles, mice, water rats, squirrels, rabbits, and hares are natural reservoirs of infection. They acquire infection through tick, fly, and mosquito bites and by contact with contaminated environments. Epizootics with sometimes extensive die-offs of animal hosts may herald outbreaks of tularemia in humans (CDC, 2011; CDC, 2005c). In the United States, ticks that transmit tularemia to humans include the dog tick (*Dermacentor variabilis*), the wood tick (*Dermacentor andersoni*), and the lone star tick (*Amblyomma americanum*). Deer flies (*Chrysops spp.*) have been shown to transmit tularemia in the western United States. Infections due to tick and deer fly bites usually take the form of ulceroglandular or glandular tularemia (CDC, 2011).

Humans can become incidentally infected through diverse environmental exposures: bites by infected arthropods; handling infectious animal tissues or fluids; direct contact with or ingestion of contaminated food, water, or soil; and inhalation of infective aerosols. Humans can develop severe and sometimes fatal illness, but do not transmit the disease to others (CDC, 2011; CDC, 2005c).

Pneumonic disease is likely to occur after a bioterrorist event using aerosol delivery; the infective dose is low, only 10-50 bacteria (Siegel, et al., 2007).

### *Clinical symptoms*

Incubation Period is 2 to 10 days; usually 3 to 5 days (Siegel, et al., 2007).

The onset of tularemia is usually abrupt, with fever (38°C-40°C) beginning 3-5 days after exposure. Headache, chills and rigors, generalized body aches (often prominent in the low back), coryza, and sore throat. A pulse-temperature dissociation has been noted in as many as 42% of patients. A dry or slightly productive cough and substernal pain or tightness frequently occur with or without objective signs of pneumonia, such as purulent sputum, dyspnea, tachypnea, pleuritic pain, or hemoptysis. Nausea, vomiting, and diarrhea may occur. Sweats, fever, chills, progressive weakness, malaise, anorexia, and weight loss characterize the continuing illness (CDC, 2005c).

Bacteremia may be common in the early phase of infection. The initial tissue reaction to infection is a focal, intensely suppurative necrosis consisting largely of accumulations of polymorphonuclear leukocytes, followed by invasion of macrophages, epithelioid cells, and lymphocytes (CDC, 2011; CDC, 2005c).

Suppurative lesions become granulomatous, and histopathological examination of the granulomas shows a central necrotic, sometimes caseating, zone surrounded by a layer of epithelioid cells, multinucleated giant cells, and fibroblasts in a radial arrangement, typical of other granulomatous conditions such as tuberculosis and sarcoidosis (CDC, 2011; CDC, 2005c).

It might also contaminate the eyes, resulting in ocular tularemia, penetrate broken skin, resulting in ulceroglandular or glandular disease, or oropharyngeal disease with cervical lymphadenitis (CDC, 2005).

The major target organs are the lymph nodes, lungs and pleura, spleen, liver, and kidney. Untreated, bacilli inoculated into skin or mucous membranes multiply, spread to regional lymph nodes and further multiply, and then may disseminate to organs throughout the body.

Those with inhalational exposures can also develop hemorrhagic inflammation of the airways early in the course of illness, which may progress to bronchopneumonia. Histopathological examination of the lungs shows alveolar spaces filled with an exudate of mononuclear cells. Pleuritis with adhesions and effusion and hilar lymphadenopathy are common in radiological and pathological findings (CDC, 2011; CDC, 2005c).

In general, tularemia would be expected to have a slower progression of illness and a lower case-fatality rate than either inhalational plague or anthrax. Milder forms of inhalational tularemia would be indistinguishable from Q fever; another potential bioterrorism agent; establishing a diagnosis of either would be problematic without reference laboratory testing (CDC, 20011; CDC, 2005c).

### *Diagnosis/Labs*

Rapid diagnostic testing for tularemia is not widely available. Healthcare providers who suspect inhalational tularemia in patients presenting with atypical pneumonia, pleuritis, and hilar lymphadenopathy should promptly collect specimens of respiratory secretions and blood and alert the laboratory to the need for special diagnostic and safety procedures (CDC, 2011; CDC, 2005c).

Diagnosis usually made with serology on acute and convalescent serum specimens; bacterium can be detected by PCR (LRN) or isolated from blood and other body fluids on cysteine enriched media or mouse inoculation (Siegel, et al., 2007).

*F. tularensis* may be identified through direct examination of secretions, exudates, or biopsy specimens using Gram stain, direct fluorescent antibody, or immunohistochemical stains (CDC, 2011; CDC, 2005c).

Designated laboratories in the National Public Health Laboratory Network can quickly identify *F. tularensis*; test results can be available within several hours of receiving the specimens, if the laboratory is alerted and prepared (CDC, 2005c). Growth of *F. tularensis* in culture is the definitive means of confirming the diagnosis of tularemia. It can be grown from pharyngeal washings, sputum specimens, and even fasting gastric aspirates in a high proportion of patients with inhalational tularemia. It is only occasionally isolated from blood (CDC, 2011; CDC, 2005c).

Laboratory workers who encounter/handle cultures of this organism are at high risk for disease if exposed (Siegel, et al., 2007).

### *Vaccine*

A live attenuated vaccine derived from avirulent *F. tularensis* biovar palaeoarctica (type B) has been used in the US to protect those working in laboratories routinely working with the bacterium. The vaccine is currently under review by the Food and Drug Administration (CDC, 2011; CDC, 2005c).

### *Reporting*

Report suspected or confirmed tularemia cases immediately to your local health department or to:

- **NV State Department of Emergency Management 24 hours per day at 775-687-0400; or**
- **CDC at 770.488.7100.**

*Treatment (See Table 3 below)*

In a contained casualty setting, where individual patient management is possible, parenteral antimicrobial therapy is recommended. Streptomycin is the drug of choice. Gentamicin, which is more widely available and can be used intravenously, is an acceptable alternative. Treatment with aminoglycosides should be continued for 10 days. Tetracyclines and chloramphenicol are also used, but relapses and primary treatment failures occur at a higher rate with these bacteriostatic agents than with aminoglycosides, and they should be given for at least 14 days to avoid relapse. Both streptomycin and gentamicin are recommended as first-line treatment of tularemia in children (CDC, 2011; CDC, 2005c).

In a mass casualty setting, doxycycline and ciprofloxacin, administered orally, are the preferred choices for treatment of both adults and children. As described in the table below, 'Treatment with ciprofloxacin should be continued for 10 days; treatment with doxycycline should be continued for 14-21 days (CDC, 2011; CDC, 2005c).

Since it is unknown whether drug-resistant organisms might be used in a bioterrorist event, antimicrobial susceptibility testing of isolates should be conducted quickly and treatments altered according to test results and clinical responses. Antibiotics for treating patients infected with tularemia in a bioterrorist event are included in the national pharmaceutical stockpile maintained by CDC, as are ventilators and other emergency equipment (CDC, 2011; CDC, 2005c).

Persons beginning treatment with streptomycin, gentamicin, doxycycline, or ciprofloxacin in the incubation period of tularemia and continuing treatment daily for 14 days might be protected against symptomatic infection. Therefore, if an attack is discovered before individuals become ill, exposed persons should be prophylactically treated with 14 days of oral doxycycline or ciprofloxacin (CDC, 2011; CDC, 2005c).

If an attack is discovered only after individuals become ill, persons potentially exposed should begin a fever watch. Those who develop an otherwise unexplained fever or flu-like illness within 14 days of presumed exposure should begin treatment as outlined above (CDC, 2011; CDC, 2005c).

<b>Table 3. Working Group Consensus Recommendations for Treatment of Patients With Tularemia in the Contained and Mass Casualty Settings and for Postexposure Prophylaxis*</b>	
<b>Patient Category</b>	<b>Recommended Therapy</b>
<b>Contained Casualty</b>	
<b>Adults</b>	<p><b>Preferred choices:</b>            Streptomycin, 1g IM twice daily            Gentamicin, 5 mg/kg IM or IV once daily†</p> <p><b>Alternative choices:</b>            Doxycycline, 100 mg IV twice daily            Chloramphenicol, 15 mg/kg IV 4 times daily            Ciprofloxacin, 400 mg IV twice daily†</p>
<b>Children</b>	<p><b>Preferred choices:</b>            Streptomycin, 15 mg/kg IM twice daily (should not exceed 2 gm/d)            Gentamicin, 2.5 mg/kg IM or IV 3 times daily†</p> <p><b>Alternative choices:</b>            Doxycycline,              If weight &gt;= 45 kg, 100 mg IV</p>

	If weight < 45 kg, give 2.2 mg/kg IV twice daily  Chloramphenicol, 15 mg/kg IV 4 times daily† Ciprofloxacin, 15 mg/kg IV twice daily‡
<b>Pregnant Women</b>	<b>Preferred choices:</b> Gentamicin, 5 mg/kg IM or IV once daily† Streptomycin, 1 g IM twice daily  <b>Alternative choices:</b> Doxycycline, 100 mg IV twice daily Ciprofloxacin, 400 mg IV twice daily†
<b>Mass Casualty Setting and Postexposure Prophylaxis</b>	
<b>Adults</b>	<b>Preferred choices:</b> Doxycycline, 100 mg orally twice daily Ciprofloxacin, 500 mg orally twice daily†
<b>Children</b>	<b>Preferred choices:</b> Doxycycline, and  If ≥45kg give 100 mg orally twice daily If <45 kg then give 2.2 mg/kg orally twice daily  Ciprofloxacin, 15 mg/kg orally twice daily‡
<b>Pregnant Women</b>	<b>Preferred choices:</b> Ciprofloxacin, 500 mg orally twice daily† Doxycycline, 100 mg orally twice daily
<p>* One antibiotic, appropriate for treatment for patient age, should be chosen from among the alternatives. Treatment with streptomycin, gentamicin, or ciprofloxacin should be continued for 10 days; treatment with doxycycline or chloramphenicol should be continued for 14-21 days. Persons beginning treatment with intramuscular (IM) or intravenous (IV) doxycycline, ciprofloxacin, or chloramphenicol can switch to oral antibiotic administration when clinically indicated.</p> <p>† Not a U.S. Food and Drug Administration-approved use.</p> <p>‡ Ciprofloxacin dosage should not exceed 1 g/d in children.</p>	

### Precautions

Since person to person transmission is not known to occur, postexposure prophylactic treatment of close contacts of tularemia patients is not recommended, nor is isolation recommended for tularemia patients for the same reason (CDC, 2011; CDC, 2005c). In hospitals, standard precautions are recommended.

Laboratory personnel should be alerted when tularemia is suspected. Examination of cultures in which *F. tularensis* is suspected should be done in a biological safety cabinet. Manipulation of cultures and other procedures that might produce aerosols or droplets (e.g., grinding, centrifuging, vigorous shaking, animal studies) should be conducted under biosafety level 3 conditions (CDC, 2011; CDC, 2005c).

Bodies of patients who die of tularemia should be handled using standard precautions. Autopsy procedures likely to produce aerosols or droplets should be avoided (CDC, 2011; CDC, 2005c).

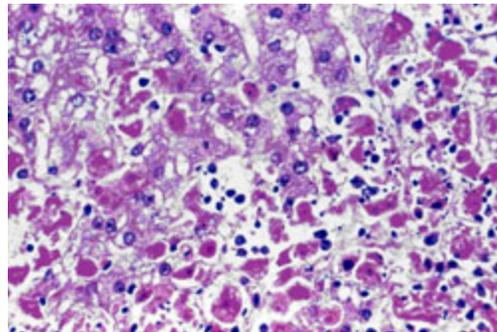
Clothing or linens contaminated with body fluids of patients with tularemia should be disinfected per standard hospital procedure (CDC, 2011; CDC, 2005c).

Under natural conditions, *F. tularensis* can survive for extended periods in a cold, moist environment. Information is not available about survivability of an intentionally released aerosol form of *F. tularensis*, but it

would likely have a short half-life due to desiccation, solar radiation, oxidation, and other environmental factors and a very limited risk from secondary dispersal. Following an urban release, the risk to humans of acquiring tularemia from infected animals or arthropods is likely small and can be reduced by educating the public to avoid sick or dead animals and to take precautions to protect against biting arthropods (CDC, 2011; CDC, 2005c).

### Viral Hemorrhagic Fevers

The hemorrhagic fever viruses are a mixed group of viruses that cause a serious multisystem syndrome. Characteristically, the overall vascular system is damaged and the body's ability to regulate itself is impaired. Symptoms are high fever, skin rash, bleeding diathesis, and in some cases, high mortality; the disease caused is referred to as viral hemorrhagic fever (VHF). Among the more commonly known VHFs are Ebola and Marburg viruses (Filoviridae), Lassa virus (Arenaviridae), Crimean-Congo hemorrhagic fever and Rift Valley Fever virus (Bunyaviridae), and Dengue and Yellow fever viruses (Flaviviridae). While none of these viruses is endemic in the United States, outbreaks in affected countries provide potential opportunities for importation by infected humans and animals. Additionally, there are concerns that some of these agents could be used as bioweapons (Siegel, et al., 2007).



This micrograph of human liver tissue infected with the Ebola virus, the cause of Ebola hemorrhagic fever (Ebola HF), depicts the hepatic histopathologic changes that occur due to this illness. Courtesy of Public Health Image Library, CDC.

### *Transmission*

Transmission to humans is via contact with infected animals or via arthropod vectors. Person-to-person transmission is documented for Ebola, Marburg, Lassa and Crimean-Congo hemorrhagic fever viruses. Transmissions within households also have occurred among individuals who had direct contact with ill persons or their body fluids, but not to those who did not have such contact. Person-to-person transmission is associated primarily with direct blood and body fluid contact. In resource-limited healthcare settings, transmission of these agents to healthcare personnel, patients and visitors has been described and in some outbreaks has accounted for a large proportion of cases (Siegel, et al., 2007).

Percutaneous exposure to contaminated blood carries a particularly high risk for transmission and increased mortality. The finding of large numbers of Ebola viral particles in the skin and the lumina of sweat glands has raised concern that transmission could occur from direct contact with intact skin though epidemiologic evidence to support this is lacking. Postmortem handling of infected bodies is an important risk for transmission (Siegel, et al., 2007).

### *Incubation*

The range for incubation is 2-19 days; 5-10 days is most common.

### *Clinical Symptoms*

Symptoms include febrile illnesses with malaise, myalgias, headache, vomiting and diarrhea that are rapidly complicated by hypotension, shock, and hemorrhagic features. Massive hemorrhage occurs in more than 50% of patients (Siegel, et al., 2007).

### *Diagnosis*

Diagnosis can be made using reverse transcription polymerase chain reaction (RT-PCR), serologic detection of antibody and antigen, pathologic assessment with immunohistochemistry and viral culture with electron microscopy for confirmation of morphology.

### *Recommended Precautions*

There have been many inconsistencies among the recommendations for precautions against VHF in US hospitals. The majority of evidence on HFV transmission indicates that Standard, Contact and Droplet Precautions with eye protection are effective in protecting healthcare personnel and visitors who may attend an infected patient. Single gloves are adequate for routine patient care; double-gloving is advised during invasive procedures (e.g., surgery) that pose an increased risk for blood exposure. Routine eye protection (i.e. goggles or face shield) is particularly important. Fluid-resistant gowns should be worn for all patient contact. Airborne Precautions are not required for routine patient care; however, use of AIIRs is prudent when procedures that could generate infectious aerosols are performed (e.g., endotracheal intubation, bronchoscopy, suctioning, autopsy procedures involving oscillating saws). N95 or higher level respirators may provide added protection for individuals in a room during aerosol-generating procedures (Siegel, et al., 2007).

When a patient with a syndrome consistent with hemorrhagic fever also has a history of travel to an endemic area, precautions are initiated upon presentation and then modified as more information is obtained (Siegel, et al., 2007).

If disease is believed to be related to intentional release of a bioweapon, epidemiology of transmission is unpredictable pending observation of disease transmission. Until the nature of the pathogen is understood and its transmission pattern confirmed, Standard, Contact and Airborne Precautions should be used. Once the pathogen is characterized, if the epidemiology of transmission is consistent with natural disease, Droplet Precautions can be substituted for Airborne Precautions. Emphasize:

1. Use of sharps safety devices and safe work practices;
2. Hand hygiene;
3. Barrier protection against blood and body fluids upon entry into room (single gloves and fluid-resistant or impermeable gown, face/eye protection with masks, goggles or face shields); and
4. Appropriate waste handling.

Use N95 or higher respirators when performing aerosol-generating procedures. In settings where airborne infection isolation (negative pressure) rooms (AIIRs) are unavailable or the large numbers of patients cannot be accommodated by existing AIIRs, observe Droplet Precautions (plus Standard Precautions and Contact Precautions) and segregate patients from those not suspected of VHF infection. Limit blood draws to those essential to care.

### *Reporting*

Report any suspected or confirmed VHF cases immediately to your local health department or to:

- **NV State Department of Emergency Management 24 hours per day at 775-687-0400;** or
- **CDC at 770.488.7100.**

## Conclusion to Biological Weapons

Healthcare providers must remain vigilant about the possibility that symptoms they are seeing among their patients may be caused by an intentional release of a biological agent. Generally, with biological agents, the recognition that an intentional release may have occurred may not occur right away. It may take days or weeks to recognize that a large group of people may have been exposed to a biological agent.

Healthcare workers must maintain a high degree of suspicion. Concurrently they must also strive to maintain current knowledge and skill related to the potential biological agents that can be used in a terrorist attack. This includes recognition of symptoms, knowing how to protect oneself during care of the exposed, and how to treat those exposed. An equally important component is becoming very familiar with the emergency plans of the organizations in which one works and developing and practicing emergency plans at home.

## **Chemical Terrorism**

Chemical agents used as weapons are likely to be detected more quickly in the population than are biological agents, because an incubation period is not needed. Chemical agents can have very serious health effects, some are immediate and other effects take time to be felt. Many chemicals are not easily detected, so that a likely scenario is that a large number of people will become sickened before the chemical attack is identified. Epidemiologic clues that might suggest the covert release of a chemical agent include (CDC, 2003d):

- An unusual increase in the number of patients seeking care for potential chemical-release--related illness;
- Unexplained deaths among young or healthy persons;
- Emission of unexplained odors by patients;
- Clusters of illness in persons who have common characteristics, such as drinking water from the same source;
- Rapid onset of symptoms after an exposure to a potentially contaminated medium (e.g., paresthesias and vomiting within minutes of eating a meal);
- Unexplained death of plants, fish, or animals (domestic or wild); and
- A syndrome (i.e., a constellation of clinical signs and symptoms in patients) suggesting a disease associated commonly with a known chemical exposure (e.g., neurologic signs or pinpoint pupils in eyes of patients with a gastroenteritis-like syndrome or acidosis in patients with altered mental status).

However, it is also possible that a covert release of a chemical agent might not be identified easily for a number of reasons (CDC, 2003d):

- Symptoms of exposure to some chemical agents (e.g., ricin) might be similar to those of common diseases (e.g., gastroenteritis);
- Immediate symptoms of certain chemical exposures might be nonexistent or mild despite the risk for long-term effects (e.g., neurocognitive impairment from dimethyl mercury, teratogenicity from isotretinoin, or cancer from aflatoxin);
- Exposure to contaminated food, water, or consumer products might result in reports of illness to healthcare providers over a long period and in various locations;
- Persons exposed to two or more agents might have symptoms not suggestive of any one chemical agent (i.e., a mixed clinical presentation); and
- Healthcare providers might be less familiar with clinical presentations suggesting exposure to chemical agents than they are with illnesses that are treated frequently.

As with the planning for a biological attack, healthcare organizations also have planned for the possibility of a chemical attack. **Each professional is urged to identify and read the emergency response plan for chemical attacks in her/his healthcare organization.** These plans have been made in response to state and

federal requirements. While specifics will vary from organization to organization, the overall goals will be similar.

In the event of a chemical release, public health officials, defense and emergency personnel would be directing the population as to how to proceed. The Agency for Toxic Substance Disease Registry (ATSDR), in 2001 released *Managing Hazardous Materials Incidents: A Planning Guide for the Management of Contaminated Patients, Vol. I-III*. It provides information about how to manage such emergencies, including the prehospital and emergency department management. Prehospital guidelines describe the activities that typically occur in the three concentric areas surrounding the hazardous materials (HAZMAT) incident. This would apply to any intentional or accidental release of chemicals.

- **The Hot Zone** (or Exclusion Area) is the area surrounding the chemical release; it is assumed to pose an immediate health risk.
- **The Decontamination Zone** (or Warm Zone) is the area surrounding the Hot Zone where primary contamination is not expected but where personnel must use protective clothing and equipment to avoid chemical exposure from contaminated victims.
- **The Support Zone** (or Cold Zone) is the outermost ring where no exposure or risk is expected. The incident commander, medical personnel, and other support persons and equipment operate in the Support Zone.

According to ATSDR (2001) guidelines, rescuers should be trained and appropriately attired before entering the **Hot Zone**. If the proper equipment is not available, or if rescuers have not been trained in its use, call for assistance from a local or regional HAZMAT team or other properly equipped response organization.

**When a chemical is unidentified**, worst-case possibilities concerning toxicity must be assumed. The potential for severe local effects (e.g., irritation and burning) and severe systemic effects (e.g., organ damage) should be assumed when specific rescuer-protection equipment is selected.

- **Respiratory Protection:** Pressure-demand, self-contained breathing apparatus (SCBA) should be used in all response situations.
- **Skin Protection:** Chemical-protective clothing should be worn when local and systemic effects are unknown.

Quickly ensure a patent airway. If trauma is suspected, maintain cervical immobilization manually and apply a cervical collar and a backboard when feasible.

If victims can walk, lead them out of the Hot Zone to the Decontamination Zone. Victims who are unable to walk may be removed on backboards or gurneys; if these are not available, carefully carry or drag victims to safety.

In the **Decontamination Zone**, whenever the chemical or concentration is unidentified, personnel should wear the same protective equipment used in the Hot Zone (see above).

Quickly ensure a patent airway. Stabilize the cervical spine with a collar and a backboard if trauma is suspected. Administer supplemental oxygen as required. Assist ventilation with a bag- valve-mask device if necessary. Victims who are able and cooperative may assist with their own decontamination. Remove and double-bag contaminated clothing and personal belongings.

Flush exposed or irritated skin and hair with plain water for 3 to 5 minutes. For oily or otherwise adherent chemicals, use mild soap on the skin and hair.

Flush exposed or irritated eyes with plain water or saline for at least 5 minutes. Remove contact lenses if present and easily removable without additional trauma to the eye. If a corrosive material is suspected or if

pain or injury is evident, continue irrigation while transferring the victim to the Support Zone, for further treatment or to be transported to a hospital.

In cases of ingestion, do not induce emesis. Victims who are conscious and able to swallow should be given 4 to 8 ounces of water. Obtain medical care immediately.

**In the Support Zone**, be certain that victims have been decontaminated properly (see Decontamination Zone above). Victims who have undergone decontamination or who have been exposed only to gas or vapor and who have no evidence of skin or eye irritation generally pose no serious risks of secondary contamination. In such cases, Support Zone personnel require no specialized protective gear.

Quickly ensure a patent airway. If trauma is suspected, maintain cervical immobilization manually and apply a cervical collar and a backboard when feasible. Ensure adequate respiration; administer supplemental oxygen as required. Ensure a palpable pulse. Establish intravenous access if necessary. Attach a cardiac monitor.

Intubate the trachea in cases of respiratory compromise. When the patient's condition precludes endotracheal intubation, perform cricothyroidotomy if equipped and trained to do so.

Treat patients who have bronchospasm with aerosolized bronchodilators. Use these and all catecholamines with caution because of the enhanced risk of cardiac dysrhythmias after exposure to certain chemicals. Patients who are comatose, hypotensive, or have seizures or cardiac dysrhythmias should be treated according to advanced life support (ALS) protocols.

Facilitate transport to a medical facility. Report to the base station and the receiving medical facility the condition of the patient, treatment given, and estimated time of arrival at the medical facility.

If a chemical has been ingested, prepare the ambulance in case the victim vomits toxic material. Have ready several towels and open plastic bags to quickly clean up and isolate vomitus.

In an ideal situation the **decontamination** process would occur in the field, near the site of exposure, prior to reaching the hospital. According to *OSHA Best Practices for Hospital-Based First Receivers of Victims* (2005), worst-case scenarios take into account challenges associated with communication, resources, and victims. During mass casualty emergencies, hospitals can anticipate little or no warning before victims begin arriving. Additionally, first receivers can anticipate that information regarding the hazardous agent(s) would not be available immediately. Hospitals also can anticipate a large number of self-referred victims (as many as 80 percent of the total number of victims) and assume victims will not have been decontaminated prior to arriving at the hospital (OSHA, 2005).

Healthcare workers risk occupational exposures to chemical, biological, or radiological materials when a hospital receives contaminated patients, particularly during mass casualty incidents. These hospital employees, who may be termed first receivers, work at a site remote from the location where the hazardous substance release occurred. This means that their exposures are limited to the substances transported to the hospital on victims' skin, hair, clothing, or personal effects. The location and limited source of contaminant distinguishes first receivers from other first responders (e.g., firefighters, law enforcement, and EMS personnel), who typically respond to the incident site (i.e., the Release Zone) (OSHA, 2005).

OSHA guidelines (2005) suggest that hospitals identify:

- Decontamination Zone which includes any areas where the type and quantity of hazardous substance is unknown and where contaminated victims, contaminated equipment, or contaminated waste may be present. Employees in this zone might have exposure to contaminated victims, their belongings, equipment, or waste. This zone includes, but is not limited to, places where initial triage and/or medical stabilization of possibly contaminated victims occur, pre-decontamination waiting (staging) areas for

victims, the actual decontamination area, and the post-decontamination victim inspection area. This area will typically end at the ED door.

- Post-Decontamination Zone is an area considered uncontaminated. Equipment and personnel are not expected to become contaminated in this area. At a hospital receiving contaminated victims, the Hospital Post-decontamination Zone includes the ED (unless contaminated).

Other agencies such as the Agency for Toxic Substances and Disease Registry (ATSDR) (2001) further divide these zones into more specific functional areas, such as triage, decontamination, and critical care areas, for example.

OSHA (2005) guidelines cover protection for first receivers during releases of chemicals, radiological particles, and biological agents (overt releases) that produce victims who may need decontamination prior to administration of medical care. Although intended for mass casualty incidents as they affect emergency department personnel at fixed hospitals, the basic principles and concepts of this guidance also apply to mobile casualty care facilities and temporary shelters, such as would be necessary in the event of a catastrophic incident involving tens or hundreds of thousands of victims.

Healthcare providers are again reminded to identify and read the emergency plans at their own healthcare organizations.

#### *Healthcare Providers Must Know How to Protect Themselves*

Given that the specific chemical agent will likely be unknown, and it is likely that many of the patients coming for treatment will not have been decontaminated, it is critical that healthcare providers know how to protect themselves from exposure to any chemical agent. Indeed, the fundamental difference between any hazardous materials incident and other emergencies is the potential for acute risk from contamination to both patient and responder (ATSDR, 2001).

No single combination of protective equipment (PPE) and clothing is capable of protecting against all hazards. Thus, PPE should be used in conjunction with other protective methods. The use of PPE can itself create significant worker hazards, such as heat stress, physical and psychological stress, and impaired vision, mobility, and communication. Responders in PPE can also be frightening to patients, particularly pediatric patients. In general, the greater the level of PPE protection, the greater are the associated risks. For any given situation, equipment and clothing should be selected that provide an adequate level of protection. Excessive protection can be as hazardous as under-protection, and should be avoided. In addition, personnel should not be expected to use PPE without adequate training (ATSDR, 2001).

Healthcare providers who are also first receivers typically include clinical staff and other hospital staff who have a role in receiving and treating contaminated victims (e.g., triage, decontamination, medical treatment, and security) and those whose roles support these functions (e.g., set up and patient tracking) (OSHA, 2005). Since the specific agent is not likely to be known, the optimal specific protections needed, will not be known. However, PPE that hospitals could use to effectively protect first receivers assisting victims contaminated with unknown substances, according to OSHA (2005) are:

- Powered air-purifying respirator (PAPR) with an assigned protection factor of 1,000;
- Chemical-resistant protective garment;
- Head covering if it is not already included in the respirator;
- Double layer of protective gloves, and
- Chemical-protective boots.

As part of OSHA's required hazard assessment process, each hospital also must consider the specific hazards first receivers might reasonably be expected to encounter. The hospital must then augment OSHA's PPE selection when necessary to provide adequate protection against those specific identified hazards (OSHA, 2005).

For additional information about PPE for specific chemical attacks, go to [http://www.osha.gov/dts/osta/bestpractices/firstreceivers\\_hospital.pdf](http://www.osha.gov/dts/osta/bestpractices/firstreceivers_hospital.pdf).

### *Routes of Exposure and Accompanying Symptoms*

The most likely routes of exposure--inhalation, direct contact with the skin or eyes, and ingestion-are described. For each route of exposure, the risk of injury depends on the toxicity of the chemical involved, the concentration of the material, and the duration of contact (ATSDR, 2001).

**Inhalation** is the most common route of exposure to gases and vapors. Liquids and solids may also be inhaled when they are finely divided mists, aerosols, fumes, or dusts. Highly water soluble gases and vapors and larger mist or dust particles (greater than 10 microns in diameter) generally are deposited in the upper airways. Less soluble gases and vapors and smaller particles can be inhaled more deeply into the respiratory tract. Usually, highly water-soluble materials rapidly produce symptoms of upper airway irritation, whereas less soluble materials may produce delayed symptoms in the lower airways. Inhaled substances may be absorbed into systemic circulation, causing toxicity to various organ systems. When available, information is provided on odor threshold, warning properties, and symptoms to be expected at specific exposure levels (ATSDR, 2001).

**Skin and eye contact** can occur by exposure to solids, liquids, or gases. Corrosive agents cause direct damage to tissues by various mechanisms including low or high pH, chemical reaction with surface tissue, removal of normal skin fats (defatting), or removal of moisture (desiccant effect). Some chemicals absorbed through the skin and eyes can produce systemic toxicity. Absorption, and therefore toxicity, is more likely to occur when the normal skin barrier is disrupted (e.g., chemical burn, cut, or abrasion) or when the chemical is highly fat-soluble (e.g., organophosphate and organochlorine pesticides) (ATSDR, 2001).

**Ingestion** is not a common route of exposure in most hazardous materials (HAZMAT) incidents, although it is common in suicide attempts. Ingestion of corrosive agents can cause severe burns to the mouth, throat, esophagus, and stomach. Ingested chemicals may also be aspirated into the lungs, especially after vomiting, causing chemical pneumonitis. Ingested chemicals may react with stomach acid, creating products that are toxic to the patient, and potentially, the healthcare provider (e.g., hydrogen cyanide from ingested cyanide salts) (ATSDR, 2001).

### *Decontamination*

While the specifics of treatment for each of the chemical substances differ, there are commonalities to any chemical attack. One of the most effective interventions is prompt **decontamination** from the chemicals. Decontamination of the victim occurs for two primary reasons (CDC, 2006f):

- To prevent the chemical from being further absorbed by the victim's body or from spreading on the victim's body, and
- To prevent the chemical from spreading to other people, including medical personnel, who must handle or who might come in contact with the person who is contaminated with the chemical.

Most chemical agents can penetrate clothing and are absorbed rapidly through the skin. **Therefore, the most important and most effective decontamination for any chemical exposure is decontamination done within the first minute or two after exposure** (CDC, 2006f). Removal of outer clothing can eliminate much of the contamination. Flushing the skin, eyes and mucous membranes with water can eliminate a great deal of the contamination of victims of the attack (CDC, 2006f).

Decontamination is the process of removing, diluting, or neutralizing harmful materials that have gathered on patients, personnel and/or equipment during the response to a chemical incident. Many incidents have occurred involving seemingly successful rescue, transport, and treatment of chemically contaminated individuals by unsuspecting emergency personnel who, in the process, contaminate themselves, the equipment, and the facilities to which they bring the victim (ATSDR, 2001).

Decontamination is extremely important because it:

- Protects all hospital personnel by sharply limiting the transfer of hazardous materials from the contaminated area into clean zones.
- Protects the community by preventing transportation of hazardous materials from the hospital to other sites in the community by secondary contamination.
- Protects workers by reducing the contamination and resultant permeation of, or degradation to, their protective clothing and equipment.
- Protects other patients already receiving care at the hospital.

**Primary contamination** refers to direct contact of the victim with the hazardous material. Methods of decontamination for patients who have primary contamination will be addressed in the Patient Management section, later in this course.

**Secondary contamination** refers to the transfer of material from the victim to other patients, personnel or equipment. The potential for secondary contamination has implications for decontamination and triage of victims and for the protection of rescue and healthcare personnel. Immediate victim decontamination is recommended for materials that pose risks of secondary contamination; this eliminates both the potential for rescuer contamination and further exposure to the victim.

A substance poses a risk of secondary contamination if it is both toxic and likely to be carried on the clothing, skin, or hair of victims in sufficient quantities to threaten other personnel. Substances that present the most serious risks of secondary contamination include the following (ATSDR, 2001):

- Highly toxic liquids and solids or finely divided solids (e.g., organophosphate pesticides).
- Radioactive liquids and dusts.
- Certain biologic agents (e.g., harmful viruses or bacteria).

Every effort must be made to decontaminate contaminated victims before they are transported to a medical care facility.

Examples of substances with little or no risk of secondary contamination include the following (ATSDR, 2001):

- Gases (e.g., carbon monoxide, amine)
- Vapors (unless they condense to a liquid state on clothing or skin)
- Substances with no serious toxicity or skin absorption (e.g., propylene glycol, motor oil).

Secondary contamination also may be a risk in cases of ingestion. Ingested materials may react with stomach acid to produce noxious gases, which can pose risks to both the victim and rescuers. Vomitus may off-gas the hazardous material or a reaction product. Toxic vomitus should be quickly isolated in closed containers (ATSDR, 2001).

Avoiding contact is the easiest method of decontamination that is, not to get the material on the worker or his protective equipment in the first place. However, if contamination is unavoidable, then proper decontamination or disposal of the worker's outer gear will be necessary. Segregation and proper disposal of the outer gear in a polyethylene bag or steel drum will be necessary until thorough decontamination is completed. With extremely hazardous materials, it may be necessary to dispose of equipment as well (ATSDR, 2001).

Physical decontamination of protective clothing and equipment can be achieved by several different means. These all include the systematic removal of contaminants by washing, usually with soap and water, and then rinsing. In rare cases, the use of solvents may be necessary. There is a trend toward using disposable clothing (e.g., suits, boots, gloves) and systematically removing these garments in a manner that precludes contact with the contaminant. The appropriate decontamination procedure will depend on the contaminant and its

physical properties. Thoroughly researching the chemicals involved and their properties, or consultation with an expert, is necessary to make these kinds of decisions (ATSDR, 2001).

#### *Patient Management: Decontamination and Treatment*

Ideally, decontamination is performed in the field, at the site of the chemical release and before treatment is started. However, once the patient comes to the hospital, contaminated patients and equipment must remain separate from the treatment areas, whenever possible. However, basic airway, breathing, and circulation must be addressed in victims who have life-threatening symptoms, regardless of where they happen to be, including in the Contamination or Hot Zone. As stated in the previous section, patients heavily contaminated with highly toxic organophosphate insecticides pose great risks of secondary contamination to healthcare personnel; patients should not be touched until staff is appropriately gloved and gowned. Persons soaked with flammable materials cannot be treated until decontamination has been carried out because of risk of fire and explosion. If treatment must be started prior to decontamination, then whenever possible, simultaneous treatment and decontamination of patients should be carried out (ATSDR, 2001).

Contaminated victims received in indoor facilities create potentially serious risks of secondary contamination to hospital personnel, especially if materials are volatile. Basic decontamination is safely and practically performed outside in a naturally ventilated area adjacent to the ambulance entrance. The ATSDR identifies 2 specific areas for patient management: Decontamination and Critical Care.

Patients who are able and cooperative may assist with their own **decontamination**. Remove and double-bag contaminated clothing and personal belongings.

Avoid removing clothing over the patient's head. It may be necessary to cut clothing off the patient, or at the least, disturb as little of the fabric while removing the clothing so as not to further release any chemical or vapors. For easier retrieval, consider bagging the victim's jewelry and other valuables separately from clothing. Nonporous materials such as metal jewelry may be easy to decontaminate by washing, whereas clothing or shoes may require disposal. Leather items can be especially difficult to decontaminate and may need to be incinerated.

Flush exposed or irritated skin and hair with plain water for 3 to 5 minutes. For oily or otherwise adherent chemicals, use mild soap on the skin and hair. Rinse thoroughly with water.

Flush exposed or irritated eyes with plain water or saline for at least 5 minutes. Remove contact lenses if present and easily removable without additional trauma to the eye. If a corrosive material is suspected or if pain or injury is evident, continue irrigation while transferring the patient to the Critical Care Area.

Some chemicals react violently with water, liberating toxic gases or creating explosions. Cautions about water reactivity generally do not apply when decontaminating victims with water. Adding large amounts of water to the small amount of residual chemical on the victim's body poses little risk of creating a serious reaction hazard. In fact, the naturally occurring moisture on the skin will react with the chemical; hastening removal of the chemical from the skin is preferable to leaving it to potentially cause further injury.

Solid contaminants should be gently brushed from hair, skin, and clothing. During brushing, protect the victim's eyes. The length of time for flushing exposed skin or eyes with water will vary with the chemical and the circumstances of exposure. Chemicals that cause only mild skin or eye irritation can be flushed for 3 to 5 minutes. Concentrated or strongly alkaline materials may require 10 to 15 minutes. Eye decontamination may be continued while the patient is transferred to the Critical Care Area. An attempt should be made to remove contact lenses. Avoid forceful removal that may inflict injury. Difficulty in removing contact lenses should not delay irrigation or transfer to the Critical Care Area (ATSDR, 2001).

Removal of oily or insoluble materials from the skin and hair requires washing with soap or shampoo. Any liquid hand- or dishwashing soap is satisfactory. Use only soft-bristled brushes; abrasive brushing may

enhance skin injury and penetration. Bleach, vinegar, or solutions used for decontaminating equipment should not be used for washing skin, hair, or eyes. Neutralizing agents should not be used because the heat of the neutralization may cause added injury. Flooding volumes of water are preferable (ATSDR, 2001).

In cases of ingestion, do not induce emesis. Administer 4 to 8 ounces of water to dilute stomach contents if the patient is conscious and able to swallow. Immediately transfer the patient to the Critical Care Area (ATSDR, 2001).

Emesis is not generally recommended in the protocols. Vomiting is relatively ineffective in emptying the stomach after a chemical ingestion and may be harmful to the victim. Vomiting may increase the risk of pulmonary aspiration or damage to the esophagus and stomach if irritating or corrosive chemicals have been ingested. Activated charcoal adsorbs many chemicals and is relatively easy to administer. For most chemical ingestions, a slurry of 50 to 60 grams of activated charcoal should be administered to an adult patient who is awake and has a gag reflex. If a corrosive chemical has been ingested, do not administer activated charcoal because it may obscure the view when endoscopy is performed (ATSDR, 2001).

Chemical contamination is not a reason to NOT treat patients with life-threatening injury. Even if the patient has NOT been decontaminated, if the patient is unresponsive, evaluate and support airway, breathing, and circulation. Intubate the trachea in cases of respiratory compromise. If the patient's condition precludes intubation, surgically create an airway. Treat patients who have bronchospasm with aerosolized bronchodilators; use these and all catecholamines with caution because of the potential enhanced risk of cardiac dysrhythmias.

Patients who are comatose, hypotensive, or have seizures or ventricular dysrhythmias should be treated in the conventional manner.

If appropriate decontamination efforts have been completed before entry to the Critical Care Area, special precautions, such as covering floors and walls with plastic or shutting off the ventilation system, are not needed. However, if the patient has ingested a chemical, prepare to isolate toxic vomitus quickly. ED personnel in the Critical Care Area generally do not need specialized protective gear. However, if risk of residual skin contamination exists (e.g., potent chemicals, such as some organophosphate pesticides, or radioactive dust), water-resistant gowns or aprons, latex gloves, and eye-splash protection should be used (ATSDR, 2001).

In the Critical Care Area, the focus is on treatment of the patient, particularly on the specific areas of exposure and any injuries present. Generally, treatment consists of supportive measures.

For **inhalation exposures**, administer supplemental oxygen by mask. Treat patients who have bronchospasm with aerosolized bronchodilators; use these and all catecholamines with caution because of the potential or possible enhanced risk of cardiac dysrhythmias. Bronchodilators may provoke ventricular dysrhythmias in some patients who have been exposed to aromatic or halogenated hydrocarbons.

Although pulse oximetry is a convenient way to continuously monitor oxygenation in patients, it is unreliable or falsely normal in patients who have dyshemoglobinemias (e.g., methemoglobinemia or carboxyhemoglobinemia) because it measures only oxygen dissolved in the blood and not the status of tissue oxygenation. In patients who have altered hemoglobins, the pulse oximeter does not reflect the impaired oxygen carrying or delivery capacity of the red cells. In these situations, a Co-Oximeter should be used to measure specific levels of hemoglobins unable to transport oxygen. Chemically induced pulmonary edema is due to leaky pulmonary alveoli, not left ventricular failure as is cardiogenic pulmonary edema. Patients who have chemically induced pulmonary edema do not benefit from digoxin, morphine, afterload reduction, or diuretics. Supplementary oxygen, delivered by mechanical ventilation and positive end-expiratory pressure, if needed, are standard treatments for chemically induced (noncardiogenic) pulmonary edema.

Corticosteroids and antibiotics have been commonly recommended for treatment of chemical pneumonitis, but their effectiveness has not been substantiated. Soluble irritants (e.g., ammonia or hydrogen chloride) rapidly produce respiratory effects; poorly soluble irritants (e.g., phosgene and some nitrogen oxides) produce slow onset of airway irritation and respiratory distress. Poorly soluble agents are commonly associated with delayed (12 to 72 hours) onset pulmonary edema. The time period for developing pulmonary edema varies with the chemical and is noted in each individual protocol. Watch for signs of respiratory distress and intubate if necessary.

Many chemicals can cause progressive airway injury or systemic illness with delayed onset. Watch for signs of laryngeal edema and respiratory system compromise, such as progressive hoarseness, stridor, hypoventilation, or cyanosis.

For **skin exposures**, if concentrated chlorine gas or chlorine-generating solutions contact the skin, chemical burns may occur; treat as thermal burns. The extent and depth of injury in a chemical burn is often not immediately apparent; hence the severity of the burn is frequently underestimated. Loss of circulating fluid may occur. In addition, dermal absorption of a corrosive chemical may contribute to systemic toxicity. If the liquefied compressed gas is released and contacts the skin, frostbite may result. If a victim has frostbite, treat by rewarming affected areas in a water bath at a temperature of 102 to 108°F (40 to 42°C) for 20 to 30 minutes and continue until a flush has returned to the affected area.

Because of their larger surface area: body weight ratio, children are more vulnerable to toxicants absorbed through the skin.

Patients who have been exposed to highly corrosive, penetrating, oily, or persistent chemicals may require additional or continuous decontamination. Residues may remain in the armpits, groin, buttocks, hair, ears, nostrils, and under the fingernails and toenails. If the material is highly contaminating (e.g., organophosphate pesticides or radioactive dust), care givers should wear gowns and gloves to protect themselves. Use liquid soap for cleansing the skin and hair. Special decontaminating agents are recommended for only a few chemicals (see specific protocols later in this section of the course).

For **eye exposures**, ensure that adequate eye irrigation has been completed. Test visual acuity. Examine the eyes for corneal damage using a magnifying device or a slit lamp and fluorescein stain. For small corneal defects, use ophthalmic ointment or drops, analgesic medication, and an eye patch. Immediately consult an ophthalmologist for patients who have severe corneal injuries.

Ensure that contact lenses have been removed, that no visible residual material is in the conjunctival sac, and that the pH of the conjunctival fluid is normal. Irrigation is easily continued in a hospital setting using intravenous tubing to provide a steady, low-pressure stream of water or saline. A Morgan Lenscan also be placed to provide continuous, thorough eye decontamination. Do not use neutralizing or other decontaminating solutions. A corneal burn or abrasion can easily be seen with the aid of fluorescein stain, a UV light source, and a magnifier or slit lamp. The disrupted corneal surface allows accumulation of the fluorescein, which fluoresces under UV light. If serious injury is evident (e.g., extensive corneal fluorescein accumulation, cloudy or bloody material in the anterior chamber, or obvious perforation of the globe), an ophthalmologist should be consulted immediately.

For **ingestion exposures**, do not induce emesis. If the patient is alert and charcoal has not been given previously, administer a slurry of activated charcoal. If a corrosive material is suspected, administer 4 to 8 ounces of water do not give a slurry of activated charcoal.

Consider endoscopy to evaluate the extent of gastrointestinal-tract injury. Consider the possibility of exposure to multiple chemicals as well as multiple-system injuries. For example, smoke inhalation can cause airway injury because of heat and irritant chemicals and coma from asphyxiants such as carbon monoxide and cyanide. Consider possible opioid overdose and evaluate for hypoglycemia; administer naloxone (Narcan) and dextrose according to established protocols. Treat patients who have seizures with conventional

anticonvulsants (e.g., diazepam, phenytoin, or phenobarbital). Consider the possibility that coma or seizures may be from a head injury or from alcohol or other drug intoxication, rather than from hazardous material exposure. Anticipate endotracheal intubation if the patient's level of consciousness deteriorates or his/her Glasgow Coma Score is less than 12. Place an intravenous line in all patients who are unconscious, obtunded, hypotensive, or may become so. Patients exposed to substances that may cause cardiac sensitization or intravascular hemolysis will also require intravenous access. An initial bolus of an appropriate intravenous solution should be given as clinically indicated. The fluid should be titrated to maintain a urine output of 1-2 cc/kg/hour and systolic blood pressure greater than 90 mm/Hg. Care must be taken not to overhydrate the patient. Treat patients who have hypotension using rapid infusions of normal saline (250 mL to 1 L in adults). Use dopamine or other inotropic drugs for persistent hypotension. Hypotension may be complicated by hypothermia or hyperthermia. Initial and ongoing evaluation of core body temperature may be indicated. Hypothermia should be considered if the victim was stripped and decontaminated with cold water or in a cold ambient setting. Hyperthermia may result from certain systemic poisons (e.g., dinitrophenol).

Routine **laboratory studies** for all exposed patients include CBC, glucose, and electrolyte determinations. Additional studies for patients exposed to an unidentified chemical include ECG monitoring, renal function tests, and liver-function tests. Chest radiography and pulse oximetry/CO-oximetry (or ABG measurements) are recommended for severe inhalation exposure. Additional, specific recommendations are listed in the laboratory tests section to aid both diagnosis and treatment.

Laboratory test results are often within normal range immediately after an exposure but may become abnormal after a delay of several hours or even days, depending on the specific chemical exposure. For example, for some inhaled toxins, chest radiography may not show signs of pulmonary edema until 12 to 24 hours post-exposure or signs of liver injury may not appear for 2 to 3 days following exposure. Pulse oximetry may provide falsely normal, unreliable, or misleading results in patients with abnormal hemoglobin states (e.g., methemoglobinemia or carboxyhemoglobinemia). Tests to measure a specific chemical contaminant in biologic samples are rarely available on an emergency basis. The turnaround time may be several hours to days or even weeks (if at all possible); hence, these tests rarely are clinically useful. However, the results of these tests may aid in confirming or documenting exposure. A regional poison control can assist with the selection and interpretation of specialized laboratory tests.

Patient disposition should be determined based on the symptoms, the intrinsic toxicity of the chemical, and course of illness. The usual duration of observation in an emergency department is 6 to 8 hours. Some patients may be safely discharged from the emergency department while others will require prolonged observation or intensive care.

Consider hospitalization if:

- The chemical agent is known to produce delayed onset illness or is unidentified, the asymptomatic patient should be admitted for observation.
- Patients who have a suspected serious exposure and persistent or progressive symptoms.
- When the chemical has not been identified, the patient should be observed for an extended period or admitted to the hospital.

Asymptomatic patients who have minimal exposure, normal initial examinations, and no signs of toxicity after an appropriate amount of observation may be discharged with instructions to seek medical care promptly if symptoms develop.

Do not release clothing or personal items to the patient before a determination of residual contamination is made. Most items can be reused after washing. However, some contaminated articles cannot be rendered safe for reuse (e.g., leather goods, such as shoes, that are contaminated with methyl bromide or organophosphate pesticides). Some articles will require disposal at a hazardous waste site or by incineration. Consult a HAZMAT specialist affiliated with the local fire department or the ATSDR/CDC Emergency Response 24-hour Hotline ([404] 639-0615) for advice on the disposition of contaminated personal effects.

The release of chemical weapons is a public health crisis of great magnitude. If it has not already occurred, ensure that the local and state health department has been notified. Contact the **Nevada State Department of Emergency Management 24 hours per day at 775-687-0400; or CDC at 770.488.7100.**

#### *Additional Interventions for a Chemical Attack*

Depending on the nature and location of the chemical release, emergency personnel, public health officials, other government officials and elected leaders will determine the course of action for the population to take. In addition to decontamination and medical intervention, other possible actions may be necessary, such as sheltering in place or evacuation.

**Sheltering in place** means to make a shelter where you are, whether that is at home, school, work or elsewhere. It is a way to make the building as safe as possible to protect oneself and others until help arrives. Sheltering in a vehicle should not be a first choice; vehicles are not airtight enough to give adequate protection from chemicals (CDC, 2006d).

If at home, choose a room in for the shelter. The room should have as few windows and doors as possible. A large room with a water supply is best-something like a master bedroom that is connected to a bathroom. **For most chemical events, this room should be as high in the structure as possible to avoid vapors (gases) that sink.** This guideline is different from the sheltering-in-place technique used in tornadoes and other severe weather and for nuclear or radiological events, when the shelter should be low in the home. If one is not at home, then choose a room as above, regardless of the location (CDC, 2006d).

Act quickly and follow the instructions of local public safety personnel such as law enforcement, EMS, fire, or local emergency management officials. Every situation can be different, so local emergency management coordinators might have special instructions for you to follow. In general, do the following (CDC, 2006d):

- Go inside as quickly as possible. Bring any outdoor pets indoors.
- If there is time, shut and lock all outside doors and windows. Locking them may pull the door or window tighter and make a better seal against the chemical. Turn off the air conditioner or heater. Turn off all fans, too. Close the fireplace damper and any other place that air can come in from outside.
- Go in the shelter-in-place room and shut the door.
- Turn on the radio. Keep a telephone close at hand, but don't use it unless there is a serious emergency.
- Sink and toilet drain traps should have water in them (you can use the sink and toilet as you normally would). If it is necessary to drink water, drink stored water, not water from the tap.
- Tape plastic over any windows in the room. Use duct tape around the windows and doors and make an unbroken seal. Use the tape over any vents into the room and seal any electrical outlets or other openings.
- If you are away from your shelter-in-place location when a chemical event occurs, follow the instructions of emergency coordinators to find the nearest shelter. If your children are at school, they will be sheltered there. Unless you are instructed to do so, do not try to get to the school to bring your children home. Transporting them from the school will put them, and you, at increased risk.
- Listen to the radio for an announcement indicating that it is safe to leave the shelter.
- When leaving the shelter, follow instructions from local emergency coordinators to avoid any contaminants outside.

In the event that an **evacuation** is necessary, direction will be provided by the emergency personnel. Act quickly and follow the instructions of local public safety personnel such as law enforcement personnel, EMS, fire, departments, or local emergency management officials. Every situation can be different, so local emergency management coordinators could give you special instructions to follow for a particular situation (CDC, 2006c).

Some chemical attacks might make evacuation dangerous because of the length of time it may take to evacuate, the prevailing winds and chemical "plume" formation and its direction, etc. Evacuating may put people in harm's way. In such a case it may be safer to stay indoors than to go outside (CDC, 2006d).

#### *Specific Chemical Agents and Their Treatment*

The state of knowledge regarding the treatment of patients potentially exposed to hazardous substances, either through intentional or accidental release in the environment, is constantly evolving and is often uncertain. The Agency for Toxic Substances and Disease Registry (ATSDR) developed guidelines for the management and treatment of chemical exposures in their updated 2011 *Managing Hazardous Materials Incidents: Medical Management Guidelines for Acute Chemical Exposures*, part III of the guidelines. The information provided in the chemical protocols is an attempt to offer an accurate and practical approach to the management of hazardous materials emergencies. According to ATSDR, the user of the protocols should be aware that large data gaps exist in the scientific literature (ATSDR, 2011).

Exposure to hazardous chemicals may produce a wide range of adverse health effects. The likelihood of an adverse health effect occurring, and the severity of the effect, is dependent on (ATSDR, 2011):

- The toxicity of the chemical;
- The route of exposure;
- The nature and extent of exposure; and
- Factors that affect the susceptibility of the exposed person, such as age and the presence of certain chronic diseases.

Various chemical agents could be used as covert weapons, and the actual clinical syndrome will vary depending on the type of agent, the amount and concentration of the chemical, and the route of the exposure. However, certain clinical presentations might be more common with a covert chemical release. Certain syndromes are associated with groups of chemical agents with similar toxic properties that have been used previously, have high toxicity, or are easily available (CDC, 2003d). Table 4 describes the clinical presentation and the potential causes of a variety of symptoms.

<b>Table 4. Selected* Clinical Presentations and Potential Etiologies (CDC, 2003d)</b>		
<b>Category</b>	<b>Clinical Presentation</b>	<b>Potential Etiology</b>
<b>Cholinergic crisis</b>	Salivation, diarrhea, lacrimation, bronchorrhea, diaphoresis, urination.  Miosis, fasciculations, weakness, bradycardia, tachycardia, hypertension, hypotension, altered mental status, seizures.	Nicotine†; organophosphate insecticides† (decreased acetylcholinesterase activity); carbamate insecticides; medical carbamates (physostigmine).
<b>Generalized Muscle Rigidity</b>	Seizure-like, generalized muscle contractions or painful spasms (neck or limbs), usually tachycardia and hypertension.	Strychnine (intact sensorium)
<b>Oropharyngeal pain and ulcerations</b>	Lip, mouth and pharyngeal ulcerations and burning pain.	Paraquat (dyspnea, hemoptysis secondary to pulmonary edema or hemorrhage; can progress to pulmonary fibrosis over days to weeks);

		<p>Diquat;</p> <p>Caustics (acids and alkylines);</p> <p>Inorganic, mercuric salts;</p> <p>Mustards (sulfer).</p>
<b>Cellular hypoxia</b>	<p>Mild: Nausea, vomiting, headache;</p> <p>Severe: Altered mental status, dyspnea, hypotension, seizures, metabolic acidosis</p>	<p>Cyanide † (hydrogen cyanide gas or sodium cyanide) - bitter almond odor ±;</p> <p>Sodium monofluoroacetate (SMFA) † (hypocalcemia or hypokalemia);</p> <p>Carbon monoxide;</p> <p>Hydrogen sulfide;</p> <p>Sodium azide;</p> <p>Methemoglobin-causing agents.</p>
<b>Peripheral neuropathy and neurocognitive effects</b>	<p>Peripheral neuropathy signs and symptoms; muscle weakness and atrophy; "glove and stocking" sensory loss; depressed or absent deep-tendon reflexes.</p> <p>Neurocognitive effects: memory loss, delirium, ataxia, encephalopathy.</p>	<p>Mercury (organic) † (visual disturbances, parasthesias, ataxia);</p> <p>Arsenic (inorganic) † (delirium or peripheral neuropathy);</p> <p>Thallium (delirium or peripheral neuropathy);</p> <p>Lead (encephalopathy);</p> <p>Acrylamide (encephalopathy or peripheral neuropathy).</p>
<b>Severe gastrointestinal illness, dehydration</b>	<p>Abdominal pain, vomiting, profuse diarrhea (possibly bloody); hypotension possibly followed by multisystem organ failure.</p>	<p>Arsenic †;</p> <p>Ricin † (inhalation additional route of exposure, severe respiratory illness possible);</p> <p>Colchicine;</p> <p>Barium (hypkalemia common).</p>
<p>* Not intended as a complete differential diagnosis for each syndrome or a complete list of chemicals that may be used in an attack.  † Potential agents for a covert chemical release based on historic use, high toxicity and ease of use.  ± Unreliable sign.</p>		

Chemicals that may be used as weapons of terrorism comprise a long list. These agents are categorized as (ATSDR, 2001):

- Biotoxins
- Blister Agents/Vesicants
- Blood Agents
- Caustics (Acids)
- Choking/Lung/Pulmonary Agents
- Incapacitating Agents
- Long-Acting Anticoagulants
- Metals
- Nerve Agents
- Organic Solvents
- Riot Control Agents/Tear Gas
- Toxic Alcohols
- Vomiting Agents

Within each category of agent, there are multiple specific agents. Because of the quantity of agents that could be used, it is impossible to cover them all in such a course. For more detailed information about the many possible chemical agents that could be used in a chemical attack, the learner is directed to the Agency for Toxic Substances & Disease Registry at <http://www.atsdr.cdc.gov/MMG/index.asp>.

*Medical Management Guidelines exist for the following chemicals (ATSDR, 2001).* The learner is directed to the above website for specific information on exposures to the following chemicals:

- Acrolein
- Acrylonitrile
- Ammonia
- Aniline
- Arsenic Trioxide
- 1,3-Butadiene
- Benzene
- Blister Agent (Sulfur Mustard Agents [H, HD], Sulfur Mustard Agent [HT])
- Blister Agent (HN, 1HN, 2HN, 3HN) Nitrogen Mustards
- Blister Agent (Lewisite [L], Mustard-Lewisite Mixture [HL])
- Bromomethane
- Calcium Hypochlorite/Sodium Hypochlorite
- Carbon Disulfide
- Chlordane
- Chlorine
- Crotonaldehyde
- Cyanide
- 1,2-Dibromoethane
- Diborane
- Ethylene Dibromide
- Ethylene Glycol
- Ethylene Oxide
- Fluorine (hydrogen fluoride & fluorides)
- Formaldehyde
- Gasoline, Automotive
- Hydrogen Chloride
- Hydrogen Cyanide (HCN)
- Hydrogen Fluoride (HF)

- Hydrogen Peroxide
- Hydrogen Sulfide
- Malathion
- Mercury
- Methyl Isocyanate
- Methyl Mercaptan
- Methylene Chloride
- Nerve Agent (GA, GB, GD, VX)
- Nitrogen Oxides
- Parathion
- Phenol
- Phosgene Oxime
- Phosphine
- Selenium Hexafluoride
- Sodium Hydroxide
- Sulfur Dioxide
- 1,1,1-Trichloroethane
- Tetrachloroethylene (PERC)
- Toluene
- Toluene Diisocyanate
- Trichloroethylene (CE)
- Unidentified Chemical
- Vinyl Chloride
- Xylenes

### Conclusion, Chemical Weapons

Initially the specific chemical agent used during a chemical attack will likely be unknown. There exists a vast number of potential chemicals which could be used as weapons, making being knowledgeable about each of them highly improbable. Such a situation requires healthcare workers should focus on personal protective equipment and decontamination. Treatment protocols can be utilized once the specific agent is identified. Since the specific agent may not be known immediately, healthcare workers will need to protect themselves while following the emergency plans of the healthcare organizations in which they work.

Healthcare providers must engage in thorough safety planning that coordinates the emergency plans of the workplace with the plans at home and with those that other family members may be involved in. Knowing your loved ones are safe during such an emergency can allow healthcare providers to focus on their own safety and the safety of their patients.

### **Radiological Terrorism**

Radiological terrorism is particularly frightening because of its potential for massive destruction, its impact on both short and long term health effects and its lasting genetic impact.

Radiological threats can come from a variety of sources (CDC, 2003f):

- **Radiation Dispersal Device.** This could be a conventional explosion that scattered radioactive material such as a dirty bomb, if a truck carrying radioactive materials were exploded, or an aerosol containing the radioactive material were to be spread over a large area. In such a situation, there may be hundreds of injured people with many hundreds contaminated or exposed. Generally, the radiation levels are not sufficient to cause acute radiation sickness, however there would be immediate psychological effects and risk of long-term health effects.

- **Major event at or near a nuclear facility.** This could occur if an airplane crashed into a nuclear power plant or spent nuclear fuel pool. Most recently this occurred following the earthquake and subsequent tsunami of March 15, 2011 in Japan. Significant amounts of radioactive materials would be released. Injuries are in the dozens, many experiencing symptoms related to acute radiation syndrome; there would be thousands of contaminated or exposed people in the surrounding area who would have a greater risk of long term health effects.
- **Nuclear Detonation.** The immediate physical devastation could appear similar to that of the World Trade Center following the events of September 11, 2001. However, the dust and debris from this event would be highly radioactive. There would be thousands of people both contaminated and injured at the scene. In addition, there would be thousands of people in a large area potentially extending many miles outward from the initial point of attack with serious radiation exposures, although they may have no obvious physical injury or contamination. Radioactive fallout with potential for long-term health effects would extend over a large region far from ground zero. There would likely be many persons experiencing symptoms related to acute radiation syndrome.

In 2010, the National Security Staff Interagency Policy Coordination Subcommittee for Preparedness and Response to Radiological and Nuclear Threats developed *Planning Guidance for Response to a Nuclear Detonation*. This document is available from <http://www.usuhs.mil/afri/outreach/pdf/planning-guidance2010.pdf> and provides detailed information aimed at response activities in an environment with a severely compromised infrastructure immediately after such an event (the first 24-72 hours), when federal resources are likely to be still being mobilized. The target audience for this document are emergency response planners, however, first responders, healthcare providers and others who would likely be called into service during such an event would benefit from this information. The learner is directed to that document for further information.

While emergency and law enforcement personnel conduct routine radiological monitoring, an emergency situation may not immediately be recognized as a radiological threat.

Just as with biological and chemical threats, planning has occurred for the possibility of radiological threats. The Nevada State Health Division in 2012, updated *The State of Nevada Radiological Emergency Response Plan*. The 24 hour emergency hotline for radiological emergencies in Nevada is 1 (877) GET RAD 1 (438-7231).

The Nevada State plan should be integrated into the emergency plans of each healthcare organization. Healthcare providers are urged to identify and follow the emergency response plans in their healthcare organizations. Such plans should be integrated into the healthcare provider's own personal and family emergency plans.

OSHA's 2005 *OSHA Best Practices for Hospital-Based First Receivers of Victims* (2005) provides guidelines for the protection for first receivers during releases of chemicals, radiological particles, and biological agents (overt releases) that produce victims who may need decontamination prior to administration of medical care. Although intended for mass casualty incidents as they affect emergency department personnel at fixed hospitals, the basic principles and concepts of this guidance also apply to mobile casualty care facilities and temporary shelters, such as would be necessary in the event of a catastrophic incident involving tens or hundreds of thousands of victims. These previous general guidelines covered in the Chemical Weapons section of this course, also apply to the Radiological threats.

**Radiation** cannot be detected by the human senses. A radiological survey conducted with specialized equipment is the only way to confirm the presence of radiation. If a terrorist event involves the use of radioactive material, both patient exposure and contamination must be assessed (CDC, 2006g).

**Exposure** occurs when a person is near a radiation source. People exposed to a source of radiation can suffer radiation illness if their dose is high enough, but they do not become radioactive. For example, an x-ray machine is a source of radiation exposure. A person does not become radioactive or pose a risk to others following a chest x-ray (CDC, 2006g).

Exposure to radiation can cause two kinds of health effects. **Deterministic effects** are observable health effects that occur soon after receipt of large doses. These may include hair loss, skin burns, nausea, or death. **Stochastic effects** are long-term effects, such as cancer. The radiation dose determines the severity of a deterministic effect and the probability of a stochastic effect. The object of any radiation control program is to prevent any deterministic effects and minimize the risk for stochastic effects. When a person inhales or ingests a radionuclide, the body will absorb different amounts of that radionuclide in different organs, so each organ will receive a different **organ dose** (CDC, 2003f).

A person can receive an **external dose** by standing near a gamma or high-energy beta-emitting source. A person can receive an **internal dose** by ingesting or inhaling radioactive material. The external exposure stops when the person leaves the area of the source. The internal exposure continues until the radioactive material is flushed from the body by natural processes or decays. A person who has ingested a radioactive material receives an internal dose to several different organs. The absorbed dose to each organ is different, and the sensitivity of each organ to radiation is different.

**Contamination** occurs externally when loose particles of radioactive material are deposited on surfaces, skin, or clothing. Internal contamination occurs when radioactive particles are inhaled, ingested, or lodged in an open wound (CDC, 2006g).

Contaminated patients should be decontaminated as soon as possible, without delaying critical care. Patients who have been exposed to radiation, but are not contaminated with radioactive material, do not need to be decontaminated.

**Internal contamination** should be considered if persistently high survey readings are noted following decontamination. Internal contamination generally does not cause early symptoms.

### Medical Management Principles

Addressing contamination issues should not delay treatment of life-threatening injuries. It is unlikely that the levels of radioactivity associated with a contaminated patient would pose a significant health risk to care providers. In certain rare instances, the presence of imbedded radioactive fragments or large amounts of external contamination may require expedited decontamination. In-house radiation professionals should be included in the response team.



The symbol above is called a tri-foil and it is the international symbol for radiation. The symbol can be magenta or black, on a yellow background. This sign is posted where radioactive materials are handled, or where radiation-producing equipment is used. This sign is used as a warning to protect people from being exposed to radioactivity.

Courtesy of US EPA.

### Staff Protection Guidelines

Knowing how to protect oneself from potential exposure and contamination is critical for healthcare providers. Know and follow your organization's emergency plans for radiological emergencies. However, some general guidelines pervade most plans.

Initially obtaining as much information as possible is proactive protection. Obtain as much patient and site information as feasible from first responders (CDC, 2003f).

The first step in protecting staff is to establish an assessment center removed from the emergency department to rapidly screen victims for injury and contamination and to provide for decontamination. Radiation control zones, where potential radioactive contamination exists, should be established within the hospital and the administration should ensure that there is someone in charge of access to/from the control zones, and that they have a law enforcement representative present (CDC, 2003f).

The assessment center should be used for observation, decontamination, limited treatment and evaluation and reuniting with family members where possible (CDC, 2003f).

Suggested personnel protection equipment that also facilitates the ease of clean-up includes (CDC, 2006g; CDC, 2003f):

- Follow standard guidelines for protection from microbiological contamination.
- Surgical masks should be adequate.
- N95 masks, if available, are recommended.
- Goggles, gowns, double-gloves with inner one taped and outer glove removed after each contact).
- Plastic wrap (e.g., disposable trash bags, Saran Wrap™, ZipLoc™ bags, etc.) to cover and protect instruments and equipment (CDC, 2003f).
- Disposable shoe coverings (CDC, 2003f).
- Butcher paper or equivalent on floor (CDC, 2003f).
- If possible, personal dosimeters for staff members who might have frequent contact with contaminated patients (CDC, 2003f).
- Survey hands and clothing at frequent intervals with a radiation meter.
- Due to fetal sensitivity to radiation, assign pregnant staff to other duties.

### ***Establish an Assessment Center/Ad Hoc Triage Area***

In most mass casualty incidents a large majority of people will self-triage and go directly to the closest and most familiar hospitals; they will probably bypass field triage and treatment whether contaminated or not (CDC, 2003f) so hospitals often have little, if any, advance notification of incoming patients. Most of the individuals who come to the hospital are ambulatory, minimally injured, or those who are concerned about potential contamination. The general community medical care needs to continue despite the occurrence of a disaster (CDC, 2003f). Principles applicable to an assessment/triage area include (CDC, 2006g; CDC, 2003f):

- Base the location of the Assessment Center/Triage Area on your hospital's disaster plan and the anticipated number of casualties.
- Establish a contaminated area and clean area separated by a buffer zone.
- Remove your contaminated outer garments when leaving the contaminated area.
- Have your body surveyed with a radiation meter when exiting a contaminated area.
- Under the triage process for patients with **life-threatening** conditions, emergency department staff should stabilize and treat physical symptoms according to standard procedures. The threat of contamination should not preclude patient treatment.
- Under the triage process for patients with **non-life threatening** conditions, when possible, trained staff should survey all patients for radioactive contamination.

### ***Decontamination Guidelines***

Survey the patient with a radiation meter (CDC, 2006g; CDC, 2003f):

- Perform surveys using consistent technique and trained personnel.
- Note exceptionally large amounts of surface or imbedded radioactive material.
- Handle radioactive objects with forceps and store in lead containers.
- Record location and level of any contamination found.

Remove patient clothing (CDC, 2006g; CDC, 2003f):

- Carefully cut and roll clothing away from the face to contain the contamination.
- Removing the clothing from the patient should remove 70 to 90% of the contamination. Staff or responders should bag and tag clothing, dressings, etc., for future evaluation and potential use as criminal evidence and small personal belongings (jewelry, wallet, etc.) should be surveyed for contamination. If the personal belongings are not contaminated they can be returned to the patient. Otherwise, steps must be taken to decontaminate the items before giving them back to the patient. If the patient is medically able to remove his/her own clothing and wash, then the patient should do so; however, providers should maintain communication during the process.
- Repeat patient survey and record levels.
- Staff should address privacy concerns of patients who are undressing. Disposable dressing gowns should be provided for patients concerned about modesty and to ensure that the environment is appropriate to remove clothing (e.g., not too cold, etc.).

Cleanse contaminated areas (CDC, 2006g; CDC, 2003f):

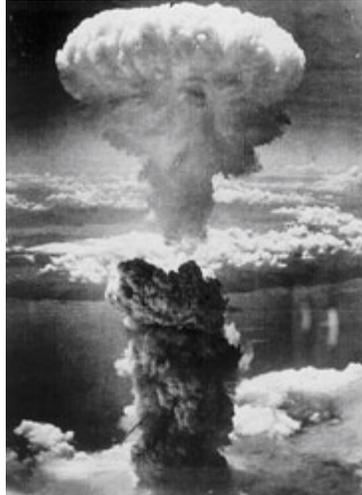
- For mass casualties, consider establishing separate shower areas for ambulatory and non-ambulatory patients.
- Responders should attempt as much decontamination as possible either at the designated assessment center or outside the hospital. Minimize the amount of contamination that actually enters the emergency department or the hospital. Decontamination areas should be separated from the hospital.

- Wash wounds first with saline or water. Care should be taken with the washing procedure, ensuring that radioactive materials are not incorporated into a wound.
- If facial contamination is present, flush eyes, nose, and ears, and rinse mouth.
- Gently cleanse intact skin with soap and water, starting outside the contaminated area and washing inward. Do not irritate or abrade the skin.
- Ambulatory patients can be washed easily; however, nonambulatory patients must be on gurneys that can be washed.
- Localized contamination can be rinsed off with pre-moistened wipes or washed with soap and water as opposed to showering the individual.
- Resurvey and note levels.
- Repeat washing until survey indicates radiation level is no more than twice background or the level remains unchanged.
- Cover wounds with waterproof/bio-occlusive dressing.
- Care should be taken with the washing procedure, ensuring that radioactive materials are not incorporated into a wound.
- If a patient has both wounds and very high, localized levels of internal contamination, this may indicate that the patient has a radioactive fragment or fragments internally. The physician, in consultation with the hospital radiation safety officer if possible, should consider surgically removing the fragment(s) using forceps to avoid potential local radiation injury to the hands of the provider.
- Dispose of waste water through normal channels. In a mass casualty emergency, staff should dispose of the water used to decontaminate patients via the sewer system. It is unlikely hospitals will have an effective water-holding system for any mass casualty event.
- Hospitals should decontaminate the facility and staff who had contact with contaminated patients to prevent the spread of contamination. Staff should consult their radiation safety officer for step-by-step procedures.
- If the patient does not show any signs of contamination or meet hospital admittance criteria, providers should recommend that the patient take a thorough shower as soon as possible.

### Health Effects of Radiological Threats

#### *Acute Radiation Syndrome*

Acute Radiation Syndrome (ARS), sometimes called radiation toxicity or radiation sickness, is an acute illness caused by irradiation of the entire body, or most of the body, by a high dose of penetrating radiation in a very short period of time, usually a matter of minutes. The major cause of this syndrome is depletion of immature parenchymal stem cells in specific tissues. Examples of people who suffered from ARS are the survivors of the Hiroshima and Nagasaki atomic bombs, the firefighters that first responded after the Chernobyl Nuclear Power Plant event in 1986, and some unintentional exposures to sterilization irradiators (CDC, 2006h).



**A dense column of smoke arises after the 2nd atomic bomb ever used was dropped by US forces on the Japanese port city of Nagasaki on August 8, 1945. Photo courtesy of the US National Archives and Record Administration.**

The required conditions for Acute Radiation Syndrome (ARS) are (CDC, 2006h; CDC, 2003f):

- The radiation dose must be large (i.e., greater than 0.7 Gray (Gy) or 70 rads); mild symptoms may be observed with doses as low as 0.3 Gy or 30 rads.
- The dose usually must be external (i.e., the source of radiation is outside of the patient's body). Radioactive materials deposited inside the body have produced some ARS effects only in extremely rare cases.
- The radiation must be penetrating (i.e., able to reach the internal organs). High energy X-rays, gamma rays, and neutrons are penetrating radiations.
- A significant portion of the body must have received the dose. Most radiation injuries are local, frequently involving the hands; these local injuries seldom cause classical signs of ARS.
- The dose must have been delivered in a short time, usually a matter of minutes. Fractionated doses are often used in radiation therapy. These are large total doses delivered in small daily amounts over a period of time. Fractionated doses are less effective at inducing ARS than a single dose of the same magnitude.

There are three classic ARS Syndromes (CDC, 2006h):

### 1. **Bone marrow syndrome (Hematopoietic)**

The full syndrome will usually occur with a dose between 0.7 and 10 Gy (70 - 1000 rads) though mild symptoms may occur as low as 0.3 Gy or 30 rads.

The survival rate of patients with this syndrome decreases with increasing dose. Onset of symptoms occurs 1 hour to 2 days after exposure. Symptoms are anorexia, fever, and malaise. A drop in all blood cell counts occurs for several weeks. Most deaths occur within a few months after exposure. The primary cause of death is the destruction of the bone marrow, resulting in infection and hemorrhage.

### 2. **Gastrointestinal (GI) syndrome**

The full syndrome will usually occur with a dose greater than approximately 10 Gy (1000 rads) although some symptoms may occur as low as 6 Gy or 600 rads.

Survival is extremely unlikely with this syndrome. Symptoms are malaise, anorexia, severe diarrhea, fever, dehydration, and electrolyte imbalance. Destructive and irreparable changes in the GI tract and

bone marrow usually cause infection, dehydration, and electrolyte imbalance. Death usually occurs within 2 weeks.

### 3. **Cardiovascular (CV)/ Central Nervous System (CNS) syndrome**

The full syndrome will usually occur with a dose greater than approximately 50 Gy (5000 rads) although some symptoms may occur as low as 20 Gy or 2000 rads.

Symptoms begin with extreme nervousness and confusion; severe nausea, vomiting, and watery diarrhea; loss of consciousness; and burning sensations of the skin. The onset occurs within minutes of exposure. Death occurs within 3 days. Death likely is due to collapse of the circulatory system as well as increased intracranial pressure as the result of increased intracranial fluid volume caused by cerebral edema, vasculitis, and meningitis.

There are four stages of ARS (CDC, 2006h):

#### 1. **Prodromal stage (N-V-D stage)**

The classic symptoms for this stage are nausea, vomiting, as well as anorexia and possibly diarrhea, depending on dose, which occur from minutes to days following exposure. The symptoms may last (episodically) for minutes up to several days.

#### 2. **Latent stage**

In this stage, the patient looks and feels generally healthy for a few hours or even up to a few weeks.

#### 3. **Manifest illness stage**

In this stage the symptoms depend on the specific syndrome and last from hours up to several months.

#### 4. **Recovery or death**

Most patients who do not recover will die within several months of exposure. The recovery process lasts from several weeks up to two years.

The diagnosis of ARS can be difficult to make because ARS is produced by a myriad of non-specific symptoms. Also, depending on the dose, the prodromal stage may not occur for hours or days after exposure, or the patient may already be in the latent stage by the time they receive treatment, in which case the patient may appear and feel well when first assessed (CDC, 2006h).

If a patient received more than 0.05 Gy (5 rads) and three or four CBCs are taken within 8 to 12 hours of the exposure, a quick estimate of the dose can be made. If these initial blood counts are not taken, the dose can still be estimated by using CBC results over the first few days. It would be best to have radiation dosimetrists conduct the dose assessment, whenever possible (CDC, 2006h).

If no radiation exposure is initially suspected, you may consider ARS in the differential diagnosis if a history exists of nausea and vomiting that is unexplained by other causes. Other indications are bleeding, epilation, or white blood count (WBC) and platelet counts abnormally low a few days or weeks after unexplained nausea and vomiting. Consider CBC and chromosome analysis and consultation with radiation experts to confirm diagnosis (CDC, 2006h).

### Cutaneous Radiation Injury

Cutaneous radiation injury (CRI) is injury to the skin and underlying tissues from acute exposure to a large external dose of radiation. Some skin damage is likely with ARS, however CRI can occur without symptoms of ARS, especially with acute exposures to beta radiation or X-rays. Sometimes this occurs when radioactive materials contaminate a patient's skin or clothes (CDC, 2006h).

When the basal cell layer of the skin is damaged by radiation, inflammation, erythema, and dry or moist desquamation can occur. Also, hair follicles may be damaged, causing epilation. Within a few hours after irradiation, a transient and inconsistent erythema (associated with itching) can occur. Then, a latent phase may occur and last from a few days up to several weeks, when intense reddening, blistering, and ulceration of the irradiated site are visible (CDC, 2006h).

In most cases, healing occurs by regenerative means; however, very large skin doses can cause permanent hair loss, damaged sebaceous and sweat glands, atrophy, fibrosis, decreased or increased skin pigmentation, and ulceration or necrosis of the exposed tissue (CDC, 2006h).

CRI can occur with radiation doses as low as 2 GY or 200 rads; the severity of CRI symptoms increases with an increased dose of radiation. Most cases of CRI have occurred accidentally through contact with unsecured radiation sources from food irradiators, radiotherapy equipment, or well depth gauges. CRI has occurred in people who were overexposed to x-radiation from fluoroscopy units (CDC, 2006g).

- Skin damage can manifest within hours, days, or weeks after radiation exposure.
- Early signs and symptoms include itching, tingling, erythema, or edema without exposure to heat or caustic chemicals. They may be seen within hours or days after exposure, and is usually followed by a latent period, lasting from a few days to several weeks.
- Although lesions may not appear for weeks to months post exposure, when they appear they is intense reddening, blistering, and ulceration of the irradiated site. Depending on the radiation dose, a third and even fourth wave of erythema are possible over the ensuing months or possibly years but then can be debilitating or even life-threatening (CDC, 2006g).
- Delayed occurrence of lesions is a differentiating factor from thermal burns.
- Note time of occurrence of signs and symptoms and progressive changes in appearance.
- Treat localized injuries symptomatically, focusing on pain and infection control.
- In most cases, healing occurs by regenerative means; however, large radiation doses to the skin can cause permanent hair loss, damaged sebaceous and sweat glands, atrophy, fibrosis, decreased or increased skin pigmentation, and ulceration or necrosis of the exposed tissue (CDC, 2006g).

#### *Patient Treatment* (CDC, 2006g; CDC, 2003f):

Staff must not allow the threat of contamination to impede the delivery of medical assistance. The right thing to do in almost every occasion when an individual who is contaminated and has a life-threatening condition is to admit him/her to the Emergency department for immediate care.

Initially, hospitals should obtain as much patient and situation history as possible, noting circumstances surrounding the patient and the situation that might indicate exposure. This also includes looking for corroborating evidence. The Armed Forces Radiobiology Research Institute (AFRRI) has developed a software program in conjunction with Radiation Emergency Assistance Center/Training Site (REAC/TS) that can be effectively used to record information. This software can also be used for dose assessment and treatment management. It can be found at: <http://www.usuhs.mil/afri/outreach/guidance.htm>.

If radiation exposure is suspected (CDC, 2006h):

- Secure ABCs (airway, breathing, circulation) and physiologic monitoring (blood pressure, blood gases, electrolyte and urine output) as appropriate.
- Treat major trauma, burns and respiratory injury if evident.
- In addition to the blood samples required to address the trauma, obtain blood samples for CBC (complete blood count), with attention to lymphocyte count, and HLA (human leukocyte antigen) typing prior to any initial transfusion and at periodic intervals following transfusion.
- Treat contamination as needed.
- If exposure occurred within 8 to 12 hours, repeat CBC, with attention to lymphocyte count, 2 or 3 more times (approximately every 2 to 3 hours) to assess lymphocyte depletion. CBCs taken over the next several days can then be compared to the baseline measurements and used to assess the radiation dose received. These data are of key importance in evaluating patients for acute radiation syndrome.
- When internal contamination is suspected, body excreta may contain radioactive substances. Collection of urine and feces should be considered on those patients. Also, swabs from body orifices should be taken for survey or analysis for radionuclides. Although state and federal assistance may be made available for receiving and analyzing these samples, hospitals should identify during their emergency planning what agencies or laboratories the samples should go to for analysis.
- In the first 48 hours, the basic premise is that healthcare providers should conduct standard patient assessments, take care of immediately life-threatening problems, and take care of all other problems that require immediate attention.
- Emergency department staff should:
  - Treat symptoms according to ordinary patient treatment practices and procedures.
  - Take care of wounds by irrigating, debriding, and covering to the best extent possible.
  - Look for the symptoms of acute radiation syndrome (discussed later in this course). Have a trained technician perform a radiation survey if symptoms, patient history, and situation history indicate the possibility of contamination.
- Suggested supplies and medications to keep on hand and have easily accessible in large quantities include IVs, fluid support, anti-diarrhea, anti-emetic medications, and potassium iodide tablets.
- Hospitals should consider keeping a supply of **potassium iodide** to help reduce the risk of thyroid cancer from radioactive iodine exposure. Such exposures may arise from a nuclear power plant incident or in radioactive fallout from a terrorism event involving the detonation of a nuclear device (CDC, 2012).
- Hospitals should adhere to FDA recommendations (*Guidance: Potassium Iodide as a Thyroid Blocking Agent in Radiation Emergencies*, U. S. Department of Health and Human Services, Food and Drug Administration, Center for Drug Evaluation and Research, December, 2001) for administration of Potassium Iodide, which is summarized in Table 5.

Table 5. FDA Recommendations for the Administration of Potassium Iodide (KI) Threshold Thyroid Radioactive Exposures and Recommended Doses of KI for Different Risk Groups (FDA, 2001)				
	Predicted Thyroid Exposure (cGy or rad)	KI dose (mg)	Number of 130 mg tablets	Number of 65 mg tablets
Adults over 40 years of age	$\geq 500$	130	1	2
Adults over 18 years through 40 years of age	$\geq 10$			
Pregnant or lactating women	$\geq 5$			
Adolescents* 12-18 years		65	1/2	1
Children 3-12 years				
Children over 1 month-3 years		32	1/4	1/2
Birth through 1 month		16	1/8	1/4
* Adolescents approaching adult size (> 70 kg) should receive the full adult dose (130 mg).				

- **Pregnant Women:** Because all forms of iodine cross the placenta, pregnant women should take KI to protect the growing fetus. However, pregnant women should take only one dose of KI following internal contamination with (or likely internal contamination with) radioactive iodine (CDC, 2012).
- **Breastfeeding Women:** Women who are breastfeeding should take only one dose of KI if they have been internally contaminated with (or are likely to be internally contaminated with) radioactive iodine. Because radioactive iodine quickly gets into breast milk, CDC recommends that women internally contaminated with (or are likely to be internally contaminated with) radioactive iodine stop breastfeeding and feed their child baby formula or other food if it is available. If breast milk is the only food available for an infant, nursing should continue (CDC, 2012).
- Potassium iodide supplementation is not as effective for those individuals over 40 years of age and therefore it is generally recommended that these individuals only receive supplementation if it is estimated that their exposure is significant enough to potentially destroy the thyroid leading to hypothyroidism.
- Potassium iodide should be taken immediately though it may still have a significant impact if taken even 3-4 hours after exposure. It should be available to those in a radioactive fallout area. The Nuclear Regulatory Commission requires that states with a population within the 10-mile emergency planning zone of commercial nuclear power plants consider including potassium iodide as a protective measure for the general public to supplement sheltering and evacuation in the unlikely event of a severe nuclear power plant accident.
- FDA Guidance recommends that persons with known iodine sensitivity should avoid potassium iodide, as should individuals with dermatitis herpetiformis and hypocomplementemic vasculitis, extremely rare conditions associated with an increased risk of iodine hypersensitivity.
- Individuals with multinodular goiter, Graves' disease, and autoimmune thyroiditis should be treated with caution -- especially if dosing extends beyond a few days.
- Unless other protective measures are not available, it is not recommended to provide repeat dosing in pregnant females and neonates because of the potential for potassium iodide to suppress thyroid function in the fetus and neonate.
- Healthcare providers should avoid giving the perception to patients and the community that potassium iodide prevents adverse health effects from radiation exposure in general. However, staff should understand that offering potassium iodide may help address some patient psychological concerns (FDA, 2001).
- Monitor for fluid and electrolyte balance and evidence of hemodynamic instability.

- Treat symptomatically with focus on prevention of infection, including antibiotics.
- Consider cytokines, e.g. Neupogen®, and hematopoietic growth factors.
- Perform surgical interventions within the first 48 hours or delay until after hematopoietic recovery.
- Consider use of biodosimetry dose assessment software from [www.afrii.usuhs.mil](http://www.afrii.usuhs.mil).
- Nose or mouth contamination may indicate inhalation or ingestion.
- Assessment may include analysis of urine, blood, and fecal samples or whole body counts. Consult with radiation experts.
- Radiation experts may recommend early administration of radionuclide-specific decorporation agents such as Prussian Blue, DTPA, or Bicarbonate.

**Prussian blue** has been used, since the 1960s, to treat people who have been internally contaminated with radioactive cesium and nonradioactive thallium, once an ingredient in rat poisons. It can be prescribed at any point after the determination has been made that a person who is internally contaminated would benefit from treatment. Prussian blue will help speed up the removal of cesium and thallium from the body (CDC, 2010a).

Prussian blue traps radioactive cesium and thallium in the intestines and keeps them from being re-absorbed by the body. The radioactive materials then move through the intestines and are excreted in bowel movements. Prussian blue reduces the biological half-life of cesium from about 110 days to about 30 days. Prussian blue reduces the biological half-life of thallium from about 8 days to about 3 days. Because Prussian blue reduces the time that radioactive cesium and thallium stay in the body, it helps limit the amount of time the body is exposed to radiation (CDC, 2010a).

Prussian blue, available by prescription, is safe for most adults, including pregnant women, and children (2-12 years). Dosing for infants (ages 0-2 years) has not been determined yet. Women who are breast feeding their babies should stop breast feeding if they think they are contaminated with radioactive materials and consult with their doctors. People who have had constipation, blockages in the intestines, or certain stomach problems should be sure to tell their doctors before taking Prussian blue (CDC, 2010a).

It is given in 500-milligram capsules that can be swallowed whole, or by breaking the capsules and mixing the contents in food or liquid, for those who cannot swallow the capsule whole. Breaking open the capsules will cause people's mouths and teeth to be blue during the time of treatment (CDC, 2010a). Prussian blue usually is given 3 times a day for a minimum of 30 days, depending on the extent of the contamination (CDC, 2010a).

The most common side effects of Prussian blue are upset stomach and constipation. These side effects can easily be treated with other medications. People may have blue feces during the time that they are taking Prussian blue (CDC, 2010a).

The CDC has included Prussian blue in the Strategic National Stockpile (SNS) (SNS is covered later in this course).

**DTPA**, a chelating agent, is another treatment for radiation contamination. A chelating agent works by binding a toxin for GI or most commonly, urinary elimination. As with other chelating agents, DTPA works by binding and holding on to radioactive materials. DTPA is approved by the FDA for chelation of plutonium, americium, and curium. Once bound to a radioactive material or poison, the DTPA is then passed from the body in the urine. Chelating agents help decrease the amount of time it takes to get a poison out of the body (CDC, 2006I).

DTPA comes in two forms: calcium (Ca-DTPA) and zinc (Zn-DTPA). When given within the first day after internal contamination has occurred, Ca-DTPA is about 10 times more effective than Zn-DTPA at chelating plutonium, americium, and curium. After 24 hours have passed, Ca-DTPA and Zn-DTPA are equally effective in chelating these radioactive materials (CDC, 2006I).

DTPA is currently only available by injection and is not available in an oral form. DTPA may be injected directly into a vein in the arm or through intravenous drip. Adults who have inhaled plutonium, americium, or curium

can be treated with DTPA mist or spray that is breathed into the lungs. Inhaling DTPA might cause some people, especially those with asthma, to cough or wheeze. The safety and effectiveness of inhaled DTPA has not been shown in children (CDC, 2006l).

DTPA should be taken only as long as needed. In the past, most people who have needed treatment with DTPA have only needed one dose. However, internal contamination with very high levels of plutonium, americium, or curium may require treatment with DTPA every day for weeks or months. The length of treatment with DTPA will depend on a) the amount of radioactive material in your body and b) how well your body gets rid of the radioactive material. There are no medical reasons why a person who is internally contaminated with plutonium, americium, or curium should not be treated with Ca-DTPA or Zn-DTPA. However, keep the following guidelines in mind (CDC, 2006l):

- Because radioactive materials chelated to DTPA are passed out of the body in the urine, DTPA must be used carefully in people whose kidneys do not function properly.
- Ca-DTPA should be used carefully in people who have a disease called "hemochromatosis." (Hemochromatosis is a genetic disease that causes the body to absorb too much iron from foods and other sources, such as vitamins containing iron.)
- Breathing treatments using DTPA may not be safe for some people with asthma. If a person with asthma requires treatment with DTPA, the drug should be injected.
- DTPA should not be used to treat people who are internally contaminated with the radioactive materials uranium or neptunium.

DTPA does not build up in the body or cause long-term health effects. People who are given repeat doses of Ca-DTPA within a short period of time may have nausea, vomiting, diarrhea, chills, fever, itching, and muscle cramps. Other side effects may include headache, lightheadedness, chest pain, and a metallic taste in the mouth (CDC, 2006l).

Ca-DTPA (and Zn-DTPA) can chelate certain important minerals: zinc, magnesium, and manganese. DTPA treatment may interfere with the normal production of blood cells. As a precaution, patients receiving long-term treatment with DTPA should be given a vitamin and mineral supplement that contains zinc (CDC, 2006l).

CDC has included both Ca-DTPA and Zn-DTPA in the Strategic National Stockpile (CDC, 2006f).

High dose of radiation can lead to destruction of the bone marrow, potentially resulting in uncontrolled bleeding and infection, is a major concern. To help the recovery of the bone marrow, growth factors that stimulate the blood cells to multiply can be used. **Filgrastim (trade name Neupogen®)**, is a drug that was approved for use by the FDA in 1991 for cancer patients with bone marrow damage due to chemotherapy or radiotherapy. Treated patients have had fewer infections, less need for intravenous antibiotics, and shortened hospital stays than those who did not receive the drug. Filgrastim may also be useful for patients who have bone marrow damage from accidental exposures to high doses of radiation and it is expected to provide similar benefits (CDC, 2005j).

People may be prescribed filgrastim following chemotherapy or radiation therapy to assist in their recovery. Also, people may be prescribed filgrastim following a high dose of radiation from a radiation emergency. Filgrastim is safe for most adults, but should not be taken by people who have known hypersensitivity to E. coli-derived proteins, filgrastim, or any component of filgrastim. Children and pregnant women should take filgrastim with caution. It is not known if filgrastim is excreted in human milk, so breastfeeding women should take filgrastim with caution as well (CDC, 2005j).

It is given by injection under the skin or through intravenous infusion. The usual treatment is 5 micrograms per kilogram of patient weight (mcg/kg) of filgrastim (daily for up to 2 weeks, either by injection or intravenous infusion. Possible side effects of filgrastim include fever, diarrhea, skin rash and weakness. The most common side effect is mild to moderate bone pain (CDC, 2005j).

## Psychosocial issues

In urban areas, hundreds to thousands may seek care. The majority will self-refer to the nearest hospital. Many will need decontamination. Many may seek radiological screening, but will not be contaminated. Have radiation exposure fact sheets available for patients and families. The majority however will simply seek reassurance. It is likely that psychogenic illness symptoms, such as nausea or vomiting, may manifest. Vomiting due to radiation exposure is usually recurrent rather than episodic.

Mental health professionals should be included on the response team. Persons with psychiatric disorders, particularly anxiety disorders are likely to need significant reassurance and perhaps increased treatment.

Pregnant patients require special counseling (see Prenatal Radiation Exposure below).

Separate areas for radiation screening and counseling could be needed for patients with minimal risk of exposure or injury.

## Prenatal Radiation Exposure

Because the human embryo or fetus is protected in the uterus, a radiation dose to a fetus tends to be lower than the dose to its mother for most radiation exposure events. However, the human embryo and fetus are particularly sensitive to ionizing radiation, and the health consequences of exposure can be severe, even at radiation doses too low to immediately affect the mother. Such consequences can include growth retardation, malformations, impaired brain function, and cancer (2011a).

Estimating the radiation dose to the fetus requires consideration of all sources external and internal to the mother's body. For this document, the fetal radiation dose from sources external to the mother's body can be estimated by determining the dose to the mother's abdomen. Estimating the dose from sources internal to the mother's body is more complex. Experts in radiation dosimetry, such as hospital medical physicist and health physicists should be consulted regarding fetal dose estimation. The National Council on Radiation Protection and Measurements (NCRP) Report No. 128, "Radionuclide Exposure of the Embryo/Fetus," provides detailed information for assessing fetal doses from internal uptakes. Fetal dose estimations from medical exposures to pregnant women can be found in "Publication 84: Pregnancy and Medical Radiation" from the International Commission on Radiological Protection (ICRP) (CDC, 2011a).

Fetal sensitivity to radiation-induced health effects is highly dependent on fetal dose, and the mother's abdomen provides some protection from external sources of ionizing radiation. In addition, noncancer health effects depend on gestational age (CDC, 2011a).

## Polonium 210

Headlines in recent years related to the use of Polonium 210 (Po-210) have made its inclusion among radiological threats necessary. Po-210 is considered to be one of the most hazardous radioactive materials known, but it must be inhaled or ingested to exert its toxic effects. It is found naturally in the environment, and the general population is internally contaminated with small but measurable amounts of it on a regular basis through food, water, and air. Because tobacco leaves are known to concentrate Po-210, users of tobacco products are likely to have higher levels of this radioactive element in their bodies. Po-210 decays to a stable isotope of lead (Pb-206) by emitting alpha particles, and the largest part of the alpha dose is delivered over the first 100 days following a single administration (2006j).

In 2007 CDC recommended that clinicians conduct a thorough history and physical examination on all individuals who present with health concerns. The primary goal of this evaluation should be to rule out a diagnosis of Acute Radiation Syndrome as a result of internal contamination with Po-210. Although the onset of Acute Radiation Syndrome (ARS) due to internal contamination may be delayed as compared to that

caused by external radiation exposure, it is unlikely that an individual will develop new onset ARS many weeks following exposure (CDC, 2006j).

CDC further suggests that clinicians consider the appropriateness of the following tests when providing care for individuals who have recently traveled to locations known to be environmentally contaminated with Po-210 (CDC, 2006j):

- Complete Blood Count (CBC) with differential. In otherwise asymptomatic individuals, abnormal CBC results may be useful in detecting/diagnosing subclinical ARS caused by internal contamination with Po-210. Identification of subclinical decreases in lymphocyte or neutrophil counts, however, is unlikely to alter the acute medical management of the individual.
- 24-hour urine collection to assay for the presence of Po-210.

Detection of Po-210 in the urine (in excess of background) is strongly suggestive of internal contamination. In the absence of adverse health effects, however, individuals identified as being internally contaminated with Po-210 do not face an immediate health risk. CDC does not recommend the use of conventional or alternative medical therapies to treat elevated body burdens of Po-210 in individuals without clinical findings of ARS (CDC, 2006j).

### Conclusion to Radiological Threats

Radiological threats are often very frightening to the population at large and to healthcare providers. Its potential for significant loss of life as well as significant illness is daunting. The initial management of patients is similar to that of chemical threats involving decontamination and appropriate personal protective equipment on the part of healthcare providers, as well as speedy treatment of wounds and radiation illness.

### **Health Alert Network**

The threat of bioterrorism in the United States is at an all time high. New health threats that challenge the abilities of our existing local and state public health infrastructures are becoming more common. Further, our society is increasingly mobile, meaning that a disease originating in one state may be transferred to many other states in a single day. Without the needed communication system in place, clusters of disease cases can go undiagnosed for weeks while disease spreads silently (NSHD, 2011).

The Health Alert Network (HAN) is a nationwide communications system that was established by the CDC, and is implemented by each state. It is designed to enable a two-way, 24/7 flow of critical health information among the Nevada State Health Division and local and rural health care professionals throughout the state, including physicians, nurses, hospitals, laboratories, clinicians, public health workers, emergency management and others (NSHD, 2011).

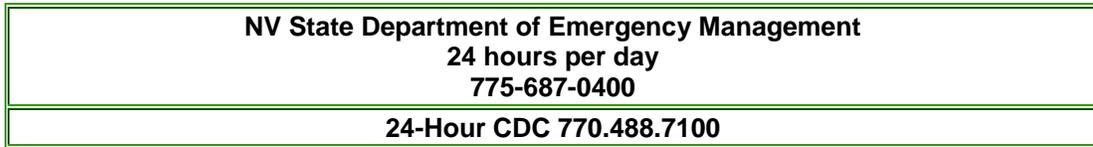
HAN messages range from informational updates of general interest to alerts which require immediate action. HAN members are identified and tracked in a secure database maintained by Public Health Preparedness. If you are a public health professional, please contact John Flamm, E & I Officer, at 775.684.4057 to sign up to receive Nevada HAN messages, or to access the network (NSHD, 2011).

A bioterrorism event, and other public health emergencies, may first be recognized by local health care providers, who notice a sudden surge in the emergency room, or a pattern of unusual cases or diagnoses. Health facilities throughout the United States must have the capacity to detect and respond to these threats. The answer is the Health Alert Network, which provides these essential capabilities (NSHD, 2011):

- Ongoing surveillance activities to quickly identify potential health threats.
- Laboratory capability to perform testing to determine the threat agent.
- The ability to conduct disease investigations.

- Effective protocol for reporting incidents and sharing information.
- Efficient emergency communications among all involved parties.

When fully deployed, the Nevada HAN links local health departments to one another and to other partner organizations critical for effective preparedness and response.



### **Strategic National Stockpile**

An act of terrorism targeting the U.S. civilian population, or a large scale natural disaster will require rapid access to large quantities of pharmaceuticals and medical supplies. Such quantities may not be readily available unless special stockpiles are created. Anticipating a terrorist strike is difficult and few state or local governments have the resources to create sufficient stockpiles on their own.

In 1999 Congress charged the Department of Health and Human Services (HHS) and the Centers for Disease Control and Prevention (CDC) with the establishment of the National Pharmaceutical Stockpile (NPS). The mission was to provide a re-supply of large quantities of essential medical materiel to states and communities during an emergency within twelve hours of the federal decision to deploy.

The Strategic National Stockpile (SNS) is a national repository of large quantities of medical countermeasures, vaccines, and other medical supplies stored in strategic locations around the nation. These assets are designed to supplement state and local public health departments in the event of a large-scale public health emergency that causes local supplies to run out (CDC, 2011b).

Managing the procurement, storage, and transportation of supplies in the SNS involves monitoring the shelf-life of pharmaceuticals to ensure that they are kept within U.S. Food and Drug Administration potency limits; conducting quality assurance practices; and ensuring that all SNS materials are based on the latest scientific data, threat levels, and overall ability to deploy a public health emergency. SNS supplies include (CDC, 2011b):

- 12-Hour Push Packages and Managed Inventory - Once federal and state authorities agree that SNS assets are needed, the 12-Hour Push Packages can be delivered to any state in the continental United States within 12 hours of the decision to deploy. Each package contains 50 tons of a broad spectrum of medical assets. If the incident requires additional or different supplies, they can be delivered within 24 to 36 hours from SNS's managed inventory. All states have plans to receive SNS supplies and distribute them as quickly as possible to local jurisdictions, who then dispense them to their communities.
- CHEMPACKs are containers of nerve-agent antidotes placed in secure locations at state and local levels to facilitate rapid response to an incident. More than 92% of the U.S. population is within a one-hour buffer of these supplies. Containers are located in more than 1,300 sites in all states and the District of Columbia.
- Federal Medical Stations - These modular and rapidly deployable stations provide a platform for the care of displaced persons who have non-acute health-related needs that cannot be met in a shelter for the general population during an incident. The stations are stocked with beds and supplies to care for up to 250 patients for up to three days.



**Storage of medications at CDC.** Photo courtesy of CDC.

The SNS is a national repository of antibiotics, chemical antidotes, antitoxins, life-support medications, IV administration, airway maintenance supplies, and medical/surgical items. The SNS is designed to supplement and re-supply state and local public health agencies in the event of a national emergency anywhere and at anytime within the U.S. or its territories (CDC, 2010b).

The SNS is organized for flexible response. The first line of support lies within the immediate response 12-hour Push Packages. These are caches of pharmaceuticals, antidotes, and medical supplies designed to provide rapid delivery of a broad spectrum of assets for an ill defined threat in the early hours of an event. These Push Packages are positioned in strategically located, secure warehouses ready for immediate deployment to a designated site within 12 hours of the federal decision to deploy SNS assets (CDC, 2010b).

If the incident requires additional pharmaceuticals and/or medical supplies, follow-on vendor managed inventory (VMI) supplies will be shipped to arrive within 24 to 36 hours. If the agent is well defined, VMI can be tailored to provide pharmaceuticals, supplies and/or products specific to the suspected or confirmed agent(s). In this case, the VMI could act as the first option for immediate response from the SNS Program (CDC, 2010b)

During a national emergency, state, local, and private stocks of medical materiel will be depleted quickly. State and local first responders and health officials can use the SNS to bolster their response to a national emergency, with a 12-hour Push Package, vendor managed inventory (VMI), or a combination of both, depending on the situation. The SNS is not a first response tool (CDC, 2010b).

The SNS Program is committed to have 12-hour Push Packages delivered anywhere in the U.S. or its territories within 12 hours of a federal decision to deploy. The 12-hour Push Packages have been configured to be immediately loaded onto either trucks or commercial cargo aircraft for the most rapid transportation. Concurrent to SNS transport, the SNS Program will deploy its Technical Advisory Response Unit (TARU). The TARU staff will coordinate with state and local officials so that the SNS assets can be efficiently received and distributed upon arrival at the site (CDC, 2010b).



Photo Courtesy of CDC.

The decision to deploy SNS assets may be based on evidence showing the overt release of an agent that might adversely affect public health. It is more likely, however, that subtle indicators, such as unusual morbidity and/or mortality identified through the nation's disease outbreak surveillance and epidemiology network, will alert health officials to the possibility (and confirmation) of a biological or chemical incident or a national emergency. To receive SNS assets, the affected state's governor's office will directly request the deployment of the SNS assets from CDC or the Department of Health and Human Service (HHS). HHS, CDC, and other federal officials will evaluate the situation and determine a prompt course of action (CDC, 2010b).

## Conclusion

Although the thought of biological, chemical and radiological weapons of mass destruction is horrifying to contemplate, healthcare providers must be prepared for such a possibility. Planning for emergencies should be undertaken in our own homes, with our families, as well as in our healthcare organizations. It is critical that healthcare providers are familiar with the emergency plans of our organizations and to continue to have a high degree of suspicion related to patterns of illnesses and symptoms that present to us among our patients. Healthcare providers must be knowledgeable and skilled in recognizing these symptoms and how to treat them. In the event of a terrorism attack with weapons of mass destruction, healthcare providers must be alert to the potential for their use and must prepare to take necessary action to save the lives of our patients, while ensuring that we are also protected. It is not a matter of if, it is a matter of when.

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## Test

**\*If you have downloaded the course off the Internet and wish to submit your test online you must return to our website ([www.accesscontinuingeducation.com](http://www.accesscontinuingeducation.com)) to do so.**

1. Healthcare providers should maintain a high degree of suspicion and be alert to patterns and diagnostic clues that might indicate unusual illness outbreaks that may be indicative of an intentional release of biological, chemical or radiological weapons. Among such patterns are all the following **EXCEPT**:
  - A. Geographic clustering of illness.
  - B. Temporal clustering of illness.
  - C. Declining rates of persons seeking medical care and treatment.
  - D. Unusual age distribution among those affected.
  
2. In Nevada healthcare providers should report any suspicion of biological, chemical or radiological threat to the **NV State Department of Emergency Management 24 hours per day at 775-687-0400; or the CDC at 800-232-4636.**
  - A. True.
  - B. False.
  
3. Transmission of the anthrax bacteria occurs by all of the following **EXCEPT**:
  - A. Direct skin contact with spores.
  - B. Person to person transmission of inhalation anthrax.
  - C. Inhalation of aerosolized spores.
  - D. Consumption of undercooked or raw meat products or dairy products from infected animals.
  
4. Symptoms of botulism include symmetrical cranial neuropathies, generalized weakness, dysarthria, symmetric descending weakness and respiratory dysfunction, descending flaccid paralysis, intact mental state and the absence of fever.
  - A. True.
  - B. False.
  
5. The procedure for smallpox vaccination presented in this course calls for all the following **EXCEPT**:
  - A. The use of a bifurcated needle.
  - B. Multiple perpendicular insertions into the deltoid; 3 for primary vaccination and 15 for revaccination.
  - C. The use of alcohol to prepare the vaccination site.
  - D. Loosely covering the vaccination site after insertions.

6. Treatment for plague:
- A. Should begin within 24 hours after the first symptoms develop in order to reduce the risk of death.
  - B. Should be considered prophylactically for healthcare workers with close contact exposure.
  - C. Includes oral tetracycline and fluoroquinolone as well as intramuscular or intravenous medications, streptomycin or gentamicin.
  - D. Includes all of the above.
7. Biologic agents with potential to be used as weapons, are those with ease of dissemination or transmission, potential for major public health impact due to high mortality, potential for public panic and social disruption, and special requirements for public health preparedness.
- A. True.
  - B. False.
8. In a chemical incident situation, primary contamination refers to the potential for an exposed patient to further contaminate other patients, healthcare providers and equipment.
- A. True.
  - B. False.
9. Gastrointestinal chemical contamination may produce secondary contamination in the form of toxic vomitus.
- A. True.
  - B. False.
10. All the following is true about decontamination **EXCEPT**:
- A. It is the process of removing or neutralizing harmful materials that have gathered on patients, personnel and/or equipment during the response to a chemical incident.
  - B. Removal of outer clothing can eliminate 85% to 90% of contamination.
  - C. It protects all hospital personnel by sharply limiting the transfer of hazardous materials from the contaminated area into clean zones.
  - D. It eliminates all possibility of harmful effects from the chemical.
11. Sheltering in place, as an intervention for a chemical attack, should not include the use of a vehicle because they are not airtight enough to prevent exposure.
- A. True.
  - B. False.

12. Exposure to hazardous chemicals may produce a wide range of adverse health effects. The likelihood of an adverse health effect occurring, and the severity of the effect, are dependent on all the following **EXCEPT**:
- The toxicity of the chemical.
  - The route, nature and extent of exposure.
  - Factors that affect the susceptibility of the exposed person, such as age and the presence of certain chronic diseases.
  - Whether or not the chemical is released overtly or covertly.
13. The Agency for Toxic Substances & Disease Registry (ATSDR), provides information regarding chemical substances, including those that may be used in a terrorist attack, to healthcare providers regarding:
- General Information (synonyms, appearance, routes of exposure, potential for secondary contamination, sources/uses, physical properties, and exposure standards).
  - Health effects (organ systems affected by acute exposure, potential sequelae, and chronic effects).
  - Pre-hospital management (personal protection, decontamination, support, triage, and transportation, organized by hot zone, decontamination zone, and support zone).
  - Emergency department management (management and treatment).
  - Patient information sheet (information of exposure, potential effects, and follow-up instructions).
- True.
  - False.
14. Exposure to radiation can cause:
- Deterministic effects which are those observable health effects that occur soon after receipt of large doses of radiation, such as hair loss, skin burns, nausea, or death.
  - Stochastic effects are long-term effects, such as cancer.
  - Neither A or B.
  - Both A and B.
15. Decontamination guidelines for radiological contamination includes:
- Surveying the patient with radiation meter.
  - Removing the patient's clothing.
  - Cleaning the patient with water and soap.
  - All of the above.
16. The hematopoietic syndrome that results from Acute Radiation Syndrome (ARS) can start with nausea, vomiting, diarrhea and progress to bone marrow suppression, infection, hemorrhage and death.
- True.
  - False.

17. In the event of a radiological event, The Armed Forces Radiobiology Research Institute (AFFRI) in conjunction with the Radiation Emergency Assistance Center/Training Site (REAC/TS) provides guidance to healthcare providers regarding treatment.
- A. True.
  - B. False.
18. In the event of radiological exposure, potassium iodide is used as a treatment for the prevention of hepatic cancer.
- A. True.
  - B. False.
19. The Health Alert Network (HAN) is a nationwide communications system that was established by the CDC, and is implemented by each state. It is designed to enable a two-way, 24/7 flow of critical health information among the Nevada State Health Division and local and rural health care professionals throughout the state, including physicians, nurses, hospitals, laboratories, clinicians, public health workers, emergency management and others. HAN provides:
- A. Ongoing surveillance activities to quickly identify potential health threats and effective protocols for reporting incidents and sharing information.
  - B. Laboratory capability to perform testing to determine the threat agent.
  - C. The ability to conduct disease investigations.
  - D. All of the above.
20. The Strategic National Stockpile is:
- A. Designed to supplement and re-supply state and local public health agencies in the event of a national emergency anywhere and at anytime within the U.S. or its territories.
  - B. Organized for flexible response by providing Push Packages, caches of pharmaceuticals, antidotes, and medical supplies designed to provide rapid delivery of a broad spectrum of assets for an ill defined threat in the early hours of an event. These Push Packages are positioned in strategically located, secure warehouses ready for immediate deployment to a designated site within 12 hours of the federal decision to deploy SNS assets.
  - C. Requested by the governor of the state which needs the assistance and is deployed after determination by the federal government that such action is needed.
  - D. All of the above.