Food Safety

the Center for Food Security & Public Health

IOWA STATE UNIVERSITY

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 No.	Outbreaks (%)	Cases No.	Cases (%)	Deaths No.	Deaths (%)
Bacterial						
Bacillus cereus	14	(0.5)	691	(0.8)	0	(0.0)
Brucella	1	(0.0)	19	(0.0)	0	(0.0)
Campylobacter	25	(0.9)	539	(0.6)	1	(3.4)
Clostridium botulinum	13	(0.5)	56	(0.1)	1	(3.4)
Clostridium perfringens	57	(2.1)	2,772	(3.2)	0	(0.0)
Escherichia coli	84	(3.1)	3,260	(3.8)	8	(27.6)
Listeria monocytogenes	3	(0.1)	100	(0.1)	2	(6.9)
Salmonella	357	(13.0)	32,610	(37.9)	13	(44.8)
Shigella	43	(1.6)	1,555	(1.8)	0	(0.0)
Staphylococcus aureus	42	(1.5)	1,413	(1.6)	1	(3.4)
Streptococcus, group A	1	(0.0)	122	(0.1)	0	(0.0)
Streptococcus, other	1	(0.0)	6	(0.0)	0	(0.0)
Vibrio cholerae	1	(0.0)	2	(0.0)	0	(0.0)
Vibrio parahaemolyticus	5	(0.2)	40	(0.0)	0	(0.0)
Yersinia enterocolitica	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						
Ciguatoxin	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)
Scombrotoxin	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						
Giardia lamblia	4	(0.1)	45	(0.1)	0	(0.0)
Trichinella spiralis	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						
patiti 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

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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

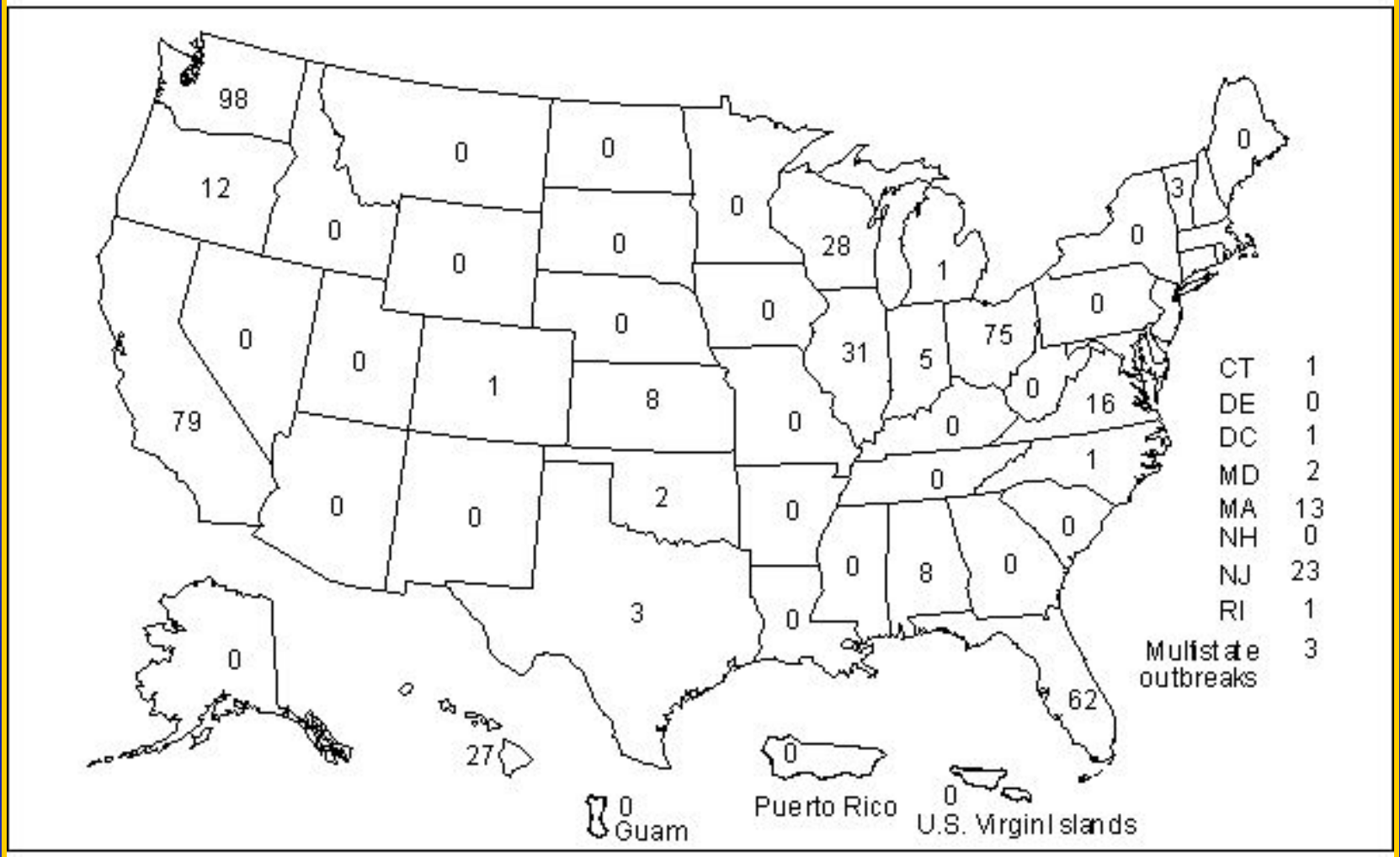
Surveillance

- 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

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Important Organisms

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

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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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

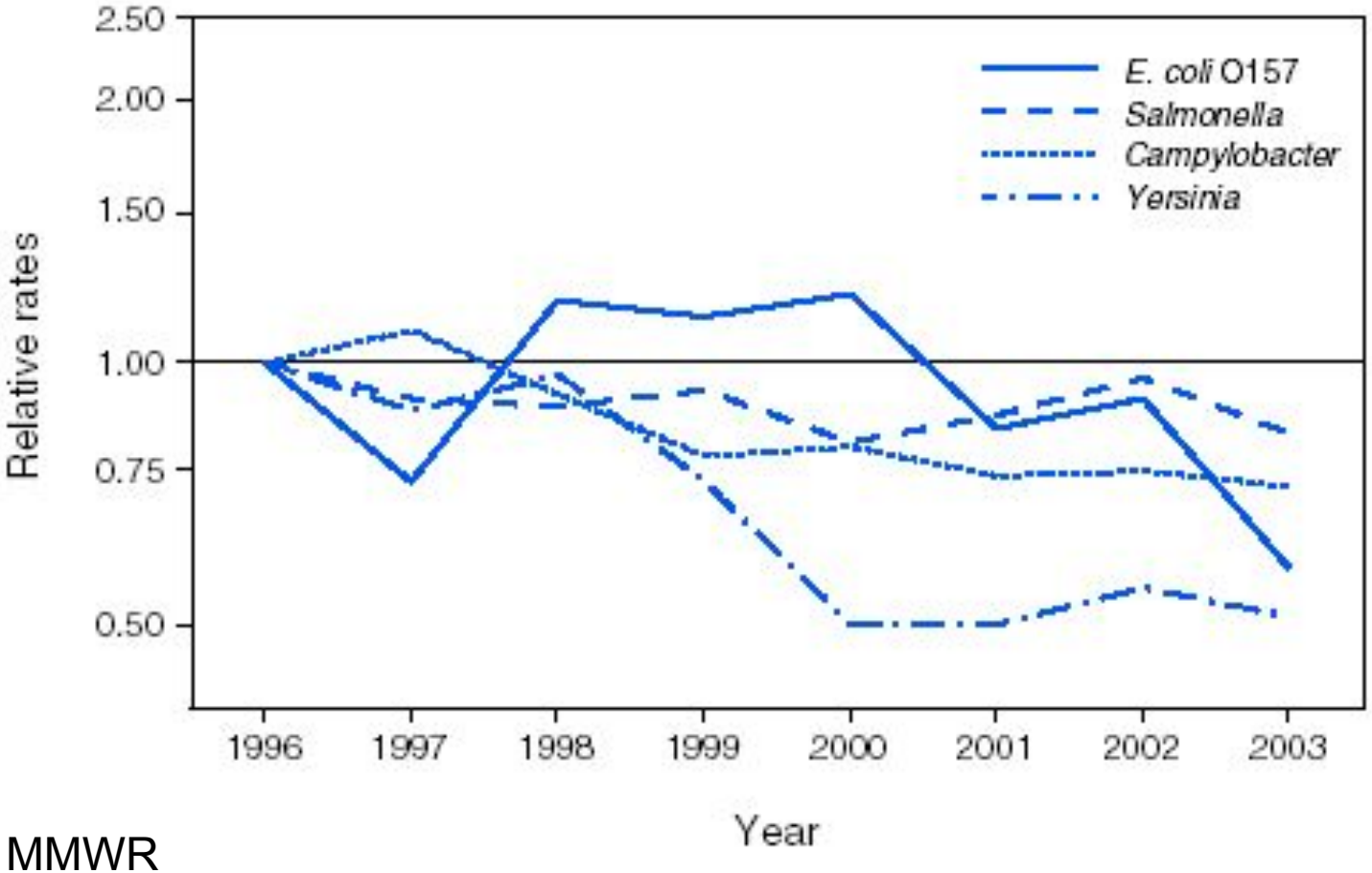

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FIGURE 2. Relative rates compared with 1996 of laboratory-confirmed cases of *Shigella, Listeria*, and *Vibro*, by year — Foodborne Diseases Active Surveillance Network, United States, 1996–2003

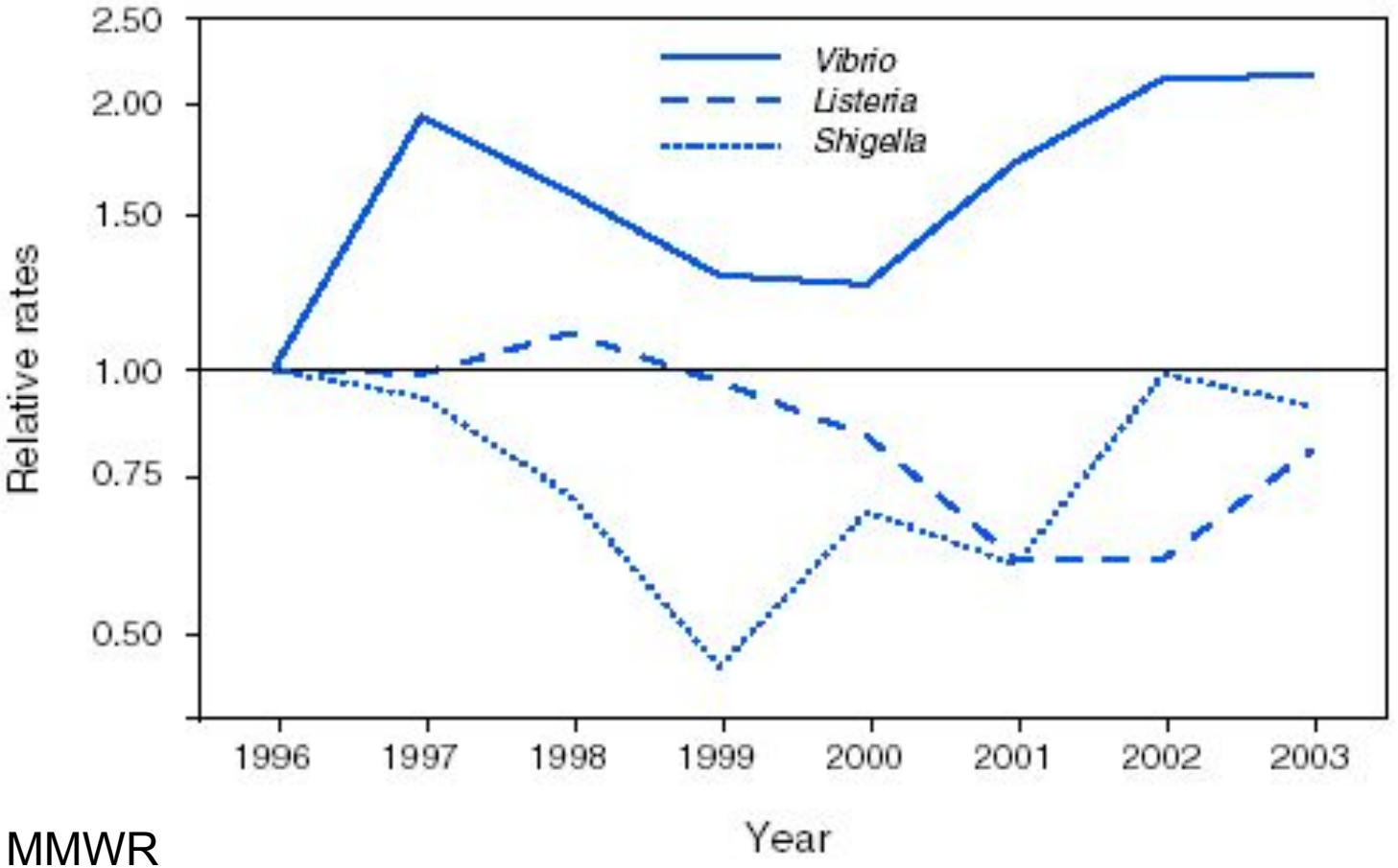

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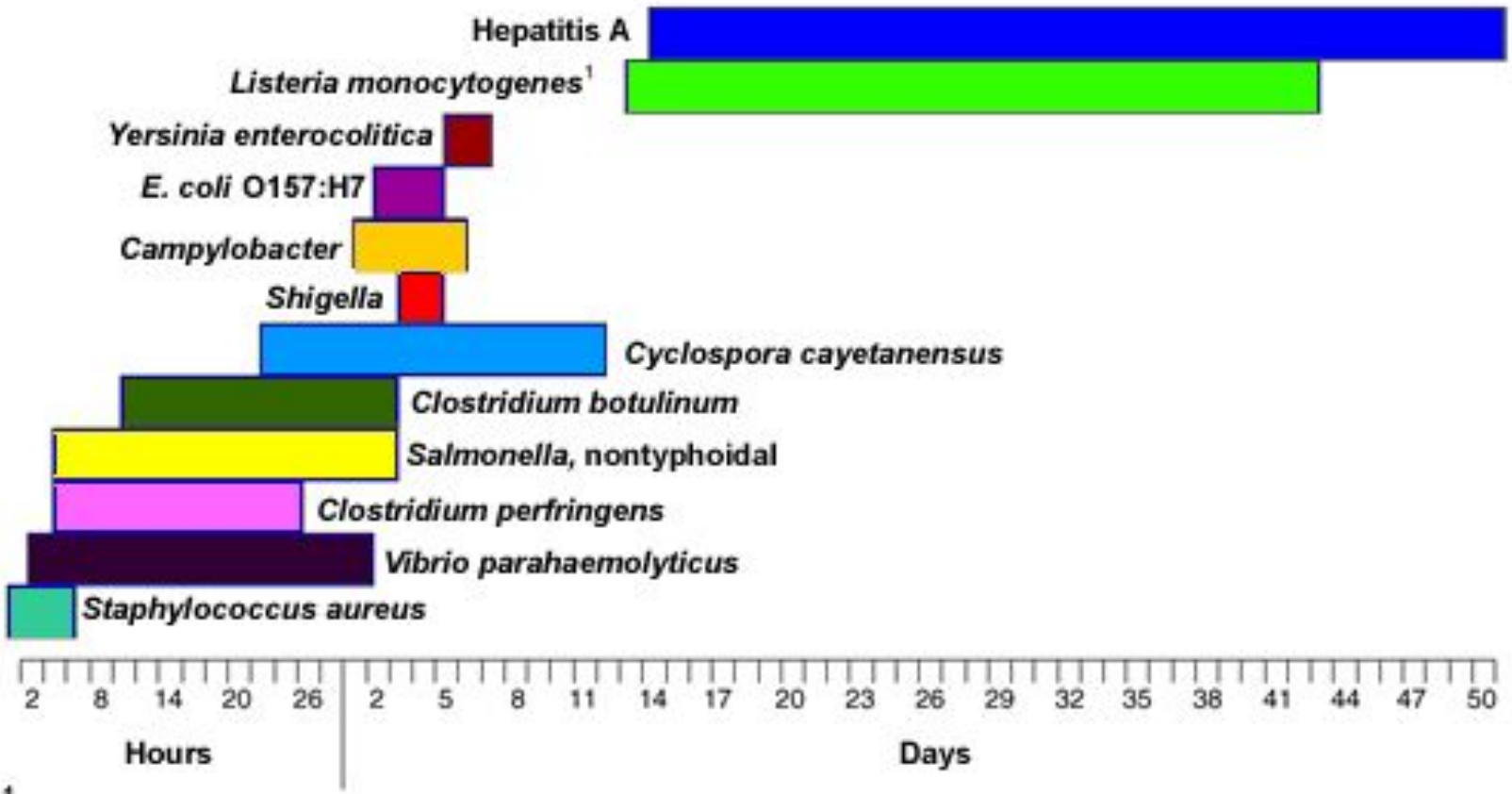
Figure 1
Usual incubation period ranges for select foodborne diseases



[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, "Surveliance 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

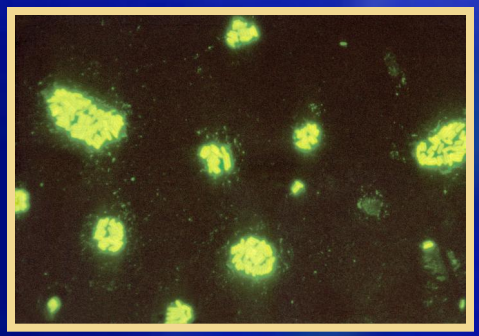
- Leading cause of bacterial diarrhea
- 2.4 million people each year
  - Children under 5 years old
  - Young adults (ages 15-29)
- Very few deaths
- Can lead to Guillain-Barré Syndrome
  - Leading cause of acute paralysis
  - Develops 2-4 weeks after *Campylobacter* infection (after diarrheal signs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

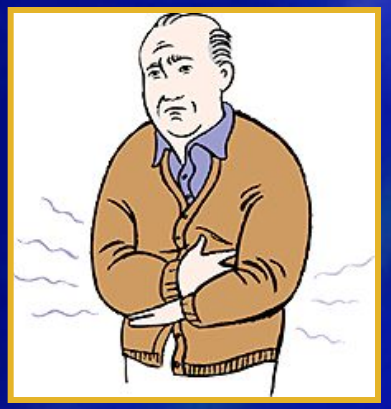
Salmonellosis

- 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

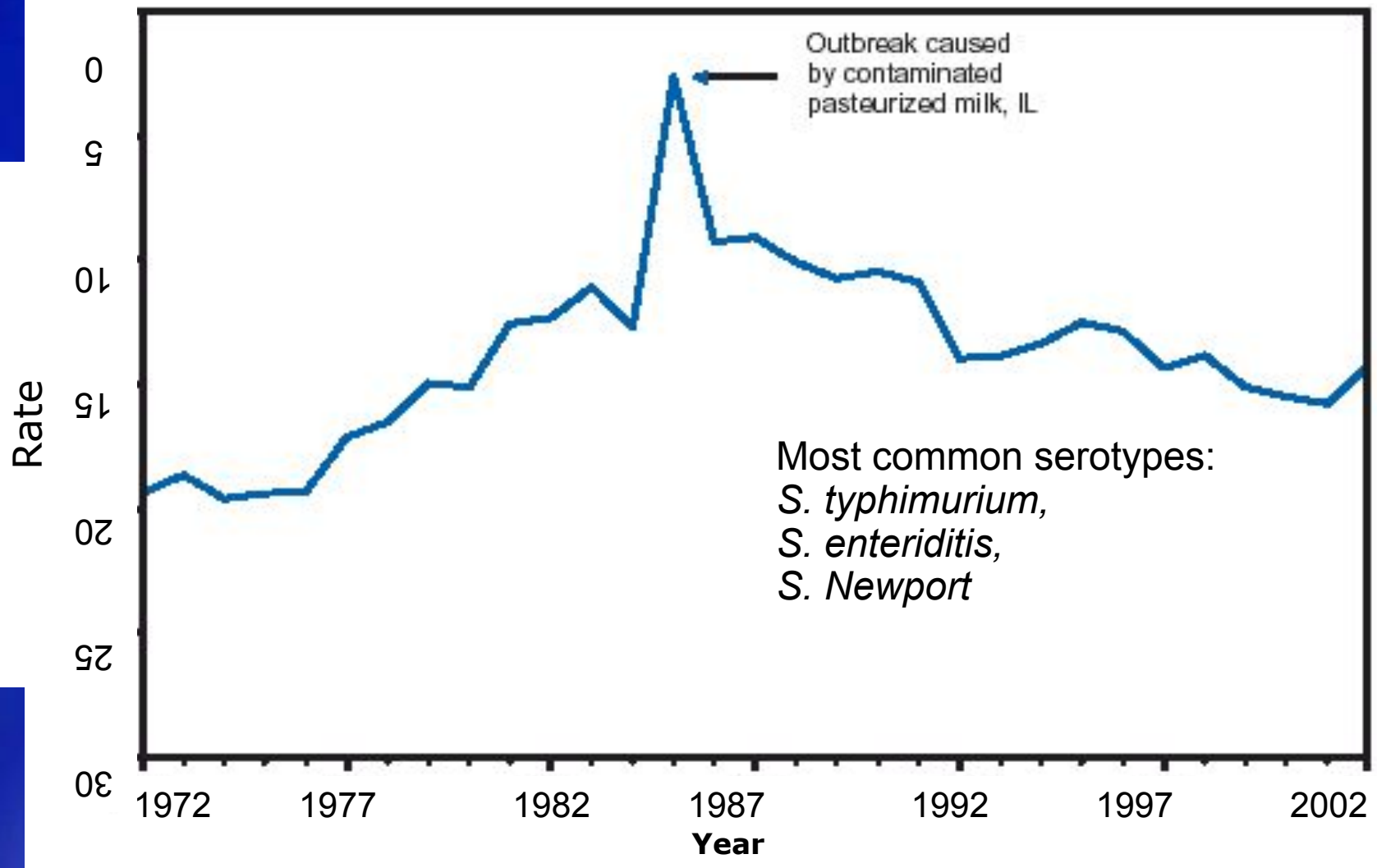


Salmonellosis

- 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



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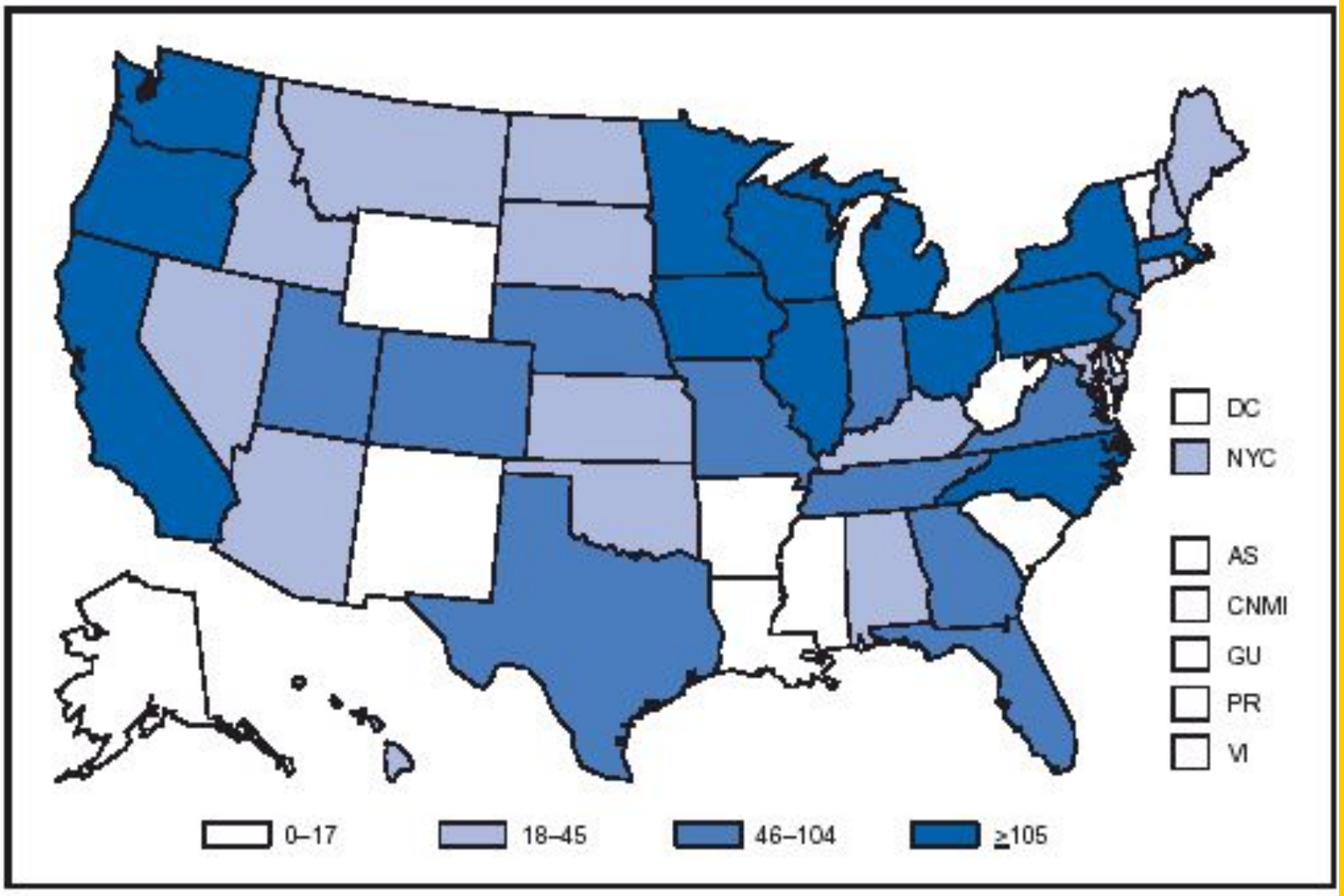
E. coli O157:H7

- 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



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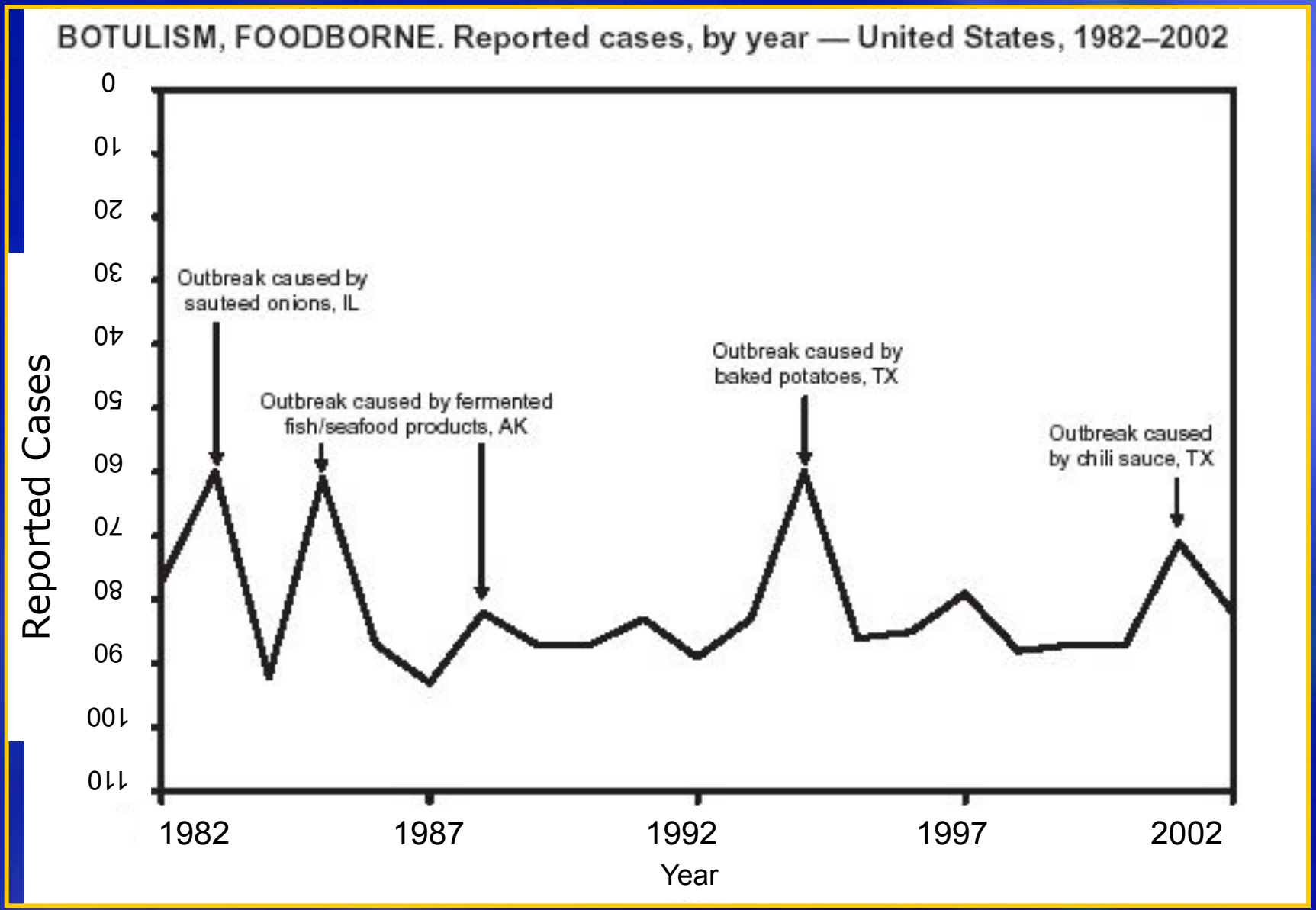
Botulism

- *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

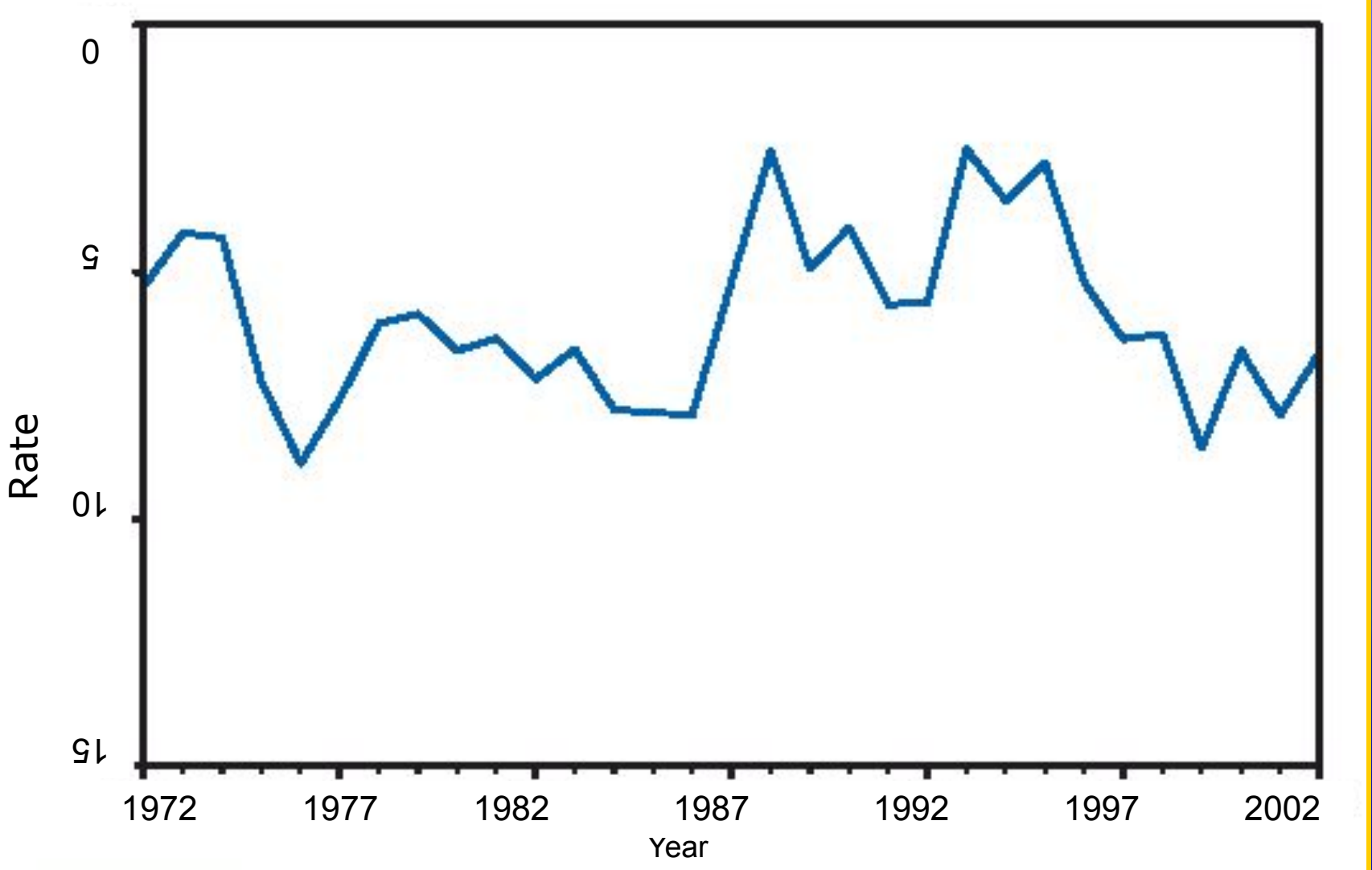

BOTULISM, FOODBORNE. Reported cases, by year — United States, 1982–2002
Reported Cases
0
10
20
30
40
50
60
70
80
90
100
110
Outbreak caused by sauteed onions, IL
Outbreak caused by fermented fish/seafood products, AK
Outbreak caused by baked potatoes, TX
Outbreak caused by chili sauce, TX
1982
1987
1992
1997
2002
Year

MMWR

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



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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

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 SS01;1 03/17/2000

Prevention and Control

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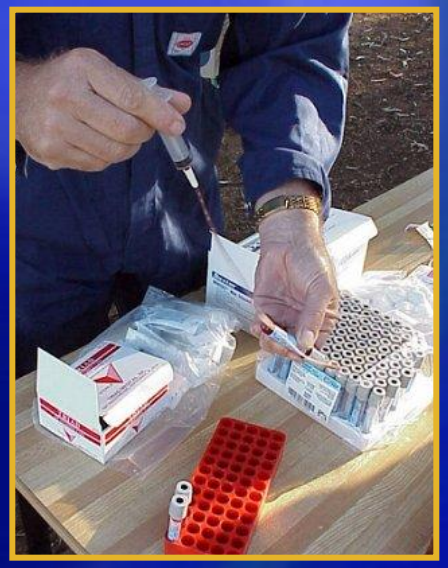
HACCP

- 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

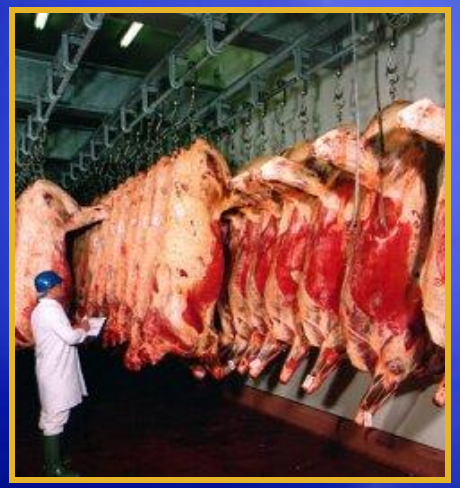
On Farm Strategies

- 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)

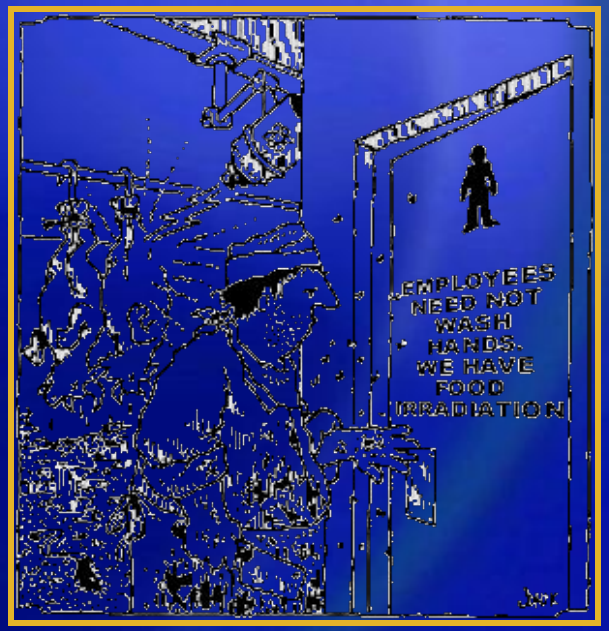


Irradiation

- 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; *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.

In the Home

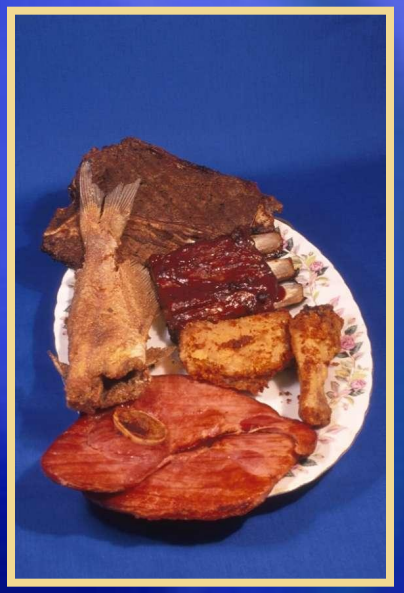
- Drink pasteurized milk and juices
- Wash hands carefully and frequently
  - After using the bathroom
  - Changing infant's diapers
  - Cleaning up animal feces
- Wash hands before preparing food

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

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Acknowledgments

Author: Glenda Dvorak, DVM, MS, MPH

Co-authors: Danelle Bickett-Weddle, DVM, MPH
Radford Davis, DVM, MPH

Reviewer: Jean Gladon, BS