The horrible events of September 11, 2001 changed our lives forever. The terrorist acts on that day cost approximately 3000 people their lives. They were the worst terrorist attacks on domestic soil in United States history. We are now experiencing a great sense of vulnerability and are constantly questioning our safety and that of our families. Top picture: Plumes of smoke poured over New York City as the World Trade Center collapsed to the ground. Bottom picture: Three unidentified rescue workers walked away from the crash site at the Pentagon. The Daily Progress photo by Dan Lopez via Associated Press.

The October, 2001 anthrax attacks were conducted via four envelopes mailed from Trenton, New Jersey containing *Bacillus anthracis* spores that were sent through the U.S. postal system (two of which are shown above). A fifth envelope was likely responsible for the Florida cases but was never recovered. Twenty-two cases of anthrax resulted; eleven inhalational and eleven cutaneous cases. In all, five people died from inhalational anthrax. The person/group responsible has not been identified. Bioterrorism was and remains a real threat.

The purpose of this presentation is to increase awareness about zoonotic diseases and bioterrorism and to emphasize that we all have an important role in protecting our communities and our country. We will cover several topics including the role of animals in public health, the importance of emerging and zoonotic disease, generalities about bioterrorism, the U.S. government agencies involved in preparing and protecting our nation, and a brief overview of potential bioterrorism agents. Finally, we will discuss the human health professional’s responsibility and what to do if bioterrorism is suspected. Prevention by preparedness is our objective.
It is estimated that pets are present in 59% of U.S. households. Many areas depend on livestock for their livelihood. Animals far outnumber humans in the world. The U.S. human population is almost 300 million, and chickens alone outnumber the humans in this country. It is important to consider animals, disease ecology, and public health in preparedness plans. Listed are the economic importance of livestock and poultry in our nation and estimated numbers as of 2003 (www.nass.usda.gov:81/ipedb).

<table>
<thead>
<tr>
<th>Animal</th>
<th>Number</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle and calves</td>
<td>94.9 million</td>
<td>~$70.5 billion</td>
</tr>
<tr>
<td>Hogs and Pigs</td>
<td>60 million</td>
<td>~$4.5 billion</td>
</tr>
<tr>
<td>Broiler</td>
<td>374 million</td>
<td>~$1 billion</td>
</tr>
<tr>
<td>Sheep and lamb</td>
<td>6.1 million</td>
<td>~$600 million</td>
</tr>
</tbody>
</table>

(These are live animal values and do not consider the value of the products we harvest from these species.) The images above show only a few ways in which animals are present in our everyday lives. The top right photo shows two pet dogs (courtesy DB Weddle, ISU); the bottom right picture shows two mares and their foals (courtesy DB Weddle, ISU); and the bottom left photo shows a very large flock of turkeys.

Animals are an integral part of our society. Pets can provide companionship, services for the disabled, protection, and much more. The health benefits of the human-animal bond are well recognized. Wildlife play an important role in our communities by providing a sense of tranquility and also sport, e.g. hunting. Animals provide entertainment, e.g. racing, zoos, circus. Livestock and poultry generate needed income for producers and the economy while supplying a safe food product for consumers. This slide highlights the positive impact animals have on public health. The top photo shows a member of the Beagle Brigade (dogs that are used for inspection in airports); the bottom left picture shows a group of cows in a field; the bottom right photo shows a hippopotamus race. Images found at: www.belizeinvest.org.bz/profile_agric_livestock.shtml, www.sporting-pictures.com/animal.htm.

Despite the many positive contributions made by animals in our society, they also have disease implications for humans. The word zoonotic is used to refer to diseases that can be transmitted from animals to humans. Understanding the role of animals in zoonotic diseases is important for detection of diseases. This is true whether the diseases are newly emerging or intentionally introduced. Diseases can be directly transmitted from an animal to a human, e.g. cats with pneumonic plague can infect humans through their respiratory secretions. Transmission can also be indirect. For example, humans can become ill by eating food contaminated with a zoonotic agent. Meat contaminated with \textit{E. coli} O157:H7 or \textit{Salmonella} from cattle, chickens or turkeys, if not properly cooked, can make humans ill. Vectors can transmit diseases from animals to humans, e.g. the mosquito is a vector that transmits West Nile Virus from birds to humans. Another form of indirect transmission is through fomites, which are inanimate objects such as bedding, bandages, feed bowls, etc that can transmit pathogens. The top photo shows a picture of a housecat, which can transmit disease such as pneumonic plague to humans; the bottom photo shows a meat inspector in a plant. Images from: www.ii.uib.no/~mortena/blog/; www.meatscience.org/Inside/history.htm.
Animals can serve as a reservoir, shedder, and/or spreader of disease. Some examples of this include: rodents which serve as a reservoir for plague; wild buffalo infected with brucellosis shed the disease to susceptible cattle. The interface between domestic animals and wildlife is important in disease transmission. If an agent is transmitted to wildlife there is potential of an enzootic cycle (a disease with low morbidity constantly present in the animal community) being established, recurring human infections, greater costs associated with control or eradication of the disease, and the spreading to neighboring states and or countries is possible. The above photo shows a deer mouse, *Peromyscus maniculatus*, which can be a reservoir for diseases such as Hantavirus.

Animals can serve as sentinels (one that will show signs of the disease prior to humans) for some zoonotic diseases. Birds are sentinels for West Nile Virus in humans (top photo). Early recognition of a disease in a sentinel animal could potentially save human life. The bottom photo of a prairie dog reminds us of another consideration regarding animal interaction: the risk of the emergence of new zoonotic diseases, such as Monkeypox. Let’s look at some recent examples.

This slide demonstrates a number of zoonotic diseases that have recently emerged. Graphic by T. Engelhaupt, ISU.

Several recent publications have highlighted that many of the emerging diseases are zoonotic. The publication from 2001 (from the Philosophical transactions of the Royal Society of London. Series B: Biological sciences) did a statistical evaluation of emerging diseases and estimated that 75% of emerging pathogens are zoonotic. The route of transmission is still unknown for over 200 human pathogens. The second publication (the issue report of Trust for Health, HealthyAmericans.org) highlights recent diseases that affect both animals and humans, and encourages efforts to prevent these types of diseases. The picture of the cat is from the New York Times. A Taiwanese woman put a mask on her cat to protect it from SARS.

There are many risk factors associated with transmission of zoonoses. This slide highlights a few. Many of these are the same factors that contribute to emerging diseases. Frequent contact with wild or domestic animals is an obvious risk factor. Our desire to live on the wilderness fringe is thought to have contributed to the emergence of Lyme disease and Rocky Mountain Spotted Fever. Our attraction for the odd and unusual pet has contributed to exposure to zoonotic disease and Monkeypox is an example of that. Live animal market settings like those in Asia have large numbers of animals and people mixing together. SARS is an example of a disease that may have emerged in that setting. Working with livestock is a risk for zoonotic disease, e.g. anthrax is also called “wool sorter’s” disease because the organism can be transferred from the wool of an infected sheep to the person processing the wool. Exposure to animal waste is a risk for transmission of a zoonotic pathogen. An example of a natural exposure that demonstrates this occurred on Martha’s Vineyard in 2000. Several lawn care...
Workers were diagnosed with tularemia. It was proposed that \textit{F. tularensis} was shed in animal excrement and infected people after the organism was mechanically aerosolized and inhaled when they mowed the lawn. People with compromised immune systems are at an increased risk for zoonotic disease and should take precautions to protect themselves.

The risk of zoonotic disease transmission can be reduced while still enjoying and interacting with animals. As with any disease, follow proper hygiene, especially hand washing. Children should be supervised to make sure they use soap and water and have adequate contact time to kill bacteria. Keep areas that have been contaminated with animal waste clean and disinfected.

There are many precautions that can be taken to decrease the risk of zoonotic diseases. Limit exposure to stray animals and wildlife. Encourage reporting to appropriate authorities if a stray animal is observed. Follow proper guidelines for preparing and cooking food to decrease risk of disease. Encourage proper pet selection and selection of domesticated species. Realize the risks of non-domestic exotic species for pets. Good hygiene at petting zoos is important; handwashing and avoiding animals that appear sick. There are special considerations that should be addressed with immunocompromised individuals and their interactions with animals. Prepared guidelines are available at the CDC website. The above photo shows a young girl feeding a goat from her hand at a petting zoo; photograph by DB Weddle, ISU.

Pictured is the animal petting area at the Iowa State Fair. The photographer watched to see what actions people would take following petting these animals. (This State Fair requires health certificates for all animals, but that should not replace good hygiene practices following handling of animals.) Photograph by RG Davis, ISU.

This family gets an A+. After petting the animals they proceeded to the hand washing area provided. We did not follow them to determine whether they proceeded to another public health risk- the fried food stands. Photograph by RG. Davis, ISU.
The connection or relationship of animals and people is important and has boundless positive aspects. It does potentially have some negative public health implications. Education and communication between the veterinary and human health communities and the public are important. Animals and disease ecology must be considered in the plans for prevention, response, and recovery to a zoonotic disease agent.

Infectious disease outbreaks are first recognized at the local level. Human health professionals should be prepared to: recognize the expected (common) disease outbreaks, recognize the unusual, and collect, process and store samples in case they are needed. The human health professional should be familiar with the agents that might be used in an attack, know what signs to look for, ask questions about animal exposure and clinical signs, and know who to call if an intentional or accidental release of a biological agent is suspected. Human health professionals have the responsibility of providing leadership and disseminating sound scientific information.

“Biological warfare is defined as the use of microorganisms or toxins derived from living organisms, to cause death or disease in humans, animals, or plants in civilian settings. The definition would apply to the lone perpetrator acting independently, to state-supported terrorism, and to undeclared wars, as well as to declared armed conflict. Of the 3 targets (humans, animals, and plants) in the United States, the greatest threat would appear to be to human beings and animals.” Source: Huxsoll D, Patrick W, Parrott C. Veterinary services in biological disasters. *JAVMA* 1987;190:714-722. This definition will be used for our purposes. The motivations of terrorists and terrorist groups to launch a bioterrorist attack are many, e.g. economic, social, religious and/or political.

Greater than 95% of the diseases/agents on the CDC’s Category ABC list affect both animal and humans. Awareness about zoonotic potential is important to preparedness efforts. This information is important for veterinarians, human health professionals, animal owners, and the general public. Pictured is a portion of the wall chart developed by the Center for Food Security and Public Health. Five of the six Category A agents affect animals. The chart demonstrates how different species are affected by the different agents. So, although an agent is zoonotic that does not mean it will affect every other species. For example, notice the difference between anthrax and plague. In an outbreak, knowing which animals are most likely to be affected will be important in educating animal owners and in the response. If these agents are used in a biological attack, the disease may present differently and species not usually infected may develop disease. However, being aware of what is normal is very important to enable us to detect what is abnormal.
Characteristics of a Biological Attack

- Difficult to detect release
- Dissemination may cover large area
- Possible secondary spread
- Recognition of agent may be delayed days to weeks
- Difficulties in catching perpetrator

It can be difficult to detect when biological agents are released. Dissemination often covers a large geographic area and clinical cases may take days to weeks to recognize. There is also the possibility of secondary spread if the agent is contagious person-to-person, zoonotic, or spread through a vector. These factors, especially the delayed recognition, give the perpetrator plenty of time to leave the area.

Infectious Disease Outbreak

This graph depicts the onset of an infectious disease outbreak. Note the time from exposure to the onset of symptoms. This demonstrates how cases may be delayed in their recognition, and by the time patients seek care, the perpetrator is gone. Animal disease follows a similar pattern. However, if an animal species is more susceptible to an organism (acts as a sentinel) then the time course from exposure to disease may be shorter than in humans. Increased awareness of these situations could lead to early detection in animals and allow the opportunity to mitigate the disease in humans.

Clues to Intentional Zoonotic Agent Release

- Clustering of morbidity or mortality
  - Temporally or geographically
  - Animals or people affected
- Generally healthy animals or people affected
- Unusual symptoms for area
- Unusual age distribution
- Disease occurring outside typical season

Although there are many difficulties in detecting a bioterrorism attack, there are several clues that suggest a biological agent may have been released. Healthcare providers should be alert to illness patterns and diagnostic clues that might indicate an unusual infectious disease outbreak associated with intentional release of a biologic agent. Indications of intentional release of a biologic agent include: 1) an unusual clustering of illness or mortality in a given geographic region or limited time frame for a large number of people or animals. This may also include abnormal or atypical unexplained symptoms; 2) normally healthy people or animals suddenly becoming ill; 3) symptoms occurring in patients from an area that does not usually have clinical signs of that particular disease (e.g. one cat or person with signs of plague in Florida, a state known to be plague free); 4) an unusual age distribution for common diseases (e.g. an increase in chickenpox-like illness among adult patients may be smallpox); or 5) the disease is occurring outside its “typical” season (e.g. flu-like symptoms in humans in June in the northern hemisphere).

U.S. Agencies

Because of the threat of bioterrorism and the attack in 2001, various U.S. government agencies have made changes to strengthen our national security and the public health system.
Public Health Security and Bioterrorism

- Preparedness Response Act
  - June 12, 2002
- Improve ability of the U.S. to prevent, prepare for, and respond to bioterrorism and other public health emergencies
- $4.3 billion to various federal, state and local agencies
- Upgrade facilities, enhance security, etc

Department of Homeland Security

- DHS established January 2003
- Mission
  - Prevent, protect, and respond to acts of terrorism on U.S. soil
- Established four policy directorates
  - Responsibilities for coordinating HHS and USDA
- Guard borders and airports, coordinate the response for future emergencies, analyze threats and intelligence, protect our critical infrastructure

Centers for Disease Control and Prevention

- CDC’s Mission:
  - Promote health and quality of life by preventing and controlling disease, injury, and disability
- Preparing for bioterrorism since 1998
- One of first agencies to respond to anthrax incidents

Our country has increased spending to improve our public health system. On June 12, 2002, the President signed the "Public Health Security and Bioterrorism Preparedness Response Act of 2002". Public Law 107-188 is designed to improve the ability of the United States to prevent, prepare for, and respond to bioterrorism and other public health emergencies. The Act is divided into the following five titles: Title I - National Preparedness for Bioterrorism and Other Public Health Emergencies; Title II - Enhancing Controls on Dangerous Biological Agents and Toxins; Title III - Protecting Safety and Security of Food and Drug Supply; Title IV - Drinking Water Security and Safety; and Title V - Additional Provisions. $4.3 billion dollars have been appropriated to state and local governments to improve planning and educate health care personnel; the CDC to upgrade their facilities; the Secretary of Health and Human Services to stockpile medical supplies; the FDA and USDA to enhance agricultural security, research and development; and to assess vulnerability and develop response plans.

On November 25, 2002, President Bush signed the "Homeland Security Act of 2002" into law. On January 24, 2003 the Department of Homeland Security (DHS) was established. “The creation of the DHS is the most significant transformation of the US government since 1947, when Harry S. Truman merged the various branches of the US Armed Forces into the Department of Defense to better coordinate the nation’s defense against military threats.” (from www.dhs.gov) Twenty-two federal agencies were brought together to streamline and centralize efforts to protect our nation’s homeland. The DHS provides one point of contact for state and local groups and the private sector. The mission of the DHS is to prevent terrorist attacks within the US, protect against terrorist attacks by decreasing our vulnerability, and minimizing damage from potential attacks and natural disasters. The DHS is organized into: Four Policy directorates (bureau or department): Border and Transportation Security (guard borders and airports), Emergency Preparedness and Response (coordinate the response for future emergencies), Information Analysis and Infrastructure Protections (analyze threats and intelligence), and Science and Technology (protect our critical infrastructure); a Management Directorate; the US Coast Guard; and the US Secret Service. Within the four policy directorates are multiple responsibilities for coordinating the efforts of the Department of Health and Human Services (HHS) and the United States Department of Agriculture (USDA).

The Centers for Disease Control and Prevention (CDC) is recognized as the lead federal agency for protecting the health and safety of people - at home and abroad. They provide credible information to enhance health decisions and promote health through strong partnerships. The CDC serves as the national focus for developing and applying disease prevention and control, environmental health, and health promotion and education activities designed to improve the health of the people of the United States. The CDC is headquartered in Atlanta, Georgia, and is an agency of the Department of Health and Human Services. Dr. Julie L. Gerberding is the Director. CDC has been responding to public health emergencies for decades and has been preparing for bioterrorism in particular since 1998, and CDC’s bioterrorism plans were put into action in Fall 2001. CDC was one of the first agencies to respond during the anthrax outbreaks. One of the primary elements learned from these attacks was the importance of rapid identification. CDC works hard to help local and state health departments increase their capabilities for early detection.
The mission of the Strategic National Stockpile (SNS), previously called the National Pharmaceutical Stockpile, is to ensure the availability of life-saving pharmaceuticals, antidotes and other medical supplies and equipment necessary to counter the effects of nerve agents, biological pathogens and chemical agents. The SNS Program stands ready for immediate deployment to any U.S. location in the event of a terrorist attack using a biological, toxin or chemical agent directed against a civilian population. These response packages are stored in strategic locations around the U.S. to ensure rapid delivery anywhere in the country. Following the federal decision to deploy, the SNS will typically arrive by air or ground in two phases. The first phase shipment is called a 12-hour Push Package. “12” because it will arrive in 12-hours or less, “push” because a state need only ask for help—not for specific items, and “package” because the Program will ship a complete package of medical material to respond to a broad range of threats. Also available are inventory supplies known as Vendor Managed Inventory, or VMI. VMI packages can be tailored to provide pharmaceuticals, vaccines, medical supplies and/or medical products specific to the suspected or confirmed agents. A CDC team of five or six technical advisors will also be deployed at the same time as the first shipment. Known as a Technical Advisory Response Unit (TARU), this team is comprised of pharmacists, emergency responders, and logistics experts that will advise local authorities on receiving, distributing, dispensing, replenishing, and recovering SNS material. The SNS was tested in a real-life terrorist attack in response to the tragic events of September 11th and all facets of the New York operation performed exactly as intended.

The Iowa slides have been included as an example. Delete them and put in the information appropriate for your state.

Iowa’s Homeland Security Office works under the direction of the Federal Homeland Security Office. The mission of the Iowa Homeland Security office is to develop and coordinate the implementation of a comprehensive state strategy to secure the State of Iowa from terrorist threats or attacks and to coordinate the State of Iowa’s efforts to detect, prepare for, prevent, protect against, respond to and recover from terrorist attacks within Iowa. Iowa’s Homeland Security Office assesses current capabilities and assets of state government, identifies critical assets important to Iowa citizens, and ensures that they are protected, works with local emergency management agencies in each of Iowa’s 99 counties, and facilitates communication between many state departments and agencies, including the Iowa Department of Public Health and the Iowa Department of Agriculture and Land Stewardship.
Preparing Iowa

- Iowa Department of Public Health
  www.idph.state.ia.us/odedp
- Iowa Department of Agriculture
  and Land Stewardship
  - Highly infectious animal disease program

The Iowa Department of Public Health established the Office of Disease Epidemiology and Disaster Preparedness (ODEDP) in October 2001. The ODEDP encompasses two centers, the Center for Acute Disease Epidemiology (CADE) and the Center for Disaster Operations and Response (CDOR). The ODEDP leads development and implementation of an integrated system of health and public health services in preparedness for and response to disaster/terrorism incidents, outbreaks of infectious disease, and other public health threats and emergencies. The Iowa Department of Agriculture and Land Stewardship (IDALS) has been working on response plans for outbreaks of highly infectious animal diseases including the chain of communication between state agencies.

Category ABC Agent Overview

In this section, we first discuss how the CDC Category ABC disease/agent list was established and then overview the diseases.

Classification

- Prepared by the CDC’s Bioterrorism Preparedness and Response Office
- Category A: Highest priority
- Category B: Second highest priority
- Category C: Third highest priority

In 1999 Congress requested that the national public health capabilities for response to acts of biological terrorism be upgraded. The CDC was designated as the lead agency for overall public health planning. In order to focus their preparedness efforts, the CDC needed to select and prioritize biological agents based on the threat they posed to public health. A group of national experts including infectious disease specialists, Department of Health and Human Services personnel, civilian and military intelligence experts, and law enforcement officials gathered to establish the list. The general criteria used for selection and prioritization were: 1) the public health impact based on illness and death; 2) the delivery potential to large populations based on stability and ability to mass produce and distribute a virulent agent; 3) potential for person to person transmission; 4) the public perception as related to public fear and potential civil disruption; 5) the special public health preparedness needs, stockpiles required, surveillance and diagnostic needs. Special attention was given to those agents that had previously been used or researched as a bioweapon. Based on these criteria, agents were scored and divided into A, B and C Categories. This is not a federally legislated list and is subject to change based on review of agents. Using this standardized system allows the CDC to add or remove agents. As veterinarians it is important to be aware of these agents and review these diseases as they relate to veterinary patients.

“For Weaponization’ of Agents

- Alter characteristics of a pathogen to make it a more effective weapon
  - Enhance transmission
  - Increase virulence
  - Resistant to antibiotics
  - Evade vaccine protection
  - Alter clinical signs

For each Category ABC disease we discuss, we will briefly review the agent, highlighting transmission and clinical signs in humans and animals, discuss the agent as a bioweapon, and then how we can prevent and control disease. However, before discussing the diseases, it is important to understand weaponization of an agent. If an agent has been weaponized, characteristics of the pathogen may have been altered to make it a more effective weapon. For example, the transmission of a pathogen may be enhanced or the virulence increased; the organism may have been altered to make it resistant to antibiotics it would otherwise be susceptible to; weaponization of an organism may allow it to evade the normal protective immunity induced by vaccine, or it may even alter the clinical signs. It is difficult to know. However, reviewing the agents and what we currently know about them is still important for our enhanced awareness of these agents.
The agents/diseases in Category A are anthrax, botulism, plague, smallpox, tularemia, and viral hemorrhagic fevers. Smallpox is the only disease not considered to be zoonotic.

Anthrax is caused by *Bacillus anthracis*, a spore forming, Gram positive aerobic rod. It has a worldwide distribution and is particularly common in parts of Africa, Asia and the Middle East. In the United States, foci of infection occur in South Dakota, Nebraska, Mississippi, Arkansas, Texas, Louisiana and California, with smaller areas in other states. Spores can remain viable for decades in the soil or animal products, such as dried or processed hides and wool. Spores can also survive for 2 years in water and 10 years in unpasteurized milk. The vegetative form of the organism is thought to be destroyed within a few days during the decomposition of unopened carcasses (exposure to oxygen induces spore formation). Natural transmission of anthrax to humans is most commonly through occupational exposure to infected animals, their fluids or tissues. Routes of transmission for anthrax include direct contact, inhalation or ingestion of the organism. Anthrax spores can be acquired through direct contact with animal products, such as hides or wool. A wound or abrasion is required for entry. Spores can also be inhaled by the processing of these materials, bone meal or contaminated dust. Ingestion of meat containing viable spores is another route of transmission for anthrax. Animals typically acquire anthrax through ingestion of the spores in the soil. Person-to-person transmission of anthrax is rare and has only been reported in cases of cutaneous anthrax. The photo shows a *B. anthracis* bacilli Gram stain. Images from CDC Public Health Image Library.
Anthrax: The Disease

- Humans
  - Cutaneous
    - 95% of natural cases
    - Mortality 5-20%
  - Pulmonary
    - Mortality 75-95%
  - Gastrointestinal
    - Mortality >50% mortality

- Animals
  - Ruminants at greatest risk
  - No cutaneous lesions

There are three forms of disease in humans with anthrax infection. 1) **Cutaneous anthrax** (upper photo) is the most common form seen in natural infections (95% of cases). It occurs when spores enter through breaks in the skin (cuts, abrasions). This form is characterized by a pruritic papular skin lesion, surrounded by edema and vesicles. Most lesions scab over (eschar) and resolve spontaneously but disseminated, fatal infections can occur in approximately 5-20% of cases. 2) **Pulmonary anthrax** occurs after inhaling spores from contaminated dust or animal products (i.e., wool, hides). Natural infections are mainly seen among workers who handle infected hides, wool, and furs. Symptoms may include fever, malaise, a nonproductive cough and mild chest pain. However, severe respiratory distress soon follows with fatal septicemia and shock within one to two days. 3) **Gastrointestinal anthrax** develops after consumption of contaminated meat. The initial symptoms may be mild malaise and gastrointestinal symptoms. Severe symptoms can develop and rapidly progress to shock, coma and death. Anthrax in animals primarily affects livestock, especially ruminants (shown in bottom photo). The most susceptible species is cattle, followed by sheep, horses, goats then pigs. Dogs and cats can also be affected, but natural cases are uncommon. Peracute disease and sudden death of the animal is most often seen. Hemorrhaging from orifices (i.e., anus, nostrils, vulva, or mouth or eyes) as well as incomplete rigor mortis and bloating may also be noted. A large number of anthrax organisms can be found in hemorrhagic exudates. If clinical signs are seen they may include recumbency, depression, listlessness, fever, labored breathing, abortion; also edema of the tongue, throat, sternum, perineum, and flanks may occur. Horses with acute disease may exhibit colic and death within 48-96 hours. There are no reported cases of cutaneous infection in animals. Bottom photo courtesy of DB Weddle, ISU.

Anthrax: Zoonotic Importance

- Zoonotic potential
  - Direct contact
  - Inhalation
  - Ingestion
- High risk groups:
  - Occupational
    - Livestock
    - Slaughterhouse workers
    - Tannery or wool industry workers
    - Veterinarians
  - Lab workers

Zoonotic transmission of the organism from animals can occur either by direct contact, inhalation or ingestion. As previously mentioned, the groups at highest risk for naturally acquiring anthrax include those occupationally exposed to animals. The above photo depicts people sorting wool, which can be a risk factor for zoonotic pulmonary anthrax, “wool-sorter’s disease.”

Anthrax: The Bioweapon

- Bioweapon
  - History
  - Easy to produce
  - Spores infective and highly resistant
  - Aerosolization
  - Low lethal dose
  - High mortality

Anthrax has a long history of being researched and developed for use as a bioweapon. *B. anthracis* was part of the U.S. bioweapons research program in the 1950’s and 1960’s. In 1979, an accidental release of aerosolized anthrax (which was publicly denied by the government) occurred from a military compound in the Soviet Union. The neighboring residents experienced high fevers, difficulty breathing, and a large number died. Fatality estimates ranged from 200-1000. It wasn’t until 1992 that Russian President Boris Yeltsin finally acknowledged that the release occurred from a large scale military research facility. Iraq also admitted, in 1991, they had been doing research with *B. anthracis* as a bioweapon. There are several characteristics of *B. anthracis* that make it an attractive bioweapon. It is widely available (distributed worldwide in soil) and is relatively easy to produce. The spores are highly resistant, and remain infective when aerosolized. The lethal dose for inhalation of spores is low and mortality is high; case-fatality rates for inhalational anthrax can reach 75-90%. Untreated pulmonary and gastrointestinal infections are almost always fatal, especially if recognized too late for effective treatment. The above image shows *Bacillus anthracis* non-hemolytic on sheep blood agar with “Medusa head” appearance (non-pigmented, dry ground glass surface, edge irregular with comma projections). Image from CDC Public Health Image Library.
Botulism (also called “limberneck” in waterfowl) is caused by neurotoxins produced by *Clostridium botulinum*, a Gram positive, spore-forming, anaerobic bacillus, that is found in the soil worldwide. After spores of the organism germinate they can release 7 different antigenic types of neurotoxins (classified A through G), which irreversibly bind neuromuscular junctions. Botulism can affect many species of birds, fish, and mammals, including humans. Different neurotoxin types affect different species, however, clinical disease is the same for all species, progressive flaccid paralysis. Transmission of botulinum neurotoxin typically occurs through the foodborne route. This is either through direct consumption of the neurotoxin in contaminated food (i.e. home-canned vegetables, improperly fermented fish or undercooked meat products such as sausage) or through ingestion of *C. botulinum* in food which then sporulate and release neurotoxin in the gastrointestinal tract (i.e. honey in infants). In animal species, the toxin is typically ingested in feed (i.e., contaminated silage, hay or grain for livestock; meat or fish for carnivores; decaying vegetation for waterfowl). Humans can also become infected through exposure of a wound to the clostridial spores, which then grow under anaerobic conditions. Aerosolization of the neurotoxin is also possible and the most likely transmission route that would be used in a bioterrorism event. The zoonotic potential for this organism comes from ingestion of contaminated animal meat products (i.e., improperly fermented fish or undercooked sausage). The child in this picture is too weak to hold up its head as noted by the limp appearance of the neck and arms. It was an infant case of botulism. 72% of natural botulism cases occur in children under 1 year of age. California Department of Health Services http://www.dhs.ca.gov/dcdc/InfantBot/toxfig2.htm.

Clinical signs of botulism for all species are relatively consistent and manifests as progressive flaccid paralysis. Other signs include generalized weakness, dizziness, dysphagia, drooping eyelids. In humans, gastrointestinal symptoms may precede the neurological symptoms. Clinical disease in animals is most often seen in waterfowl, mink, cattle, sheep, and horses (especially foals). Ruminants and horses will often hypersalivate while humans experience dry mouth. Paralysis of the respiratory muscles can occur within 24 hours and is most commonly the cause of death. All suspected cases of botulism should be considered a medical emergency. The reported case-fatality rate for botulism cases is 5-10%, when treated early. This photo depicts chicks with limberneck, a common clinical manifestation of botulism in waterfowl.

Botulinum toxins are known to have been weaponized by several countries and terrorist groups in the past. It was part of the U.S. bioweapons program, Iraq has produced large volumes of this toxin, and the Aum Shinrikyo cult in Japan tried unsuccessfully to use it in 1990. Botulinum toxin is relatively easy to produce and transport, is extremely potent and lethal. It is considered the single most poisonous substance known, with only a few nanograms of the toxin causing severe illness. A deliberate release of the toxin, either via aerosol, food, or water, is expected to cause clinical illness similar to foodborne illness. Additionally, detection of uncommon toxin types, such as C, D, F, or G, may also raise suspicion of an intentional release.
**Plague: The Agent**

- *Yersinia pestis*
- Transmission
  - Flea bite
  - Direct contact
    - Infected animal tissue or fluids
    - Aerosol
  - Person-to-person
- Zoonotic potential
  - Rodents, cats

Plague is caused by *Yersinia pestis*, a Gram negative coccobacillus and is a facultative intracellular pathogen. An average of 10-15 human cases per year occur in the U.S., primarily in the Southwestern United States. Human cases of plague typically occur in April through November, when fleas and their hosts are most active. Transmission can occur via various routes. Of these, transmission from the bite of an infected flea (particularly a rodent flea) is the most common. People (hunters, wildlife personnel) can be directly infected by handling the tissues of infected rodents (reservoir host) or their fleas. Plague can also be transmitted by aerosol (i.e., infected person or animal [cat] sneezing or coughing). This is the only route of person-to-person transmission for plague and is highly contagious. Upper photo: *Xenopsylla cheopis* (oriental rat flea) engorged with blood. Bottom photo: California ground squirrel.

**Plague: The Disease**

- Humans
  - Bubonic (50-60% fatality)
  - Septicemic (~100% fatality)
  - Pneumonic (~100% fatality)
- Animals
  - Rodents: reservoir
    - Ground squirrels, prairie dogs, rats
  - Cat: similar to human forms

Plague is a continuum of illness, progressing from one form to the next if left untreated. 1. **Bubonic plague** is the most common form and accounts for roughly 80% of cases, and includes flu-like symptoms and very swollen, painful lymph nodes (called “bubo”), as shown in the upper photo, an enlarged axillary lymph node. Without treatment, 50-60% of bubonic cases are fatal.

2. **Septicemic** plague, is manifested as septic shock, disseminated intravascular coagulation, and necrosis of extremities can be seen (this is often seen in the finger tips (bottom photo), tip of the nose, and toes and is the result of microthrombi blocking capillaries and the circulation to these areas). 3. **Pneumonic** is the least common form but one of the most fatal. It occurs when the organism is inhaled (primary) or after blood-borne spread to the lungs (secondary). Dyspnea and hemoptysis are rapidly followed by respiratory failure and shock (<48 hours). This is the only form of plague that can be transmitted person-to-person because the agent is aerosolized with a cough. Without treatment, almost 100% of septicemic and pneumonic cases are fatal. Although many mammals have been found to be serologically positive for plague, the majority of animal cases occur in the reservoir species of rodents (i.e., ground squirrels, rock squirrels, prairie dogs, chipmunks, woodrats, etc). Typically the rodents serve as a maintenance host with very little death in the population. However intermittent epidemics do occur and result in rapid death of the rodents. Any fleas present on the animals during this time, seek out new hosts (i.e., cats or other carnivores), thus allowing the disease to spread.

**Plague: Zoonotic Importance**

- Transfer of infected fleas
- Contact with infected rodents
- Contact with infected cat
  - Sneezing droplets
  - Flea transfer
  - Scratch or bite

The zoonotic potential for plague lies in its various routes of transmission. Possible transfer to humans from infected fleas or infected tissue or droplet spray from infected animals may occur. Infected fleas can be transferred from wild rodents or domestic animals, particularly cats to humans. Additionally the organism may be transferred through aerosolization. Human cases have developed from domestic cat exposure. The outdoor domestic cat can be infected by eating infected rodents or acquiring infected rodent fleas. They then expose their owners to the infected flea or respiratory aerosol when coughing. Rare cases of bite or scratch transmission of plague from cats to people have been documented. Wild carnivores, prairie dogs (top photo), canines, and farm animals appear to be very resistant to disease, although dogs have been infected experimentally.
<table>
<thead>
<tr>
<th>Plague: The Bioweapon</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>History</strong></td>
</tr>
<tr>
<td><strong>Available</strong></td>
</tr>
<tr>
<td><strong>Pneumonic form highly contagious</strong></td>
</tr>
<tr>
<td><strong>WHO estimate</strong></td>
</tr>
<tr>
<td>– 50 kg agent: City population 5 million</td>
</tr>
<tr>
<td>– 150,000 cases pneumonic plague</td>
</tr>
<tr>
<td>– Potential mortality: 100,000</td>
</tr>
</tbody>
</table>

Plague has been a part of the bioweapons research programs in several countries, including U.S. and Soviet Union. In WWII, the Japanese reportedly released plague carrying fleas over Chinese cities killing at least 109 people. Other methods of aerosolizing plague have been studied and would be more damaging. Plague occurs in many areas of the world, making it readily available. Pneumonic plague can be highly contagious. In 1970, the World Health Organization assessment estimated that, in a worst case scenario, a dissemination of 50 kg of *Y. pestis* in an aerosol cloud over a city of 5 million might result in 150,000 cases of pneumonic plague, 80,000-100,000 of which would require hospitalization and 36,000 of which would be expected to die. This does not include secondary cases and their resulting deaths, which could bring total mortality to 100,000.

<table>
<thead>
<tr>
<th>Smallpox: The Agent</th>
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<tbody>
<tr>
<td><strong>Orthopoxvirus</strong></td>
</tr>
<tr>
<td><strong>Variola virus</strong></td>
</tr>
<tr>
<td><strong>Eradicated worldwide in 1977</strong></td>
</tr>
<tr>
<td>– Officially declared in 1980</td>
</tr>
<tr>
<td><strong>Transmission</strong></td>
</tr>
<tr>
<td>– Person-to-person</td>
</tr>
<tr>
<td>– Direct contact</td>
</tr>
<tr>
<td>– Fomites</td>
</tr>
<tr>
<td>– Aerosol</td>
</tr>
</tbody>
</table>

Smallpox results from infection by variola virus (Family Poxviridae, Genus Orthopoxvirus). The last naturally acquired case of smallpox occurred in 1977 and the last two laboratory-acquired infections were in 1978. In 1980, the World Health Organization (WHO) declared that smallpox had been eradicated worldwide. Currently, the only known stocks of virus are stored at the Centers for Disease Control and Prevention (CDC) in Atlanta and the Institute for Viral Preparations in Moscow, however, other countries may have clandestine stores of virus. Humans are the only species naturally susceptible to infection. The smallpox virus is transmitted person-to-person. Patients are known to be infectious from the time the rash appears and remain infectious until the time the scabs have separated (approximately 7 to 10 days). Virus is spread by direct contact or inhalation of aerosols. Transmission on fomites, such as contaminated clothing or bedclothes, is possible for short periods of time; however, variola does not remain viable for more than 2 days outside a human host.

<table>
<thead>
<tr>
<th>Smallpox: The Disease</th>
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<tbody>
<tr>
<td><strong>Human disease</strong></td>
</tr>
<tr>
<td>– Acute</td>
</tr>
<tr>
<td>– Initially flu-like</td>
</tr>
<tr>
<td>– Fever, malaise</td>
</tr>
<tr>
<td>– Headache, backache, vomiting</td>
</tr>
<tr>
<td>– Progressive skin eruptions</td>
</tr>
<tr>
<td>– Macules to papules to vesicles</td>
</tr>
<tr>
<td>– Hemorrhagic and malignant forms possible</td>
</tr>
<tr>
<td>– Both have high mortality rate (up to 95%)</td>
</tr>
<tr>
<td><strong>Only affects humans</strong></td>
</tr>
<tr>
<td>– Experimentally</td>
</tr>
<tr>
<td>– Cynomolgus monkeys</td>
</tr>
</tbody>
</table>

Smallpox has an acute onset; the initial clinical signs may include fever, malaise, rigors, vomiting, headache, backache and occasionally delirium. The characteristic skin lesions usually appear 2 to 3 days later; the first signs are macules, which develop into papules and eventually pustular vesicles. These lesions are most common on the face and extremities and develop in synchronous “crops.” Two forms of smallpox may be seen, variola minor and variola major. Variola minor is a mild disease and variola major is a more severe disease, which in a small percentage of people develops into either hemorrhagic or malignant forms. The malignant form has a mortality rate of 95%. Animal species are not susceptible to naturally occurring smallpox, however cynomolgus monkeys have been infected by high dose inoculation of the virus. [Note: cynomolgus = a monkey in the genus Macaca used in laboratory research]. There is concern that pets may serve as mechanical/fomite transmission source, spreading the virus from one person to another in the event of an outbreak. The above images show semi-confluent pustules on the child’s face (left) and pustules on the chest (right).

<table>
<thead>
<tr>
<th>Smallpox: The Bioweapon</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>History</strong></td>
</tr>
<tr>
<td><strong>Easy to produce large scale</strong></td>
</tr>
<tr>
<td><strong>Aerosolization</strong></td>
</tr>
<tr>
<td><strong>Diagnosis signals a bioterrorism event</strong></td>
</tr>
<tr>
<td><strong>Secondary spread</strong></td>
</tr>
<tr>
<td>– Person-to-person</td>
</tr>
<tr>
<td>– Fomites</td>
</tr>
<tr>
<td><strong>Mortality 30% (unvaccinated)</strong></td>
</tr>
<tr>
<td><strong>No effective treatment</strong></td>
</tr>
</tbody>
</table>

Smallpox does have a history as a bioweapon. During the French and Indian War, soldiers were reported to have distributed blankets infected with smallpox to the Native American Indian population. Japan considered its use during WWII, and the Soviet Union was reported to have produced massive quantities of the virus in the 1980s. Since the disease has been eradicated from the world, any new case of smallpox would signal a bioterrorism event. The virus is a threat as a bioweapon because it is relatively easy to produce it in large amounts. Also, aerosolized virus would be expected to infect large numbers of individuals, younger people have no immunity against this disease, and the resistance of those vaccinated more than 10 years ago is unknown. Secondary spread would be a concern as the virus is transmitted person to person and through fomites. The overall mortality rate for variola major is 3% in vaccinated individuals and 30% in those unvaccinated. This disease would greatly stress...
our medical facilities and require extensive care for controlling the public’s reaction.

Tularemia, or “rabbit fever”, is caused by *Francisella tularensis*, a Gram negative bacteria. It does occur naturally in the U.S. with an estimated 200 cases per year. Humans can acquire tularemia from animal species (zoonotic potential). The primary route is by contact with or ingestion of infected rodents (blood or tissues), particularly rabbits (bottom image). The disease is also commonly transmitted from the bite of an infected tick. Less commonly transmission can occur from the bite of an infected deerfly or by inhalation of aerosolized droplets, particles or contaminated dust. Person-to-person transmission of tularemia has not been documented. Top photo: *Dermacentor variabilis* (American dog tick) which is an effective transmitter of tularemia. From Iowa State University-Entomology Department Image Gallery.

In humans, there are six clinical forms of the disease related to the route of exposure. Initial symptoms for all are flu-like signs (fever, chills, headache, and myalgia). **Glandular** and **ulceroglandular** (top and bottom photos) forms are the most common presentations of this disease. Seventy-five to 85% of cases are ulceroglandular. They involve enlargement of the local lymph node or inoculation site (glandular) with possible ulceration (ulceroglandular). **Oculoglandular** occurs when the conjunctiva becomes infected by rubbing eyes with contaminated fingers or by splashing contaminated materials in the eyes. The **oropharyngeal** presentation is caused by ingestion of organism in contaminated food (undercooked meat) or water. **Typhoidal** and **pneumonic** forms usually occur following inhalation, or hematogenous spread of the organism. Both of these forms tend to present as atypical pneumonia and most fatalities occur with these forms and can be as high as 30-60% when untreated. Overall, all forms of tularemia, have less than 8% mortality, if untreated (less than 1% when treated).

In animals, wild rodents and lagomorphs (rabbits and hares) are important reservoirs of the organism as well as important in the transmission of the disease to humans. Affected animals are typically found dead or dying. Infected rabbits may exhibit strange behavior such as, running/hopping slowly making them easily captured, rubbing their noses and feet on the ground, muscle twitching, anorexia, diarrhea and dyspnea. Several domestic animal species are also susceptible to tularemia including sheep, young pigs, horses, dogs, and cats. Signs of septicemia such as fever, lethargy, anorexia, and coughing are most commonly seen. Older swine and bovine seem to be resistant to disease and are asymptomatic. Streptomycin is the treatment of choice for both humans and animal species. Upper photo: Thumb with ulceration due to tularemia. Lower photo: Girl with ulcerating lymphadenitis due to tularemia (Kosovo, April 2000) from CDC Public Health Image Library.
**Tularemia: Bioweapon**

- History
- Stable
- Aerosolized
- Low infective dose via inhalation
- Case-fatality: 30-60% (untreated)
- 1970 WHO estimation
  - 50 kg agent: city population 5 million
  - 250,000 ill
  - 19,000 deaths

Tularemia has a history as a potential biological weapon. It was researched in Japan in the 1930-40’s and during World War II. In the 1950-60’s, the United States military developed weapons which aerosolized the *F. tularensis*, and it is suspected that other countries may have included this organism in their bioweapons research program as well. There are many characteristics that make *F. tularensis* a good agent for bioterrorism. It is stable, survives in mud, water, and dead animals for long periods of time, and has previously been stabilized as a bioweapon. Only a low dose is needed to cause inhalational disease. The severe forms of the disease (typhoidal and pneumonic) would be the expected forms seen in the event of a biological attack and can result in a 30-60% case fatality rate if untreated. In 1969, the World Health Organization (WHO) estimated that if 50 kg of virulent *F. tularensis* particles were aerosolized over a city with 5 million people, the result would be 250,000 illnesses and 19,000 deaths. Illness would be expected to persist for several weeks and disease relapse would occur during the following weeks or months. Recently, the Centers for Disease Control and Prevention (CDC) also estimated the economic losses (total base cost to society) associated with an outbreak of tularemia to be $5.4 billion for every 100,000 persons exposed.

**Viral Hemorrhagic Fevers**

- Ebola and Marburg (Arenaviruses)
- Machupo and Lassa (Filoviruses)
- Transmission
  - Person-to-person
  - Direct contact
  - Fomites
  - Machupo and Lassa (Zoonotic Potential)
    - Rodent urine or feces or food and water contaminated by these materials

Viral hemorrhagic fevers (VHF) refer to a group of illnesses caused by several families of RNA viruses (Arenaviruses, Filoviruses, Bunyaviruses, Flaviviruses). Today we will only discuss Ebola, Marburg, Lassa and Machupo. Through the book “The Hot Zone” and the movie “Outbreak”, the general public has become aware and fearful of these diseases. These viruses cause a multi-systemic syndrome, which we refer to as viral hemorrhagic fever. Generally the overall vascular system is damaged and the bodies ability to regulate itself is impaired. Some hemorrhagic fever viruses cause mild disease while others are life threatening. Transmission of these viruses varies but is most commonly spread person-to-person by direct contact with body fluids such as blood, urine, saliva, feces or other secretions. Transfer can also occur from these materials on fomites, such as bedding. Machupo and Lassa viruses can also be spread in rodent urine or feces and transmitted to humans through breaks in the skin, ingestion or aerosol.

**VHF: The Disease**

- Humans
  - Early: fever, fatigue
  - Severe: Hemorrhage of internal organs and from body orifices
  - Shock, seizures
- Animals
  - Only non-human primates susceptible

Specific signs and symptoms of disease vary with the specific VHF, but initially they include marked fever, fatigue, dizziness, muscle aches, loss of strength, and exhaustion. Patients with severe cases of VHF may have petechiae and hemorrhaging of the skin, internal organs, or body orifices like the mouth, eyes, or ears. The disease continues to progress to shock, nervous system malfunction, delirium, seizures and coma. Some types of VHF are associated with renal failure and multiorgan dysfunction. Most animals are considered resistant to viral hemorrhagic fever viruses except non-human primates, which show signs similar to humans but also tend to have cutaneous skin rashes. For the Arenaviruses (Lassa and Machupo), rodent reservoirs, the mice are typically asymptomatic. The zoonotic potential for some VHF is unknown at this time but considered possible from affected non-human primates. In some outbreaks in Africa, these animal species are eaten and may be linked to outbreaks of VHF, especially Ebola. Humans can also acquire several of the VHF from exposure (aerosolization or direct contact) with infected rodent excrement. Photo Vincent Massey Collegiate, Winnipeg.
VHF: The Bioweapon

- Aerosolized
- Not readily available
- Requires specialized production
- Person-to-person and nosocomial transmission occur
- Estimated fatality rate
  - Variable but can be 50-90% for some

Information on the development of VHF for weaponization or research in bioweapons program is limited. However, they are included in the lists of agents of concern in bioterrorism because of their potential to be weaponized (perhaps aerosolized) and because many are highly lethal. Person-to-person and nosocomial transmission occurs. Due to the communicability of these viruses and the visual picture the public has of these diseases, it is suspected that public panic and social disruption would be high if these diseases were present in the U.S. The mortality rates vary with virus, with the highest for the Filoviruses (case-fatality rate for Ebola is 50-90% and for Marburg is 23-25% in humans, but much higher for non-human primates) Mortality rates reported for Arenaviruses are lower with 5-30% for Machupo and 30-50% for Lassa. Again higher rates have been reported in non-human primates (80-100% for Machupo and 53-60% for Lassa).

Category B: Agents/Diseases

- Brucellosis
- Glanders
- Melioidosis
- Psittacosis
- Q Fever
- Typhus Fever
- Viral encephalitis
- Toxins
- Food Safety Threats
- Water Safety Threats

The diseases we just reviewed were the Category A agents, i.e. those that were given highest priority by the CDC. This next group is the Category B agents/diseases and have been given second priority by the CDC. The first four in this group are bacteria, then there are two rickettsial organisms, Q Fever and Typhus fever, and one group of viruses, the viral encephalitides focusing on VEE, followed by some select toxins, and organisms that pose a threat to food and water.

### Brucellosis: The Agent

- *Brucella* species
- Transmission: Zoonotic
  - Direct contact (breaks in skin)
  - Vaginal or uterine discharge
  - Placenta, blood, urine
  - Ingestion
  - Unpasteurized milk or dairy
  - Aerosol
  - Self-inoculation with vaccine
  - Person-to-person rare

Brucellosis (also called undulant fever or Bang’s disease) is caused by various species of *Brucella*, a Gram-negative, facultative intracellular rod (see next slide for species, its natural host and role as human pathogen). The organism can persist in the environment indefinitely, if frozen in aborted fetuses or placentas. However, the organism is susceptible to many disinfectants. Transmission of brucellosis can be by entry of the organism through breaks in the skin following direct contact with reproductive tissues of infected animals (placentas, vaginal or uterine discharge) but also blood, urine, semen or milk. Due to successful control measures in livestock (U.S. Eradication Program), this route of transmission is relatively uncommon. Today the most common route of transmission of brucellosis is through ingestion of infected unpasteurized milk or dairy products (particularly for *B. melitensis*). Other routes of transmission include inhalation of infectious aerosols from infected animal tissues or from contaminated dust. Another less common route of transmission for *Brucella* is self-inoculation with the livestock vaccine. Person-to-person transmission of Brucellosis is considered rare.

### Brucellosis: Zoonotic Potential

<table>
<thead>
<tr>
<th>Species</th>
<th>Natural Host</th>
<th>Human pathogen</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>B. abortus</em></td>
<td>Cattle, bison, elk, horses</td>
<td>YES</td>
</tr>
<tr>
<td><em>B. melitensis</em></td>
<td>Goats, sheep, cattle</td>
<td>YES</td>
</tr>
<tr>
<td><em>B. suis</em></td>
<td>Swine, rodents</td>
<td>YES</td>
</tr>
<tr>
<td><em>B. canis</em></td>
<td>Dogs</td>
<td>YES</td>
</tr>
<tr>
<td><em>B. ovis</em></td>
<td>Sheep</td>
<td>NO</td>
</tr>
</tbody>
</table>

There are a variety of species of *Brucella* with various natural hosts. The majority can affect humans. The zoonotic potential of most *Brucella* organisms involves transmission through contact with infected animal reproductive tissue. This can occur either from direct contact, aerosolization or droplets. *Brucella* can also be ingested through unpasteurized milk. The organism is killed by pasteurization.
Brucellosis can involve any organ or organ system and has a very insidious onset with varying clinical signs. The incubation period in humans is typically 7-21 days, but can be up to several months. The one common sign in all patients is an intermittent/irregular fever with variable duration, thus the term undulant fever. There are 3 forms of the disease in humans. The acute form (<8 weeks from illness onset) may be asymptomatic or develop as nonspecific, flu-like symptoms. The undulant form (<1 yr. from illness onset and symptoms) include intermittent fevers and arthritis. In chronic form (>1 yr. from onset), symptoms may include chronic fatigue-like syndrome, and depressive episodes. In 2-20% of chronic cases, the genitourinary tract can become infected, particularly in males. Illness in people can be very protracted and painful and can result in an inability to work and loss of income. Infected adult animal species are typically asymptomatic, with the exception of reproduction problems. Brucellosis can cause abortions, stillbirths, and infertility, epididymitis and/or orchitis, and also fistulous withers in horses. If the disease becomes chronic in most species, it can cause arthritis and lameness.

Glanders is caused by a Gram negative bacteria, *Burkholderia mallei* (formerly called *Pseudomonas mallei*). *B. mallei* is transmitted by ingestion or inhalation of infected tissues or fluids. Infection can also occur through contact with broken skin or mucous membranes. Person-to-person transmission has been reported but is uncommon. Animal-to-human transmission is also possible but considered relatively inefficient. Horses, mules and donkeys are the major host and principal species affected by this organism. Cats, dogs, goats and camels can also be infected, but ruminants appear to be resistant. Photo: Ulcerative lesion on the lip of a donkey from the Gray book (www.vet.uga.edu/vpp/gray_book/Images/056.htm).

The clinical disease in horses and humans is similar. Infection by contact leads localized infection leading to nodules, abscesses and ulceration of the skin, mucous membranes, lymphatics, and soft tissues. This form can also become established chronically in the affected person or animal. Infection by inhalation leads to acute glanders that results in pulmonary abscesses, pneumonia, or pleural infusion. If the organism spreads systemically, the septicemic form can rapidly develop into fever, chills, myalgia, chest pain, tachycardia, and death within 7-10 days. The case fatality rate for the septicemic form is 95% in cases that are untreated and more than 50% in those that are treated. Chronic glanders affects the joints and muscles forming ulcerated and purulent lesions. Clinical signs in equines may include fever, cough, inspiratory dyspnea, nasal discharge, nasal ulcers.
Glanders is considered a zoonotic disease. Transfer of the organism can occur through contact with nasal discharges or wound exudates, which are highly infectious. Aerosolization of the agent from these materials can also pose a risk to humans in close contact with equines or laboratorians working to diagnose the disease. For this reason the high risk groups for acquiring glanders include individuals closely associated with equines: veterinarians, horse owners, handlers, groomers, etc. and diagnostic laboratory professionals.

During World War I, glanders was believed to have been spread deliberately by agents of the Central Powers to infect large numbers of Russian horses and mules on the Eastern Front, which greatly affected the movement of troops, supply convoys, and artillery movement. Additionally, human cases of glanders in Russia increased during and after WWI. During World War II, the Japanese deliberately infected horses, civilians, and prisoners of war with *B. mallei* at the Pinfang (China) Institute. In 1943-44, the U.S. studied this agent as a possible bioweapon but did not weaponize it. After World War II the former Soviet Union is believed to have evaluated *B. mallei* as a potential BW agent. In the 1980’s, it is thought that the Soviet Union produced more than 2,000 tons of dry glanders agent in a single year. *B. mallei* is easily produced, considered highly infectious and can be aerosolized. The overall mortality rate for all forms of glanders is 40% but when septicemic infection is acquired it is almost always fatal (95%), if untreated.

Melioidosis is caused by *Burkholderia pseudomallei*, an aerobic, Gram-negative motile bacillus related to the agent that causes glanders. The organism is found in soil and water of endemic areas and is commonly thought of as a disease of rice farmers in Thailand and other subtropical/tropical areas. Transmission occurs when open skin wounds or abrasions come in contact with contaminated soil or water. Transmission also occurs by ingestion of contaminated water or through the inhalation of dust contaminated with the organism. Person-to-person and animal-to-person transmission is rare but can occur via blood or contaminated body fluids such as urine, milk and nasal secretions.

Most human cases of melioidosis are asymptomatic. Clinical disease can manifest in a focal, pulmonary, septicemic or chronic/latent form. Most cases commonly present as a pulmonary infection ranging from mild bronchitis to severe necrotizing pneumonia with fever and chest pain. In wound infections, melioidosis develops into focal skin abscesses. Infection can spread to other systems and infrequently CNS infection can occur. The chronic/latent form of the disease can occur years after initial infection with the organism. Following the Vietnam War many soldiers who returned home, later developed the disease, giving its nickname as the “Vietnamese time bomb”. The most severely affected animals species are sheep, goats and pigs. Infection results in suppurative or caseous lesions of the lymph nodes or other organs. Sheep and goats are more prone to pneumonia and caseous lung abscesses. Nasal discharge or encephalitis may also develop as well as lameness if the joints become affected. Horses, dogs and rodents are also susceptible to *B. pseudomallei* but are affected less frequently.
Melioidosis: The Bioweapon

- Minor history
- Easy to produce
- Available
- Aerosolization
  - Increased number of septicemic and pulmonary forms
- Mortality rate can be as high as 90%

Burkholderia pseudomallei was studied by the U.S. as a bioweapon but was never weaponized. But there have been reports that the former Soviet Union bioweapons program also researched this bacteria. The organism can be easily aerosolized and is readily available in soil and water in southeast Asia and Iran. Although natural infections have a mortality rate less than 10%, it is thought that a bioweaponized form of the agent would result in a greater number of septicemic or severe pulmonary infections. Mortality rates can be as high as 90% for these forms.

Psittacosis: The Agent

- Chlamydophila psittaci
  - Gram negative
  - Resistant
- Reportable in U.S.
  - 50-100 reported cases per year
- Transmission
  - Zoonotic Potential
    - Inhalation of contaminated dust from feathers or bird droppings
    - Person-to-person possible

Psittacosis or avian chlamydiosis is caused by Chlamydophila psittaci, a Gram negative, obligate intracellular bacterium. It occurs naturally worldwide and is usually a sporadic disease. In the U.S., psittacosis is reportable in humans. There are 50-100 confirmed cases per year in the U.S. (1-2 deaths per year), but some estimate as many as 100-200 cases actually occur annually. The true incidence is unknown due to poor reporting compliance and frequent misdiagnosis. Pet store employees, owners of pet birds, and poultry processing plant workers account for the majority of the reported cases. The organism can be very resistant to drying. Infectivity of C. psittaci has been documented in straw or on hard surfaces for 2-3 weeks, canary feed for 2 months, in poultry litter for up to 8 months, and in diseased turkey carcasses for almost a year. Transmission is zoonotic, primarily occurring through the inhalation of contaminated dust from feathers or bird droppings. Person-to-person transmission is rare but may occur during paroxysmal coughing.

Psittacosis: The Disease

- Humans
  - Asymptomatic
  - Flu-like signs
    - Fever, chills, headache
    - Nonproductive cough, dyspnea
  - Severe pneumonia
    - Especially in adults 30-60 years old
- Birds
  - Depression, nasal discharge, conjunctivitis, dyspnea
  - Yellow-green diarrhea
  - Possibly neurologic signs

In humans, clinical signs can range from asymptomatic to systemic illness with severe pneumonia. Pneumonia occurs most commonly in adults 30-60 years old. Other signs include abrupt onset of fever, chills, headache, nonproductive cough, and breathing difficulty. Treated cases are rarely fatal. In severe infections, mortality rates can range from 10-40%, if untreated. In birds, clinical symptoms include depression, ruffled feathers, in appetence, nasal discharge, respiratory distress, yellowish-green or green diarrhea, and conjunctivitis. Egg production may decrease. Pigeons and ducks may have neurologic signs.

Psittacosis: The Bioweapon

- Easily obtained
- Aerosolized
- Stable in the environment

C. psittaci has previously been part of the bioweapons research programs of several countries. Some characteristics that may make it a good potential bioweapon include its stability in the environment, ease for aerosolization and ease to obtain (worldwide occurrence).
Q fever (“query” or “puzzling” fever) is caused by *Coxiella burnetii*, an obligate intracellular parasite, which is currently considered a rickettsial agent (new studies may change its family). The disease has a worldwide distribution with the exception of New Zealand. The organism has an unusual spore-like structure which make it very stable and resistant in the environment. It can survive 7-10 days on wool at room temperature, 1 month on fresh meat in cold storage, 120 days in dust and more than 40 months in skim milk. However, it is killed by pasteurization. Domestic ruminants represent the most frequent source of human *C. burnetii* infection. The organism is shed in high numbers in placental tissue and body fluids of infected animals. It is highly infectious with as little as one organism able to cause disease. Transmission occurs by inhalation of contaminated dust or infective aerosols, direct contact with infectious organism. Ingestion of unpasteurized milk is another route, as well as tick inoculation, but this is principally seen in animal species. Person-to-person transmission is rare but possible. Transfer can occur transplacentally, leading to congenitally infected infants. Rare cases of transfer of the organism through blood transfusions, bone marrow transplants and intradermal inoculation have also been reported. Sexual transmission of *C. burnetii* has been documented in laboratory rodents and hypothesized for a rare number of human cases.

In humans most cases of Q fever are asymptomatic. Only about 50% of people infected show signs of clinical illness. The two clinical forms of the disease are acute (less than six months duration) and chronic (greater than six months duration). Symptoms of acute disease vary in severity and duration and usually manifests as self-limited febrile or flu-like illness. However it can result in an atypical pneumonia or hepatitis may also occur. Chronic disease only occurs in 1-5% cases and primarily in persons with prior heart disease or immunocompromised conditions. Endocarditis is the major clinical presentation for chronic Q fever. Ruminants (sheep, cattle, and goats) are the most important reservoirs of disease. Cats, dogs, rabbits, horses and many other animals can also be affected. Animals infected are typically asymptomatic, except for reproductive problems. Abortions and stillbirths are most commonly seen. Mastitis in dairy cattle may occur.

Natural infection of Q fever is primarily transmitted to humans through contact with parturient material from infected animals. This may be from direct contact with the material, inhalation of droplets or dust contaminated by the infective parturient material. However the organism can also be in the urine, feces and milk of infected animals and contribute to the spread. There have been documented human case of Q fever in persons who lived near sheep farms or roads traveled by sheep, but yet the people had no livestock themselves. There is also a report of a case where a cat infected with Q fever had kittens in the same room where a child’s birthday party was being held. Several of the children developed Q fever.

Q fever is another agent that has historically been researched as a potential bioterrorism agent. It was part of the U.S. bioweapons research in the 1950’s and 1960’s. Some reports suggest that a portion of the information about the human infectivity of this organism (i.e. one organism can cause disease) was from experiments at the bioweapon research facility during this time. As a potential bioterrorism agent, *C. burnetii* is easily accessible, environmentally resistant, highly infectious, and stable when aerosolized. *Coxiella burnetii* organisms can be carried considerable distances by wind, up to ½ mile or more. Although mortality is low with this disease, the long duration of the disease would quickly overwhelm healthcare facilities in the event of an attack.
Typhus fever, also known as epidemic typhus, is caused by \textit{Rickettsia prowazekii}. This disease was responsible for the deaths of over 10% of the English population, in 1557. In humans, it is only transmitted by the infected excreta of the human body louse, \textit{Pediculus humanus corporis}. [Note: This is a different species than the human head louse, \textit{Pediculus humanus capitus}]. \textit{Rickettsia prowazekii} is an obligate intracellular parasite for both humans and the louse. Lice infected with the organism die approximately two weeks after feeding on the infected blood from a human host. The human host is essential in the long term propagation, since the organism is not transmitted to the eggs of the louse (no transovarial transmission). Patients are infective for lice during the febrile illness and possibly for 2-3 days after their temperature returns to normal. Infected body louse pass rickettsia in their feces within 2-6 days after the blood meal. The rickettsia may remain viable in dead lice for weeks and in the feces for 2-3 days. Transmission of \textit{R. prowazekii} occurs when the louse feces enters a bite wound or skin abrasion. Person-to-person transmission has not been documented. Photo: Human body louse (\textit{Pediculus humanus corporis}) from J. Kalisch, University of Nebraska.

The disease is characterized by the sudden appearance of headaches and high fever for two weeks. Once infected, simultaneous symptoms may include chills, prostration, coughing, severe muscular pain, bronchial disturbances, and mental confusion. A macular eruption (dark spot on the skin) appears on the fifth to sixth day, initially on the upper trunk, which then spreads to the entire body except the face, palms, and soles of the feet. Mortality rate increases with age and may reach 60% in untreated persons older than 50 years. In epidemic conditions mortality can near 100%. Domestic animals are not susceptible to \textit{R. prowazekii}. However, the flying squirrel (\textit{Glaucomys volans}) in the eastern U.S. have been found to act as a host to \textit{R. prowazekii}. There have been sporadic human cases of typhus reported, however the route of transmission has not been determined at this time and may be linked to flying squirrel louse or fleas. Photo: Macular eruption on the skin of a human with typhus.

\textit{R. prowazekii} might be considered in biowarfare is that it is readily available (outbreaks are common in Africa), remains infective in the lice feces for several weeks, and can be aerosolized. In 1969, \textit{R. prowazekii} was one of the agents selected by the WHO to estimate casualties if the agent was aerosolized as bioweapon. The estimate for a city of 5 million was that 300,000 would be exposed and 125,000 would become ill and 8,000 would die.

The viral group in the list of Category B agents is a group of arboviruses (viruses transmitted by arthropods), called the viral encephalitides. Although there are many of potential concern, the CDC specifically lists Eastern equine encephalitis (EEE), Western equine encephalitis (WEE) and Venezuelan equine encephalitis (VEE) as those of primary concern. All three are in the Alphavirus genus and are RNA viruses, most commonly transmitted by mosquitoes. Following a bloodmeal from a viremic host - generally birds for EEE and WEE, and birds and horses for VEE – the virus replicates in the salivary glands of the female mosquito. The virus is then transmitted back to birds, rodents or to dead end hosts, such as humans and horses. EEE and WEE have not been reported to be transmitted person-to-person, however it can occur for VEE and viremia in humans can affect mosquitoes for up to 72 hours.
Viral Encephalitis: The Disease

- Humans
  - Asymptomatic to flu-like illness
  - Fever, myalgia, headache, nausea and vomiting
  - Neurological symptoms
  - Disorientation, stupor, coma, seizures, paralysis

- Horses
  - Signs similar to humans
  - Asymptomatic carriers
  - Neurological or death
  - Can act as sentinels

In humans, infections can range from asymptomatic to flu-like illness to severe neurological damage or death. For all fever myalgia, headache with or without nausea and vomiting are the initial presenting signs. This can develop to neurological signs such as disorientation, stupor, coma, seizures, paralysis and death in some cases. EEE and WEE tend to affect children and the elderly more frequently. The infection rate and morbidity rate of viral encephalitides can be quite high, the overall mortality rate is relatively low. Persons affected by these viruses can quite commonly have permanent neurological damage. Equidae are also highly susceptible and disease would occur simultaneously with human disease. Photo: Coop of WNV sentinel chickens.

Viral Encephalitis: The Bioweapon

- History
- Easy to produce
- Aerosolization
- High rate of infection
  - With long term disability possible

Of the viral encephalitides, VEE has the most history of being researched as a potential bioweapon. It was tested in the U.S. bioweapons program in the 1950s and 1960s and it is thought that other countries have also weaponized it. VEE can be produced in large amounts by unsophisticated and inexpensive systems. The virus can be aerosolized or spread by releasing infected mosquitoes. Humans are highly susceptible and approximately 90-100% of exposed individuals could become infected and have clinical signs. There is a low overall human case-fatality rate.

Toxins: The Agents

- Staphylococcal enterotoxin B (SEB)
- Ricin toxin from the castor plant
- Clostridium perfringens epsilon toxin

Next we will discuss three toxins included in the CDC’s Category B agent list. They are Staphylococcal enterotoxin B, ricin toxin from the castor plant, and Clostridium perfringens epsilon toxin. Toxins are biological agents produced by living organisms such as bacteria, plants, or animals. Toxins do not typically have zoonotic (animal to human) potential. If the toxin is aerosolized and inhaled more severe symptoms may be seen, such as nonproductive cough, chest, pain and shortness of breath. Photo of soldiers eating- USARIEM http://www.usariem.army.mil/nbd/nutri.htm

Staphylococcal Enterotoxin B (SEB): The Agent

- Staphylococcus aureus
- Transmission: Ingestion and inhalation
- Humans
  - Fever, chills, headache, myalgia
  - Inhalation = non-productive cough
  - Ingestion = nausea, vomiting, diarrhea
  - Typically self-limited in 8-24 hours
- Animals
  - Limited information available
  - Signs likely to be similar to human

Although bacterial toxins are more difficult to produce than plant toxins, they are typically much more toxic. Staphylococcal enterotoxin B (SEB) is an exotoxin produced by Staphylococcus aureus. It is one of the toxins responsible for staphylococcal food poisoning in humans. It is a superantigen and acts by stimulating cytokine release and inflammation. Routes of exposure could include ingestion or inhalation. Natural infection most commonly occurs by ingestion, typically through food contaminated by an infected person. Organisms may be present in the nasal passages, throat, skin of people. As a bioweapon, SEB is considered a stable compound that is easily soluble in water; it is additionally resistant to a broad range of temperatures. In humans, the clinical signs resulting from SEB exposure via ingestion would occur in approximately 4-10 hours. Following inhalation exposure, clinical signs would occur in approximately 3-12 hours. The general symptoms include sudden onset of high fever persisting for several days, chills, and myalgia and are self-limiting in 8-24 hours. Following inhalation, a non-productive cough, chest pain, and dyspnea can occur. Following ingestion, nausea, vomiting, and diarrhea predominate. There is little information about clinical signs from SEB in animals, although S. aureus is associated with many diseases. Experimental exposure of mice and monkeys to aerosolized SEB resulted in diarrhea and vomiting, followed by depression, dyspnea, shock and occasional death.
Ricin toxin is a toxin from the beans of the castor plant, *Ricinus communis*. It is one of the most lethal and easily produced plant toxins. The toxin is present in the entire plant but is concentrated in its seeds. Ricin toxin works through the mechanism of inhibiting protein synthesis. Plant toxins are easy to produce at a low cost because raw materials are available worldwide. Transmission of ricin toxin can occur through ingestion, inhalation and injection. Person-to-person and animal to person transmission are not a concern. Many species can be affected, but horses are considered the most susceptible. Clinical signs vary with route of exposure. Following ingestion, severe gastrointestinal signs are most common and may include abdominal pain, diarrhea, fever, vomiting, hematuria. Vascular collapse and death can occur quickly. After aerosol exposure, clinical signs may include fever, tightness of the chest, cough, and dyspnea. Severe respiratory, circulatory collapse and death can occur as rapidly as 36-72 hours. Castor plant- Cooperative extension, Purdue University www.vet.purdue.edu/depts/addl/toxic/plant11.htm.

*Clostridium perfringens* types B and D produce epsilon toxin. *C. perfringens* type B infection causes severe enteritis in young calves, foals, piglets, and lambs (lamb dysentery) and *C. perfringens* type D causes enterotoxemia (overeating disease, pulpy kidney disease) in sheep and goats, and rarely cattle. The clinical signs of enterotoxemia are primarily a result of epsilon toxin, which causes increased intestinal and vascular permeability, and liver damage. In calves, clinical signs include diarrhea, abdominal pain and listlessness. Sheep and goats have watery to bloody diarrhea. Neurologic signs can be common in all. There is little or no information about the effects of epsilon toxin on humans. Human disease is usually caused by *C. perfringens* type A and C.

Toxins have a history of being researched and used as bioweapons. The U.S. stockpiled and researched SEB during its bioweapons program 1 the 1950’s and 1960’s. Ricin is though to have been used in the assassination of Bulgarian defector, Georgi Markov in London in 1978. Additionally, in 1991 in Minnesota, four members of the Patriots Council (an antigovernment extremist group) were arrested for plotting to kill a U.S. Marshall with ricin. The group planned to mix the homemade ricin with DMSO and then smear it on the door handles of the Marshall’s car. The plan was discovered and all four men were arrested. Additionally, some reports have indicated that ricin may have been used in the Iran-Iraq war during the 1980s and that quantities of ricin were found in Al Qaeda caves in Afghanistan. In January of 2003, castor oil beans, the equipment and containers for crushing them, and traces of the ricin toxin were found in a London apartment. Although aerosolized SEB would not likely produce significant mortality, it could render 80% or more of exposed people clinically ill and unable to perform their duties for 1-2 weeks. The demand on the medical and logistical systems could be overwhelming. All of the toxins are available worldwide, relatively easy to produce, stable, and can potentially affect many species. There is no concern about transmission of the toxin from an affected individual.

There are an estimated 250 pathogens that can cause food-borne related illnesses. The most commonly recognized bacterial foodborne infections are caused by *Campylobacter*, *Salmonella* and *E. coli* O157:H7. Viruses, parasites, natural or manufactured chemicals and organism toxins can also cause foodborne disease. Most agents cause gastrointestinal upset (nausea, diarrhea, abdominal cramps) which are self-limiting in 4-5 days. However, some agents have severe complications if left untreated. *Campylobacter* is considered the leading bacterial cause of foodborne related diarrhea, with an estimated 2.4 million people affected each year. Common sources include raw or undercooked poultry, raw milk or items contaminated with infected animal or human feces. Animal sources include poultry, cattle, puppies, kittens and pet birds. Many serotypes of *Salmonella* can also cause foodborne related illness.
enteritidis and S. typhimurium are the most common isolates, accounting for about 41% of U.S. human cases. Common sources for Salmonella food-borne illness include raw poultry or eggs, beef, unwashed fruit and alfalfa sprouts. Pet reptiles can also be a common source. E. coli O157:H7 is another major pathogen of foodborne related illnesses. Common sources include undercooked or raw hamburger, salami, lettuce and alfalfa sprouts. It has also been associated with unpasteurized milk, apple juice or cider as well as contaminated well water. Cattle are the most common animal source however other mammals can serve as a source. Severe sequela can occur with E.coli infection.

Restaurants have served as a conduit for terrorism before. In 1984, the Bagwan Shree Rajneesh cult in The Dalles, Oregon deliberately contaminated salad bars with Salmonella typhimurium in an attempt to incapacitate voters for an upcoming local election. At least 10 restaurants were affected and possibly one supermarket. Additionally, coffee creamers in some restaurants were also contaminated. The incident resulted in 751 people becoming ill. It wasn’t until one of the cultists broke a vow of silence and came forth one year later that the details of the “attack” became known. Plans were being made to contaminate the water also. This incident was meant to be a trial run before a full scale biological crime.

Fifty-three percent of the U.S. drinking water comes from ground (well, aquifer) water. Surface waters such as lakes, reservoirs, and streams, are used by cities but require filtration and/or chemical treatment. Two organisms are listed in the CDC’s Category B list as examples of water safety threats. They are Cryptosporidium parvum and Vibrio cholerae.

Cryptosporidium parvum is a coccidian protozoa that multiplies rapidly and colonizes the intestine. These small oocysts are infective immediately upon excretion and found in animals worldwide with peak illness occurring in the spring & late autumn/early winter. Transmission of the organism is primarily through person-to-person, animals-to-person (zoonotic), waterborne and foodborne routes. Sources of human infections generally come from ingesting contaminated food and water or from contact with infected scouring calves. Inhalation of the organisms has occurred, but it is very rare. Clinical signs are related to acute gastroenteritis and are usually self-limiting. Approximately 10% of human patients require hospitalization for intravenous rehydration. Severe, life threatening disease can occur in immunocompromised individuals. Although cryptosporidium can affect a number of animal species, young calves (1-3 weeks old) are most susceptible and can have profuse watery diarrhea leading to dehydration and death if not treated. Dogs, cats, horses and pigs seem to be resistant.
**Vibrio cholerae: The Agent**

- *Vibrio cholerae*
  - Gram negative bacteria
- Transmission
  - Fecal-oral
  - Contaminated shellfish
- Humans
  - Acute, mild diarrhea
  - 5% severe disease
- Animals
  - Resistant to disease

Cholera results from infection by *Vibrio cholerae*, a Gram negative bacteria. Cholera is endemic in the Middle East, Africa, Central and South America, parts of Asia, and the Gulf Coast of the U.S. Major epidemics occur periodically in less developed countries. Transmission is by fecal-oral route. Infections are particularly common after ingesting contaminated water. Occasionally cases are seen in people who have eaten raw or undercooked shellfish, especially oysters, from contaminated waters. Infection with *V. cholerae* results in acute diarrhea that is often mild or asymptomatic. However, 1 in 20 can have severe disease with profuse watery diarrhea, vomiting, and leg cramps. Without treatment, dehydration, shock and death can occur within hours. Humans appear to be the only natural host for *V. cholerae*. Experimentally some lab animals have been infected and dogs are susceptible if massive doses of bacteria are given.

**Water Safety: Public Health Significance**

- 1993
  - Municipal water supply contaminated
    - Milwaukee, WI
    - *Cryptosporidium parvum*
    - 40,000 ill
- 1997
  - Decorative water fountain
    - Minnesota Zoo
    - 369 cases
    - Mostly young children

Throughout the years in the U.S., several cult groups have planned or implemented attempts to contaminate water sources. There are approximately 27 potential biological organisms and chemicals that could be used to threaten the safety of our water supply. Two examples of accidental contaminations occurred in Milwaukee and Minnesota. In Milwaukee, a *Cryptosporidium parvum* outbreak occurred in 1993 and was the largest contamination of a municipal water supply. 403,000 people were affected and 40,000 became ill. In 1997, a decorative water fountain at the Minnesota Zoo (where children were allowed to play) became contaminated with *Cryptosporidium*. There were 369 cases of disease with the majority being in persons under 10 years old.

**Category C**

- Nipah virus
- Hantavirus

We will now discuss the diseases of third highest priority on the CDC Category Agent List, both of which are viruses.

**Nipah Virus: The Agent**

- Paramyxovirus; Henipavirus
- Reservoir: Fruit bats
- Transmission
  - Aerosol, direct contact with infective tissues
  - Not person-to-person
- Zoonotic Potential
- 2004 break: Bangladesh
  - 26 human deaths

Nipah virus is a newly discovered Paramyxovirus (reclassified in a new genus Henipavirus in 2004), which causes a severe respiratory disease in pigs and severe encephalitis in humans. The reservoir for the virus is thought to be fruit bats, which are called flying foxes. Suspected transmission of the virus occurs from bats roosting in fruit trees close to pig confinements. The virus then spreads rapidly through the swine herd by direct contact or aerosolization (usually coughing). It can then be passed to humans, dogs, cats and other species. Nipah is a zoonotically transmitted disease. During the only outbreaks of Nipah virus in Malaysia and Singapore in 1998-99, the majority of humans cases (~93%) had close contact with infected pigs. Transmission to humans and among swine can also occur from direct contact with infected body fluids. To date, no person-to-person or bat-to-person transmission has been reported. Photo of a Malayan flying fox (fruit bat). The most recent outbreak of Nipah virus occurred in mid-March of 2004 in the Faridpur District of Bangladesh, resulting in 34 human cases and 26 deaths.
**Nipah Virus: The Disease**

- **Humans**
  - Encephalitis
    - Fever, headache, dizziness, disorientation
    - Respiratory distress possible
  - Swine
    - Asymptomatic
    - Severe respiratory disease
    - Dyspnea, open mouth breathing, barking cough
    - Neurological signs possible
  - Dogs and cats
    - Neurological and respiratory

In humans, the incubation period is 3-14 days. Initial symptoms include fever and headache, dizziness, drowsiness, disorientation and vomiting. Some cases show signs of respiratory illness. In severe cases, a rapidly progressive encephalitis can occur with a mortality rate of 40%. In swine, Nipah virus is highly contagious and easily spread. Many pigs are asymptomatic. Clinical signs include acute fever (>104°F), tachypnea and dyspnea with open mouth breathing, and a loud, explosive barking cough may also be noted. Occasionally, neurological signs can occur. Clinical signs in pigs were noted 1-2 weeks before illness in humans so this species may serve as a sentinel. Disease in other animal species is poorly documented. Other species demonstrate respiratory and neurological signs.

**Nipah Virus: The Bioweapon**

- Emerging pathogen
- Aerosolization potential
- Wide host range
- High morbidity and mortality
- Biolevel 4

Nipah virus is listed as a Category C potential bioterrorism agent by the CDC. It is described as an emerging pathogen with potentially high morbidity and mortality as well as a major health impact. Currently transmission of the disease involves close contact with pigs. Aerosolization may be a possible bioterrorist method of dispersal. The potential for this virus to infect a wide range of hosts and produce significant mortality in humans makes this virus a public health concern. Nipah virus is a very dangerous pathogen and has been classified as a Biolevel 4 agent. Photo from Dr. James Roth-ISU of hog confinement barns that were affected during the Nipah virus outbreak in Malaysia, 1999.

**Hantavirus: The Agent**

- Bunyaviridae
- Reservoir: Rodents
  - Deer mouse in U.S.
  - Not house mouse
- Transmission
  - Infective rodent feces, urine or saliva
  - Inhalation
  - Direct contact
  - Ingestion

Hantavirus is an RNA virus in the Bunyaviridae family. There are over 25 serotypes of the virus distributed worldwide. In the U.S., the Sin Nombre (“without a name”) serotype is the most commonly isolated. Hantavirus is considered a re-emerging disease as its incidence has increased over the years. Additionally it is classified as a “viral hemorrhagic fever”. Rodent reservoirs vary with the hantavirus serotype but are asymptomatic. The deer mouse is the primary carrier in most areas of the United States. Transmission of the virus primarily occurs through inhalation of aerosolized infective virus particles from rodent excrement. Viral particles are shed by rodent reservoirs in their urine, feces and saliva, therefore human exposure most commonly occurs when the microenvironment of rodents is disturbed (i.e., spring cleaning) and the aerosolized infectious particles from rodent excrement are inhaled. Transmission can also occur through direct contact (mucous membranes or skin abrasions) with the infective material. The virus particles can contaminate food consumed by humans and cause infection, and in very rare cases, a bite from an infected rodent can precipitate the disease. Photo: Deer mouse (*Peromyscus maniculatus*) is distinguished from the house mouse by it white belly, large ears and a furry tail with white on its underside. In contrast, the house mouse, *Mus musculus*, has no white belly and it has a hairless, scaly tail.

**Hantavirus: The Disease**

- Humans
  - Fever, myalgia, headache
  - Rapid progression to severe respiratory disease
  - Hantavirus Pulmonary Syndrome
  - Hemorrhagic Fever with Renal Syndrome
  - Death can occur in 48 hours
- Not seen in domestic animals

Two clinical forms of disease occur in humans, hantavirus pulmonary syndrome (HPS) and hemorrhagic fever with renal syndrome (HFRS). Only the HPS is seen in the U.S. while the HFRS occurs more frequently in Asia and Europe. Clinical signs in humans initially include fatigue, fever, myalgia, and headache. The disease can progress rapidly to a severe respiratory syndrome. Approximately 40% of patients die within the first 48 hours due to uncorrected hypoxia and shock. The disease is not seen in domestic animals.
Hantavirus: The Bioweapon
- Aerosolized
- Rapid disease
- Requires hospitalization
- Mortality 40%
- Hemorrhagic Fever with Renal Syndrome
  - Clinical form not typically seen in U.S.

Other Important Diseases
- Transmissible Spongiform Encephalopathy
- Rift Valley Fever
- Hendra Virus
- West Nile Virus
- Monkeypox
- Foot and Mouth Disease

Transmissible Spongiform Encephalopathy: The Agent
- Prions
  - Proteinaceous infectious particles
  - Mutated proteins
- Very long incubation period
- Neurological signs in all species
- No treatment available

Bovine Spongiform Encephalopathy
- Mad cow disease
- Incubation: 2 to 8 years
- 1995
  - United Kingdom
  - vCJD
  - People exposed to BSE
  - Before bovine offal ban in 1989
- Active U.S. surveillance
  - First case December 2003
  - Now have enhanced surveillance

Information regarding the use of hantavirus as a bioweapon is limited. However, it satisfies the criteria for the CDC’s Category C agents in that it is an emerging/re-emerging agent and could be mass disseminated (aerosolized). Additionally, the disease progresses rapidly, typically requiring hospitalization, and the mortality rate can reach 40%. If the HFRS form of the disease occurred in the U.S., diagnosis may be delayed since it is not form typically seen.

The next several disease agents that will be covered include transmissible spongiform encephalopathies, Rift Valley fever, Hendra, West Nile virus, and Monkeypox. These agents/diseases are not part of the CDC Category ABC list, so because some are important zoonotic diseases and others may be of interest to your audience, due to their recent appearance in the media, they have been included by the Center for Food Security and Public Health.

Transmissible spongiform encephalopathy (TSE) describes a group of diseases thought to be caused by prions (short for proteinaceous infectious particles). This abnormal protein causes a variety of diseases in various species. TSEs in humans include variant Creutzfeldt-Jakob disease (vCJD), Kuru, Gerstmann-Straussler-Scheinker syndrome (GSS), and fatal familial insomnia (FFI) can occur. In animals, bovine spongiform encephalopathy (BSE, or mad cow disease), scrapie in sheep, chronic wasting disease (CWD) in deer and elk, transmissible mink encephalopathy (TME), and feline spongiform encephalopathy (FSE) can occur. The incubation period for most of these diseases is many years. In humans with vCJD, clinical signs include depression and schizophrenia leading to ataxia and involuntary muscle movement. This eventually progresses to complete immobility and muteness. In animals, initial clinical signs can be subtle, but usually involve behavioral changes, such as excitability, nervousness, aggressiveness, and increased sensitivity to noise. Sheep with scrapie typically exhibit intense pruritus. The terminal state of TSEs in cattle, deer and elk, can result in extreme wasting despite a good appetite. Additionally, tremors and muscle fasciculations, especially in the neck and face, can occur. There is no known treatment at this time.

Bovine spongiform encephalopathy (BSE), is the only TSE that has been shown to be transmitted to humans. BSE in cattle is thought to have occurred from feeding meat or bone meal from scrapie-infected sheep to cattle or from spontaneous genetic mutation in a cow that was then fed to other cows. The first cases of BSE appeared in the U.K. in 1986. The incubation period ranges from 2 to 8 years and is always fatal. In 1995, ten human cases similar to Creutzfeldt-Jakob disease (CJD) were reported in the U.K. However, the disease was affecting people at a younger age, eliciting behavioral changes not seen with classic CJD and demonstrated different brain lesions. The disease was termed variant Creutzfeldt-Jakob disease (vCJD). Currently, it is thought that consumption of BSE contaminated beef products (prior to the U.K.’s specified bovine offal ban in 1989) may be responsible for the disease. The mortality rate is 100% for cattle and humans. Active surveillance for BSE in the U.S. began in 1990. In May 2003 BSE was diagnosed in an 8 year old angus beef cow in Alberta, Canada. All herd mates tested negative. This is the first case of BSE originating in Canada. In December 2003, the first case of BSE in the U.S. was diagnosed. Traceback investigation confirmed the cow as being imported from Canada in 1996. The 2004 United States BSE enhanced surveillance program
Rift Valley Fever (RVF), another viral hemorrhagic fever, is an RNA virus caused by a Phlebovirus in the family Bunyaviridae. Rift Valley fever is a disease endemic throughout most of Africa, but in 2000 outbreaks occurred for the first time on the Arabian Peninsula (Saudi Arabia and Yemen). It can be transmitted by mosquitoes, inhalation of virus, or direct contact with the virus in infected body fluids and aborted fetuses. Mosquito eggs can be infected transovarially and lay dormant for many years in the dry soil of grassland areas. Following heavy rainfalls, the eggs hatch and these newly infected mosquitoes then seek an feeding source (human or animal). Once a ruminant or human is infected, they serves as an amplifying host with a viremia that infects other mosquitoes.

Typically humans are asymptomatic or have self-limiting flu-like symptoms. In less than 1% of humans infected, severe disease can occur resulting in retinitis, hemorrhagic fever or encephalitis. Progression to shock, coma, and death occurs in about 50% of these affected patients. In sheep, cattle and goats, RVF causes a very high rate of abortion and death in neonates. Other clinical signs that may be seen in animals include fever, mucopurulent nasal discharge and possibly vomiting. Mortality in adult animals, especially those that have aborted, can be 20-30%. Vaccination of sheep, goats and cattle is used to control the disease in endemic areas. The current vaccine can be abortigenic and teratogenic but is usually less harmful than the effect of the disease.

The WHO prepared an estimate of casualties if RVF virus was aerosolized. The estimate suggests that if 50 kg of the agent were disseminated from an airplane it would have a 1 km downwind reach with 35,000 humans incapacitated and 400 deaths (1% mortality). The virus is very stable but inactivated by various chemicals.

Hendra virus is one of three newly discovered Paramyxoviruses (Hendra virus, Nipah virus, Menangle). It was first identified during an outbreak in Australia in 1994. Twenty-one horses were affected with severe respiratory illness; 14 died or were euthanized. Three humans were also affected, two of which died. The reservoir for the virus has been found to be fruit bats (flying foxes). To date, natural infections have only been documented in horses and humans. Experimental infections have been reported in cats, horses and guinea pigs. Hendra virus does not appear to be highly contagious, but can be spread through close contact. Infected cats can transmit the infection to horses through their urine. Additionally, horses can be infected by eating material contaminated with the virus. Infected animals can spread the virus to humans. The method of transmission is unknown but is thought to be through contact with body fluids (urine, blood, oral cavity) of the infected animal. Aerosol transmission appears to be inefficient. No person-to-person transmission has been reported to date.
**Hendra Virus: The Disease**

- **Humans**
  - Flu-like illness
  - Rapid progression to respiratory failure or encephalitis
- **Horses, cats**
  - Acute respiratory signs
  - Nasal discharge, fever
  - Encephalitis
  - Sudden death

The initial symptoms in humans resemble viral flu-like signs which rapidly progresses to respiratory failure or encephalitis, followed by death. In horses and experimentally infected cats, signs include acute respiratory dyspnea, nasal discharge (clear to serosanguinous), anorexia, depression and fever (up to 105.8°F). Most horses become ataxic; head pressing may be occasionally seen. This is followed by sudden death 1-3 days after the onset of clinical signs.

**West Nile Virus: The Agent**

- **Flavivirus**
- **Reservoir: Birds (Corvids)**
- **Humans and horses**
  - Dead end hosts
- **Transmission**
  - Mosquitoes
  - Culex species
  - Person-to-person
  - Blood transfusion, organ donation, breast feeding

West Nile virus (WNV) is a Flavivirus, that prior to 1999 was never found in the U.S. It can cause severe encephalitis in humans, horses, birds and other animal species. Transmission typically occurs from a mosquito vector. *Culex* species are the most important maintenance vector, however, WNV has been detected in 29 species of mosquitoes. It has been isolated from ticks, but their role in transmission is still unclear. More recently, cases of WNV have occurred through person-to-person transmission through blood transfusions, organ donation (4 cases), and breast feeding of infants (1 case). Bird species are the primary reservoir of WNV. Mosquitoes pick up the virus from birds then transmit it to mammals via bites. It is thought that viremia in humans and horses is NOT high enough to serve as a reservoir source.

**West Nile Virus: The Disease**

- **Humans**
  - ~80% Asymptomatic
  - ~20% "West Nile Fever"
    - Fever, headache, myalgia, prolonged fatigue
    - 1:150 cases severe
      - "West Nile Encephalitis"
      - Case-fatality 3-15%
      - Highest in elderly
- **Animals**
  - Horses, birds, mammals, and reptiles

In humans, the incubation period for WNV is approximately 3-14 days. Eighty-percent of persons infected will be asymptomatic. Approximately 20% will develop a mild illness, termed “West Nile Fever.” Signs begin with acute fever (usually >102.2°F), headache, and myalgia, and gastrointestinal symptoms. Illness usually lasts less than a week, but prolonged fatigue is common. Approximately 1 in 150 WNV infections will result in severe neurological disease called “West Nile encephalitis,” “West Nile meningitis” or “West Nile meningoencephalitis.” Symptoms of severe infection include headache, high fever, muscle weakness, and paralysis. This can occur in patients of all ages. The case-fatality rate ranges from 3-15% and is highest among the elderly. Year-round transmission of WNV is possible in some areas. Horses are the most commonly affected domestic animals and many are asymptomatic. Of those that do become ill, about 40% result in death. Clinical signs for horses include a wide variety of neurological signs, from facial paralysis and head tilt, to recumbency and seizures.

**West Nile Virus: Public Health Significance**

- **2003**
  - Human illness in U.S.
    - 9,862 cases - 264 deaths
  - Equine illness in U.S.
    - 4,554 cases
    - 40% of ill result in death
  - Other mammals
    - dogs, squirrels, cats
- **Method of introduction to U.S. unknown**

In 2003, 9,862 human cases of WNV were reported in the U.S. with 264 deaths. Reported equine cases totaled 4,554 (down from 14,717 the previous year – most likely due to vaccine protocols implemented). Also in 2003, cases were documented in dogs (30), squirrels (17), cats (1) and 32 unidentified animal species. In 2002, 4156 human cases of WNV were reported in the U.S., with 284 deaths. Among fatal cases, the median age was 78 years old; 59% were male. Reported equine cases totaled 14,717. Forty percent resulted in death. There is much speculation concerning the introduction of WNV into the United States. The source has never been determined.
Foot and Mouth Disease (FMD) is caused by a highly contagious Picornavirus. FMD is transmitted among animals by direct contact, aerosol, and fomites. Direct contact with large infective droplets from the breath of an infected animal, or contact with infective body fluids like saliva, feces or urine are some modes of FMD transmission. The milk and semen of infected animals may be contagious for up to four days prior to the commencement of clinical signs. Humans and animals that come in contact with a FMD infected animal may serve as a source for transmission of the virus to susceptible animals through large respiratory droplets (direct transmission) and small size aerosol particles (aerosol transmission). The wind is able to carry the virus for long distances under the correct conditions. Fomite (indirect transmission) transmission occurs when an inanimate object comes in contact with an animal that is infected and is then introduced to a susceptible animal. Examples of fomites include contaminated clothing, footwear, contaminated vehicles, feed or water sources, and meat and meat by-products in which the pH has remained above 6.0.

The incubation period for FMD averages of 3 to 8 days. The virus is shed before clinical signs develop in infected animals. Initial clinical signs in cattle are fever, excessive salivation, depression, and anorexia caused by painful vesicles of the lips, tongue, gums, nostrils, and teats. Lameness is caused by hoof lesions in the area of the coronary band and interdigital space. When the vesicles rupture, large painful sores remain which may become secondarily infected. Lameness is contagious for up to four days prior to the commencement of clinical signs. Their lesions are more severe and progress more rapidly than in other species. In pigs, sheep, and goats the clinical signs are similar to cattle but milder. Lameness tends to be the predominant sign. Pigs are considered the amplifying hosts because virus concentration in aerosols is very high. Sheep and goats are maintenance hosts because they have very mild clinical signs and diagnosis can be delayed.

FMD is considered by many to be the most economically devastating livestock disease virus in the world. This is largely due to the fact that it is highly transmissible, results in economic losses in animal production, and depopulation is the most effective means of control. FMD is an agroterrorism threat to the U.S. because agriculture is a large part of the U.S. economy and our livestock are susceptible to the virus. One sixth of the U.S. domestic product is tied to agriculture and one eighth of all U.S. jobs are directly or indirectly tied to agriculture. The U.S. share of the global market for agricultural goods averages just under 20%. Since U.S. farms produce far beyond the domestic demand for many crops, maintaining a competitive agricultural system in the global market is critical to ensuring the economic viability of U.S. agriculture. An attack on the agricultural industry will have devastating direct effects, but indirectly the export system and reliant industries such as equipment manufacturers, restaurants, and tourism would also be influenced. Agricultural exports in 2000 were valued at $51 billion. Factors that make the U.S. agriculture system at risk for FMD introduction include travelers to and from countries with FMD, meat and food products of animal origin not approved for importation, other items or things that could be contaminated with FMD virus including live animals.
Monkeypox virus is a naturally occurring relative of variola (smallpox) virus and is endemic in central and western Africa. Monkeypox disease is clinically indistinguishable from smallpox, with the exception that monkeypox is less severe and there is often notable enlargement of cervical and inguinal lymph nodes. The virus was first identified and named when it was isolated from laboratory monkeys in 1958. The first isolation of the monkeypox virus from humans in Africa was in 1970. The reservoir for monkeypox virus may be an African squirrel. Many different rodents, rabbits, and primates are susceptible to infection. The virus is transmitted through bites, aerosols, or direct contact with lesions or body fluids from infected animals or humans. Fomite transmission is also possible. Transmission can be from animal-to-person, animal-to-animal or person-to-person. Epidemiological evidence in Africa indicates a rate of person-to-person transmission of 3.3 to 30%. The incubation period is approximately 12 days for humans and 6-7 days for animals. Images courtesy of CDC and USDA APHIS. Upper photo Gambian pouched rat. Middle photo: prairie dog. Bottom photo: rope squirrel. Photos courtesy of the CED website.

In rodents symptoms include fever, conjunctivitis, cough, lethargy and a blister-like rash. The disease in non-human primates is usually fever followed by a self-limiting rash. In humans, flu-like symptoms occur in the first 10 days, followed by the development of the rash (macular, papular, vesicular or pustular) and enlarged lymph nodes. An infected animal or person is contagious one day before clinical symptoms and for 21 days after symptoms or until scabs heal. Case-fatality rates reported from a rural African outbreak ranged from 1-10% with higher death rates among children.

In June 2003, monkeypox was diagnosed for the first time in humans in the United States. Trace back investigations identified that the virus was introduced into the U.S. in a shipment of 800 small mammals which arrived in Texas on April 9 from Ghana, Africa. It appears that infected rodents (dormice, Gambian giant pouched rats, rope squirrels) from this shipment were placed in contact with prairie dogs at an animal distribution facility in Illinois. The prairie dogs were then sold and went to 6 states [Illinois, Indiana, Kansas, Missouri, Ohio, and Wisconsin]. There have been 93 prairie dogs suspected of being infected with monkeypox virus. The CDC confirmed 4 of those cases. The CDC has also confirmed monkeypox in 1 Gambian rat, 3 dormice, and 2 rope squirrels from the original shipment. In 2003, 72 human suspect cases of monkeypox were reported to CDC. Thirty seven were confirmed and 35 were investigated. The majority of human cases reported some contact with an infected prairie dog. To date there are no confirmed cases of transmission between humans. In addition, there are no reports of human cases due to contact with animals other than prairie dogs or cases of transmission to other animal species in contact prairie dogs or African rodents. Monkeypox has not been reported in dogs or cats, and their susceptibility is unknown. Weaponization of monkeypox has raised concern as to whether or not it would constitute a threat similar to that posed by variola virus (smallpox). “Nevertheless, (a) the pathogenicity of monkeypox for
humans, (b) the potential morbidity of an aerosolized monkeypox virus attack, and (c) the theoretical potential that genetic recombination could produce a modified animal poxvirus with enhanced virulence for humans have raised the specter that another poxvirus besides variola might constitute either a serious biowarfare threat or a reemergent public health problem.” From: Textbook of Military Medicine: Medical aspects of chemical and biological warfare, 1997. The map shows the distribution and number of human cases confirmed in the US as of July 11, 2003.

The final section of the presentation addresses the responsibilities/opportunities of the human health professionals.

Most of the Category ABC agents are zoonotic and 75% of all emerging diseases are zoonotic. Human health and veterinary medicine must become more connected and an integral component in the public health system. To do this, both should communicate and:

- Be aware, contribute, and assist in development of local and state disease surveillance programs.
- Report zoonoses.
- Be involved with emergency response plans at all levels.

Report zoonoses to appropriate officials so trends can be detected. Integrate into emergency response plans at all levels. Your knowledge of infectious diseases, many of which are zoonotic, and understanding of biosecurity issues is an important contribution to emergency response plans. For additional information see the following article: Donald L. Noah. Biological terrorism against animals and humans: a brief review and primer for action. JAVMA 2002;221:40-43.

In conclusion, if a bioterrorism event is suspected it is important to stay informed of the situation and remain calm. Each event is very specific and reactions to them can be quite different. It is everyone’s responsibility to follow the advice of public health officials and abide by federal and state guidelines. Movement restrictions may be necessary to prevent spread of disease. In a society that is free to come and go as we please, this may be difficult to accept at first. Remember that it is for the betterment of society and the particular situation to follow the advice of educated and trained infectious disease and bioterrorism specialists.
Contacts

- Phone numbers to know
  - Public Health Officials
  - Local and State
  - Local Veterinarian
  - State Public Health
  - Veterinarian or
  - State Veterinarian

It is important to keep a list with these phone numbers close at hand. If in doubt it is better to call and let the officials decide if your situation needs further investigation. The quicker an outbreak can be identified the quicker it can be contained and controlled.

Summary

- Bioterrorism is a real threat
- Many bioterrorism agents are zoonotic
- Animals may be the first to show signs
- Ask questions about animals exposure and clinical signs
- Public health infrastructure is being strengthened

We have discussed several main points. We highlighted that animals play an integral role in public health. We looked at the threat of bioterrorism, pointing out that the threat does exist and Americans need to be educated about it. Many of the bioterrorism agents are zoonotic and most emerging diseases are zoonotic. We discussed that animals may be the first to show signs of these diseases. It is important to ask questions about animals and animal exposure. We overviewed the public health infrastructure and discussed the systems and programs in place that have been, or are being, strengthened.

Summary

- Awareness education is important component of preparedness and protection
- Prevention, recognition, and response involves everyone
- You play a critical role

Awareness of these diseases and principles of zoonotic diseases is important and educating others is an important component of preparedness and protection. Communication between physicians, veterinarians and their patients/clients about human-animal exposures is important. Prevention, recognition and response involves everyone. Most importantly, each of you play a critical role.

Readings

For more reading on bioterrorism, agroterrorism, and the agricultural bioterrorism programs of various nations, these titles are recommended.

Conclusion

“The best prescription, is knowledge.”

Dr. C. Everett Koop
Former U.S. Surgeon General
Acknowledgments

Development of this presentation was funded by a grant from the Centers for Disease Control and Prevention to the Center for Food Security and Public Health at Iowa State University.

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