Slide 1

Practical Applications for Managing Biological Risks

Zoonotic Transmission Control for Dairy Producers

This presentation will review some key points of biological risk management and general prevention steps that can be applied to every farm to decrease the risk of zoonotic disease transmission.

Slide 2

Biological Risk Management (BRM)

- Overall process of awareness education, evaluation, and management

- Designed to improve infection/disease control
  - Foreign and domestic diseases
- Provide tools to minimize risk

Center for Food Security and Public Health
Iowa State University 2006

Biological risk management is the overall process of awareness education regarding the risk of infectious diseases entering or spreading through an animal facility. It also involves evaluating and managing those risks. BRM is designed to help livestock producers understand the need for infection or disease control, not only for foreign animal disease threats but domestic diseases as well. Biological risk management provides the tools to minimize the risk (photo courtesy of: DB Weddle).

Slide 3

Biological Risk Management (BRM)

- Disease risk cannot be totally eliminated
  - Animal, its environment
  - Decrease exposure
  - Infectious agent interactions

- Minimize threat to animals and humans
- No one-size-fits-all answer

Center for Food Security and Public Health
Iowa State University 2006

BRM recognizes that disease risk cannot be eliminated, but that the risk can be managed through effective control measures. As animal caretakers, it is our duty to be knowledgeable of the animal and its environment to minimize the risk of disease and keep the people working with them safe. It may seem hopeless to try to completely eliminate exposure to infectious diseases, especially diseases that are always present (endemic). For nearly all diseases there is a relationship between dose and severity. A threshold dose is required to establish infection, and low doses may cause subclinical or only mild infections. For endemic diseases, reducing the dose of infectious agent the animal is exposed to can positively affect the farm's economic impact and help justify the cost of implementing BRM. Many different solutions exist and because all dairy facilities are different, there is not a one-size-fits-all answer. Photo depicts two dairy employees working in a milking parlor (Photo courtesy of USDA - ARS).

Slide 4

Routes of Transmission

- Spread of disease agents
  - Animal ⟷ human
- Different modes of transmission
  - Aerosol
  - Direct contact
  - Fomite
  - Oral
  - Vector-borne

Center for Food Security and Public Health
Iowa State University 2006

The approach that was taken in the development of the biological risk management tools was to look at diseases based on their route of transmission to the animal, or human in the case of zoonotic diseases. Disease agents can be spread from animals to humans through a variety of transmission modes. Many infectious agents can be transmitted by more than one route of infection. This presentation will focus on how to prevent zoonotic transmission from animals to humans. This photo shows several dairy cows grazing in a pasture (Photo courtesy of USDA – ARS)

Slide 5

Zoonotic Diseases of Cattle Present in the U.S.

- Anthrax
- Brucellosis
- Cryptosporidiosis
- Dermatophilosis
- *E. coli*
- *Giardia*
- Leptospirosis
- Listeriosis
- Pseudocowpox
- Q Fever
- Ringworm
- *Salmonella*
- Tuberculosis
- Vesicular stomatitis

Center for Food Security and Public Health
Iowa State University 2006

Zoonotic diseases of cattle that are present in the U.S. include anthrax, brucellosis, cryptosporidiosis, dermatophilosis (derm-ATOF-ill-O-sis) , *E. coli*, *Giardia* (gee-arr-DEE-ah), leptospirosis, listeriosis, pseudocowpox (SUE-doe-cow-pox), Q Fever, ringworm, *Salmonella*, tuberculosis and vesicular stomatitis.

Slide 6

Zoonotic Diseases of Cattle Foreign Animal Diseases

- Bovine Spongiform Encephalopathy
  - Mad cow disease
- Melioidosis
- Rift Valley Fever

Center for Food Security and Public Health
Iowa State University 2006

Zoonotic diseases of cattle that are not found in the U.S. are called foreign animal diseases. Examples include bovine spongiform encephalopathy (BSE) or "mad cow disease", melioidosis (mel-EE-oid-OH-sis), and Rift Valley Fever (RVF). This is a picture of a cow with BSE which is a disease spread to people through eating BSE contaminated meat (courtesy of USDA APHIS at www.aphis.usda.gov).

Slide 7

Routes of Transmission

- Apply to all infectious agents
- People must be exposed to develop disease
- Understand different routes of transmission = Gain control
- Risk areas must be identified
  - Design protocols to minimize exposure

Center for Food Security and Public Health
Iowa State University 2006

Every disease has to enter into a person by some route, so looking at disease prevention through the routes of transmission makes sense. One advantage to this approach is that it will also help protect against new or unexpected infectious diseases. This classification system is effective and easy to understand without requiring knowledge about a wide range of diseases, like all those listed at the beginning of this presentation. While disease agents and the infections they produce vary, they all have one thing in common: a person must be exposed to them to develop disease. Once it is understood that different diseases can be acquired by different routes, it is easier to gain control over them. From a management standpoint, it may be easier to identify risk areas, such as fomites, and then design protocols to minimize exposure.

Slide 8

Human-Animal Interaction

Animals have been and continue to be a part of human lives. This interaction strengthens the need for a program like biological risk management to minimize the chances of a person working in the cattle industry from acquiring a disease.

Slide 9

Human-Animal Interaction

- Livestock producers work with animals daily
  - Most have immunity to some diseases
  - NOT foreign animal diseases
- Employees without previous livestock exposure more at risk
  - May not have immunity

Center for Food Security and Public Health
Iowa State University 2006

Livestock producers have a lot of animal contact on a daily basis and have had for years. In most cases, the farmer has been previously exposed to some zoonotic diseases and has developed some type of immunity. This is not the case with foreign animal diseases however, as people have no immunity to something that they have never been exposed to before. Additionally, employees on farm that have not worked with livestock in the past are more at risk for zoonotic disease because they may not have immunity to any of the previously listed diseases. Educating this group of people is very important so as to protect their health. The photo shows a herdsman feeding a group of Holstein dairy cattle (courtesy of USDA Agriculture Research Service

(ARS)).

Slide 10	**Risk Factors** • Changing health status, increasing age – Farmers more vulnerable to zoonoses • Immunocompromised population also at risk – Young and old – Chemotherapy – Diabetes   Center for Food Security and Public Health Iowa State University 2006	A change in a farmer's health status, or the normal aging process, can make them more vulnerable to zoonotic diseases because their immune system may not be functioning like it should. Another group of people, those that are immunocompromised are also more vulnerable to zoonotic diseases. Immunocompromised individuals include the elderly, children under the age of 5, pregnant women, chemotherapy patients, organ transplant recipients, persons with HIV/AIDS, and people with chronic diseases such as diabetes. This makes disease awareness so much more important for these people. The top photo shows an elderly farmer, while the bottom photo shows another susceptible population, an immunocompromised person in a nursing home (photo sources USDA).
Slide 11	**Risk Factors** • Poor animal health • Poor animal sanitation • Poor personal hygiene • Intensive livestock production – Increased exposure  Center for Food Security and Public Health Iowa State University 2006	Other risk factors that promote zoonotic disease transmission include poor animal health, poor animal sanitation, and poor personal hygiene. Also, intensive livestock production increases a person's exposure to many animals in a short amount of time which could increase their chances of getting a zoonotic disease. This photo depicts a person petting an Ayrshire calf (courtesy of USDA ARS).
Slide 12	**Zoonotic Disease Transmission** • Animals may not show obvious signs of illness • Awareness of all routes of transmission is essential – Develop strategy to minimize disease risk for you and your employees  Center for Food Security and Public Health Iowa State University 2006	It is important to remember that zoonotic disease transmission can occur without animals showing obvious signs of illness. That is why awareness of the various routes of transmission becomes so essential when assessing and developing a strategy to minimize the risk of zoonotic disease for you and your employees. Photo of Jersey cow's courtesy of USDA Photography Center.
Slide 13	**General Prevention Steps** Overview • Animal health • Awareness education • Personal hygiene • Personal protective equipment Center for Food Security and Public Health Iowa State University 2006	There are many general prevention steps that every person could implement to prevent a variety of zoonotic diseases. Things such as keeping animals healthy, raising awareness to zoonotic disease risk through educating those that work with animals, promoting personal hygiene like washing hands after handling animals, and wearing personal protective equipment such as gloves and coveralls. This next section will provide some general prevention recommendations for each of these areas.

Slide 14

General Prevention Steps

Animal health
- Control diseases in the herd
  - Makes economic sense
  - If the disease is not present, people cannot be exposed

Center for Food Security and Public Health
Iowa State University 2006

One of the key aspects of biological risk management is maintaining a healthy herd. This not only makes good economic sense but it also decreases the risk of getting a zoonotic disease. If the disease is not present in the herd, people cannot be exposed and become ill. For specific recommendations regarding animal health, please view the other BRM presentations that focus on specific routes of disease spread in cattle.

Slide 15

General Prevention Steps

Awareness education
- Work with herd veterinarian, livestock extension specialists
- Educate anyone who works with animals about zoonotic disease risks
- English and Spanish

Center for Food Security and Public Health
Iowa State University 2006

As mentioned previously, there are certain populations of people that are more at risk for zoonotic diseases. Work with your herd veterinarian and livestock extension specialist to educate your employees and family members about the risks. If there is diversity on farm, make sure the education is communicated in both English and Spanish so everyone recognizes the risk and how to protect themselves. Photo courtesy of USDA.

Slide 16

General Prevention Steps

Personal hygiene
- Wash hands after handling animals
  - Removes the infectious agent

Personal protective equipment
- Gloves, coveralls, boots
- Mask, goggles

Center for Food Security and Public Health
Iowa State University 2006

One of the best protections against a zoonotic disease is personal hygiene- washing your hands. Many zoonotic diseases can be spread from animals to people through direct contact and the oral route. By washing your hands after handling animals, the risk of exposure decreases because you have removed the infectious agent. Additionally, the use of personal protective equipment can reduce a person's exposure to zoonotic diseases. Wearing gloves is important if you have any cuts or abrasions on your hands as this can lead to exposure. Coveralls will help keep your clothes clean and cover your arms to minimize disease exposure when handling tissues or animals. Boots will protect your shoes from contamination and minimize spread to other areas of the farm or into the home if they are removed after working with animals, much like coveralls. Finally, if you are working with known infectious animals, perhaps while treating an animal or performing a necropsy as the photo depicts, wearing a mask over your nose and mouth and goggles to protect your eyes can decrease exposure (courtesy of VMTRC).

Slide 17

Aerosol Control

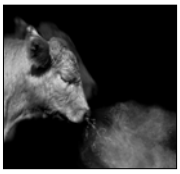
Zoonotic Transmission

Now we will look specifically at control measures you can apply on your dairy farm to minimize disease transmission to humans through the aerosol route.

Slide 18

Aerosol Transmission

- Infected droplets passed through the air from an animal to a person
  - Sneeze/cough
  - Birthing tissues
  - Fecal material
  - Urine
  - Contaminated soil



Center for Food Security and Public Health
Iowa State University 2006

Aerosol transmission occurs when infected droplets are passed through the air from an animal (infected) and breathed in by a person. We typically think of aerosol transmission as a sneeze or cough as depicted in this picture. While this can occur, the majority of aerosol transmitted zoonotic diseases actually occur when infected droplets are created from birthing tissues (placenta, birthing fluids), soil contaminated with feces, urine or bacteria and a person breathes in the dust particles. There are various prevention steps that can help decrease potential aerosol transmission and your risk of acquiring a zoonotic disease and we will review these in upcoming slides. Graphic designed by Clint May, ISU.

Slide 19

Aerosol Transmission

- Anthrax
- Listeriosis
- Melioidosis*
- Q Fever
- Rift Valley Fever*
- Tuberculosis

Center for Food Security and Public Health
Iowa State University 2006

There are many diseases transmitted by the aerosol route, both foreign animal diseases (FADs) and those that are present in the U.S. (endemic). The endemic diseases that can be transmitted by the aerosol route include anthrax, listeriosis, Q Fever and tuberculosis. Zoonotic foreign animal diseases of cattle include melioidosis (mel-EE-oid-OH-sis) and Rift Valley Fever (RVF). The main point to drive home is that they are all transmitted by the same route and prevention practices aimed at one will protect against others.

Slide 20

Aerosol Transmission

- Basic prevention steps involve:
  - Controlling dust
  - Wearing masks in certain situations

Center for Food Security and Public Health
Iowa State University 2006

There are various prevention practices that can help ensure aerosol transmission is minimized, and this section will discuss many of those. One essential step is to control the amount of dust generated in animal housing areas. Notice the large amount of dust in this dairy lot on the left. This can damage the protective cells in the respiratory tract and let contaminated particles in that can cause disease. Second, wear masks in certain situations to prevent inhaling contaminated particles. The employee in the photo on the right is wearing a mask while grading a lot. These basic steps will go a long way in preventing aerosol disease transmission. Photos courtesy of Pat Gordon, DVM.

Slide 21

Aerosol Prevention Practices

- Control dust in dry lots
  - Contaminated soil can be a source of zoonotic disease
  - Use water in limited amounts

Center for Food Security and Public Health
Iowa State University 2006

Contaminated soil can be a way that a zoonotic disease, such as Q Fever, can infect a person. There are products available to minimize dust in dry lots, as well as water mists that can be applied; however, excessive amounts of water can lead to mud which is not ideal for cattle. Photo depicts a dry lot dairy in the SW U.S. where water is used as a coolant for cows in the heat but must not be used in excess due to mud (courtesy of DB Weddle, ISU).

Slide 22

Aerosol Prevention Practices

- Wear an N-95 mask when:
  - Handling infectious animals or their tissues
  - Assisting with calving
  - Power washing

Center for Food Security and Public Health
Iowa State University 2006

If you or your employees are going to be performing a task that may generate a lot of aerosols, use a respiratory protection device, such as an N-95 mask as pictured here. A mask can protect against certain zoonotic diseases that can be inhaled. For instance, when handling infectious animals or their tissues, assisting with calving, or using a power washer to clean animal areas, a mask will help prevent breathing in infectious particles. An N-95 mask will be labeled as such (top photo) and the bottom photo shows that each has 2 straps for a better fit. N-95 means that they are the least resistant to degradation by oil aerosols and are 95% efficient at keeping out particles. They should fit snugly on your face; facial hair will decrease their ability to keep out infectious agents. Photos courtesy of Tru Twedt, DVM.

Slide 23

Aerosol Transmission Summary

- Aerosol transmission could occur on your farm
  - Anthrax, listeriosis, Q Fever, tuberculosis
- Foreign animal diseases can also be spread via aerosol
  - Melioidosis
- Prevention steps as described here can help minimize your risk

Center for Food Security and Public Health
Iowa State University 2006

Zoonotic aerosol transmission could occur on farms with diseases that are present in the United States such as anthrax, listeriosis, Q Fever, and tuberculosis. Should a foreign animal disease occur in the U.S., such as melioidosis, this too can be spread through aerosol transmission from cattle to people. Taking some of the basic prevention steps as described in this presentation can help you decrease your risk of acquiring a zoonotic disease.

Slide 24

Direct Contact and Fomite Control

Zoonotic Transmission

Now we will look specifically at zoonotic transmission and control measures you can apply on your dairy farm to minimize disease transmission to humans through the direct contact and fomite routes.

Slide 25

Direct Contact Transmission

- Pathogen in animal (blood, saliva, body fluids) or environment
- Contact with open wounds, mucous membranes, skin

Center for Food Security and Public Health
Iowa State University 2006

Transmission by **direct contact** requires the presence of an agent or organism in the environment or within an infected animal. A person becomes exposed when the agent directly touches open wounds, mucous membranes, or the skin through blood, saliva, or other body fluids. This photo shows an individual artificially inseminating a cow. Photo courtesy of USDA.

Slide 26

Fomite Transmission

- Contaminated inanimate object
- Carries pathogens
  - Brushes, needles, clothing, bedding

Center for Food Security and Public Health
Iowa State University 2006

A component of direct contact transmission is fomites. A **fomite** is an inanimate object that can carry pathogenic agents from an animal to a person. Examples of fomites include contaminated brushes, needles, clothing, and bedding (straw, shavings). These items must be managed as fomites but they will actually transmit disease through direct contact with a person. Top photo depicts a veterinarian palpating cows with fecal contaminated coveralls and rectal sleeves (photo courtesy of Stacy Holzbauer, DVM). Bottom photo depicts a dairy producer preparing a cow for the show ring by clipping the top line (photo courtesy of DB Weddle, ISU).

Slide 27

Direct Contact or Fomite Transmission

- Anthrax
- Brucellosis
- Dermatophilosis [F]
- Leptospirosis
- Melioidosis*
- Pseudocowpox [F]
- Q Fever
- Rabies
- Ringworm [F]
- Rift Valley Fever*
- *Salmonella*
- Tuberculosis
- Vesicular stomatitis

Center for Food Security and Public Health
Iowa State University 2006

There are many diseases transmitted by the direct contact route. The diseases that are already present in the U.S. include anthrax, brucellosis, leptospirosis, Q Fever, rabies, ringworm, *Salmonella*, tuberculosis and vesicular stomatitis. Diseases that can be transmitted by either direct contact or fomites include dermatophilosis, pseudocowpox (SUE-doe-cow-pox) and ringworm. Zoonotic foreign animal diseases of cattle that are transmitted through direct contact include melioidosis (mel-EE-oid-OH-sis) and Rift Valley Fever (RVF). The main point to drive home is that these are all transmitted by the same routes and prevention practices aimed at one will protect against others.

Slide 28

Direct Contact, Fomite Prevention Practices

- Basic prevention steps involve:
  - Maintaining good personal hygiene
  - Wearing personal protective equipment (PPE)
  - Keeping equipment clean

Center for Food Security and Public Health
Iowa State University 2006

There are various prevention practices that can help ensure direct contact and fomite transmission are minimized, and this section will discuss many of those. Perhaps the most essential step in prevention is to maintain good personal hygiene. Frequent hand washing, especially after contacting animals is one way to prevent harmful organisms from entering your body. Another basic prevention step is to wear the appropriate personal protective equipment (PPE) when handling animals or animal tissues. Finally, keep equipment clean to prevent it from becoming a fomite that can transmit disease. These basic steps will go a long way in preventing direct contact and fomite disease transmission. This photo depicts a worker washing equipment after milking (courtesy of DB Weddle, ISU).

Slide 29

Direct Contact, Fomite Prevention Practices

Personal hygiene

- Provide hand washing facilities
  - Warm running water, soap, clean towels
  - Located next to animal contact areas
  - Post signs reminding people to wash hands after handling animals
  - Check soap and towels weekly

Center for Food Security and Public Health
Iowa State University 2006

Personal hygiene is an important component of preventing zoonotic diseases through direct contact. Healthy human skin provides a natural barrier against most disease causing organisms that people come into contact with, except *Leptospira* bacteria from the urine of infected animals (can penetrate intact human skin). Make sure to wash your hands after handling animals. Provide hand washing facilities with warm running water, soap and clean towels located near animal contact areas as pictured here (courtesy of DB Weddle, ISU). Post signs to remind people to wash their hands after handling animals. Be sure to check soap and towels weekly. Frequent hand washing, especially after contacting animals is one way to prevent harmful organisms from entering your body.

Slide 30

Direct Contact, Fomite Prevention Practices

PPE- Gloves

- Wear latex/nitrile gloves when working with animals
  - Sick or unknown health status, create a barrier between you and the disease
  - Especially important for hands with cuts, abrasions, chapped
- Wash hands after removing gloves

Center for Food Security and Public Health
Iowa State University 2006

Personal protective equipment (PPE) is one way to create a barrier between people and disease agents. Gloves should be worn when working with sick animals or those that you are unaware of their health status (remember that infected animals do not always appear sick). This is especially important if hands have cuts, abrasions or are severely chapped because areas of broken skin provide an entrance for disease agents. Wearing gloves does not replace good hand washing habits- wash hands in warm water and soap after removing gloves. Photo courtesy of Dr. Phil Prater, Morehead State University, KY.

Slide 31

Direct Contact, Fomite Prevention Practices

PPE- Coveralls

- Require clean clothing in animal areas
- Restrict work/farm clothing from being worn outside of your operation
  - Prevent disease agents from "leaving"
  - Provide laundry facilities on farm

Center for Food Security and Public Health
Iowa State University 2006

Other prevention practices that you can incorporate on your farm are to require or provide personal protective equipment (PPE) such as clean coveralls/clothing for everyone entering animal areas. In order to prevent an employee or visitor from carrying potentially infected material off the farm and to their family, restrict work/farm clothing from being worn outside of your operation. This farm had an area to store workers clothes based on the shift they milked. Provide laundry facilities on the farm and only use these facilities for work/farm items as pictured here (courtesy of DB Weddle, ISU).

Slide 32

Direct Contact, Fomite Prevention Practices

PPE- Boots

- Require clean boots in animal areas
- Provide a boot bath or trashcan at the entrance/exit for ease of cleaning/disposing
- Wash hands after removing boots

Center for Food Security and Public Health
Iowa State University 2006

Require clean boots for everyone entering your operation to help decrease the risk of a person bringing a zoonotic disease onto your operation. Provide a boot bath or trashcan at the entrance/exit for ease of cleaning/disposing of footwear like the farm in the top photo. Wash hands in warm water and use soap after removing boots. Photos courtesy of: DB Weddle, ISU.

Slide 33

Direct Contact, Fomite Prevention Practices

Keep equipment clean

- Wash and disinfect grooming equipment if used on animals with skin abrasions
- Splash guard to catch urine, feces
- Wash down parlor equipment after soiled with urine, feces

Center for Food Security and Public Health
Iowa State University 2006

Various types of equipment can become contaminated and spread disease to humans. Things such as grooming tools can spread ringworm. Direct contact with infected urine can be a source of zoonotic leptospirosis. Installing a splash guard behind cows, as seen in this photo, can help keep feces and urine from splashing on those milking. Wash down the parlor equipment frequently to minimize direct contact with the various fomites that could be contaminated with urine or feces. (Photo courtesy of DB Weddle, ISU).

Slide 34

Direct Contact, Fomite Prevention Practices

- Some zoonotic diseases spread at calving
  - Wear water-resistant outer garment, coveralls
  - Wear rectal sleeves, gloves
- Immediately remove and dispose of all birthing tissues (placenta, fetal membranes)

Center for Food Security and Public Health
Iowa State University 2006

Due to the stress at calving, this is a time when certain zoonotic diseases can be spread (Q Fever, brucellosis). When assisting a calving, wear a water-resistant outer garment (as pictured here) or coveralls to prevent exposure through skin absorption. Wear rectal sleeves as they will cover the length of your arm and sturdy rubber or plastic gloves because latex or nitrile gloves may tear. Immediately remove all birthing tissues (placenta, fetal membranes) and dispose of properly. Photo courtesy of DB Weddle, ISU.

Slide 35

Direct Contact, Fomite Prevention Practices

- Remove soiled bedding
  - Thoroughly clean and wash area
- Clean equipment and personal protective gear
- Disinfect birthing area and equipment
- Wash hands after removing outerwear, gloves

Center for Food Security and Public Health
Iowa State University 2006

Since zoonotic agents can be found in animal body fluids, it is important to remove any soiled bedding and thoroughly clean and wash the area before disinfecting. Any equipment used to assist the calving should be thoroughly washed with warm water and soap and disinfected to remove any disease agents. It is important to wear personal protective equipment during cleaning to prevent exposure to any disease agents. The handout titled "Fomites – Managing them to Minimize Disease Spread" has more information on cleaning and disinfecting. Wash your hands after removing your protective outerwear and gloves. This calving area has had the bedding removed but still needs to be washed and disinfected before adding another animal (courtesy of DB Weddle, ISU).

Slide 36

Direct Contact, Fomite Transmission Summary

- Direct contact, fomite transmission could occur on your farm
  - Brucellosis, leptospirosis, ringworm
- Foreign animal diseases could also be spread via direct contact
  - Melioidosis, Rift Valley Fever
- Prevention steps as described here can help minimize your risk

Center for Food Security and Public Health
Iowa State University 2006

Direct contact transmission could occur on your farm with diseases like brucellosis, leptospirosis, and ringworm. Should a foreign animal disease occur in the U.S., such as melioidosis or Rift Valley Fever, they too can be spread through direct contact transmission. Taking some of the basic prevention steps as described in this presentation can help you decrease your risk of acquiring a zoonotic disease.

Slide 37

Oral and Fomite Control

Zoonotic Transmission

Now we will look specifically at zoonotic transmission and control measures you can apply on your dairy farm to minimize disease transmission to humans through the oral route.

Slide 38

Oral, Fomite Transmission

- Ingesting contaminated food, water
  - Feces, urine, unpasteurized milk, undercooked meats
- Eating or drinking after animal contact without washing hands

Center for Food Security and Public Health
Iowa State University 2006

Pathogenic agents can also be transmitted from animals to humans **orally**. This occurs by ingesting food or water contaminated with feces or urine. This can also occur if animal products are not pasteurized or cooked properly. Undercooked meat can transmit diseases such as *E. coli* and *Salmonella*. Eating or drinking after handling animal without washing your hands could also lead to oral zoonotic disease transmission. This photo depicts an employee eating while milking (courtesy of DB Weddle, ISU).

Slide 39

Oral, Fomite Transmission

- Anthrax
- Brucellosis
- Bovine spongiform encephalopathy (BSE)*
- Cryptosporidiosis
- *E. coli* F
- *Giardia*
- Leptospirosis F
- Listeriosis
- Melioidosis*
- Q Fever
- *Salmonella* F
- Tuberculosis

Center for Food Security and Public Health
Iowa State University 2006

There are many diseases transmitted through the oral and fomite route. The diseases that are already present in the U.S. that can be transmitted orally include anthrax, brucellosis, cryptosporidiosis, *E. coli, Giardia* (gee-arr-DEE-ah), leptospirosis, listeriosis, Q Fever, *Salmonella* and tuberculosis. Diseases that can be transmitted orally by a fomite include *E. coli*, leptospirosis and *Salmonella*. Zoonotic foreign animal diseases of cattle include bovine spongiform encephalopathy (BSE) and melioidosis (mel-EE-oid-OH-sis). The main point to drive home is that they are all transmitted by the same route and prevention practices aimed at one will help protect against others.

Slide 40

Oral, Fomite Prevention Practices

- Basic prevention steps involve:
  - Prevent contamination on the farm
    - Manage manure
    - Maintain good personal hygiene
  - Prevent contamination in the home
    - Proper food handling

Center for Food Security and Public Health
Iowa State University 2006

There are various prevention steps that can help ensure oral and fomite transmission are minimized, and this presentation will discuss many of those. Contamination of food can occur at several points along the food chain: on the farm or in the field, at the slaughter plant, during processing, at the point of sale, or in the home. Today we will focus on areas livestock producers can directly control: on the farm and in the home. On the farm, it is important to manage animal manure so that it does not contaminate surface water (ponds, lakes). Also, good personal hygiene such as washing hands after animal contact will prevent ingesting disease organisms. In the home, it is important to handle food properly as it may have been contaminated prior to arriving in your kitchen. These basic steps will go a long way in preventing oral disease transmission.

Slide 41

Oral, Fomite Prevention Practices

On the farm

- Manure properly handled and stored
  - Does not contaminate drinking water
- Personal hygiene practices
  - Washing hands after animal contact before eating, drinking, preparing food
  - Minimize contact with disease agents

Center for Food Security and Public Health
Iowa State University 2006

To prevent oral transmission of disease on farm, manure should be properly handled and stored so that it does not contaminate surface water or well water used for drinking. Personal hygiene practices such as hand washing after contact with animals is important to prevent ingesting disease agents. This is especially important before eating, drinking or preparing food. Minimizing contact with disease agents will also decrease your chance of contracting a zoonotic disease.

Slide 42

Oral, Fomite Prevention Practices

In the home

- Drink pasteurized milk and juices
- Wash raw fruits and vegetables before eating
- Defrost meats in the refrigerator

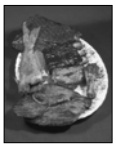
Center for Food Security and Public Health Iowa State University 2006

To prevent oral transmission of disease in the home, do not drink unpasteurized milk and juices. Pasteurization destroys potentially harmful organisms such as brucellosis and Q Fever. Make sure to wash raw fruits and vegetables before eating and thaw frozen meats in the refrigerator to avoid uneven cooling.

Slide 43

Oral, Fomite Prevention Practices

- After contact with raw meat
  - Wash hands, utensils, cutting board, kitchen surfaces with hot soapy water
- Cook beef/beef products thoroughly
  - Internal temperature of 160°F
- Eat cooked food promptly
- Refrigerate leftovers within 2 hours after cooking
  - Store in shallow containers



Center for Food Security and Public Health Iowa State University 2006

Additionally, after contact with raw meat, wash hands, utensils, cutting boards and kitchen surfaces with hot soapy water. Cook beef and beef products thoroughly to an internal temperature of 160°F and eat cooked foods promptly. Refrigerate any leftovers within 2 hours after cooking and store them in shallow containers so that the contents are cooled evenly throughout.

Slide 44

Oral, Fomite Transmission Summary

- Oral and fomite transmission could occur on your farm
  - Crypto, leptospirosis, listeriosis
- Foreign animal diseases can also be spread via oral route
  - BSE, melioidosis
- Prevention steps as described here can help minimize your risk

Center for Food Security and Public Health Iowa State University 2006

Oral and fomite disease transmission could occur on your farm with everyday diseases like and cryptosporidiosis (crypto), leptospirosis and listeriosis. Should a foreign animal disease occur in the U.S., such as BSE and melioidosis could be spread through oral transmission. Taking some of the basic prevention steps as described in this presentation can help you decrease your risk of acquiring a zoonotic disease.

Slide 45

Vector Control

Zoonotic Transmission

Now we will look specifically at zoonotic transmission and control measures you can apply on your dairy farm to minimize disease transmission to humans through the vector route.

Slide 46

Vector Transmission

- Insect
- Acquires pathogen from one animal
- Transmits to a person
  - Biological vectors
    - Ticks, mosquitoes
  - Mechanical vectors
    - Flies, cockroaches

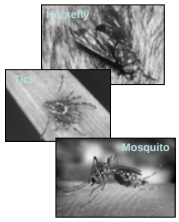
Center for Food Security and Public Health Iowa State University 2006

Vector transmission occurs when an insect acquires a pathogen from one animal and transmits it to a person. Ticks and mosquitoes are common biological vectors of disease, meaning they take the disease agent into their body and then inject it into a person. Flies and cockroaches are a common mechanical vector as they carry the disease agent on their body (legs, feet pads) rather than taking it into their body. The top photo shows a calf with numerous flies (courtesy of DB Weddle, ISU), while the bottom photo shows an adult deer tick, *Ixodes scapularis* (courtesy of USDA).

Slide 47

Vector Transmission

- Anthrax
  - Flies
- Q Fever
  - Ticks
- Rift Valley Fever*
  - Mosquitoes



Center for Food Security and Public Health
Iowa State University 2006

There are three zoonotic diseases of cattle that are transmitted by a vector; two that are present in the U.S.: anthrax (spread by flies) and Q Fever (spread by ticks); the third is a foreign animal disease, Rift Valley Fever (spread by mosquitoes). (Photos courtesy of the CDC Public Health Image Library).

Slide 48

Vector Prevention Practices

- Source reduction
  - Flies, mosquitoes
- Control adults
  - Flies, mosquitoes, ticks
- Minimize interaction with insects
  - Personal protection

Center for Food Security and Public Health
Iowa State University 2006

Vector control begins with an understanding of the insect's life cycle. Insect life stages vary and so do the specific control measures. For instance, the egg laying grounds for flies are different than that of mosquitoes and one approach does not work for all. We will discuss options in future slides. Controlling adult insects, be it flies, mosquitoes or ticks, often involves the use of insecticides. This is often less effective, so more effort should be focused on controlling egg laying areas. Finally, minimize interaction with insects, such as ticks, through personal protective measures. This would include wearing long sleeves and pants when working outside as well as using insect repellant on exposed skin. Prevention practices for each of the areas will be discussed in the next slides.

Slide 49

Vector Prevention Practices

- Source reduction, flies
  - 4 life stages
    - Egg, larva, pupa, adult
    - Cycle as short as 10 days in warm weather
  - Lay eggs in organic matter
    - Manure, feed, wet bedding
    - Disturb weekly to prevent development
  - Clean up spilled feed, feed bunks

Center for Food Security and Public Health
Iowa State University 2006

Flies have a four stage life cycle. The adult female fly lays her eggs in organic matter, be it manure, feed or wet bedding. These eggs then develop into larva, which change to pupa and finally emerge as adult flies. This process can be as short as 10 days in warm weather. One way to decrease the prevalence of flies is to minimize areas where they can lay their eggs by disturbing the piles of organic matter weekly. Keep pastures rotated, drag dry lots to break up the fecal pats, clean alleys/pens daily, clean up spilled feed, and clean around feed bunks. The photo depicts an excellent area for flies to lay their eggs- old feed (courtesy of DB Weddle, ISU).

Slide 50

Vector Prevention Practices

- Source reduction, fly larvicides
  - Feed additives
    - All animals on farm, 3 weeks prior to season
  - Parasitic wasps feed on fly pupa
  - Predatory mites, beetles feed on larva
- Adulticides
  - Knockdowns for high concentrations
  - Residuals for barn walls, ceilings
  - Baits, fly traps in conjunction with other methods

Center for Food Security and Public Health
Iowa State University 2006

Feed additives (larvicides) have some effectiveness; the key is to get it in the feed at least 3 weeks before fly season, feed it to ALL animals on farm and maintain it in the feed until the end of fly season. This should be in addition to the other hygiene procedures of cleaning yards, barns and feeding areas. Parasitic wasps, predatory mites and beetles feed on pupae/larvae living in manure, bedding, vegetation. Certain insects can only be used in certain areas because they may feed on other beneficial insects, so check with your local extension specialist for recommendations. Adulticides such as knockdowns that kill a fly on contact should be applied in areas of high fly concentrations because they do not last long in the environment (1-2 hours). Residual sprays can be applied to shaded surfaces (barn walls, ceilings) where flies rest to kill them through contact. To avoid insecticide resistance, it is a good idea to alternate between area and residual sprays. Baits and fly traps work against house flies but should be part of an integrated pest management system for best efficacy.

Slide 51

Vector Prevention Practices

- Control adult flies
- Target key areas on farm
  - Milking parlor, calf hutches
  - Barns
  - Animals

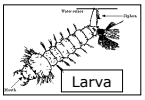
Center for Food Security and Public Health
Iowa State University 2006

Target key areas on farm, such as calf hutches (top photo) and barns, with insecticides to minimize cost. Milking parlors should be treated with approved chemicals only. Sprays approved for animals are another cost effective way to spend money on insecticides. Bottom photo depicts a heifer barn and feeding area that was recently sprayed for flies. Photos courtesy of DB Weddle, ISU.

Slide 52

Vector Prevention Practices

- Source reduction, mosquitoes
  - Lay single eggs in damp soil
  - Lay eggs on water surface
- Larvae, pupae live upside down in water;
  - Breathe via siphon, trumpet at water surface
  - Larvae need organic matter for development



Center for Food Security and Public Health
Iowa State University 2006

There are about 200 different species of mosquitoes in the United States, all of which live in specific habitats, exhibit unique behaviors and bite different species of animals. Some lay single eggs on damp soil that is later flooded by water; others lay an egg raft on the water's surface. Eggs hatch to larvae then to pupae, both of which live in the water and come to the surface to breathe by utilizing a siphon tube or trumpet while hanging upside down from the surface of the water. The larva require large amounts of nutrients for maturation and feed on organic matter in the water.

Slide 53

Vector Prevention Practices

- Source reduction, mosquitoes
- Eliminate mosquito larval habitats
- Fill tree holes
- Empty containers that hold water weekly
- Circulate lagoons, water tanks
- Drill holes in or use half tires for silage piles

Center for Food Security and Public Health
Iowa State University 2006

Mosquito source reduction consists of eliminating larval habitats or making them unsuitable for larval development. Tree holes can be good breeding grounds for some mosquitoes, so those should be filled. Containers that hold water, like stock tanks or water troughs, should be emptied weekly or agitated weekly them to keep mosquitoes from laying eggs there. By minimizing standing water through circulating lagoons or water tanks, a lot can be done to minimize mosquito egg laying areas. Another problem on farms is containers that hold water or old tires used for silage piles, as pictured on the bottom (courtesy of DB Weddle). Mosquitoes transmit disease to humans and a farm walk through to identify and eliminate trash containers is good prevention.

Slide 54

Vector Prevention Practices

- Mosquito larvicides
- Use when source reduction and biological control not feasible
- More effective and target-specific
- Less controversial than adulticides
- Applied to smaller geographic areas
  - Larvae concentrate in specific locations

Center for Food Security and Public Health
Iowa State University 2006

Larvicides are used when immature mosquito populations become larger than source reduction can manage or biological control can handle. They are often more effective and target-specific than adulticides, making them less controversial. They can be applied to smaller geographic areas than adulticides because larvae are often concentrated in specific locations, such as standing water.

Slide 55

Vector Prevention Practices

- Adulticides
- Less efficient than source reduction
- Require multiple applications
- Require proper environmental conditions
  - Light wind, no rain
- Small droplets to contact adults

Center for Food Security and Public Health
Iowa State University 2006

Adulticides are often the least efficient control program and often require multiple applications. Effective adult mosquito control with adulticides requires small droplets that drift through mosquito areas and come in contact with adults to kill them as pictured here. Insecticides are applied in a concentrated form at very low volumes such as 1 oz (29.6 mL) per acre. Excessive wind and updrafts reduce control, but a light wind is necessary for drifting spray droplets. This photo depicts a man fogging for mosquitoes.

Slide 56

Vector Prevention Practices

- Avoid mosquitoes if possible
  - Stay inside during the evening when mosquitoes are most active
  - Wear long pants and sleeves
- Use repellent
  - DEET
  - Follow label directions
  - Do NOT use DEET on pets

Center for Food Security and Public Health
Iowa State University 2006

People should avoid mosquitoes if possible as they can transmit Rift Valley Fever and other diseases. Stay inside during the evening when mosquitoes are most active. When outside, wear long pants and sleeves and use repellents on exposed skin. Repellent with DEET is the most effective. DEET is an insect repellant that is safe to use on people. Make sure to follow the label directions when using. Do NOT use DEET on pets. This picture depicts a child being sprayed with a mosquito repellent.

Slide 57

Vector Prevention Practices

- Tick control
  - Regular inspection of animals
  - Mow pastures
  - Acaricides
- Personal protection
  - Wear long sleeves
  - Tuck pants into socks
  - Repellent
  - Remove ticks immediately

Center for Food Security and Public Health
Iowa State University 2006

Tick control involves regular inspection of animals and pastures for ticks. Environmental management such as mowing pastures, as the top picture depicts, can help to reduce tick habitats. Chemical treatments with acaricides (tick killing products) can be used every 2-4 weeks on cattle during tick season. There are personal protection steps you can take to prevent tick-borne diseases. Wear long sleeved shirts and tuck them into pants. Tuck pant legs into socks or boots, as depicted in the bottom photo (courtesy of CDC). This will help keep ticks on the outside of clothing. If you'll be outside for an extended period of time, tape the area where your pants and socks meet to prevent ticks from crawling under your clothes. Use insect repellent with DEET on clothing and skin to prevent tick bites (make sure to follow all product label directions). Inspect your clothing and skin immediately and remove ticks.

Slide 58

Vector Transmission Summary

- Vector borne transmission could occur on your farm
  - Anthrax, Q Fever
- Foreign animal diseases can also be spread via vectors
  - Rift Valley Fever
- Prevention steps as described here can help minimize your risk

Center for Food Security and Public Health
Iowa State University 2006

Vector-borne transmission could occur on your farm with diseases such as anthrax and Q Fever. Should a foreign animal disease occur in the U.S., such as Rift Valley Fever, it can also be spread through vector-borne transmission. Taking some of the basic prevention steps as described in this presentation can help you decrease your risk of disease introduction and spread on your farm.

Slide 59

Zoonotic Diseases of Cattle

Now that we have reviewed various prevention steps for zoonotic diseases, let's learn a little more about the diseases that are spread from cattle to humans.

Slide 60

Anthrax in Cattle

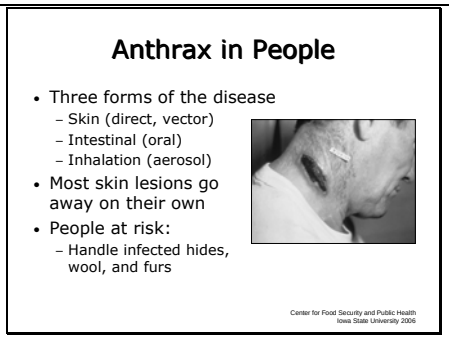
- Bacterium: *Bacillus anthracis*
- Forms spores
  - Can remain in soil for decades
- Animal disease
  - Spreads through the body
  - Rapid death

Center for Food Security and Public Health
Iowa State University 2006

Anthrax results from infection by *Bacillus anthracis*, a spore forming, Gram positive bacterium. Anthrax can be found as a spore in the soil worldwide; it 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, 10 years in milk, and up to 71 years on silk threads. However, the vegetative organisms are thought to be destroyed within a few days during the

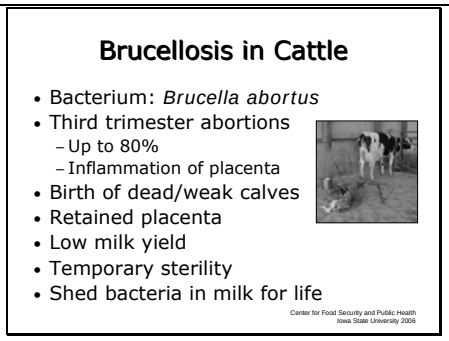
decomposition of **unopened** carcasses (exposure to oxygen induces spore formation). In cattle, sudden death may be the only sign as the photo depicts (courtesy of DB Weddle, ISU).

Slide 61



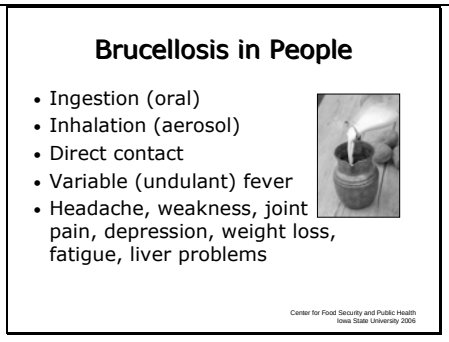
There are three forms of the disease in humans. 1) Cutaneous (skin) anthrax which develops after skin infections through **direct contact** or a **vector**, such as a biting fly. Most lesions are non-painful and go away on their own. This is a picture of a cutaneous (skin) anthrax lesion, also known as an eschar. (Photo courtesy of the CDC's Public Health Image Library). 2) Intestinal anthrax develops after ingesting (**oral**) contaminated meat. The initial symptoms may be mild malaise (all over body discomfort) and gastrointestinal symptoms. Severe symptoms can develop and rapidly progress to shock, coma and death. 3) Inhalational anthrax occurs after breathing in (**aerosol**) spores from contaminated dust. Natural infections are mainly seen among workers who handle infected hides, wool, and furs (wool sorter's disease). Symptoms may include fever, tiredness, and malaise; a nonproductive cough and mild chest pain which develops into a sudden onset of severe respiratory distress with fatal septicemia (blood infection) and shock within one to two days. Fatalities may be prevented if treated early; however, when symptoms are flu-like and non-specific, early treatment is often not sought.

Slide 62



Brucellosis, or undulant fever, is caused by various species of *Brucella* bacteria. Brucellosis causes abortions in the third trimester of pregnancy when unvaccinated cattle are exposed to the infectious organism. It is stated that greater than 80% of cattle will abort if exposed during this critical time of pregnancy. The organisms enter through the mucous membranes (gums, inside of eyelids, nose) and can cause inflammation of the placenta. Abortion can occur within 2 weeks and up to 5 months following infection. The fetus may look normal if aborted acutely after infection, or decayed if not expelled for a period of time. The pregnancy may end with a stillbirth or a weak calf. Often retained placentas and decreased milk yield follow. The overall appearance of the placenta is a leathery look. Once a cow has aborted from infection, subsequent gestations are normal, after a period of temporary sterility. Only 5% have residual sterility. Most cows will shed the organisms in the milk for life following infection. (Photo courtesy of DB Weddle, ISU).

Slide 63



Transmission of brucellosis can occur by ingestion of infected food or consuming infected unpasteurized milk or dairy products (**oral**). It can also occur by inhaling infectious **aerosols**, which is thought to be means of infection in slaughterhouses, or through **direct contact** with infected tissues through a break in the skin or mucous membranes (gums, eyes, inside of nose). Brucellosis can involve any organ or organ system and have varying signs of illness. The one common sign in all people with brucellosis is an irregular fever for a variable length of time, thus the term "undulant fever". Other signs and symptoms of brucellosis in people include headache, weakness, joint pain, depression, weight loss, fatigue and liver problems. Illness in people can be very long and painful

and can result in an inability to work and loss of income.

Slide 64

Bovine Spongiform Encephalopathy in Cattle

- BSE caused by prions
- First case in the U.K, 1986
- Long incubation: 4-5 years
- Rapid progression to death once signs appear
  - Hindlimb incoordination, tremors, falling, behavior changes
  - No treatment

Center for Food Security and Public Health
Iowa State University 2006

Bovine spongiform encephalopathy (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 then fed to other cows. It is thought to be caused by prions (short for proteinaceous infectious particles). It is considered a foreign animal disease in the U.S. The first cases of BSE appeared in the United Kingdom in 1986. There is a long incubation period with the peak incidence occurring in 4-5 year old cattle. The signs of the disease can be subtle and progress slowly. Once signs of the disease appear, the disease progresses rapidly and is fatal. Signs of BSE in cattle may include hindlimb incoordination, tremors, falling and behavior changes including nervousness and aggression. The morality rate is 100%. There is no treatment.

Slide 65

Bovine Spongiform Encephalopathy in People

- Ingestion (oral)
- 158/185 cases occurred in U.K
- Variant Creutzfeldt-Jakob disease
  - Average age of patients: 26 years
  - Changes in mood/behavior
  - Incoordination
  - Dementia
  - Fatal

Center for Food Security and Public Health
Iowa State University 2006

Currently, it is thought that ingestion (**oral**) of BSE contaminated beef products (prior to the United Kingdom's specified bovine offal ban in 1989) may be responsible for the disease. From 1996 (when the first suspected cases of vCJD occurred) to November 2005, 158 of the 185 cases worldwide were from the United Kingdom (Britain). In humans, BSE presents itself as variant Creutzfeldt-Jakob (KROITZ-felt YAH-cub) disease. The average age of people who develop this disease is 26 years. The symptoms include changes in mood or behavior, such as depression and schizophrenia, incoordination and involuntary muscle movement. The disease is fatal.

Slide 66

Cryptosporidiosis in Cattle

- Protozoan: *Cryptosporidium parvum*
- Spring, late fall/ early winter
- Scours in calves
  - < 3 weeks old
- Can be infected without signs of illness
- Estimated up to 50% of dairy calves shed "crypto"

Center for Food Security and Public Health
Iowa State University 2006

Cryptosporidium parvum (also known as "crypto") is a protozoan that multiplies rapidly and lives in the intestine. These small protozoa are infective immediately upon excretion and found in animals worldwide with peak illness occurring in the spring and late autumn/early winter. Many animals are affected; however, calves are more likely to have profuse watery diarrhea (scours) leading to dehydration and death if not treated. Calves less than 3 weeks of age appear to be the most at risk. They can be infected with crypto and pass it in their feces without showing signs of illness. It is estimated that up to 50% of dairy calves shed crypto (http://www.cfsph.iastate.edu/Factsheets/pdfs/cryptosporidiosis.pdf). Photo of Holstein calf courtesy of USDA's ARS photo library.

Slide 67

Cryptosporidiosis in People

- Ingestion (oral)
- Inhalation (aerosol)
- Symptoms
  - Profuse, watery diarrhea
  - Abdominal pain
  - Usually self-limiting
  - Severe in people with a weak immune system

Center for Food Security and Public Health Iowa State University 2006

Sources of human crypto infections generally come from ingesting (**oral**) contaminated food and water or contact with infected scouring calves. Inhalation (**aerosol**) of the organisms has occurred but it is very rare. Symptoms include profuse, watery diarrhea with cramping and abdominal pain. This disease is usually self-limiting (you will get better on your own) but approximately 10% of human patients require hospitalization for intravenous fluids. Severe, life threatening disease can occur in people with a weak immune system, such as people who are undergoing chemotherapy for cancer and people who are very young or elderly. (Photo courtesy of USDA's ARS photo library).

Slide 68

Dermatophilosis in Cattle

- Bacterium: *Dermatophilus congolensis*
- Carry the bacteria without showing signs
- Break-down of skin
  - Prolonged wetting, high humidity
- Scabs, crusts

Center for Food Security and Public Health Iowa State University 2006

Dermatophilosis is caused by the bacterium *Dermatophilus congolensis* (derm-ATOF-ilus con-go-LEN-sis). This bacteria can be found on the skin of diseased animals and also carrier animals that show no signs. Factors that break-down the natural protective barriers of the skin such as prolonged wetting by rain, high humidity, and high temperature allow the bacteria to spread. Dermatophilosis may occur in animals of any age but is more common in the young. Initially there is matting of the hair that has a "paintbrush" appearance. This leads to scabs or crust formation that may have pus underneath. A few animals may be itchy. (Photo courtesy of DB Weddle, ISU).

Slide 69

Dermatophilosis in People

- Direct contact
- Fomite
- Symptoms
  - Pustules on hands, arms
  - Sores, ulcers
  - Scars form

Center for Food Security and Public Health Iowa State University 2006

People can get dermatophilosis after **direct contact** with an infected animal or by a **fomite**, such as a brush or clippers. Pustules will develop at the site of contact, usually on the hands or arms. These sores will later break down to form shallow red ulcers that heal and leave scars. This photo depicts a 4-Her clipping her Brown Swiss heifer before the show (courtesy USDA ARS).

Slide 70

***E. coli* O157:H7 in Cattle**

- Bacterium: *Escherichia coli*
- Cattle are carriers
  - Bacteria shed in feces
  - No signs of illness

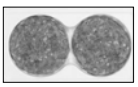
Center for Food Security and Public Health Iowa State University 2006

Escherichia coli (Esh-e-rik-E-a coe-lie) O157:H7 is a toxin producing bacterium. There are many types of *E. coli* bacteria, some types are normally found in the intestines of people and animals but do not cause illness. The specific type O157:H7 is carried in the intestines of some cattle, however they do not show signs of illness. It is shed in their feces and can be passed to other cattle or people. This is a picture of *E. coli* under an electron microscope (courtesy of Lawrence Berkeley National Lab).

Slide 71

***E. coli* O157:H7 in People**

- Ingestion (oral)
- Sources
  - Undercooked or raw hamburger; salami
  - Alfalfa sprouts; lettuce
  - Unpasteurized milk, apple juice or cider
  - Well water
- Symptoms
  - Bloody diarrhea, abdominal pain
  - Kidney failure in 2-10% of patients

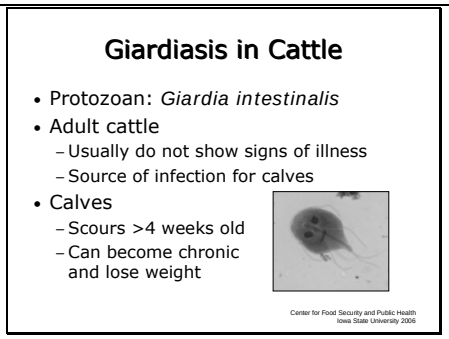


Center for Food Security and Public Health Iowa State University 2006

People can get this type of *E. coli* from cattle by ingesting (**oral**) undercooked or raw hamburger. This is the most common way to get *E. coli.* Other products that may be contaminated with *E. coli* O157:H7 include salami, lettuce and alfalfa sprouts. It has also be associated with unpasteurized milk, apple juice or cider, and contaminated well water. Symptoms of *E. coli* illness include watery or bloody diarrhea, abdominal pain, nausea and cramps. They occur about 2-5 days after exposure and can last for 5-10 days. A complication of *E. coli* infection is kidney failure. It is called hemolytic uremic syndrome (HUS). It is a life threatening condition, most commonly affecting children under 10 years of age. HUS is the most common cause of sudden onset (acute) kidney failure in children. This happens in 2-10% of patients. The photo of raw hamburger (top courtesy of

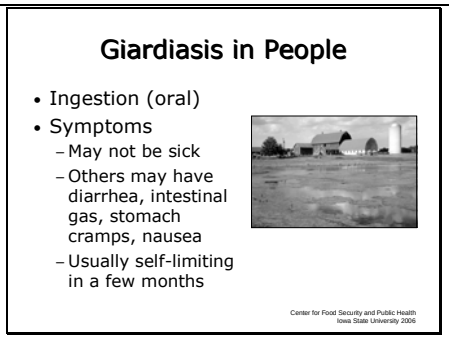
http://www.otan.us/webfarm/emailproject/rawhamburger.jpg) and lettuce in a grocery store (bottom) courtesy of the USDA Photography Center.

Slide 72



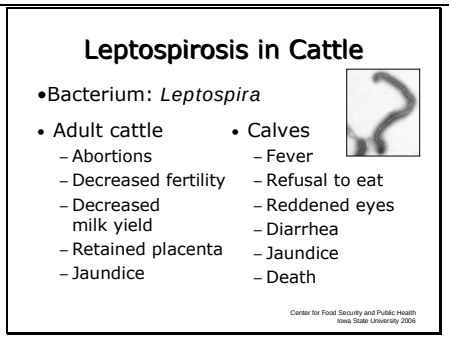
Giardiasis (gee-are-DYE-uh-sis) is caused by a one-celled, microscopic protozoan called *Giardia intestinalis* (gee-are-DEE-ah in-TES-tin-al-is). Adult cattle infected with this parasite typically do not show any signs of illness. However, they may be a source of infection for calves. Giardia can cause scours in calves at any age, but appears to be more common if they are four weeks or older. It can become a chronic (long-term) disease that causes weight loss or failure to gain weight. This photo of a *Giardia* parasite courtesy of the Japanese National Institute of Health.

Slide 73



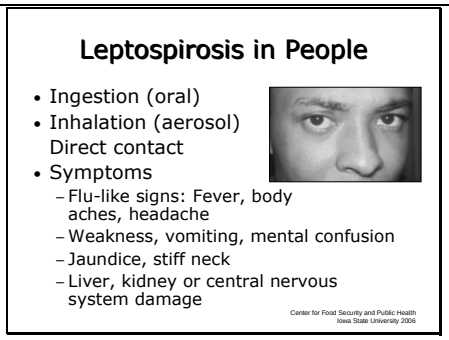
People can get *Giardia* through ingesting (**oral**) the parasite in contaminated water (like the picture shows) or if there is fecal material on their hands and they eat or drink prior to washing their hands. People with giardiasis may have no signs of illness while others may experience diarrhea, intestinal gas, stomach cramps, and nausea. The disease is self-limiting, usually clearing up on its own in a few months. (Photo courtesy of USDA Photography Center).

Slide 74



Leptospirosis is a disease caused by spiral shaped bacterium. In adult cattle, the most prominent signs of infection are abortions, decreased fertility or decreased milk yield. The placenta is retained in up to 20% of the cows that abort and infertility may occur. Jaundice, or yellowing of the skin, whites of the eyes and gums, may be seen in severely affected animals. In calves, the signs include fever, refusal to eat (anorexia), reddened eyes (conjunctivitis) and diarrhea. In severe cases, jaundice may be seen. Some calves may die within 3 to 5 days, and the survivors can be unthrifty after recovery. This photo depicts an electron micrograph of the *Leptospira* bacteria (courtesy of Noah's Arkive, The University of Georgia).

Slide 75



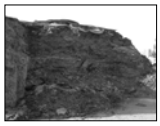
People can get leptospirosis by ingesting (**oral**) contaminated food or water, through inhaling **aerosolized** urine or water, or **direct contact** with the skin. The bacteria enters the body through mucous membranes (gums, eyes) or through cuts or abrasions on the skin. The *Leptospira* bacteria are found in the urine of infected animals and aborted fetuses or afterbirth (placenta, fluids) of cows who gave birth normally. In humans, the disease may range from mild to severe. Symptoms include flu-like illness (fever, body aches, headache), weakness, vomiting, mental confusion, jaundice (yellow skin color, yellow eyes) and a stiff neck. Severe cases can lead to damage of the liver, kidney or central nervous system (brain, spinal cord). Notice the yellowing of the eyes in this picture which is one sign of jaundice. (Photo courtesy of the CDC's

Public Health Image Library).

Slide 76

Listeriosis in Cattle

- Bacterium: *Listeriosis monocytogenes*
- Poor quality silage with a high pH
- Signs of illness
  - Facial paralysis, drooling
  - Lack of coordination
  - Circling, head pressing
  - Abortions, stillbirths
  - Death



Center for Food Security and Public Health
Iowa State University 2006

Listeriosis is caused by the bacterium *Listeriosis monocytogenes*. This bacterium is widespread in the environment in soil, plants, mud and streams. Cattle usually get this disease by eating contaminated corn silage. Poor quality silage with a high pH (low acid content) like the photo depicts, has been involved in most outbreaks because this sets up a favorable environment for the bacteria to grow and multiply. In cattle, *Listeria* can cause encephalitis, or inflammation of the brain. The signs of illness due to encephalitis are facial paralysis, drooling, lack of coordination, circling to one side and head pressing. Abortions and stillbirths mainly occur late in gestation. The infection can also be localized causing mastitis. Without treatment in animals with encephalitis, death usually occurs within 4 to 14 days. Animals with severe neurological signs usually die despite treatment. Photo courtesy of DB Weddle, ISU.

Slide 77

Listeriosis in People

- Ingestion (oral)
- Inhalation (aerosol)
- Symptoms
  - Pregnant women: Death of the fetus
  - Newborns, elderly, weak immune system
    - Infection of the blood stream, brain inflammation

Center for Food Security and Public Health
Iowa State University 2006

Most infections with listeriosis in people are caused by ingesting (**oral**) the bacteria in food, but the bacteria can also be spread by inhalation (**aerosol**), although this is not as common. Contaminated food sources include raw meat and unpasteurized dairy products. This bacteria has also been found in processed foods, such as lunch meat and hot dogs that were contaminated after processing. Listeriosis is a more serious problem in pregnant women, newborns, the elderly and people with a weak immune system. Women can become infected during pregnancy and usually show no signs of illness themselves, but this disease can cause death of the fetus during the second half of pregnancy. Listeriosis in newborns, elderly or those with a weak immune system can manifest as a blood stream infection or inflammation of the brain. Many of these infections in newborns are fatal. Photo of processed meats courtesy of the USDA's Agriculture Research Service photo library.

Slide 78

Melioidiosis in Cattle

- Bacterium: *Burkholderia pseudomallei*
- Foreign animal disease
  - Most cases occur in southeast Asia
- Rare in cattle
  - Pneumonia
  - Neurologic signs

Center for Food Security and Public Health
Iowa State University 2006

Melioidosis (mel-EE-oid-Oh-sis) is caused by the bacterium *Burkholderia pseudomallei*. It is considered a foreign animal disease and is found in tropical or subtropical areas of the world and is associated with heavy rainfall or flooded areas with high temperatures and humidity. Most cases occur in southeast Asia. This disease is rare in cattle, but they may develop pneumonia or neurologic signs.

Slide 79

Melioidiosis in People

- Ingestion (oral)
- Inhalation (aerosol)
- Direct contact
- Symptoms
  - Pneumonia
  - Fever
  - Small abscesses throughout the body
  - May become chronic

Center for Food Security and Public Health
Iowa State University 2006

The disease is primarily located in Southeast Asia, in countries such as Thailand. It is thought of as a disease of rice farmers. This is because the bacteria can be found in contaminated water and soil in these areas. Isolated cases have occurred in the United States in Hawaii and Georgia in people who traveled or were from those countries where melioidiosis is found. People can get melioidosis by either ingesting (**oral**) contaminated water, inhaling (**aerosol**) the bacteria in dust from contaminated soil or through **direct contact** of the bacteria with cuts or abrasions of the skin. Some people may be infected with the bacteria but do not get sick. Other people who are infected do not show signs of the disease for years. If the disease occurs suddenly, the patient may develop pneumonia and a fever and die after a few days. If it enters the blood stream, the bacteria can spread throughout the body creating many small abscesses. This disease can become chronic and last from months to years. (Thailand rice farmer photo http://www.escati.com/photos/characters/rice_farmer.jpg).

Slide 80

Pseudocowpox in Cattle

- Virus
- Signs of illness
  - Small, red, raised sores on teats/udder
  - Forms vesicles, scabs, nodules
  - Sore may form a "ring" or "horseshoe"
  - Slow spread, whole herd affected
  - Reinfection common

Center for Food Security and Public Health
Iowa State University 2006

Pseudocowpox (SUE-doe-cow-pox) is caused by a virus. The initial signs of pseudocowpox are small, reddish, raised sores on the teats and udders of cows. This is followed by the formation of vesicles (similar to blisters), scabs, and nodules on the udder and teats. The extension of sores often forms a "ring" or "horseshoe" of scabs that are characteristic for pseudocowpox and this occurs over the course of several weeks. Sores can also be seen around the mouth of calves nursing from affected cows. Although the disease spreads slowly through milking herds, it is common for the entire herd to eventually be affected. The length of immunity after infection is usually short and reinfection is common. (Photo of cow teat courtesy of http://www.countdown.org.au/Teat_Images.htm).

Slide 81

Pseudocowpox in People

- Direct contact
- Fomite
- Symptoms
  - "Milker's nodules"
  - Small, red, raised, flat-topped spots
  - Sores become firm nodules
  - Heals without scars

Center for Food Security and Public Health
Iowa State University 2006

People can get pseudocowpox by contacting (**direct contact**) a cow's lesions on her teats or udder or a calf's mouth. People may also get pseudocowpox through contact with a **fomite**, such as contaminated bedding or equipment. In people the lesions are also called "milker's nodules". Small, red, raised, flat-topped spots show up one to two weeks after exposure on the fingers, hands, and arms of the infected person. Within a week, the sores will become firm nodules that are red-blue in color and slightly tender. The disease is usually mild and generally the sores disappear after several weeks. Unlike cows, immunity after infection seems to develop and protects against reinfection. (Photo courtesy of Swiss Medical Weekly).

Slide 82

Q Fever in Cattle

- Bacterium: *Coxiella burnetii*
- Most do not show any signs
- May cause abortions
- Large number of bacteria shed
  - Calving (placenta, fetal fluids, fetus)
  - Milk
  - Urine
  - Feces

Center for Food Security and Public Health
Iowa State University 2006

Q (query) Fever in cattle is caused by the bacterium *Coxiella burnetii*. This bacterium is found worldwide, including in the United States. Many animals that are infected do not show any signs of illness. Abortions are the most common outcome of this disease and they generally occur late in pregnancy. Large numbers of bacteria are shed during calving in the placenta, fetal fluids, the aborted fetus as well as in milk, urine and feces.

Slide 83

Q Fever in People

- Inhalation (aerosol)
- Ingestion (oral)
- Symptoms
  - Sudden onset: flu-like, pneumonia, liver disease
  - Long term: heart complications, bone inflammation
  - Pregnant women: premature delivery, death of the fetus
- Direct contact
- Ticks (vector)

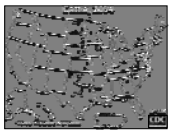
Center for Food Security and Public Health
Iowa State University 2006

Q Fever describes the symptoms seen in people, "query fever" or "puzzling fever". People can get Q Fever by inhaling (**aerosol**) contaminated barnyard dust (most common way), ingesting (**oral**) contaminated milk, by **direct contact** with infected animals during calving or through a tick (**vector**) bite (very rare). Q Fever can have a sudden (acute) onset occurring 2-3 weeks after infection. Symptoms of this form include flu-like illness (fever, chills, headache, fatigue), pneumonia and liver disease in severe cases. The disease can become chronic (long term) and can cause bone damage and affect the valves of the heart in people who have pre-existing damage. In pregnant women, infections can cause premature delivery, death of the fetus and infection of the placenta.

Slide 84

Rabies in Cattle

- Virus
- 100 cases/year
- Signs of illness
  - Unexplained paralysis
  - Anorexia
  - Nervous, irritable, hyperexcitable, unsteady
  - May be aggressive
  - Abnormal bellowing
  - Death within 7-10 days



Center for Food Security and Public Health
Iowa State University 2006

Rabies is a fatal viral disease that can affect all mammals (warm blooded animals that give birth to live young and produce milk). From 2000 to 2004 there were approximately 100 cases of rabies in cattle per year. Cattle usually get rabies from the bite of a rabid (infected) animal, such as a skunk or a raccoon. The virus affects the central nervous system (brain, spinal cord). The signs of rabies in cattle can include unexplained paralysis or behavioral signs such as anorexia (refusal to eat), nervousness, irritability, or they can become overly excited (hyperexcitability). Cattle may also develop an unsteady gait and become aggressive. Abnormal bellowing is common in cattle. Death usually occurs with in 7-10 days after signs of the illness begin. The yellow dots in this picture show the cases of confirmed rabies in cattle in the United States during 2004. (Courtesy of the CDC at http://www.cdc.gov/ncidod/dvrd/rabies/professional/professi.htm).

Slide 85

Rabies in People

- Direct contact
  - Bite of infected animal or through broken skin
- Symptoms
  - Fever, headache
  - Itching at bite site
  - Confusion, abnormal behavior
  - Difficulty swallowing
- Death within 2-10 of signs
- Vaccination BEFORE signs develop is highly effective

Center for Food Security and Public Health
Iowa State University 2006

People can get rabies by being bitten (**direct contact**) by an infected animal or if infected saliva comes into contact with broken skin or mucus membranes (gums, inside eyelids, inside the nose). Signs in humans are similar to those in animals. In most cases, signs of illness do not develop for 1-3 months after exposure. Early symptoms include fever, headache, itching at the site of the bite, confusion and abnormal behavior. People will be overstimulated by light and sounds and have difficulty swallowing. Once signs of disease begin, recovery is very rare and death usually occurs within 2-10 days. Fortunately, vaccination before signs develop is highly effective and life-saving. If you have been exposed to a rabid animal and have never been vaccinated against rabies, you will receive a series of 5 injections, typically in the muscle of the arm. These injections do not hurt any more than a flu shot. You will also receive one dose of rabies immune globulin (antibodies from blood donors given rabies vaccine).

Slide 86

Ringworm in Cattle

- Fungus, also called dermatophyte
- Usually only grow in hair, nails and the outer layer of the skin
- Signs of illness
  - Areas of hair loss, scaling, crusts
  - "Ringworm" lesion
  - May or may not be itchy
  - Small area to whole body involvement

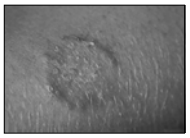
Center for Food Security and Public Health
Iowa State University 2006

Ringworm is caused by a fungus not a worm. It is also known as a dermatophyte (der-mat-O-fight). This fungus usually grows in the hair, nails and the outer layer of the skin. Animals can get ringworm from infective fungal spores on the hair of an infected animal, in the environment or from a fomite such as a brush or clippers. After exposure, it takes 2-4 weeks before signs begin to show and the signs of illness vary. Usually there are areas of hair loss with the skin scaling and crusting. The skin in the center of the lesion can die leaving a characteristic "ringworm" lesion. These areas may or may not be itchy. There can be small areas affected or the whole body can be involved.

Slide 87

Ringworm in People

- Direct contact
- Fomite
- Symptoms
  - Take 1-2 weeks to appear
  - Itchy
  - "Ringworm" lesion



Center for Food Security and Public Health
Iowa State University 2006

People can get ringworm after **direct contact** with an infected animal or a **fomite** such as a brush or clippers. Infected people can also spread ringworm to other people and animals. Symptoms of ringworm usually occur 1 to 2 weeks after infection. The most common symptom is itchiness and the lesions are most inflamed at the edge with redness, scaling, and occasional blistering. This is a photo of a typical "ringworm" lesion on a person's arm (courtesy of the CDC's Public Health Image Library).

Slide 88

Rift Valley Fever in Cattle

- Virus, foreign animal disease
  - Occurs in Africa, Saudi Arabia, Yemen
- Mosquitoes
- Abortion storm
- Adult cattle
  - Fever, weakness, anorexia, drooling, diarrhea, yellow skin
  - Death rate 10%
- Calves
  - Fever, depression, sudden death
  - Death rate 10-70%

Center for Food Security and Public Health
Iowa State University 2006

Rift Valley Fever is caused by a virus. It is a foreign animal disease that occurs in Africa, Saudi Arabia and Yemen (in the Middle East). Mosquitoes are the main way this disease is passed from animal to animal. If an animal infected with Rift Valley Fever came to the U.S., the mosquitoes here could pass it to other animals. The main sign of this disease is an abortion storm in cattle that are otherwise normal. Up to 100% of pregnant cows could abort. Possible signs of illness include fever, weakness, anorexia, drooling and diarrhea. Yellow skin or mucus membranes (jaundice) is also commonly seen. The death rate in adult cattle may be 10%. Calves develop fever, depression and may suddenly die. The death rate in calves can be from 10-70%. (Photo courtesy of Plum Island Animal Disease Center).

Slide 89

Rift Valley Fever in People

- Inhalation (aerosol)
- Direct contact
- Mosquito (vector)
- Ingestion (oral)
- No signs to flu-like symptoms
  - Fever, headache, muscle and joint pain, nausea, vomiting
  - Recovery in 4-7 days
- Severe disease in 1%

Center for Food Security and Public Health
Iowa State University 2006

Rift Valley Fever may be transmitted to people from animals through several ways. The RVF virus may be inhaled (**aerosol**) during slaughter of infected animals (as in an abattoir as the picture shows) or during the birthing process. It may be transmitted by **direct contact** with infected animal tissues, meat, or body fluids with a person's skin. A person may be bitten by a mosquito (**vector**) infected with RVF. RVF may be transmitted by ingesting (**oral**) unpasteurized milk from an infected animal, although does not occur as commonly as the others. The majority of humans who have RVF are asymptomatic (do not have signs) or have self-limiting flu-like symptoms. These symptoms include fever, headache, muscle and joint pain, and possibly nausea and vomiting. Recovery is usually in 4-7 days. In less than 1% of humans infected, severe disease can occur. This can include inflammation of the retina of the eye (retinitis), high fever with a bleeding disorder (hemorrhagic fever) or inflammation of the brain (encephalitis). The death rate in humans may reach 1%. (Photo courtesy of USDA Photography Center). The handout titled "Transmission Routes of Rift Valley Fever" gives a visual explanation of many ways this disease can be transmitted to people.

Slide 90

Salmonellosis in Cattle

- Bacterium: *Salmonella*
- Infected but show no signs
  - Shed the bacteria when stressed (transporting, weaning, calving)
- Adult cattle
  - Profuse diarrhea, anorexia, decreased milk production, weight loss, abortion
- Calves
  - Scours, joint infections, gangrene of feet, tips of ears, tail

Center for Food Security and Public Health
Iowa State University 2006

Salmonellosis is caused by may closely related bacteria called *Salmonella*. Cattle become infected with *Salmonella* when they eat food or water contaminated with feces. *Salmonella* often infects animals without showing any signs of illness. These animals will shed the bacteria in their feces during times of stress, such as transporting, weaning and giving birth (parturition). The most common sign of illness is diarrhea. Adult cattle can have profuse diarrhea, depression, refusal to eat (anorexia), a sudden decrease in milk production and weight loss. Pregnant cows may abort without showing any other signs of illness. Calves can have scours but may also develop complications such as joint infections and gangrene of the feet, tips of ears and the tail.

Slide 91

Salmonellosis in People

- Ingestion (oral)
- Direct contact
- Symptoms
  - 12 - 72 hours after infection
  - Nausea, vomiting, diarrhea
  - Cramping, abdominal pain
  - Headache, fever, chills
- Severe in children, elderly and those with a weak immune system

Center for Food Security and Public Health
Iowa State University 2006

People can get *Salmonella* by ingesting (**oral**) contaminated meat or food. You can also get it by handling animals (**direct contact**) and putting something in your mouth (**oral**) without washing your hands. Symptoms of salmonellosis begin 12 to 72 hours after infection and include nausea, vomiting, cramping abdominal pain and diarrhea, which may be bloody. Headache, fever, chills and muscle pain may also be seen. This disease is self-limiting (goes away on its own). However, it can be severe and even deadly in young children, the elderly and those with a weak immune system (immunocompromised).

Slide 92

Tuberculosis in Cattle

- Bacterium: *Mycobacterium bovis*
- 1917: U.S. eradication program began
  - Less infection, but still present
- Signs of illness
  - Slowly progressive disease
  - Early stage: Asymptomatic
  - Late stage: Weight loss, anorexia, cough, difficulty breathing

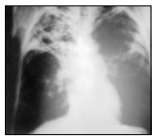
Center for Food Security and Public Health
Iowa State University 2006

Tuberculosis in cattle is caused by the bacterium *Mycobacterium bovis.* In 1917, the Cooperative State-Federal Tuberculosis Eradication Program began. This program includes the USDA Animal and Plant Health Inspection Service (APHIS), state animal health agencies, and U.S. livestock producers. Bovine tuberculosis is still present in the U.S. but at a much lower infection rate than before the eradication program began. Bovine tuberculosis is usually a slowly progressive and debilitating disease, but can occasionally have a quick onset and progress rapidly. Early stages of the infection often show no signs. As the disease progresses, weight loss, lack of appetite (anorexia), weakness, and a low-grade fever are common. If the disease involves the lungs, animals will have a cough that is worse in the morning, during cold weather or activity, and they may have difficulty breathing.

Slide 93

Tuberculosis in People

- Ingestion (oral)
- Inhalation (aerosol)
- Direct contact
- Symptoms
  - May not be sick
  - Disease of the lungs: Fever, cough, chest pain
  - Disease can spread: Kidney, spine and brain



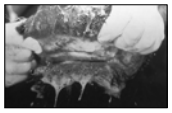
Center for Food Security and Public Health
Iowa State University 2006

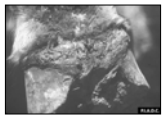
Bovine tuberculosis can infect humans and the most common route of infection is from ingesting (**oral**) raw (unpasteurized) milk or eating dairy products made from raw milk. Less commonly, the bacteria can enter the body by inhaling **(aerosol**) or through breaks in the skin (**direct contact**). A person can be infected with bovine tuberculosis but not show any signs of illness. It can infect the lungs (pulmonary tuberculosis) causing a fever, chest pain and the person may cough up blood. The disease can also spread throughout the body affecting the kidney, spine and brain. (X-ray of a patient's chest with tuberculosis courtesy of the CDC's Public Health Image Library).

Slide 94

Vesicular Stomatitis in Cattle

- Virus
- Signs of illness
  - Vesicles: Oral, mammary gland, coronary band, interdigital region
  - Salivation, lameness
- Vesicles isolated to one area of body
  - Mouth or feet
- Recover within 2 weeks





Center for Food Security and Public Health
Iowa State University 2006

Vesicular stomatitis is caused by a virus. Cattle develop oral vesicles (fluid filled lesions) that cause salivation and/or vesicles on the mammary gland, coronary band and interdigital (between the toes) region leading to lameness. These vesicles seem to isolate to one area of the body unlike other vesicular diseases. Recovery is within 2 weeks if there is no secondary infection. The top photo depicts the mouth of a cow with vesicular stomatitis. There is extensive ulceration of the dental pad and severe salivation. (Photo courtesy of Iowa State University, College of Veterinary Medicine, http://www.cfsph.iastate.edu/DiseaseInfo/ImageDB/imagesVS.htm). The bottom photo shows the back of a cow's foot. The coronary band at the heels is thickened, eroded, and covered by dried pus (Photo courtesy of Plum Island Animal Disease Center, http://www.cfsph.iastate.edu/DiseaseInfo/ImageDB/imagesVS.htm).

Slide 95

Vesicular Stomatitis in People

- Direct contact
- Incubation period: 1-6 days
- Flu-like symptoms
  - Headache, fever, pain behind the eyes, malaise, nausea, limb and back pain, oral vesicles (rare)
- Self-limiting disease
- Recovery in 4-7 days

Center for Food Security and Public Health
Iowa State University 2006

Humans are often infected through **direct contact** with infected tissues, vesicular fluid, or saliva. Following an incubation of 1 to 6 days, humans may display flu-like symptoms. These include headache, fever, pain when moving eyes, malaise (all over body discomfort), nausea, limb and back pain, and rarely, vesicles in the mouth. It is a self-limiting disease (will go away on its own). Recovery usually occurs in 4-7 days.

Slide 96

Key Learning Objectives

- Biological risk management is important
- All zoonotic diseases are transmitted by a few common routes
- Disease risk can be managed
- Awareness education is essential
- You play a critical role!

Center for Food Security and Public Health
Iowa State University 2006

Throughout this presentation, we have stressed that biological risk management is important to minimize disease spread. All zoonotic diseases are transmitted by a few common routes and by managing disease in your herd, you will decrease your chance of getting a zoonotic disease. While disease risk cannot be completely eliminated, it can be managed. Awareness education is critical for assessment and response and each of YOU play a critical role in protecting yourself and others on your farm!

Slide 97

Questions?

www.cfsph.iastate.edu/BRM
brm@iastate.edu
515-294-7189

CFSPH
Iowa State University,
College of Veterinary Medicine
Ames, IA 50011

Center for Food Security and Public Health
Iowa State University 2006

Slide 98

Acknowledgments

Development of this presentation was funded by a grant from the USDA Risk Management Agency to the Center for Food Security and Public Health at Iowa State University.

Center for Food Security and Public Health
Iowa State University 2006

Slide 99

Acknowledgments

Author: Ingrid Trevino, DVM, MPH

Reviewer: Danelle Bickett-Weddle, DVM, MPH

Center for Food Security and Public Health
Iowa State University 2006