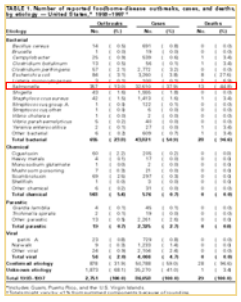
Slide 1	Food Safety	
Slide 2	**Overview** • Organisms • History • Epidemiology • Transmission • Foodborne illness • Prevention and Control	In today's presentation we will cover information regarding various organisms that cause foodborne illness and their epidemiology. We will also talk about the history of food safety, how organisms are transmitted, and various organisms that cause foodborne illnesses in humans. Finally, we will address prevention and control measures to assure food safety.
Slide 3	**Organisms** • Estimated 250 foodborne pathogens • Foodborne illness – 2 or more cases of a similar illness resulting from ingestion of a common food – Bacteria most common cause – Also viruses, parasites, natural and manufactured chemicals, and toxins from organisms	There are an estimated 250 pathogens that can cause foodborne related illnesses. Foodborne illness is defined as two or more cases of a similar illness resulting from ingestion of a common food. It can result from consuming foods contaminated with various pathogens. In most cases bacteria are the major pathogen followed by viruses, then parasites. However, natural or manufactured chemicals and toxins from organisms can also cause foodborne illnesses. The most commonly recognized foodborne infections are caused by *Campylobacter*, *Salmonella*, *E. coli* O157:H7 and by caliciviruses (better know as Norwalk viruses.)
Slide 4	 • Foodborne disease outbreaks, cases and deaths • 1993-1997 • *Salmonella* had the highest number	This table shows the number of reported food-borne outbreaks, cases and deaths from 1993-1997 in the United States. Of the bacterial agents, *Salmonella* cases had the highest number of outbreaks, cases and deaths. It is important to remember that these are only reported cases. Norwalk is thought to account for the most human cases of food-borne illness in the U.S., but many cases go unreported.CDC MMWR Surveillance for FoodBorne Disease Outbreaks, US 1993-1997 report March 17, 2000 http://www.cdc.gov/mmwr/preview/mmwrhtml/ss4901a1.htm#top
Slide 5	History	

Slide 6

History

- Early 1900's
  - Contaminated food, milk and water caused many foodborne illnesses
- Sanitary revolution
  - Sewage and water treatment
  - Hand-washing, sanitation
  - Pasteurization of milk- 1908
  - Refrigeration in homes- 1913

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During the early 20th century, contaminated food, milk and water caused many foodborne infections. The "sanitary revolution" began to try and eliminate disease organisms before they reached consumers. Public health departments or sanitation boards helped institute sewage and water treatment facilities in the early 1900's in many cities throughout the United States. Things such as hand-washing and overall improved sanitation became the campaign of public health departments. Pasteurization was developed in 1864 and used in milk in 1908 to decrease pathogen load. Refrigeration became available for household use in 1913 which helped decrease the growth of foodborne pathogens in the home. Before vaccines or antibiotics were discovered, these were the prevention methods taken.

Slide 7

History

- Animals identified as a source of foodborne pathogens
  - Improved animal care and feeding
  - Improved carcass processing
- Surveillance and research
- Outbreak investigations
- Laws and policies regarding food handling

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Once microbiology methods were improved, the etiology, characteristics, and sources of foodborne diseases were able to be identified. Animals were identified as a source of foodborne pathogens so improvements regarding healthier animal care, feeding and carcass processing also improved the quality of our food supply. Improved surveillance, research and outbreak investigations have helped discover mechanisms of contamination and led to new control measures. There are various laws and policies that have been implemented to improve food handling. These will be discussed further in the epidemiology and prevention/control sections of this presentation.

Slide 8

Epidemiology

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Slide 9

Epidemiology

- Foodborne diseases each year in US
  - Affects 1 in 4 Americans
  - 76 million illnesses
  - 325,000 hospitalizations
  - 5,000 deaths
    - 1,500 of those deaths caused by *Salmonella*, *Listeria*, and *Toxoplasma*

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The CDC estimates 1 in 4 Americans will encounter a foodborne disease each year. These outbreaks result in an estimated 76 million illnesses, 325,000 hospitalizations, and 5,000 deaths each year caused by known and unknown pathogens. Three pathogens alone, *Salmonella*, *Listeria*, and *Toxoplasma*, result in 1,500 deaths per year- more than 75% of those caused by known pathogens. The toxoplasmosis deaths primarily occur in HIV-infected patients; new treatments may help reduce this.

Slide 10

Epidemiology

- Many unrecognized or unreported
  - Mild disease undetected
  - Same pathogens in water and person to person
  - Emerging pathogens unidentifiable
- Greatest risk
  - Elderly
  - Children
  - Immunocompromised

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However, many foodborne illnesses are not recognized or go unreported for a variety of reasons. First, routine surveillance may not detect a mild foodborne illness and second, some of the same pathogens that cause foodborne illness can also be transmitted in water or from person to person. Lastly, some pathogens are emerging and are not yet identifiable or able to be diagnosed. Considering these factors, the above listed number of illnesses, hospitalizations and death may be obsolete. The elderly, children and immunocompromised individuals are usually at the greatest risk for these illnesses.

Slide 11

Surveillance/Regulation

- Surveillance
  - CDC
    - FoodNet and PulseNet
- Regulation
  - FDA
    - Domestic and imported food
  - USDA FSIS
    - Meat, eggs, poultry
  - National Marine Fisheries Service

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Food safety is addressed through surveillance and regulation by several national governmental agencies. The Centers for Disease Control and Prevention (CDC) closely monitors foodborne illnesses through its Foodborne Disease Outbreak Surveillance System. This includes both population-based (FoodNet) and laboratory surveillance (PulseNet) to identify the genetic sequence of the organism. The Food and Drug Administration (FDA) is responsible for the regulation of domestic and imported food (with the exception of meat and poultry products). The USDA Food Safety and Inspection Service (FSIS) is responsible for the regulation of meat, eggs, and poultry products. Finally, the National Marine Fisheries Service monitors foods from fishery sources.

Slide 12

Surveillance

- FoodNet: Active surveillance
  - Established 1996
  - CDC, USDA, FDA, select state health departments
  - Nine sites in U.S. monitor 13% of U.S. population
    - California, Colorado, Connecticut, Georgia, Maryland, Minnesota, New York, Oregon, Tennessee

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Data collection from foodborne illnesses have progressed in the last twenty years. Today there are active surveillance networks and several survey systems in place to monitor various causes of foodborne illness. FoodNet was established in 1996 and is a collaborative effort by CDC, USDA, FDA, and selected state health departments. It consists of a network of nine sites around the U.S. that monitors 13% of the population (approximately 36 million persons). FoodNet is an active surveillance system that monitors major causes of food-borne illness, conducts surveys for unreported cases, and studies risk factors involved with illness.

Slide 13

Surveillance

- PulseNet: Identify cause
  - Molecular fingerprinting
  - 45 state public health labs certified
- Passive surveillance: Survey methods
  - Hospital discharges
  - Outpatient treatment facilities
- FoodBorne Disease Outbreak Surveillance System
  - All states submit outbreak data

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PulseNet works to identify causes of bacterial foodborne illnesses by molecular fingerprinting pathogens. Public health laboratories in 45 states are certified to conduct the testing. There are several survey methods that collect data from hospital discharges and outpatient treatment facilities to assign persons treated to a foodborne illness case. The FoodBorne Disease Outbreak Surveillance System receives data from all states that have a recognized foodborne illness.

Slide 14

Estimated Cost

- Economic Research Service - USDA
  - Cost of top 5 foodborne pathogens
  - $6.9 billion annually
    - Medical cost
    - Productivity losses (missed work)
    - Value estimate of premature death

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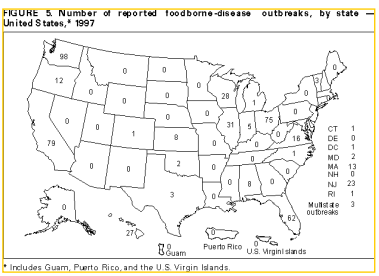
The USDA Economic Research Service estimated the annual cost for foodborne disease, caused by the top 5 pathogens (*Campylobacter*, *Salmonella*, *E. coli* O157:H7, *Shigella*, and caliciviruses), to be approximately 6.9 billion dollars. This figure includes medical costs, productivity losses from missed work, and the estimated value of premature death.

Slide 15



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This map indicates the geographical distribution of reported foodborne disease outbreaks in 1997. This is the most recent publication from CDC-MMWR as of July 2004.

Slide 16

Transmission

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Slide 17

Transmission

- Oral route
- Contamination varies
  - Organism, reservoir, handling/processing, cross-contamination
- Human reservoir
  - Norwalk-like virus, *Campylobacter*, *Shigella*
- Animal reservoir
  - *Campylobacter*, *Salmonella*, *E. coli* 0157:H7, *Listeria*, and *Toxoplasma*

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Transmission of foodborne pathogens occurs via the oral route. How those pathogens contaminate food can vary based on the organism, its reservoir, food handling/processing, and cross-contamination prior to serving. Some organisms rely on a human reservoir, such as Norwalk-like virus, *Shigella*, *Campylobacter*. Others have an animal reservoir such as *Campylobacter*, *Salmonella*, *E. coli* 0157:H7, *Listeria*, and *Toxoplasma*.

Slide 18

Transmission

- Contamination 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
  - In the home

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Contamination by foodborne pathogens 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. There are various control measures for each of these and they will be discussed in the prevention/control section.

Slide 19

Produce Processing

Event	Contamination sources
Production and harvest Growing, picking, bundling	Irrigation water, manure, lack of field sanitation
Initial processing Washing, waxing, sorting, boxing	Wash water, handling
Distribution Trucking	Ice, dirty trucks
Final processing Slicing, squeezing, shredding, peeling	Wash water, handling, cross-contamination

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Animal products are not the only food that can be contaminated. Various foodborne disease outbreaks have occurred due to fruits and vegetables. This table indicates the many possible sources for contamination during the processing of produce. Chart from CDC.

Slide 20

Important Organisms

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Slide 21

Important Organisms

- Norwalk-like viruses
- *Campylobacter*
- *Salmonella*
- *E. coli* O157:H7
- *Clostridium botulinum*
- *Shigella* spp
- *Toxoplasma*
- Emerging organisms

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Although many pathogens can cause foodborne illnesses, we will briefly cover those of greatest impact. These may also be potential bioterrorism agents for food sources. The pathogens we will discuss include Norwalk viruses, *Campylobacter, Salmonella, E. coli* O157:H7, *Clostridium botulinum, Shigella*, and recently emerging organisms.

Slide 22

Pathogen	No. of Cases
Salmonella	6,017
Campylobacter	5,215
Shigella	3,021
Cryptosporidium	480
E. coli 0157	443
Yersinia	161
Listeria	138
Vibrio	110
Cyclospora	15
Total in 2003	**15,600**

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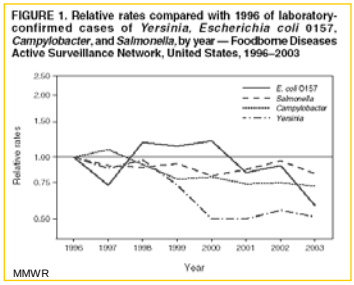
This table shows the number of laboratory-diagnosed cases of infections from nine pathogens under surveillance in the United States. There were a total of 15,600 cases of foodborne illness from these pathogens in 2003. Data from MMWR April 30, 2004/53(16)338-343.

Slide 23



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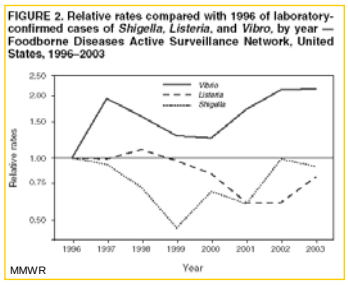
The above graph shows the relative incidence rates compared with 1996 of confirmed cases of *Yersinia, E. coli* 0157, *Campylobacter* and *Salmonella* per year. Overall, the incidence of infections caused by each of these pathogens has decreased since 1996. Data from MMWR April 30, 2004 / 53(16)338-343.

Slide 24



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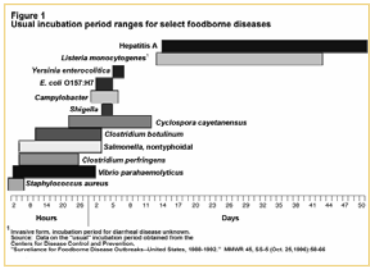
This graph shows the 2003 relative incidence rates compared with 1996 confirmed cases of *Shigella*, *Listeria* and *Vibrio* in the United States. Overall there has been a decrease in *Listeria* and *Shigella*, while there were roughly twice as many cases of *Vibrio* in 2003 than in 1996. Data from MMWR April 30, 2004 / 53(16)338-343.

Slide 25



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One of the unique factors of foodborne diseases is the variability in incubation times (period from exposure to the pathogen to the demonstration of clinical signs) of the organisms. From CDC-MMWR.

Slide 26

Norwalk-like Viruses

- Norovirus; Caliciviridae family
  - Most common foodborne agent
  - 23 million cases annually
- Sources
  - Person-to-person
    - Shed in human feces, vomitus
    - Outbreaks in daycares, nursing homes, cruise ships
  - Contaminated shellfish

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An outbreak of nausea and vomiting in Norwalk, Ohio in 1968 led to the discovery of Norwalk virus. Later, other small round structured viruses were identified as causing a similar disease and named Norwalk-like viruses. They are all members of the Caliciviridae family and have recently been renamed Norovirus. They are an important cause of sporadic gastrointestinal disease outbreaks throughout the world. It is considered the most common foodborne infectious agent and an estimated 23 million cases occur each year. The virus is transmitted in the stool and vomit of infected persons and can be shed for up to 2 weeks. Food-handlers who do not adequately wash their hands may contaminate food or water and spread this disease. Daycares and nursing homes have had outbreaks and several have occurred on cruise ships. Raw shellfish, such as clams and oysters, that are harvested from sewage contaminated waters may also induce a norovirus infection.

Slide 27

Norwalk-like Viruses

- Small infectious dose
- Signs
  - 12-48 hours post-exposure
  - Nausea, vomiting, diarrhea, abdominal cramps
  - Headache, low-grade fever
  - Duration: 2 days
- Food handlers should not return to work for 3 days after symptoms subside

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Norwalk-like virus is very contagious and can take as small as 10 viral particles to infect someone. Symptoms of Norwalk-like or Norovirus infection can appear as soon as 12 hours after exposure to the organism, but more commonly 1-2 days later. Clinical signs include nausea, vomiting, diarrhea, and abdominal cramping. Headache and low-grade fever may also occur. The disease typically lasts 2 days. This organism is can be shed in the feces and vomitus for up to two weeks, but typically it is recommended that food-handlers not return to work for 3 days after symptoms subside to prevent further spread.

Slide 28

Campylobacter jejuni

- Leading cause of bacterial diarrhea
- 2.4 million people each year
  - Children under 5 years old
  - Young adults (ages 15-29)
- Very few deaths
- Can lead to Guillain-Barré Syndrome
  - Leading cause of acute paralysis
  - Develops 2-4 weeks after *Campylobacter* infection (after diarrheal signs disappear)

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Foodborne related illnesses due to campylobacteriosis is increasing in incidence. It is caused primarily by *Campylobacter jejuni*, but also *C.* fetus *and C. coli.* According to the CDC, it is considered the leading bacterial cause of foodborne related diarrhea affecting 2.4 million people each year (5-14% of all diarrheal illnesses worldwide). Usually these are children under the age of 5 and young adults (15-29 years of age). Very few deaths are caused by this organism. Recently Guillain-Barré Syndrome has been associated with a small number of *Campylobacter* cases. This syndrome is the leading cause of acute paralysis and develops 2-4 weeks after a *Campylobacter* infection (after diarrheal signs disappear).

Slide 29

Campylobacteriosis

- Sources
  - Raw or undercooked poultry
  - Non-chlorinated water
  - Raw milk
  - Infected animal or human feces
    - Poultry, cattle, puppies, kittens, pet birds
- Clinical signs
  - Diarrhea, abdominal cramps, fever, nausea
  - Duration: 2-5 days

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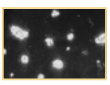
The most common sources for *Campylobacter* include raw or undercooked poultry, non-chlorinated water, raw milk or items contaminated with infected animal or human feces. Animal sources include poultry, cattle, puppies, kittens and pet birds. Clinical signs last approximately 2-5 days and include diarrhea, abdominal cramping, nausea and fever lasting 2-5 days.

Slide 30

Salmonellosis

- Gram negative bacteria
- Many serotypes can cause disease
- *S. enteritidis* and *typhimurium*
  - 41% of all human cases
  - Most common species in U.S.
- 1.4 million cases annually
  - 580 deaths



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Salmonella is a gram negative bacteria with many serotypes that cause foodborne related illnesses. The ones we most commonly associated with human foodborne illness are *S. typhimurium* and *S. enteritidis* in the U.S. They account for about 41% of all human cases reported. *S. newport* has been on the rise since 1996. Salmonellosis causes an estimated 1.4 million reported cases annually with 580 deaths. Salmonellosis is most severe in elderly, infants and persons with chronic diseases. People with AIDS are particularly vulnerable and often suffer recurring episodes. Photo: Salmonella bacteria in tetrathionate enrichment broth stained using direct FA staining technique from CDC Public Health Image Library.

Slide 31

Salmonellosis

- Sources
  - Raw poultry and eggs
  - Raw milk
  - Raw beef
  - Unwashed fruit, alfalfa sprouts
  - Reptile pets: Snakes, turtles, lizards
- Signs
  - Onset: 12-72 hours
  - Diarrhea, fever, cramps
  - Duration: 4-7 days

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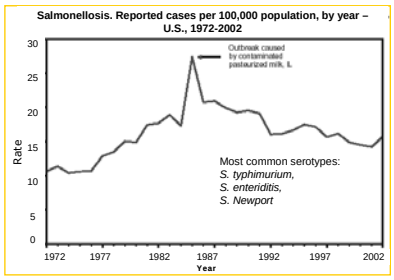
The most common sources of *Salmonella* related foodborne illnesses are raw poultry and eggs and raw milk. To date, 27 states still allow the sale of raw milk. Other causes are raw beef, and various fruits and vegetables that have had manure applied as fertilizer and not washed prior to consumption. There have been some cases from contaminated alfalfa sprouts. Additionally, pet reptiles, such as lizards, snakes, turtles, and iguanas are a common source. Clinical signs typically occur 12 to 72 hours following exposure to the pathogen. Diarrhea, fever and cramps are most often reported. These signs typically last for 4-7 days.

Slide 32



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This graph shows the reported human cases of salmonellosis per 100,000 population by year (1972-2002) in the United States: foodborne transmission accounts for ~95% of the infections in the U.S. The three most common *Salmonella* serotypes causing cases are *S. typhimurium, S. enteriditis* and *S. Newport*. In 2002, there were 44,264 total cases of human salmonellosis in the U.S. Data from the Summary of Notifiable Diseases 2002, CDC website.

Slide 33

E. coli O157:H7

- Enterohemorrhagic *Escherichia coli* (EHEC)
  - Surface proteins; toxin
- Sources
  - Undercooked or raw hamburger; salami
  - Alfalfa sprouts; lettuce
  - Unpasteurized milk, apple juice or cider
  - Well water
  - Animals: Cattle, other mammals

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Escherichia coli is another major pathogen of foodborne related illnesses. Harmless strains of *E. coli* are found in nature, including the intestinal tracts of humans and animals. Diarrheal disease is caused by several different strains of harmful *E. coli*. The most dangerous type is enterohemorrhagic *E. coli* (EHEC). It gets its name because it can cause bloody diarrhea and can lead to kidney failure in children or immunocompromised persons. *E. coli* O157:H7 is the most common EHEC and its enterohemorrhagic toxin is what actually causes the disease. The most common sources for this pathogen include undercooked or raw hamburger, salami, lettuce and alfalfa sprouts. It has also be associated with unpasteurized milk, apple juice or cider, and contaminated well water. The animal source for this organism is most commonly cattle, however, other mammals can also serve as a source. A photomicrograph of *Escherichia coli* bacteria using Gram stain technique.

Slide 34

E. coli O157:H7

- Signs
  - Watery or bloody diarrhea, nausea, cramps
  - Onset: 2-5 days
  - Duration: 5-10 days
- Sequela
  - Hemolytic Uremic Syndrome (HUS)
    - Acute kidney failure in children
    - Life threatening

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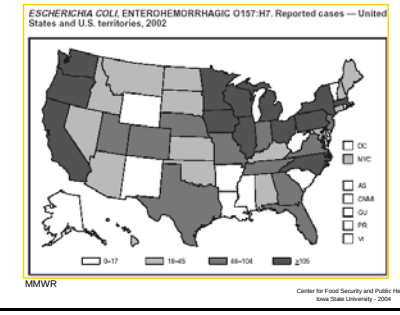
Clinical signs of foodborne *E. coli* illness include watery or bloody diarrhea, nausea and cramps. They occur about 2-5 days after exposure and can last for 5-10 days. One of the sequela to foodborne illness by this organism is hemolytic uremic syndrome (HUS). It is a life threatening condition, most commonly affecting children. HUS is the most common cause of acute kidney failure in children.

Slide 35



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This map shows the reported number of cases of *E. coli* enterohemorrhagic 0157:H7 in the U.S. in 2002. This serotype is the major culprit of the enterohemorrhagic *E. coli*, although many other *E. coli* serotypes can produce Shiga toxin and cause hemorrhagic colitis. *E. coli* 0157:H7 has been nationally notifiable since 1994. The white states reported 0-17 cases; lavender reported 18-45 cases; the lighter blue areas reported 46-104 cases while those colored darker blue indicated over 105 cases of *E. coli*-associated foodborne illness. A total of 3,840 human cases were reported to the CDC in 2002. Data from the Summary of Notifiable Diseases 2002, CDC website.

Slide 36

Botulism

- *Clostridium botulinum*
  - Neurotoxin leads to flaccid paralysis
  - Infants at greatest risk
  - Annually: 10-30 outbreaks; ~110 cases
- Sources: Home-canned foods, honey

- Signs
  - Double vision, drooping eyelids, difficulty speaking and swallowing
  - Onset: 18-36 hours

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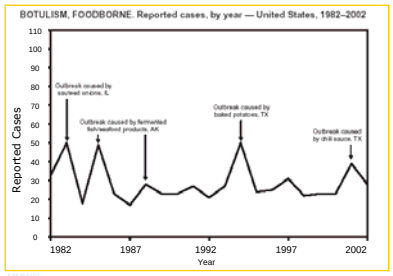
Botulism is caused by a neurotoxin from *Clostridium botulinum*. Fortunately cases are limited, but can be very severe when they do occur. This toxin causes flaccid paralysis and cranial nerve deficits, and can lead to death. Infants are at greatest risk. Approximately 10-30 outbreaks and 110 cases are reported each year. The most common sources are home-canned foods, fermented meats and honey. Signs include double vision, drooping eyelids, and difficulty speaking and swallowing. If botulism is suspected, medical attention should be sought immediately. For more information, please refer to the specific botulism PowerPoint and fact sheet.

Slide 37



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This graph depicts the trends of foodborne botulism cases in the U.S. from 1982-2002. In 1983, 28 persons in Illinois obtained food-borne botulism from a batch of sautéed onions. Twelve required ventilator support, however no deaths occurred (MMWR 1984:33(2):22-23). During 1950-2000, Alaska recorded 226 cases of food-borne botulism from 114 outbreaks. All were Alaska Natives and were associated with eating fermented foods. In 1994, an outbreak at a Greek restaurant in Texas affected 30 persons from improperly stored foil-wrapped baked potatoes. The 2001 Texas outbreak resulted in 39 cases of foodborne botulism from persons eating commercially produced chili sauce that had been improperly stored. Overall botulism is a rare disease, but it can be fatal and every case of botulism is treated as a public health emergency. Graph from the Summary of Notifiable Diseases 2002, CDC website.

Slide 38

Shigellosis

- Bacillary dysentery
  - Most cases *Shigella sonnei*
  - 90,000 cases every year in U.S.
- Sources:
  - Human fecal contamination of food, beverages, vegetables, water
- Signs:
  - Watery or bloody diarrhea, nausea, vomiting, cramps, fever
  - Onset: 2 days
  - Duration: 5-7 days

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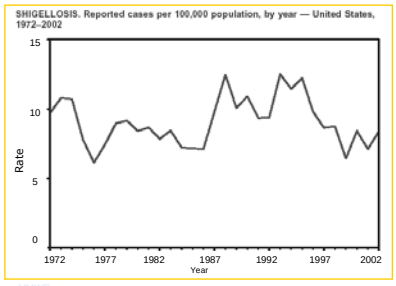
Shigellosis is also known as bacillary dysentery. Most cases are caused by *Shigella sonnei*. However, *S. dysenteriae, S. flexneri and S. boydii* can also cause foodborne related illnesses. Approximately 90,000 cases are reported every year in the U.S. The most common sources are due to human fecal contamination of food, beverages, vegetables and water. It is most commonly transmitted by sick or asymptomatically infected food service workers. Clinical signs of shigellosis are variable and include watery or bloody diarrhea, nausea and vomiting with abdominal cramps and a fever. This typically occurs 2 days after exposure and can last 5-7 days.

Slide 39



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This graph shows the reported cases per 100,000 population by year in the U.S. from 1972-2002. Outbreaks of *Shigella sonnei* in childcare settings are responsible for a large portion of the reported cases in the U.S. *S. sonnei* is also becoming resistant to antimicrobial agents such as trimethoprim-sulfamethoxazole, another cause for concern. Data from the Summary of Notifiable Diseases 2002, CDC website.

Slide 40

Toxoplasmosis

- *Toxoplasma gondii*- intracellular protozoan
  - 112,500 cases annually
  - Pregnant women/immunocompromised at greatest risk
- Sources
  - Infected cats, soil, undercooked meat
- Signs
  - Fever, headache, swollen lymph nodes

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Toxoplasmosis is caused by an intracellular protozoan, *Toxoplasma gondii*, which can infect all species of mammals, including humans. As mentioned previously, it is one of the three leading causes of death from a foodborne disease; the others were *Salmonella* and *Listeria*. It causes an estimated 112,500 cases of foodborne illness each year and 375 foodborne related deaths. Pregnant women and immuno-compromised individuals, especially HIV positive patients, are at the greatest risk of toxoplasmosis. The source of this protozoan include infected cats shedding in their feces, soil, undercooked meat, and mechanical vectors such as cockroaches and flies. Clinical signs in humans can by asymptomatic to fever, headache, and swollen lymph nodes. If the protozoan cysts develop in tissue, other more severe clinical signs can be observed. To prevent infection, gloves should be worn while gardening, changing cat litter

boxes and thoroughly washing raw fruits and vegetables before eating. Irradiation and thoroughly cooking meat to 160°F internal temperature to destroy the *Toxoplasma* cysts.

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Emerging Pathogens

- *Cyclospora* (Protozoan)
  - 1996, imported raspberries
- *Listeria monocytogenes*
  - Sources
    - Ready-to-eat meats, soft cheeses
  - Signs
    - Human abortions and stillbirths
    - Septicemia in young or low-immune

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There have also been increases in the number of cases caused by the protozoan *Cyclospora* and the bacterium *Listeria monocytogenes*. *Cyclospora* has recently been implicated in a 1996 epidemic from imported raspberries. *Listeria monocytogenes* is most often associated with foodborne illness from ready-to-eat foods such as hot dogs, lunch meat and soft cheeses. It can cause human abortions and stillbirths as well as septicemia in young persons or those with a low immune system. As stated earlier, listeriosis is one of the 3 most common causes of foodborne related death.

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Common food vehicles for pathogens

Pathogen	Food sources
Campylobacter jejuni or *coli*	Major: poultry. Minor: milk, mushrooms, clams, hamburger, water, cheese, pork, shellfish, eggs, cake icing.
Clostridium perfringens	Major: meat, meat stews, meat pies, and beef, turkey, and chicken gravies. Minor: beans, seafood.
Escherichia coli O157:H7	Major: beef particularly ground beef. Minor: poultry, apple cider, raw milk, vegetables, cantaloupe, hot dogs, mayonnaise, salad bar items.
Listeria monocytogenes	Major: soft cheese, pâté, ground meat. Minor: poultry, dairy products, hot dogs, potato salad, chicken, seafood, vegetables.
Salmonella (non-typhoid)	Major: poultry, meat, eggs, milk, and their products. Minor: vegetables, fruits, chocolate, peanuts, shellfish.
Staphylococcus aureus	Major: workers handling foods: meat (especially sliced meat) poultry, fish, canned mushrooms. Minor: dairy products, prepared salad dressing, ham, salami, bakery items, custards, cheese.
Vibrio sp.	Major: oysters. Minor: other seafood.

Pathogens causing outbreaks and the foods associated with them are reported by CDC. For more information see: Surveillance for Foodborne Disease Outbreaks --United States, 1993-1997, Vol. 49, No 55SS1 03/17/2000

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This table shows some of the common food vehicles for certain food-borne related illness pathogens.

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Prevention and Control

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HACCP

- Hazard Analysis Critical Control Point
- To monitor and control production processes
- Identify food safety hazards and critical control points
  - Production, processing and marketing
  - Establish limits
  - Monitor
- Applied to meat, poultry, and eggs

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Food producers and processors have implemented the HACCP program in their operation to reduce the possibility of food-borne pathogens. The Hazard Analysis Critical Control Point (HACCP) program is used to monitor and control the production process by identifying food safety hazards. Additionally, critical control points in production, processing and marketing are identified. Critical limits for each of these points is established and monitored for food quality and safety. It is applied to the meat, poultry and egg industries in the United States.

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On Farm Strategies

- Testing and removal for *Salmonella*
  - Serologic, fecal culture, hide culture
- Vaccinating
  - Many serotypes
  - Varying effectiveness
- Minimize rodents, wild birds
- Isolation of new animals

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Some on farm strategies that can be implemented to help control *Salmonella* are serologic testing, fecal or hide culturing of animals to identify carriers of the bacteria. Once identified, segregation of those animals, or in poultry, removal from the food production chain will decrease the chance of *Salmonella* spread to other animals. Another option for reducing the prevalence of organisms on farm is the use of vaccines. As there are many different bacteria and viruses known to cause foodborne illness, the development of vaccines for them continues to evolve. It is important to remember that vaccines are not 100% effective, and with the various serotypes of bacteria and immune status of animals, they should be used in accordance with other prevention methods. Implementing strict biosecurity protocols and minimize the number of rodents and wild birds, as they are often carriers of bacteria, will also help reduce the transmission. Isolating new animals will also help decrease the chance of spread.

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At the Slaughter Plant

- FSIS target organisms
  - *Salmonella* and *E. coli*
- Control points
  - Removal of internal organs
  - Minimize contact between carcasses
  - Proper movement through facilities
  - Chilling
  - Cooking processes (time, temperature)

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Since 1998, FSIS (Food Safety Inspection Service) has identified *Salmonella* and *E. coli* as target organisms for testing at large slaughter plants. HAACP strategies include removal of internal organs, minimizing contact between carcasses, proper movement through facilities, chilling, and the cooking process such as proper time and temperature.

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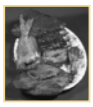
Irradiation

- Used since 1986 for *Trichina* control in pork
- Gamma rays
  - Poultry in 1990/1992
  - Meat in 1997/1999
  - Reduction of bacterial pathogens
- Kills living cells of organisms
  - Damaged and cannot survive



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Finally, irradiation of the end meat product has been in use in the United States since 1986 for the control of *Trichina* parasites in pork. In 1990, the FDA approved the use of gamma irradiation for the control of bacterial pathogen reduction in poultry (approved in 1992 by USDA), and meat was approved in 1997 by FDA (and 1999 by USDA). Irradiation works by affecting the living cells of organisms and damaging it to the point it cannot survive.

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Irradiation

- Identified with radura…..
- Does not affect taste quality
- Nutrients remain the same
- Handle foods appropriately afterwards
  - Does not sterilize
  - Contamination can still occur

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Foods that are irradiated will be marked with a distinctive logo (radura) on the package. Irradiation does not affect the taste quality of the food and the nutrients remain essentially the same. People still need to handle the food product in the same way as unirradiated foods because they are not sterilized and can become contaminated after the irradiation process.

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USDA Recall Classification

Class I	Health hazard situation; *reasonable* probability that the use of the product will cause serious, adverse health consequences or death.
Class II	Health hazard situation; *remote* probability of adverse health consequences from the use of the product.
Class III	Use of the product will *not* cause adverse health consequences.

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Should a product become contaminated, the USDA has recall classifications that can be implemented to remove the products from the market. Class I is a health hazard situation where there is reasonable probability that the use of the product will cause serious, adverse health consequences or death. Class II is also a health hazard situation where there is a remote probability of adverse health consequences from the use of the product. Class III is a situation where the use of the product will not cause adverse health consequences. *FSIS Recall Release* FSIS-RC-02-033

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In the Home

- Drink pasteurized milk and juices
- Wash hands carefully and frequently
  - After using the bathroom
  - Changing infant's diapers
  - Cleaning up animal feces
- Wash hands before preparing food

At home, prevention measures can help to reduce the likelihood of foodborne pathogens and illnesses. Drink only pasteurized milk and juices. Wash your hands carefully after using the bathroom, changing an infant's diaper, or cleaning up animal feces. Wash hands thoroughly before preparing foods.

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In the Home

- Wash raw fruits and vegetables before eating
- After contact with raw meat or poultry
  - Wash hands, utensils and kitchen surfaces
  - Hot soapy water
- Defrost meats in the refrigerator

Wash raw fruits and vegetables before eating. After contact with raw meat or poultry, wash hands, utensils and kitchen surfaces with hot soapy water. Thaw frozen meats in the refrigerator to avoid uneven cooling.

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In the Home

- Cook beef/beef products thoroughly
  - Internal temperature of 160°F
- Cook poultry and eggs thoroughly
  - Internal temperature of 170-180°F
- Eat cooked food promptly
- Refrigerate leftovers within 2 hours after cooking
- Store in shallow containers

When cooking, cook beef and beef products thoroughly to an internal temperature of 160°F. Cook poultry and eggs thoroughly to an internal temperature of 170-180 °F. Eat cooked foods promptly. Refrigerate any leftovers within 2 hours after cooking and store them in shallow containers so that the contents gets cooled evenly throughout.

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Additional Resources

- Centers for Disease Control and Prevention
  - http://www.cdc.gov/foodsafety/
- U.S. Department of Agriculture
  - http://www.foodsafety.gov
  - http://www.nal.usda.gov/fnic/foodborne/statemen.html

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Acknowledgments

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