BIOLOGICAL AGENTS

- Objectives
  - Identify indicators that may cause the EMS provider to suspect a biological incident
  - Identify signs, symptoms and management of common biological diseases
  - Ensure adequate protection for EMS providers in a biological incident

BIOLOGICAL Incident considerations:

- A deliberate release of germs or other biological substances that can make people sick
- Usually enter the body through inhalation or ingestion. Absorption and injection is possible but less likely means of entry
- The initial response will most likely be made by direct patient care providers and the public health community
- Unlike with chemical attacks, there may be a delay between exposure and onset of illness
- Incubation period is characteristic of infectious disease.
- The incubation period can range from several hours to several weeks depending on the agent (pathogen) and the exposure

Transmission of BIOLOGICAL diseases

- Victims may spread the disease prior to learning they have been infected
- Some biological agents do not cause contagious diseases (Anthrax)
- Some are highly contagious (Smallpox)

Advantages and Disadvantages of using BIOLOGICAL AGENTS for Terrorism

- Advantages
  - Easy to make
  - Available
  - Cheap
  - Hard to detect
  - Easily spread
  - Tie up resources
  - Psychological impact
  - Difficult to prepare for

- Disadvantages
  - Delayed effects
  - Production hazardous

BIOLOGICAL AGENT OVERVIEW

- Indicators of Possible Biological Agent Use
- A biological hazard may be recognized by:
  - Identification of a credible threat
  - Discovery of bioterrorism evidence such as devices, agents, or a lab
  - Non-traumatic multiple casualty incident

BIOLOGICAL AGENT CATEGORIES

- Bacterial
- Viral
- Toxins

- BACTERIAL (Bacteria are single-cell organisms that multiply by cell division and can cause disease in humans, plants or animals.)
  - Anthrax
  - Cholera
  - Plague
  - Tularemia

ANTHRAX

- Rod-shaped, gram-positive, sporulating organism
- Zoonotic disease with cattle, sheep and horses being the chief domesticated animal hosts, but other animals may be infected
- May be contracted by the handling of contaminated hair, wool, hides, flesh, blood and excreta of infected animals and from manufactured products such as bone meal, as well as by purposeful dissemination of spores
- Transmission is made through scratches or abrasions of the skin, wounds, inhalation of spores, eating insufficiently cooked infected meat, or by flies
- All human populations are susceptible
- Recovery from an attack of the disease may be followed by immunity
- The spores are very stable and may remain viable for many years in soil and water. They will resist sunlight for varying periods.

- **Signs and Symptoms of ANTHRAX**
  - Incubation period is 1-6 days
  - Fever
  - Malaise
  - Fatigue
  - Cough and mild chest discomfort is followed by severe respiratory distress with dyspnea
  - Diaphoresis
  - Stridor
  - Cyanosis
  - Shock and death occurs within 24-36 hours of severe symptoms.

- **Diagnosing ANTHRAX:**
  - Physical findings are non-specific
  - Possible widened mediastinum
  - Detectable by Gram stain of the blood and by blood culture late in the course of illness.

- **Treatment:**
  - High dose antibiotic treatment with penicillin, ciprofloxacin, or doxycycline should be undertaken.
  - Supportive therapy may be necessary.

- **Prophylaxis:**
  - A licensed vaccine for use in those considered to be at risk of exposure.
  - Vaccine schedule is 0, 2, and 4 weeks for the initial series, followed by boosters at 6, 12, and 18 months and then a yearly booster.
  - Oral ciprofloxacin may be used for known or imminent exposure.

- **Decontamination:**
  - Secretion and lesion precautions should be practiced.
  - After an invasive procedure or autopsy is performed, the instruments and area used should be thoroughly disinfected with a sporicidal agent (iodine or chlorine).

CHOLERA

- Short, curved, motile, gram-negative, non-sporulating rod.
- Grows best at a pH of 7.0, but able to tolerate an alkaline environment.
- Does not invade the intestinal mucosa, but rather "adhere" to it.
- Cholera is the prototype toxigenic diarrhea, which is secretory in nature.
- Entire clinical syndrome is caused by the action of the toxin on the intestinal epithelial cell
- Fluid loss originates in the small intestine with the colon being relatively insensitive to the toxin
- The large volume of fluid produced in the upper intestine overwhelms the capacity of the lower intestine to absorb
- Transmission is made through direct or indirect fecal contamination of water or foods, and by heavily soiled hands or utensils
- All populations are susceptible, while natural resistance to infection is variable.
- Recovery from an attack is followed by a temporary immunity which may furnish some protection for years.
- The organism is easily killed by drying. It is not viable in pure water, but will survive up to 24 hours in sewage, and as long as 6 weeks in certain types of relatively impure water containing organic matter.
- It can withstand freezing for 3 to 4 days. It is readily killed by dry heat at 117 (C, by steam and boiling, by short exposure to ordinary disinfectants, and by chlorination of water.

- **Signs and Symptoms of Cholera**
  - Incubation period is 12-72 hours
  - Vary from asymptomatic to severe with sudden onset and include
    - Vomiting
    - Headache
    - Intestinal cramping with little or no fever followed rapidly by painless, voluminous diarrhea
    - Fluid losses may exceed 5 to 10 liters per day.
    - Without treatment, death may result from severe dehydration, hypovolemia and shock.

- **Diagnosis:**
  - Clinical diagnosis. 'Rice water' diarrhea and dehydration.
  - Microscopic exam of stool samples reveals few or no red or white cells.
  - Can be identified by dark-field or phase contrast microscopy and by direct visualization of darting motile Vibrio.

- **Treatment:**
  - Fluid and electrolyte replacement
  - Antibiotics (tetracycline, ciprofloxacin or erythromycin) will shorten the duration of diarrhea and shedding of the organism.

- **Prophylaxis:**
  - A licensed, killed vaccine is available but provides only about 50 percent protection that lasts for no more than 6 months.
  - Vaccination schedule is at 0 and 4 weeks, with booster doses every 6 months.

- **Decontamination:**
  - Personal contact rarely causes infection; however, enteric precautions and careful hand-washing should be employed.
  - Bactericidal solutions (hypochlorite) would provide adequate decontamination.

PLAGUE

- Rod shaped, non-motile, non-sporulating, gram-negative, bipolar staining, facultative anaerobic bacterium
- Zoonotic disease. Rodents (rats, mice, ground squirrels) in areas where plague is present can be infected with the bacteria.
  - Fleas which live on the rodents can sometimes pass the bacteria to human beings, who then suffer from the bubonic form of plague.
- The pneumonic form of the disease would be seen as the primary form after purposeful aerosol dissemination of the organisms.
- The bubonic form would be seen after purposeful dissemination through the release of infected fleas.
- All human populations are susceptible.
- Recovery from the disease may be followed by temporary immunity.
- The organism will probably remain viable in water and moist meals and grains for several weeks.
- At near freezing temperatures, it will remain alive from months to years but is killed by 15 minutes exposure to 72 C.
- Remains viable for some time in dry sputum, flea feces, and buried bodies but is killed with several hours of exposure to sunlight.

- **Signs and Symptoms of PLAGUE:**
  - Pneumonic plague:
    - Incubation period is 2-3 days
    - High fever
    - Chills
    - Headache
    - Hemoptysis
    - Toxemia
    - Progressing rapidly to dyspnea, stridor, and cyanosis
    - Death results from respiratory failure, circulatory collapse, and a bleeding diathesis.

  - Bubonic plague:
    - Incubation period is 2 to 10 days.
    - Malaise
    - High fever
    - Tender lymph nodes (buboes); may progress spontaneously to the septicemic form, with spread to the CNS, lungs, and elsewhere.
- **Diagnosis:**
  - Clinical diagnosis.
    - After an incubation period varying from 2-3 days for primary pneumonic plague, presumably dependent upon the dose of inhaled organisms
    - Onset is acute and often fulminant
    - Malaise
    - High fever
    - Chills
    - Headache
    - Myalgia
    - Cough with production of a bloody sputum
    - Toxemia.

  - A presumptive diagnosis can be made by Gram or Wayson stain of lymph node aspirates, sputum, or CSF. Plague can also be cultured.

- **Treatment:**
  - Early administration of antibiotics is very effective.
  - Supportive therapy for pneumonic and septicemic forms is required.

- **Prophylaxis:**
  - A licensed, killed vaccine is available. Initial dose followed by a second smaller dose 1-3 months later, and a third 3-6 months later.
  - A booster dose is given at 6, 12 and 18 months and then every 1-2 years.
  - This vaccine may not protect against aerosol exposure.

- **Decontamination and Isolation:**
  - Secretion and lesion precautions with bubonic plague.
  - Strict isolation of patients with pneumonic plague is required.
  - Heat, disinfectants and exposure to sunlight renders bacteria harmless.

TULAREMIA

- Francisella tularensis is a small, aerobic, gram-negative cocco-bacillus, often varying in size and shape.It is non-motile and non-sporulating.
- Tularemia (also known as rabbit fever and deer fly fever) is a zoonotic disease and humans acquire the disease under natural conditions through inoculation of skin or mucous membranes with blood or tissue fluids of infected animals, or bites of infected deerflies, mosquitoes, or ticks.
- Less commonly, inhalation of contaminated dusts or ingestion of contaminated foods or water may produce clinical disease.
- Respiratory exposure by aerosol would cause typhoidal tularemia often having a pneumonic component.
- The organism can remain viable for weeks in water, soil, carcasses, and hides, and for years in frozen rabbit meat.
- It is resistant for months to temperatures of freezing and below.
- It is rather easily killed by heat and disinfectants.

- **Signs and Symptoms:**
  - Ulceroglandular tularemia presents with a local ulcer and regional lymphadenopathy
    - Fever
    - Chills
    - Headache
    - Malaise.

- Typhoidal or septicemic tularemia presents with:
    - Fever
    - Headache
    - Malaise
    - Substernal discomfort
    - Prostration
    - Weight loss
    - Non-productive cough.

- **Diagnosis:**
  - Clinical diagnosis.
    - Physical findings are usually non-specific. Chest x-ray may reveal a pneumonic process, mediastinal lymphadenopathy or pleural effusion.
    - Routine culture is possible but difficult.
    - The diagnosis can be established retrospectively by serology.
    - After an incubation period varying from 2 to 10 days, presumably dependent upon the dose of organisms, onset is usually acute.
  - Ulceroglandular disease usually manifests as regional lymphadenopathy, fever, chills, headache, and malaise, with or without a cutaneous ulcer.
    - In those 5 to 10 percent of cases with no visible ulcer, the syndrome is known as glandular tularemia.
    - Primary ulceroglandular disease confined to the throat is referred to as pharyngeal tularemia.
    - Oculoglandular tularemia occurs after inoculation of the conjunctivae with infectious material.
  - Typhoidal or septicemic tularemia manifests as
    - Fever
    - Prostration
    - Weight loss, but without adenopathy.
  - Diagnosis of primary typhoidal tularemia is difficult, as signs and symptoms are non-specific and there frequently is no suggestive exposure history.
    - Respiratory symptoms of substernal discomfort and a non-productive cough may be present.
    - Radiologic evidence of pneumonia or mediastinal lymphadenopathy may or may not be present in all forms of tularemia but is most common with typhoidal disease.

- Identification of organisms by staining ulcer fluids or sputum is generally not helpful.
- Routine culture is difficult, due to unusual growth requirements and/or overgrowth of commensal bacteria.
- The diagnosis can be established retrospectively by serology.

- **Treatment:**
  - Administration of antibiotics (streptomycin or gentamicin) with early treatment is very effective.

- Prophylaxis:
  - A live, attenuated vaccine is available as an investigational new drug.
    - It is administered once by scarification.
    - A two week course of tetracycline is effective as prophylaxis when given after exposure.

- **Decontamination:**
  - Secretion and lesion precautions should be practiced.
  - Strict isolation of patients is not required.
  - Organisms are relatively easy to render harmless by heat and disinfectants.

VIRUSES

- Viruses are the simplest type of microorganisms. They depend upon living cells to multiply, so a virus will not live long outside of a host.
  - Dengue Fever
  - Equine Encephalitis
  - Variola
  - Ebola
  - Smallpox

VENEZUELAN EQUINE ENCEPHALITIS

- Venezuelan equine encephalitis (VEE) virus is an arthropod-borne alphavirus that is endemic in northern South America, Trinidad, Central America, Mexico, and Florida.
- Eight serologically distinct viruses belonging to the VEE complex have been associated with human disease
- These agents also cause severe disease in horses, mules, burros and donkeys (Equidae).

- Natural infections are acquired by the bites of a wide variety of mosquitoes.
- Equidae serve as amplifying hosts and source of mosquito infection.
- In natural human epidemics, severe and often fatal encephalitis in Equidae always precedes disease in humans.
- The virus is rather easily killed by heat and disinfectants.

- **Signs and Symptoms:**
  - VEE is characterized by inflammation of the meninges of the brain and of the brain itself, thus accounting for the predominance of CNS symptoms in the small percentage of infections that develop encephalitis.
  - The disease is usually acute, prostrating and of short duration.
  - Sudden onset of illness with generalized malaise
  - Spiking fevers
  - Rigors
  - Severe headache
  - Photophobia
  - Myalgias
  - Nausea / vomiting
  - Cough, sore throat, and diarrhea may follow.
  - Full recovery takes 1-2 weeks.

- **Diagnosis:**
  - Clinical diagnosis. Physical findings are usually non-specific.
  - The white blood cell count often shows a striking leukopenia and lymphopenia.
  - Virus isolation may be made from serum, and in some cases throat swab specimens.

- **Treatment:**
  - Supportive only.

- **Prophylaxis:**
  - A live, attenuated vaccine is available as an investigational new drug.
  - A second, formalin-inactivated, killed vaccine is available for boosting antibody titers in those initially receiving the live vaccine.

- **Decontamination:**
  - Blood and body fluid precautions should be practiced.
  - Human cases are infectious for mosquitoes for at least 72 hours.
  - The virus can be destroyed by heat (80 degrees centigrade for 30 minutes) and ordinary disinfectants.

SMALL POX

- Variola virus is the cause of smallpox.
- It is an Orthopox virus and occurs in at least two strains, one of which causes variola major, and the other causes a milder disease, variola minor.
- Despite widespread availability of a vaccine, the potential weaponization of variola continues to pose a military threat. This threat can be attributed to the aerosol infectivity of the virus, the relative ease of large-scale production, and an increasingly Orthopoxvirus-naive populace.
- Although the fully-developed cutaneous eruption of smallpox is unique, earlier stages of the rash could be mistaken for varicella.
- Secondary spread of infection constitutes a nosocomial hazard from the time of onset of a smallpox patient's exanthem until scabs have separated.
- Quarantine with respiratory isolation should be applied to secondary contacts for 17 days post-exposure.

- **Signs and Symptoms:**
  - The incubation period of smallpox averages 12 days, and contacts are quarantined for a minimum of 16-17 days following exposure.
  - Clinical manifestations begin acutely with malaise, fever, rigors, vomiting, headache, and backache.
  - 2-3 days later lesions appear which quickly progress from macules to papules, and eventually to pustular vesicles.
    - They are more abundant on the extremities and face, and develop synchronously.

Overview Rash Development

- **Smallpox rash is usually most dense on the face, arms and hands, legs and feet.**
- **The trunk has fewer pocks than the extremities.**

Note the density of the rash is greater on the face than on the body.

SMALL POX vs. CHICKEN POX

- **Chickenpox is the most important disease likely to be confused with smallpox. It is caused by a different virus.**
- **During the first day or two of rash it may be impossible, from the rash alone, to differentiate smallpox from chickenpox.**
- **By day 7, most of the chickenpox lesions have already formed scabs and some scabs, in fact, have already separated. Scabs over the smallpox lesions have not yet formed.**
- **The relative density of rash on different parts of the body should be carefully observed. This diagram illustrates the differences that are usually seen.**

- **Treatment:**
  - At present there is no effective chemotherapy, and treatment of a clinical case remains supportive.

- **Prophylaxis:**
  - Immediate vaccination or revaccination should be undertaken for all personnel exposed.
  - Vaccinia-immune globulin (VIG) is of value in post-exposure prophylaxis of smallpox when given within the first week following exposure.

- **Isolation:**
  - Strict quarantine with respiratory isolation for a minimum of 16-17 days following exposure for all contacts.
  - Patients should be considered infectious until all scabs separate.

TOXINS

- Toxins are toxic substances of natural origin produced by an animal, plant or microbe. They differ from chemical agents in that they are not manmade and are much more complex materials. They are usually more toxic than many chemical agents.
  - Botulinum
  - Perfringens
  - Ricin
  - Saxitoxin
  - Mycocototoxins

- Signs and Symptoms
  - Generalized weakness
  - Dizziness
  - Dry mouth and throat
  - Blurred vision
  - Dysphonia
  - Dysphagia
  - Late sign – Respiratory failure

- Treatment
  - Supportive care
  - If respiratory failure present
    - Intubation and ventilation

RICIN

- Signs and Symptoms
  - Weakness
  - Fever
  - Cough
  - Hypothermia ~36 hours following exposure
  - Followed by hypertension and cardiovascular collapse
- Treatment
  - Supportive care

Biological Event Special considerations

- Sick or dead animals
- HEPA mask and goggles for all patients with cough or flu-like symptoms
- Young, old and immunocompromised usually first to exhibit S/S
- Large number of patients with similar syndromes
- Unusual geographic, seasonal or age group illness
- Prophylactic antibiotic therapy should be considered for emergency personnel