

Food Safety

Overview

- Organisms
- History
- Epidemiology
- Transmission
- Foodborne illness
- Prevention and Control

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

TABLE 1. Number of reported foodborne-disease outbreaks, cases, and deaths, by etiology — United States,* 1993–1997 †

| Etiology | Outbreaks | | Cases | | Deaths | |
|--------------------------------|--------------|----------------|---------------|----------------|-----------|----------------|
| | No. | (%) | No. | (%) | No. | (%) |
| Bacterial | | | | | | |
| <i>Bacillus cereus</i> | 14 | (0.5) | 691 | (0.8) | 0 | (0.0) |
| <i>Brucella</i> | 1 | (0.0) | 19 | (0.0) | 0 | (0.0) |
| <i>Campylobacter</i> | 25 | (0.9) | 539 | (0.6) | 1 | (3.4) |
| <i>Clostridium botulinum</i> | 13 | (0.5) | 56 | (0.1) | 1 | (3.4) |
| <i>Clostridium perfringens</i> | 57 | (2.1) | 2,772 | (3.2) | 0 | (0.0) |
| <i>Escherichia coli</i> | 84 | (3.1) | 3,260 | (3.8) | 8 | (27.6) |
| <i>Listeria monocytogenes</i> | 3 | (0.1) | 100 | (0.1) | 2 | (6.9) |
| Salmonella | 357 | (13.0) | 32,610 | (37.9) | 13 | (44.8) |
| <i>Shigella</i> | 43 | (1.6) | 1,555 | (1.8) | 0 | (0.0) |
| <i>Staphylococcus aureus</i> | 42 | (1.5) | 1,413 | (1.6) | 1 | (3.4) |
| <i>Streptococcus</i> group A | 1 | (0.0) | 122 | (0.1) | 0 | (0.0) |
| <i>Streptococcus</i> other | 1 | (0.0) | 6 | (0.0) | 0 | (0.0) |
| <i>Vibrio cholerae</i> | 1 | (0.0) | 2 | (0.0) | 0 | (0.0) |
| <i>Vibrio parahaemolyticus</i> | 5 | (0.2) | 40 | (0.0) | 0 | (0.0) |
| <i>Yersinia enterocolitica</i> | 2 | (0.1) | 27 | (0.0) | 1 | (3.4) |
| Other bacterial | 6 | (0.2) | 609 | (0.7) | 1 | (3.4) |
| Total bacterial | 655 | (23.8) | 43,821 | (50.9) | 28 | (96.6) |
| Chemical | | | | | | |
| Ciguatera | 60 | (2.2) | 205 | (0.2) | 0 | (0.0) |
| Heavy metals | 4 | (0.1) | 17 | (0.0) | 0 | (0.0) |
| Monosodium glutamate | 1 | (0.0) | 2 | (0.0) | 0 | (0.0) |
| Mushroom poisoning | 7 | (0.3) | 21 | (0.0) | 0 | (0.0) |
| Scombrototoxin | 69 | (2.5) | 297 | (0.3) | 0 | (0.0) |
| Shellfish | 1 | (0.0) | 3 | (0.0) | 0 | (0.0) |
| Other chemical | 6 | (0.2) | 31 | (0.0) | 0 | (0.0) |
| Total chemical | 148 | (5.4) | 576 | (0.7) | 0 | (0.0) |
| Parasitic | | | | | | |
| <i>Giardia lamblia</i> | 4 | (0.1) | 45 | (0.1) | 0 | (0.0) |
| <i>Trichinella spiralis</i> | 2 | (0.1) | 19 | (0.0) | 0 | (0.0) |
| Other parasitic | 13 | (0.5) | 2,261 | (2.6) | 0 | (0.0) |
| Total parasitic | 19 | (0.7) | 2,325 | (2.7) | 0 | (0.0) |
| Viral | | | | | | |
| hepatitis A | 23 | (0.8) | 729 | (0.8) | 0 | (0.0) |
| Norwalk | 9 | (0.3) | 1,233 | (1.4) | 0 | (0.0) |
| Other viral | 24 | (0.9) | 2,104 | (2.4) | 0 | (0.0) |
| Total viral | 56 | (2.0) | 4,066 | (4.7) | 0 | (0.0) |
| Confirmed etiology | 878 | (31.9) | 50,788 | (59.0) | 28 | (96.6) |
| Unknown etiology | 1,873 | (68.1) | 35,270 | (41.0) | 1 | (3.4) |
| Total 1993–1997 | 2,751 | (100.0) | 86,058 | (100.0) | 29 | (100.0) |

*Includes Guam, Puerto Rico, and the U.S. Virgin Islands.

† Totals might vary by <1% from summed components because of rounding.

- Foodborne disease outbreaks, cases and deaths
- 1993-1997
- *Salmonella* had the highest number

History

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



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

Epidemiology

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*

Epidemiology

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

Surveillance/Regulation

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

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

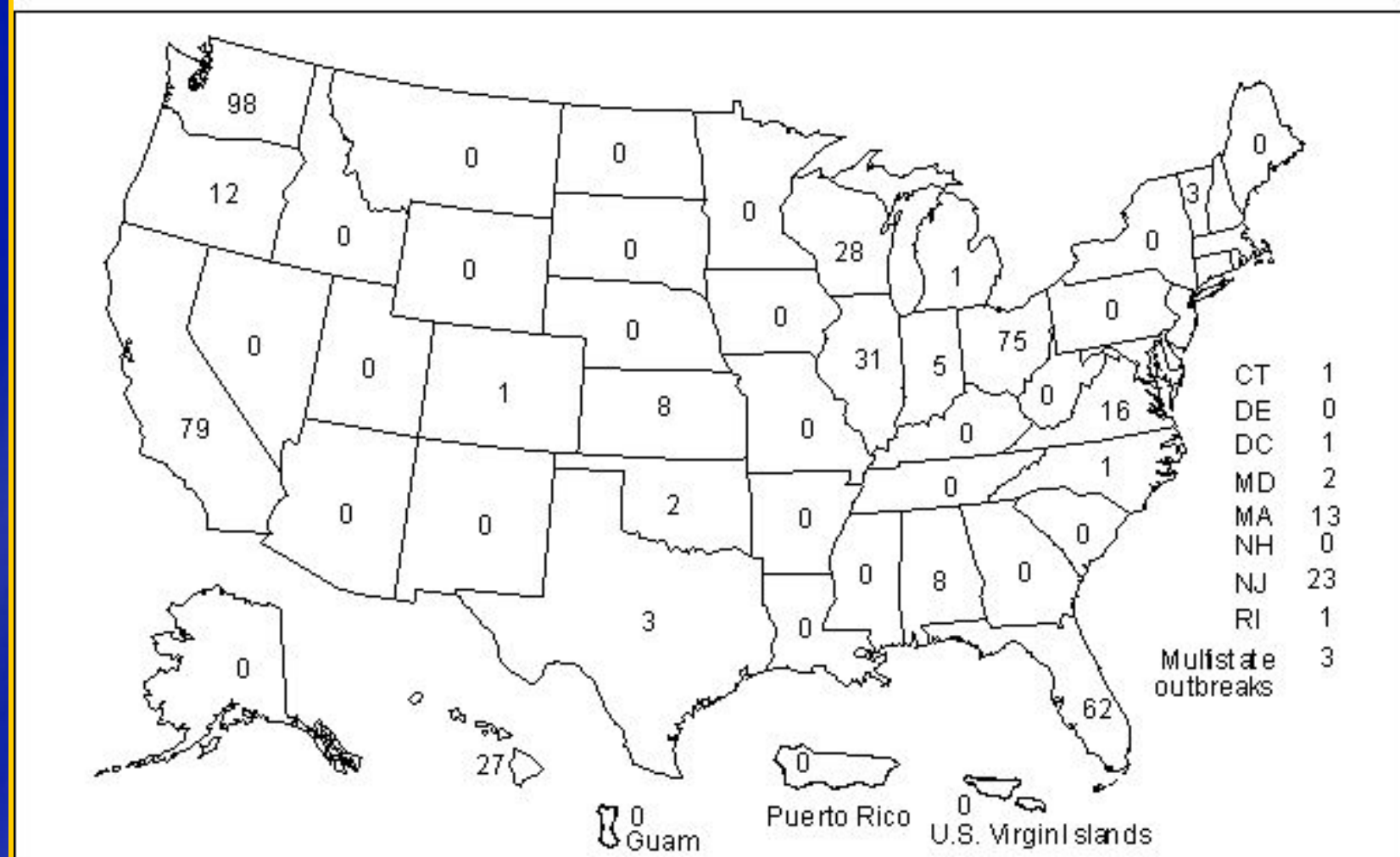
Surveillance

- 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

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

FIGURE 5. Number of reported foodborne-disease outbreaks, by state — United States,* 1997



* Includes Guam, Puerto Rico, and the U.S. Virgin Islands.

Transmission

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*

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



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 |



Important Organisms

Important Organisms

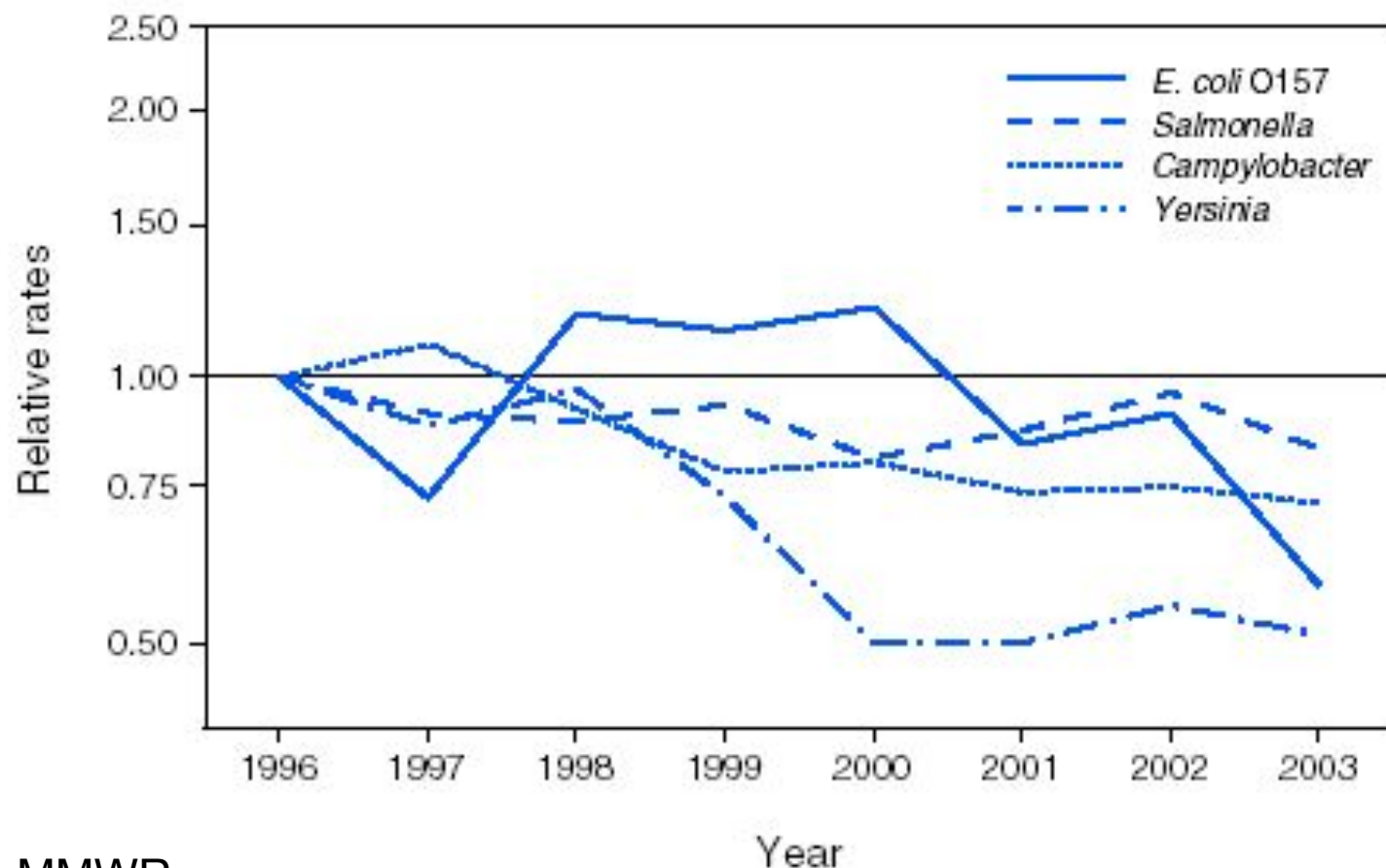
- Norwalk-like viruses
- *Campylobacter*
- *Salmonella*
- *E. coli* O157:H7
- *Clostridium botulinum*
- *Shigella* spp
- *Toxoplasma*
- Emerging organisms

| Pathogen | No. of Cases |
|------------------------|--------------|
| <i>Salmonella</i> | 6,017 |
| <i>Campylobacter</i> | 5,215 |
| <i>Shigella</i> | 3,021 |
| <i>Cryptosporidium</i> | 480 |
| <i>E. coli</i> 0157 | 443 |
| <i>Yersinia</i> | 161 |
| <i>Listeria</i> | 138 |
| <i>Vibrio</i> | 110 |
| <i>Cyclospora</i> | 15 |

Total in 2003

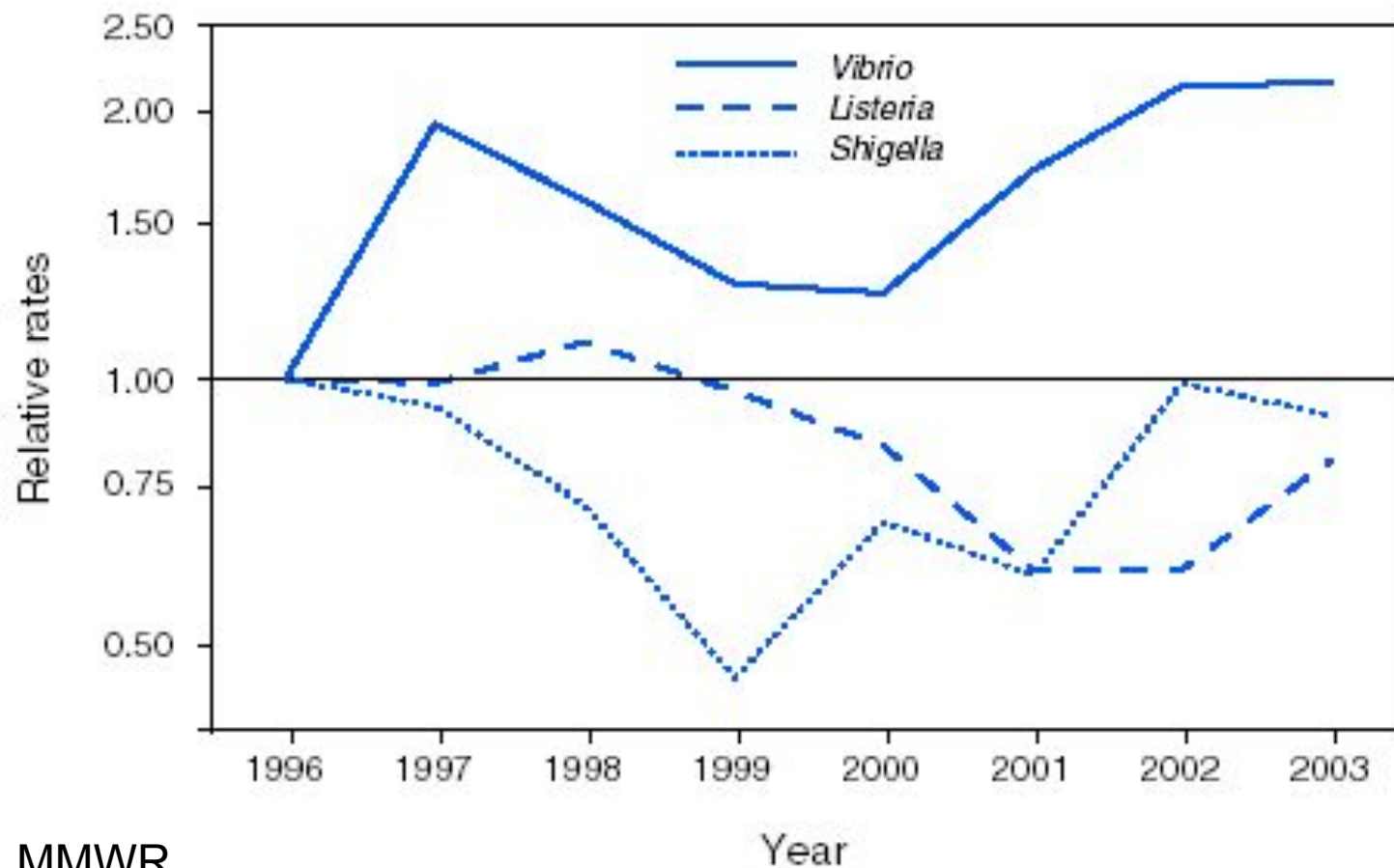
15,600

FIGURE 1. Relative rates compared with 1996 of laboratory-confirmed cases of *Yersinia*, *Escherichia coli* 0157, *Campylobacter*, and *Salmonella*, by year — Foodborne Diseases Active Surveillance Network, United States, 1996–2003



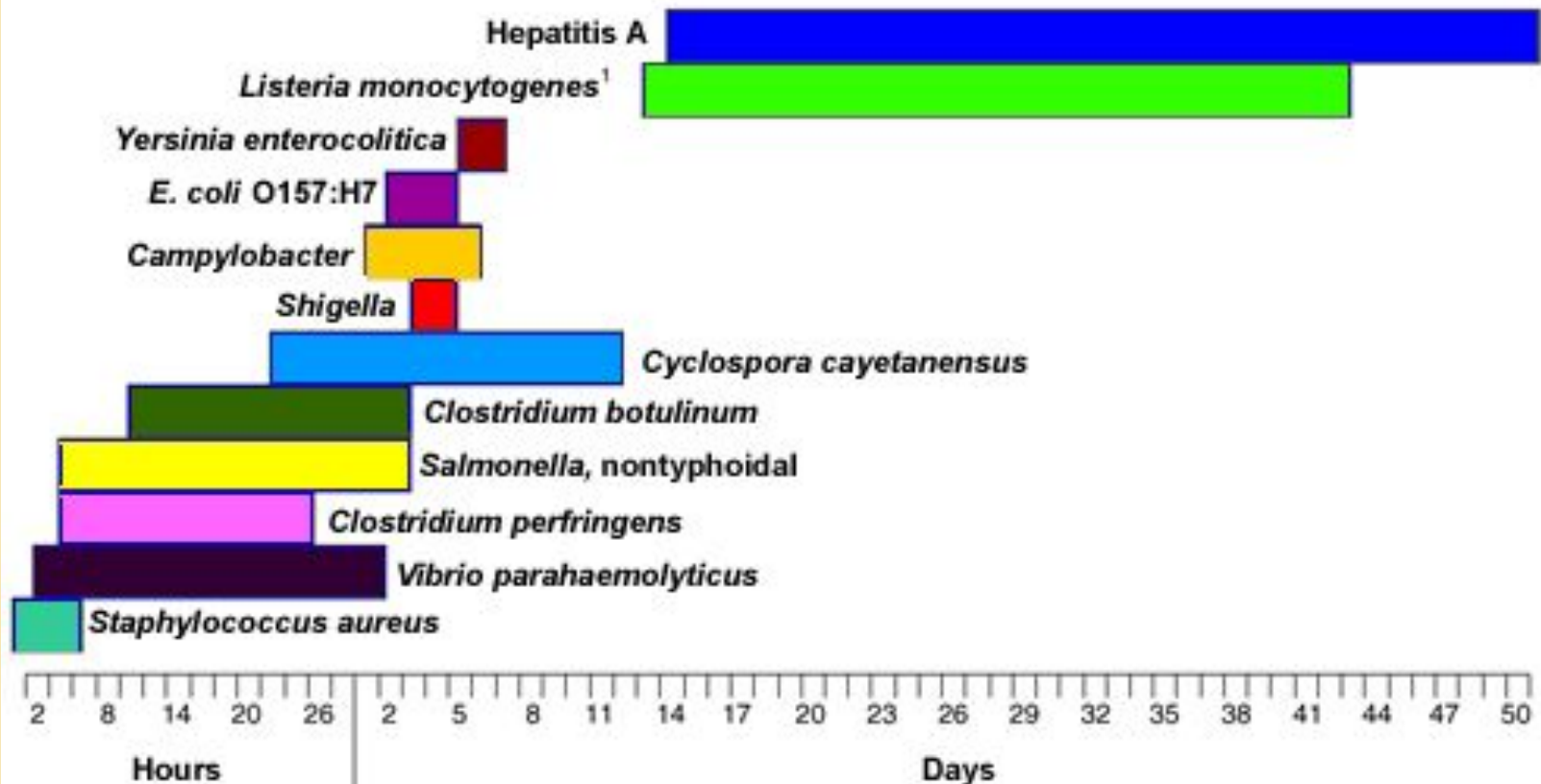
MMWR

FIGURE 2. Relative rates compared with 1996 of laboratory-confirmed cases of *Shigella*, *Listeria*, and *Vibrio*, by year — Foodborne Diseases Active Surveillance Network, United States, 1996–2003



MMWR

Figure 1
Usual incubation period ranges for select foodborne diseases



¹ Invasive form, incubation period for diarrheal disease unknown.
Source: Data on the "usual" incubation period obtained from the Centers for Disease Control and Prevention, "Surveillance for Foodborne Disease Outbreaks--United States, 1988-1992." MMWR 45, SS-5 (Oct. 25, 1996):58-66

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



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

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)

Campylobacteriosis

- Sources

- Raw or undercooked poultry
- Non-chlorinated water
- Raw milk
- Infected animal or human feces
 - Poultry, cattle, puppies, kittens, pet birds

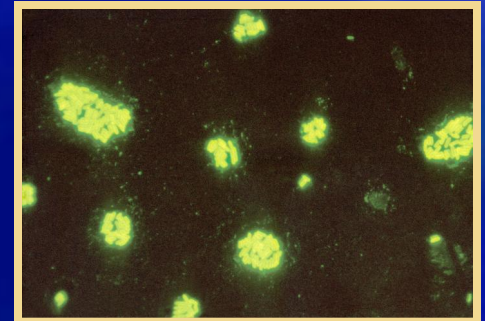


- Clinical signs

- Diarrhea, abdominal cramps, fever, nausea
- Duration: 2-5 days

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



Salmonellosis

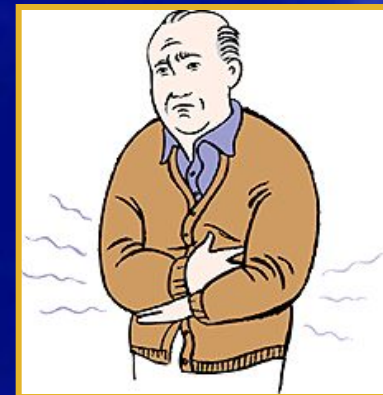
- Sources

- Raw poultry and eggs
- Raw milk
- Raw beef
- Unwashed fruit, alfalfa sprouts
- Reptile pets: Snakes, turtles, lizards

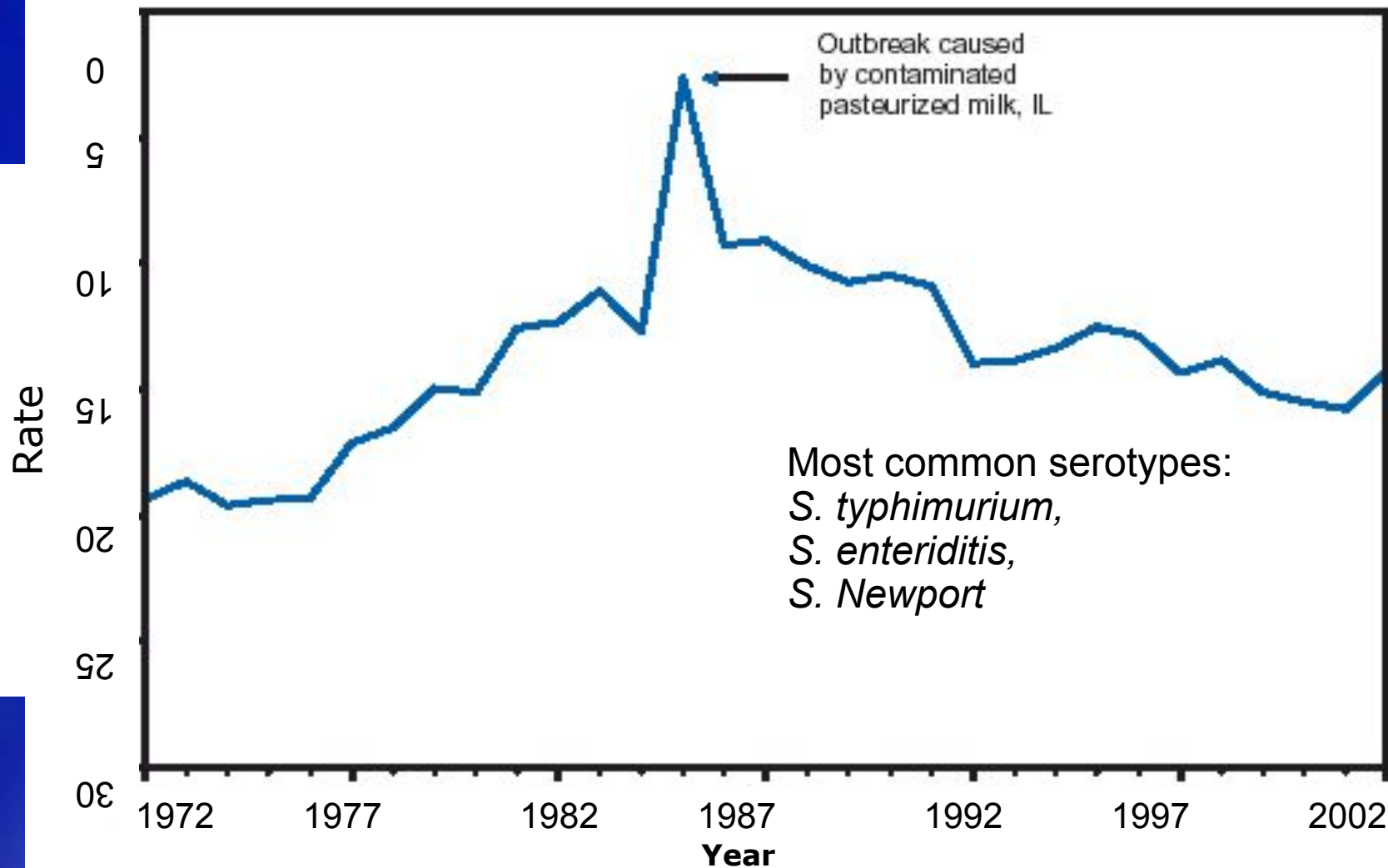


- Signs

- Onset: 12-72 hours
- Diarrhea, fever, cramps
- Duration: 4-7 days



Salmonellosis. Reported cases per 100,000 population, by year – U.S., 1972-2002



E. coli O157:H7

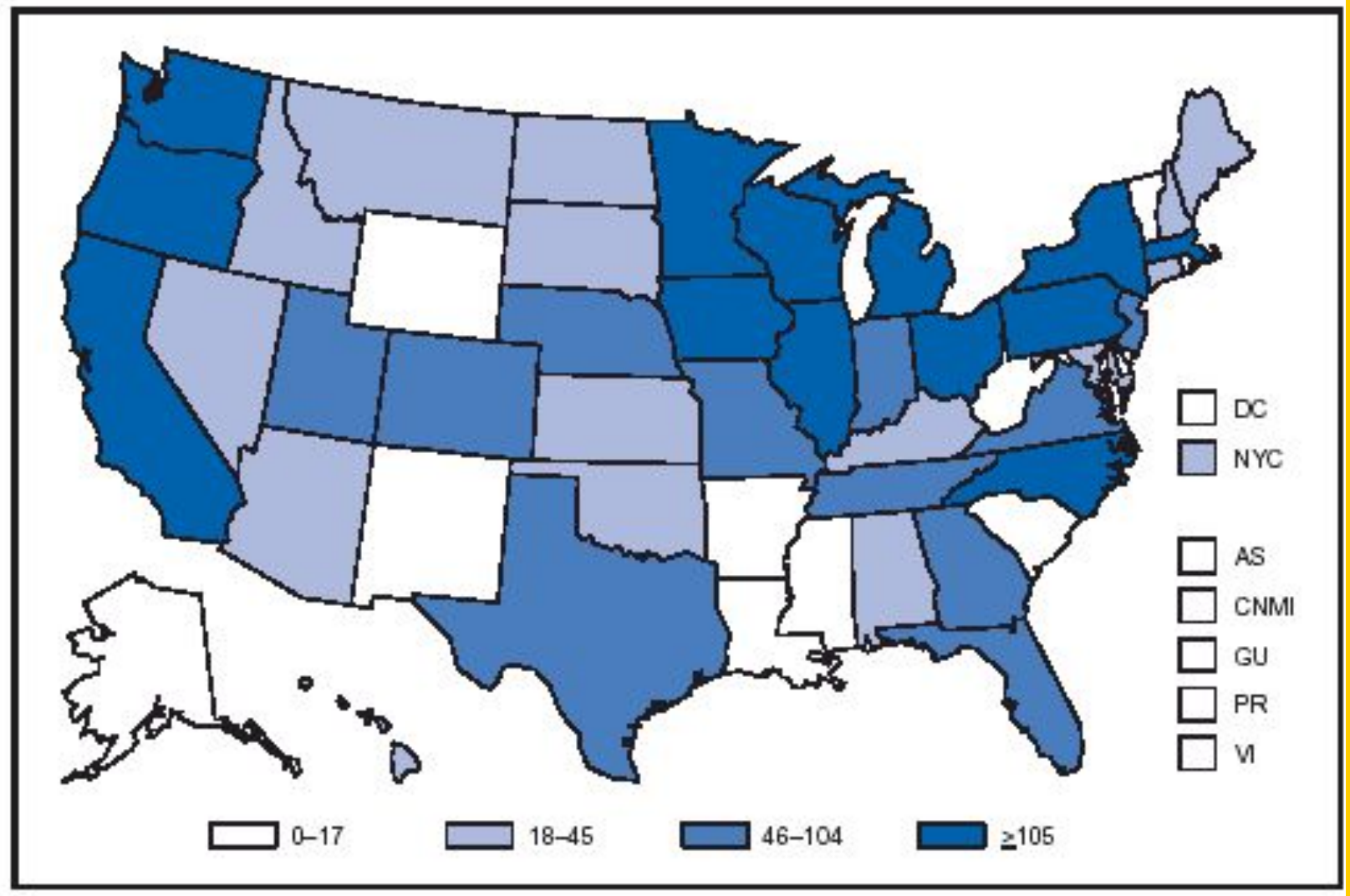
- Enterohemorrhagic *Escherichia coli* (EHEC)
 - Surface proteins; toxin
- Sources
 - Undercooked or raw hamburger; salami
 - Alfalfa sprouts; lettuce
 - Unpasteurized milk, apple juice or cider
 - Well water
 - Animals: Cattle, other mammals



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

ESCHERICHIA COLI, ENTEROHEMORRHAGIC O157:H7. Reported cases — United States and U.S. territories, 2002

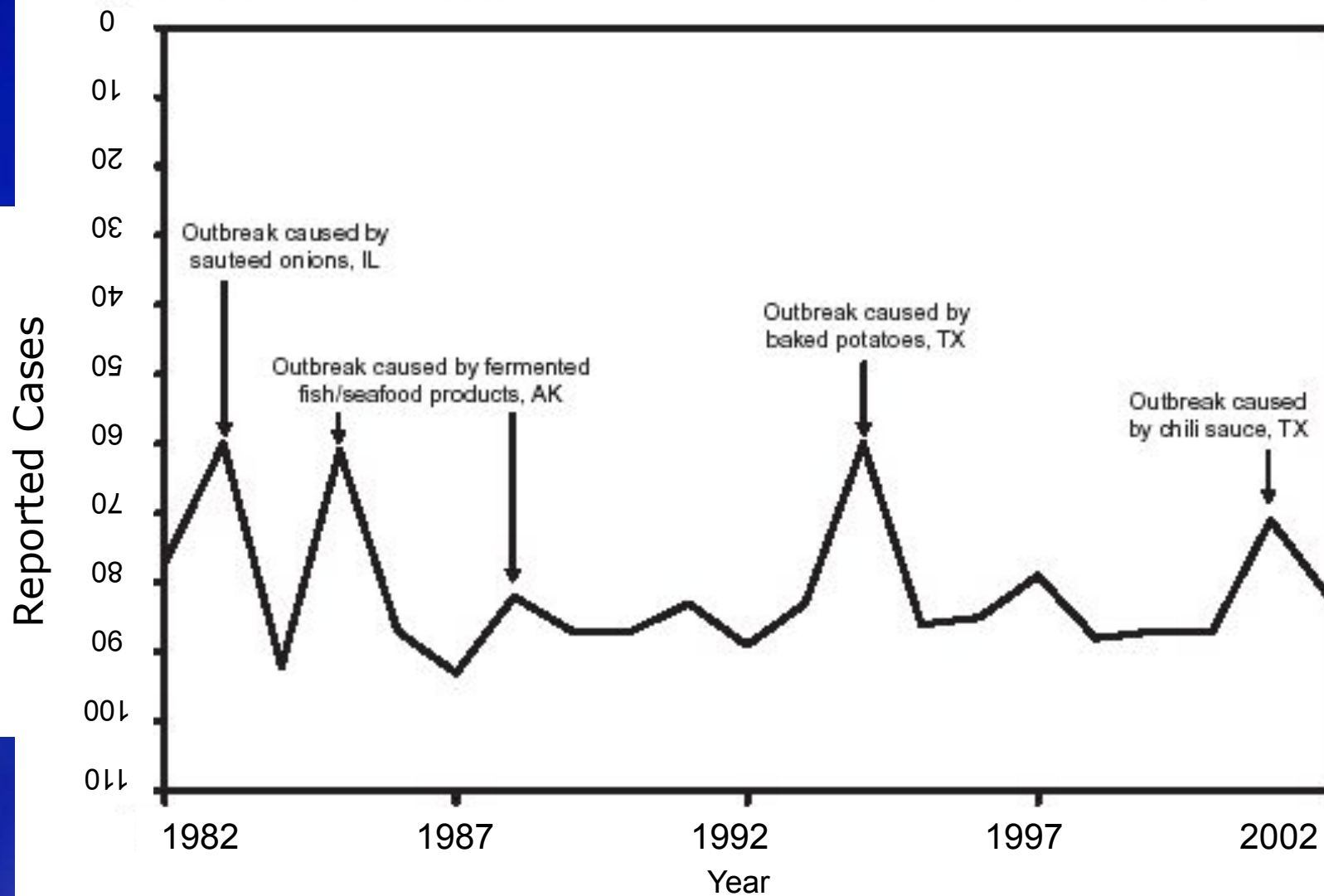


Botulism

- *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



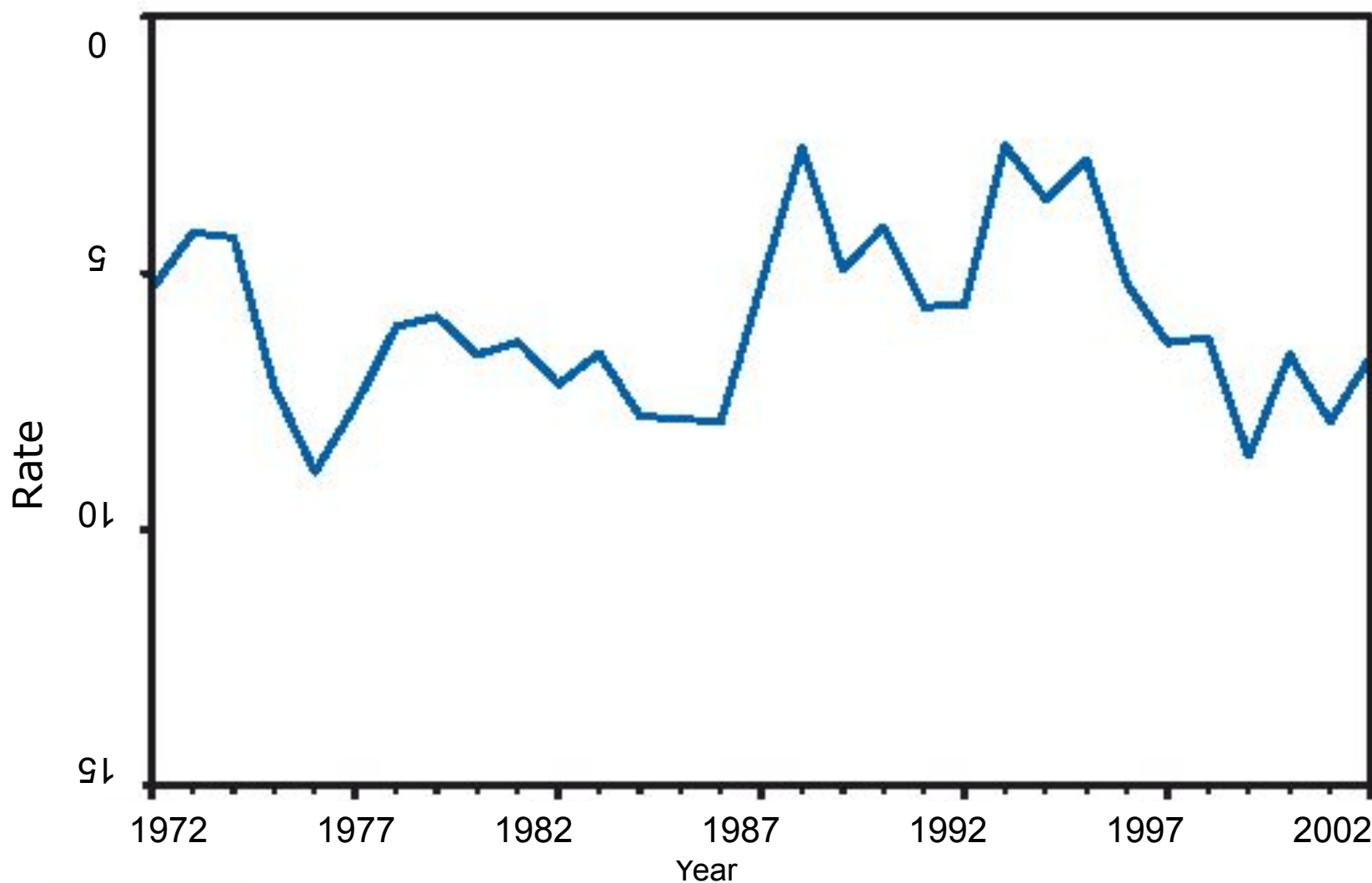
BOTULISM, FOODBORNE. Reported cases, by year — United States, 1982–2002



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

SHIGELLOSIS. Reported cases per 100,000 population, by year — United States, 1972–2002



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

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



Common food vehicles for pathogens

| <u>Pathogen</u> | <u>Food sources</u> |
|--|---|
| <i>Campylobacter jejuni</i> or <i>coli</i> | Major: poultry. Minor: milk, mushrooms, clams, hamburger, water, cheese, pork, shellfish, eggs, cake icing. |
| <i>Clostridium perfringens</i> | Major: meat, meat stews, meat pies, and beef, turkey, and chicken gravies. Minor: beans, seafood. |
| <i>Escherichia coli</i> O157:H7 | Major: beef particularly ground beef. Minor: poultry, apple cider, raw milk, vegetables, cantaloupe, hot dogs, mayonnaise, salad bar items. |
| <i>Listeria monocytogenes</i> | Major: soft cheese, pâté, ground meat. Minor: poultry, dairy products, hot dogs, potato salad, chicken, seafood, vegetables. |
| <i>Salmonella</i> (non-typhoid) | Major: poultry, meat, eggs, milk, and their products. Minor: vegetables, fruits, chocolate, peanuts, shellfish. |
| <i>Staphylococcus aureus</i> | Major: workers handling foods: meat (especially sliced meat) poultry, fish, canned mushrooms. Minor: dairy products, prepared salad dressing, ham, salami, bakery items, custards, cheese. |
| <i>Vibrio</i> 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 SS01;1 03/17/2000

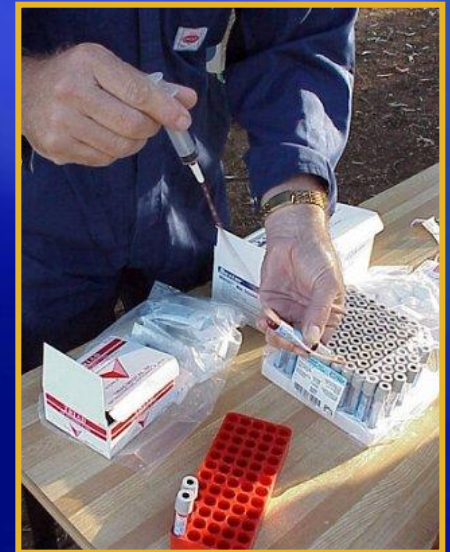
Prevention and Control

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

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



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)



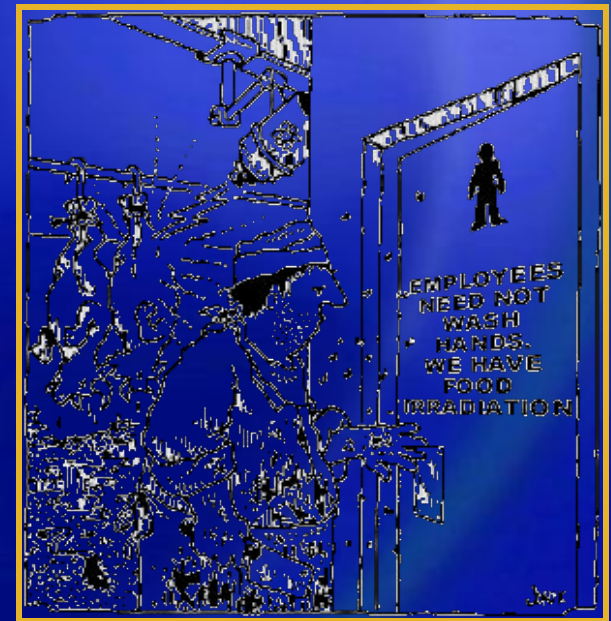
Irradiation

- 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



Irradiation

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



USDA Recall Classification

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

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



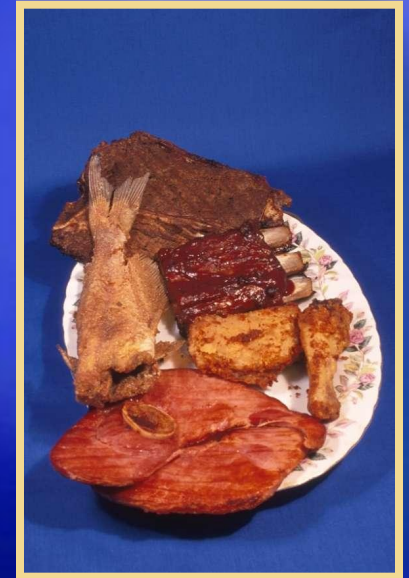
In the Home

- 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



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



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>

Acknowledgments

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

Acknowledgments

Author:

Glenda Dvorak, DVM, MS, MPH

Co-authors:

Danelle Bickett-Weddle, DVM, MPH
Radford Davis, DVM, MPH

Reviewer:

Jean Gladon, BS