Foodborne Disease Overview

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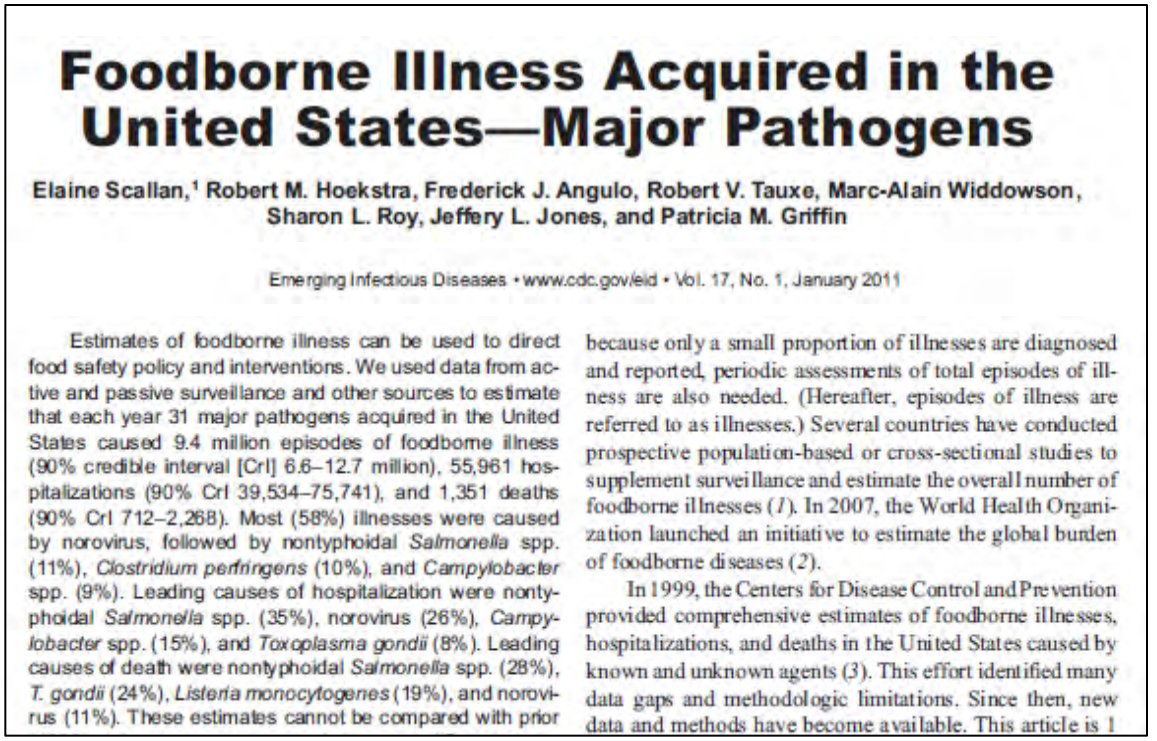
Key Points about Foodborne Disease

- Very common
- Many different germs that can cause it
  - Just a few cause majority of outbreaks
- Often more than just vomiting/diarrhea that goes away in a day or 2
  - Longer duration, loss of time at work/school, hospitalization, long-term health effects, death
- Germs commonly found on foods, in people
- Most outbreaks caused by a few errors

Foodborne Disease is Very Common

Estimates of Foodborne Disease in U.S. (Per Year)

- **47.8 million illnesses**
- **127,839 hospitalizations**
- **3,037 deaths**



Foodborne Illness Acquired in the United States—Major Pathogens

Elaine Scallan,[1] Robert M. Hoekstra, Frederick J. Angulo, Robert V. Tauxe, Marc-Alain Widdowson, Sharon L. Roy, Jeffery L. Jones, and Patricia M. Griffin

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Estimates of foodborne illness can be used to direct food safety policy and interventions. We used data from active and passive surveillance and other sources to estimate that each year 31 major pathogens acquired in the United States caused 9.4 million episodes of foodborne illness (90% credible interval [CrI] 6.6–12.7 million), 55,961 hospitalizations (90% CrI 39,534–75,741), and 1,351 deaths (90% CrI 712–2,268). Most (58%) illnesses were caused by norovirus, followed by nontyphoidal *Salmonella* spp. (11%), *Clostridium perfringens* (10%), and *Campylobacter* spp. (9%). Leading causes of hospitalization were nontyphoidal *Salmonella* spp. (35%), norovirus (26%), *Campylobacter* spp. (15%), and *Toxoplasma gondii* (8%). Leading causes of death were nontyphoidal *Salmonella* spp. (28%), *T. gondii* (24%), *Listeria monocytogenes* (19%), and norovirus (11%). These estimates cannot be compared with prior

because only a small proportion of illnesses are diagnosed and reported, periodic assessments of total episodes of illness are also needed. (Hereafter, episodes of illness are referred to as illnesses.) Several countries have conducted prospective population-based or cross-sectional studies to supplement surveillance and estimate the overall number of foodborne illnesses (*1*). In 2007, the World Health Organization launched an initiative to estimate the global burden of foodborne diseases (*2*).

In 1999, the Centers for Disease Control and Prevention provided comprehensive estimates of foodborne illnesses, hospitalizations, and deaths in the United States caused by known and unknown agents (*3*). This effort identified many data gaps and methodologic limitations. Since then, new data and methods have become available. This article is 1

Estimated Burden of Diarrheal Illness in Minnesota

- **Annual no. diarrheal illnesses** **6.1 million**
- **No. ill persons seeing a health care provider** **481,000**
- **No. persons treated in emergency rooms** **45,200**
- **No. persons hospitalized overnight** **28,400**

Many Different Germs/Agents Can Cause Foodborne Disease

- Viruses
- Bacteria
- Bacterial toxins
- Parasites
- Marine toxins
- Prions
- Mushroom toxins
- Heavy metals
- Pesticides
- Other

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- Heavy metals
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- Other

Major Categories of Common Foodborne Illnesses

- **Viral gastroenteritis (Norovirus)**
- **Bacterial intoxications**
  - ***Staphylococcus aureus, Bacillus cereus, Clostridium perfringens***
- **Bacterial infections**
  - ***Salmonella, Campylobacter, E. coli* O157**
- **Many others**

Estimated Cases of Selected Pathogens in the U.S. (Per Year)

Agent	Cases	% Food-related
Norovirus	20,865,058	26
Campylobacter	1,322,137	80
Salmonella	1,229,007	94
Giardia intestinalis	1,221,564	7
Clostridium perfringens	969,342	100
Cryptosporidium	748,123	8
Staphylococcus aureus	241,994	100
Shigella	494,908	31
Non-O157 STEC	168,698	82
Yersinia enterocolitica	116,716	90
Toxoplasma gondii	173,995	50
E. coli O157:H7	96,534	68

Estimated Food-Related Cases of Selected Pathogens in U.S. (Per Year)

Agent	Food-Related Cases	%
Norovirus	5,461,731	58
Salmonella	1,027,561	11
Clostridium perfringens	965,958	10
Campylobacter	845,024	9
Staphylococcus aureus	241,148	3
Shigella	131,254	1
Non-O157 STEC	112,752	1
Yersinia enterocolitica	97,656	1
Toxoplasma gondii	86,686	<1
Giardia intestinalis	76,840	<1
Bacillus cereus	63,400	<1
E. coli O157:H7	63,153	<1

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Foodborne Disease is Often More than Just Vomiting/Diarrhea that Goes Away in a Day or 2

Number of Cases, Deaths, and Case Fatality Rate for Bacterial Pathogens, FoodNet, 1996-2005

Pathogen	Cases	Deaths	CFR%
Salmonella	45,970	215	0.5
Listeria	1,063	173	16.3
Campylobacter	46,354	52	0.1
Vibrio	762	44	5.8
E. coli O157	4,829	40	0.8
Shigella	21,048	22	0.1
Yersinia	1,576	11	0.7
Total	121,602	557	0.5

Range of Foodborne Illnesses

- **gastroenteritis.....many**
- **birth defects.....*Toxoplasma***
- **abortion/stillbirth.....*Listeria***
- **encephalitis.....*Listeria***
- **respiratory failure……..botulism**
- **kidney failure.....*E. coli* O157**
- **arthritis.....several**
- **paralysis.....*Campylobacter***
- **invasive infection.....*Salmonella***
- **dementia.....nvCJD/TSE**

Hospitalization due to Infection with Selected Foodborne Pathogens

- ***Listeria*** **78%**
- ***E. coli* O157** **38%**
- ***Salmonella*** **25%**
- ***Campylobacter*** **15%**

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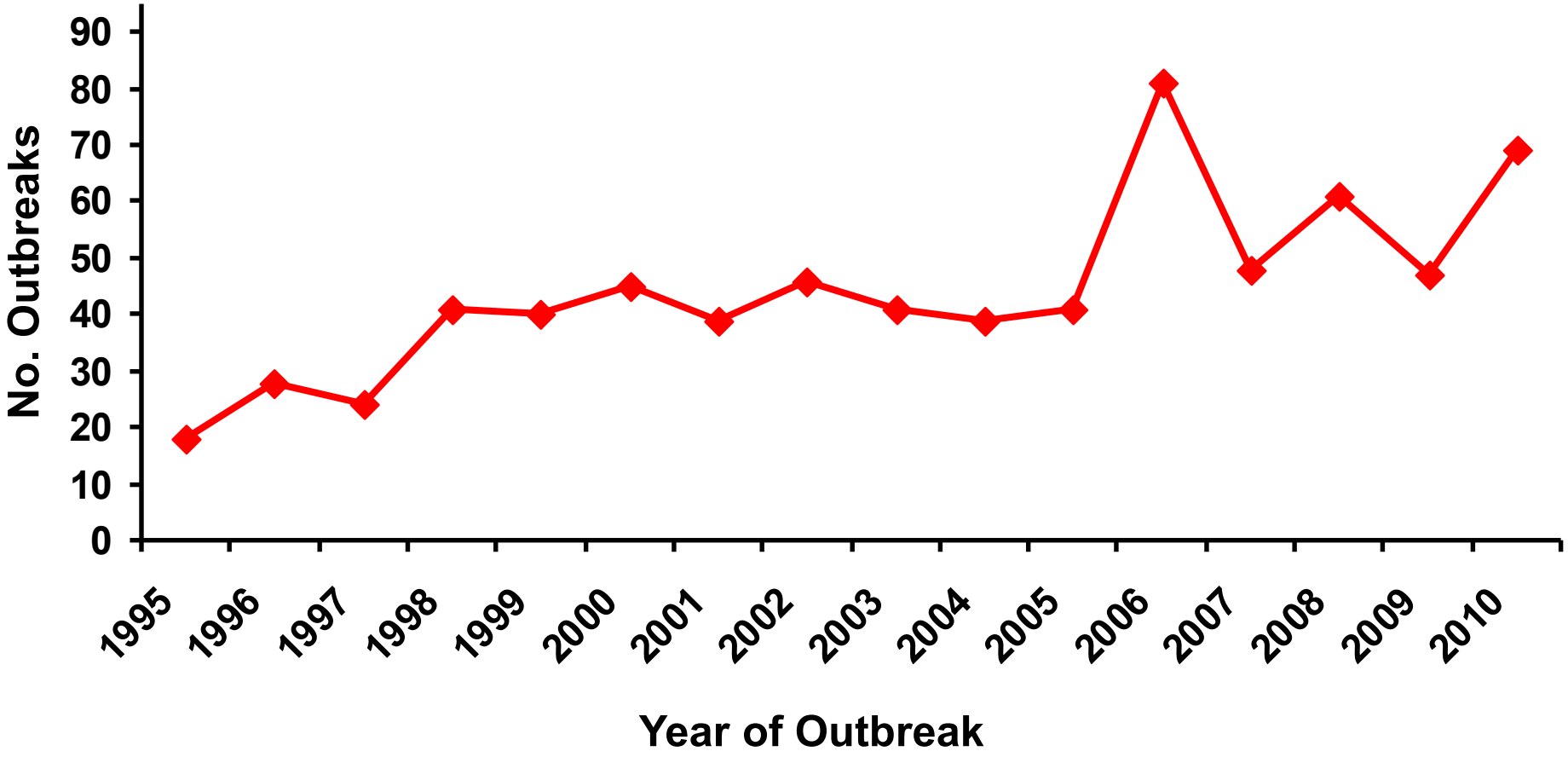
Confirmed Foodborne Outbreaks, Minnesota, 1995-2010



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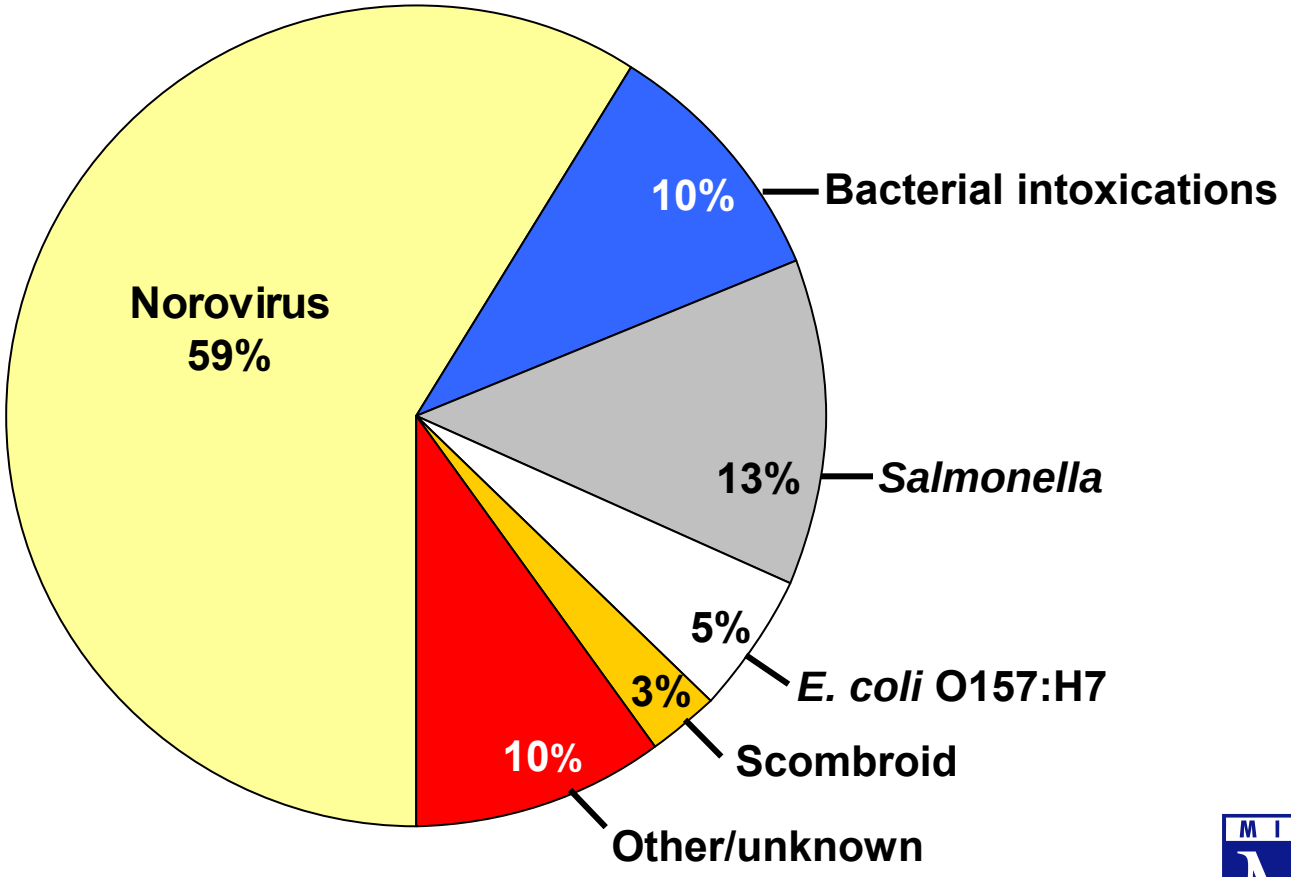
Confirmed Foodborne Outbreaks by Etiology, Minnesota,1999-2010 (n=600)



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Etiologies of Confirmed Foodborne Outbreaks, Minnesota, 2010 (n=69)

Pathogen	No.	(%)
Norovirus	39	(57%)
Salmonella	13	(19%)
E. coli O157:H7	4	(8%)
Clostridium perfringens	2	(3%)
Vibrio	2	(3%)
Suspected bacterial toxin	2	(4%)
Scombroid toxin	1	(1%)
Non-O157 STEC	1	(1%)
Campylobacter jejuni	1	(1%)
C. jejuni + *Cryptosporidium*	1	(1%)
Unknown	3	(4%)

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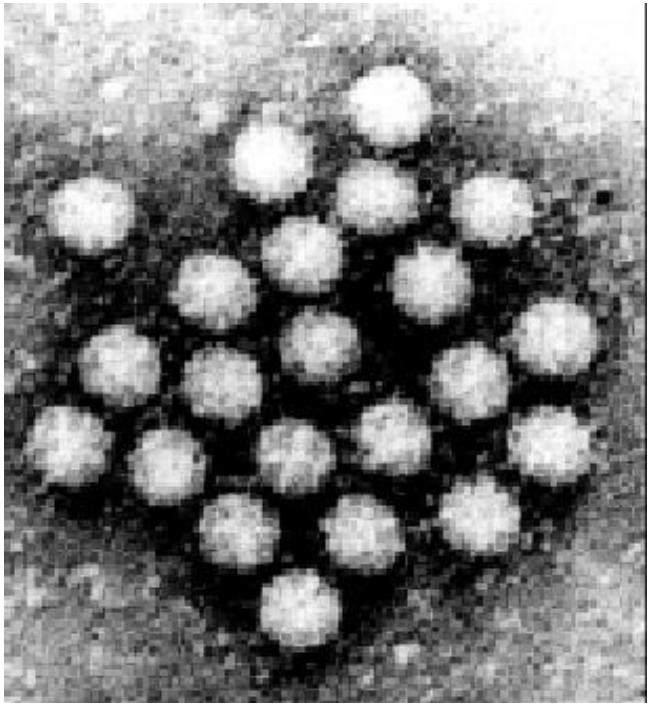
Norovirus

- Most common cause of intestinal illness, by far
- Humans are the source
- Fecal-oral transmission
  - person-person
  - foodborne
  - waterborne



Symptoms of Norovirus Infection

- Diarrhea (non-bloody)
- Nausea
- Vomiting
  - More likely in children
  - Can be primary complaint
- Abdominal pain
- Muscle aches, headache
- Low-grade fever (or none)
- Incubation: 24-48 hours (12-50)
- Duration: 12-60 hours

Treatment for Norovirus

- Self-limiting illness
- May require oral or intravenous rehydration
- 10% cases seek health care
- 1% hospitalized
  - Hospitalizations rare in healthy children and adults
- More serious in elderly or those with weakened immune systems

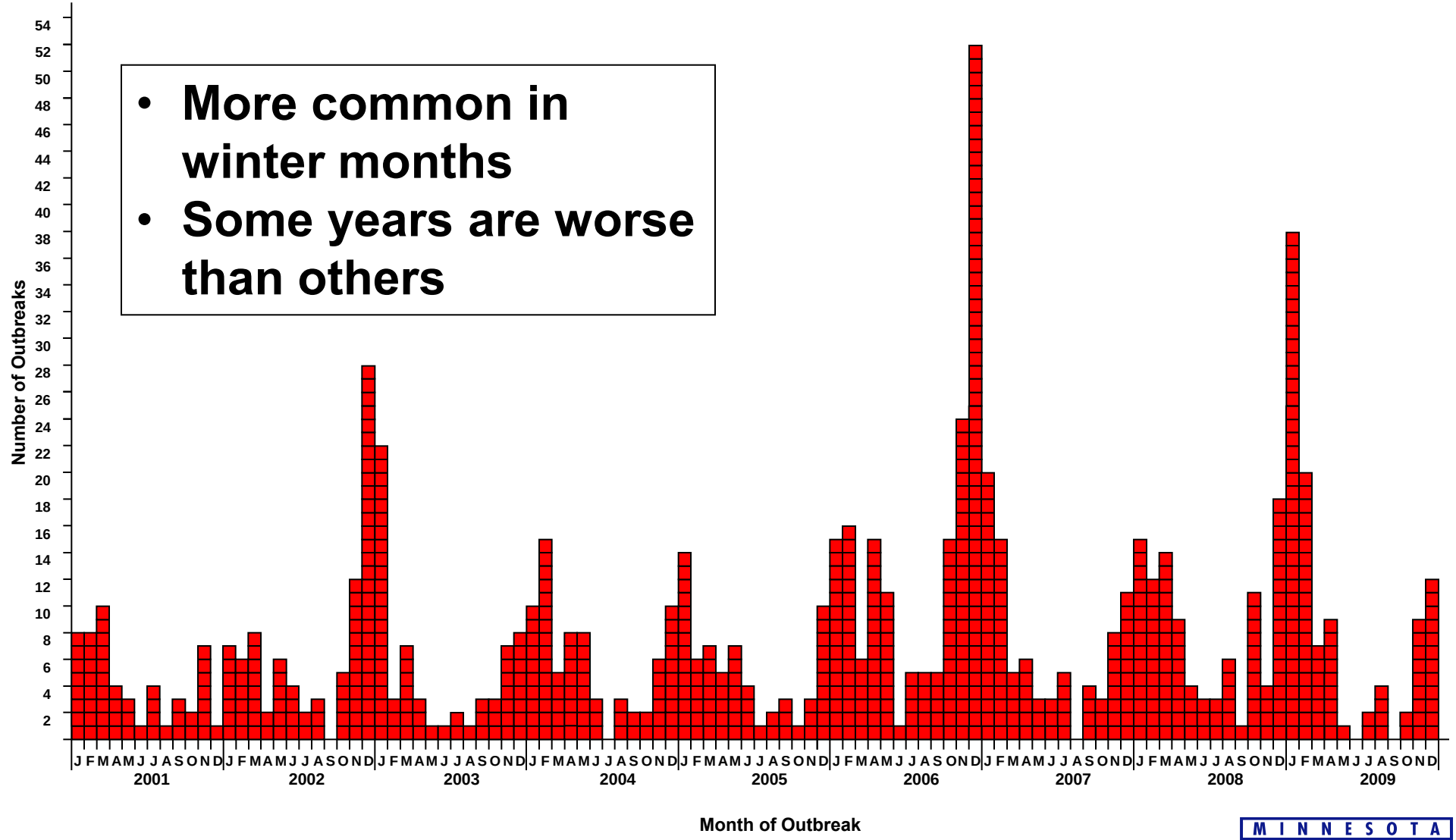
Dispelling the “Stomach Flu” Myth

- Term generally used to describe short-term (up to 2 days) gastroenteritis, with aches
  - Phrase often shortened as “flu”
    - Confused with influenza, a respiratory illness
- Not a specific disease caused by a single germ
  - In many instances probably used to describe illness caused by norovirus

Dispelling the “Stomach Flu” Myth

- People who think they have “stomach flu”:
  - Often have no idea that they could have gotten ill from eating food
  - Often have no idea that they can transmit it to others through food
- Confusion is common among public, food service industry, and to some extent among health care industry

Norovirus Outbreaks by Month, Minnesota, 2001 – 2009



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Norovirus and Foodborne Disease

- **In virtually every foodborne norovirus outbreak, the cause is passage of microscopic viral particles in feces, via the hands of a foodhandler, to ready-to-eat foods because they didn't wash their hands as well as they should have**
  - **usually, this person is or has recently been ill**
    - **Norovirus can be passed in stool for up to <u>2-3 weeks after symptoms have resolved</u>**
  - **Occasionally, cause is transfer from ill household member**

Potential Transmission Level of Norovirus

- **Norovirus is extremely contagious**
  - **Infectious dose estimated to be 10 – 100 viral particles**
  - **Passed in the feces at levels up to 10,000,000 viral particles per gram**
  - **One projectile vomiting incident can include up to 30,000,000 viral particles**

Transfer of Norovirus from Contaminated Fingers

- **NoV can transfer from contaminated fingers sequentially to 7 different environmental surfaces**
- **Secondary transfer of NoV (from contaminated surfaces → clean fingers → other surfaces): can transfer sequentially to 4 different surfaces**

Foodborne Bacterial Intoxications

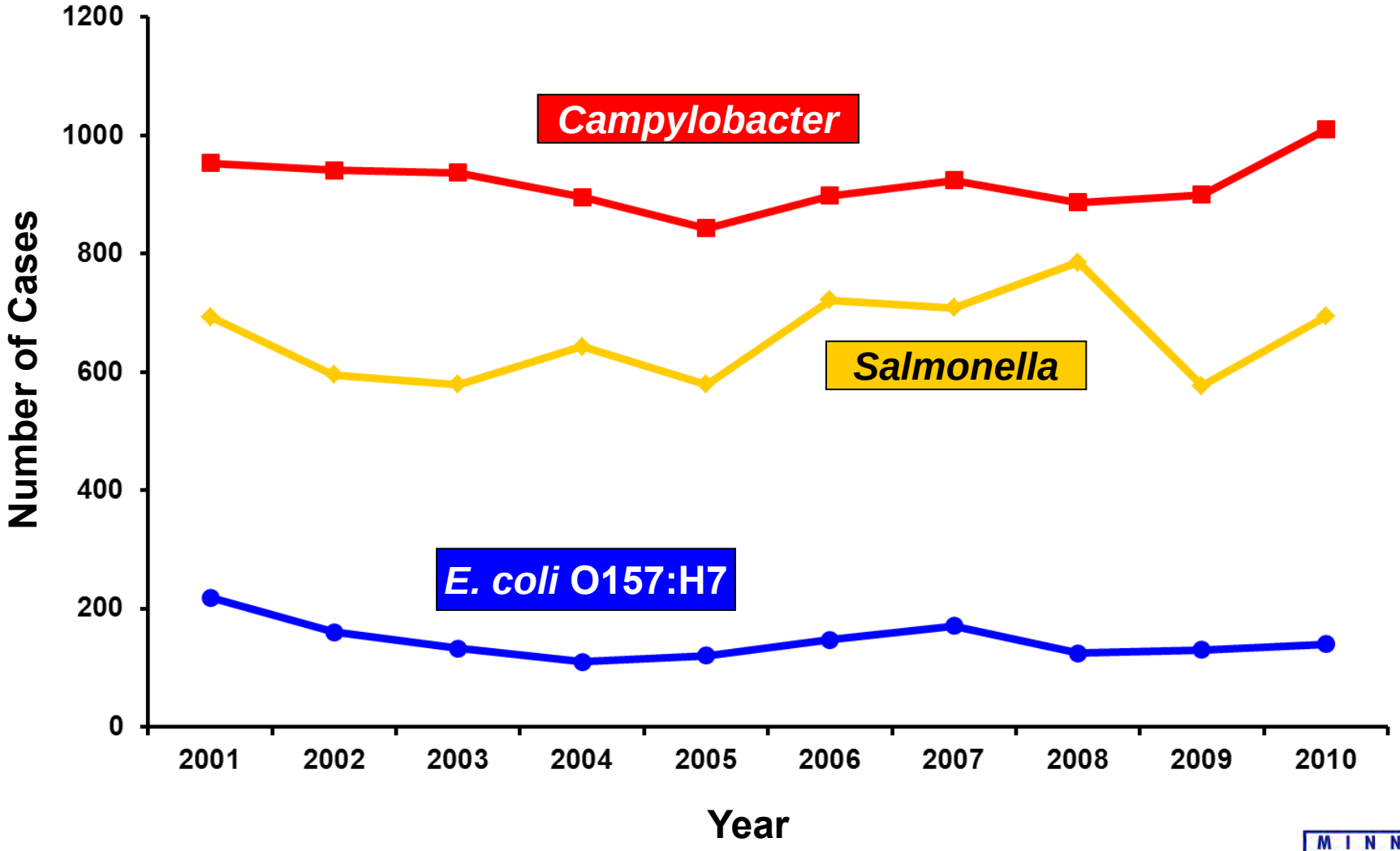
- **These bacteria very commonly found on foods**
- **Somewhat frequent cause of outbreaks**
- **Short incubation (hours), short duration (hours to <2 days)**
- **Caused by time-temperature abuse of food**

1. ***Clostridium perfringens*** **(e.g., meats, gravies)**
2. ***Staphylococcus aureus*** **(e.g., custards, salad dressings, sliced meats)**
3. ***Bacillus cereus*** **(e.g., fried rice)**

Foodborne Bacterial Infections

- ***Salmonella, Campylobacter, E. coli* O157 (and related *E. coli*)**
  - **Primary source is food animals**
  - **Clinical picture characterized by longer duration of diarrhea, bloody stools, fever (*Salmonella*, *Campylobacter*)**
    - **more severe, higher hospitalization rates than intoxications, norovirus**
    - **potential for serious complications**
  - **incubation, duration measured in days**

Selected Enteric Bacteria Reported to MDH, 2001 – 2010



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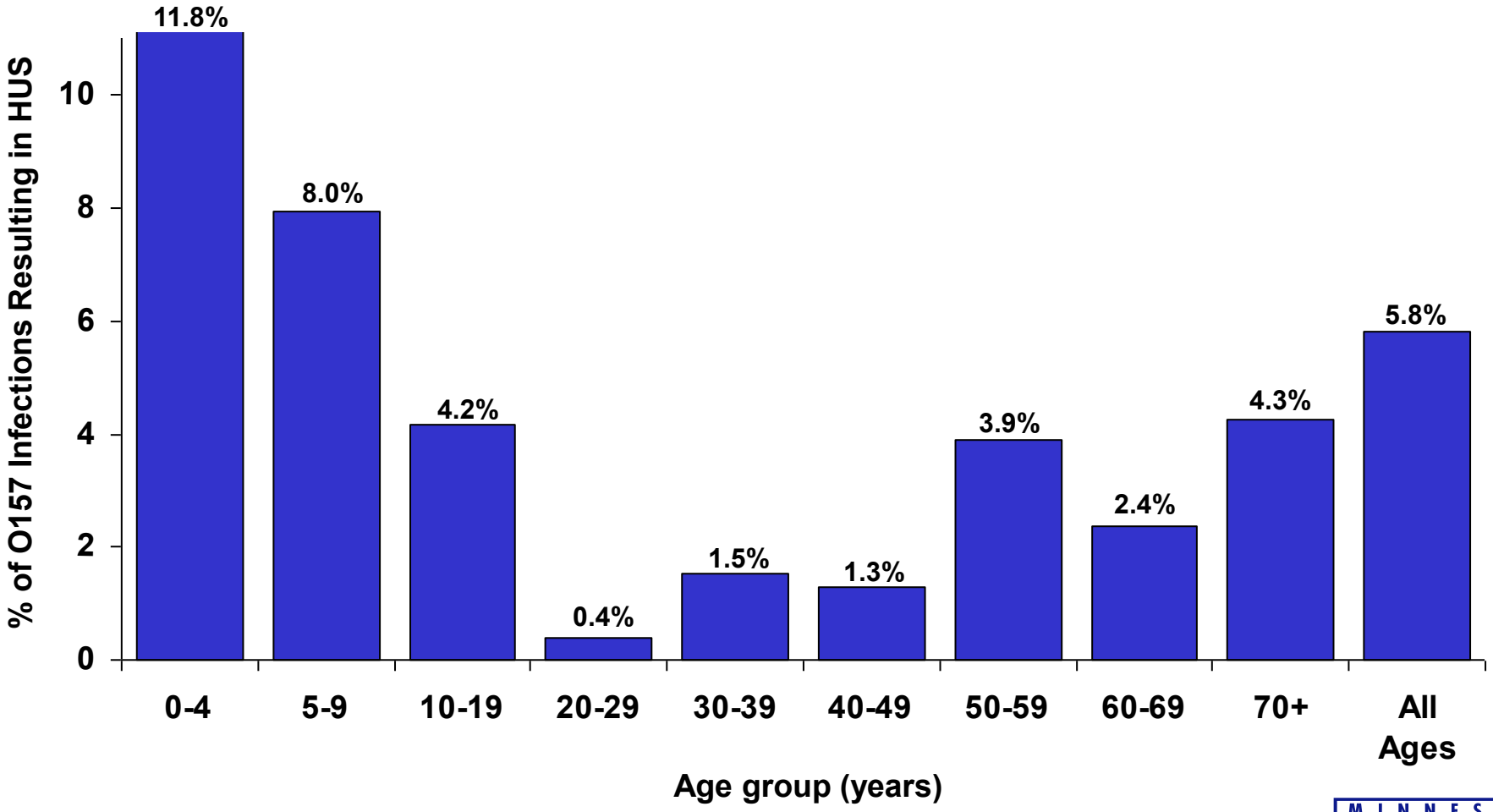
E. coli O157

- **Important cause of bloody diarrhea**
- **Primary cause of post-diarrheal hemolytic uremic syndrome in the United States**

Hemolytic Uremic Syndrome (HUS)

- Most common cause of kidney failure in children
- Characterized by:
  - Kidney failure
  - Anemia (low red blood cell count)
  - Low platelets
- 6% of cases fatal
  - Survivors often have chronic health problems

Percentage of *E. coli* O157 Infections Resulting in Hemolytic Uremic Syndrome by Age Group, Minnesota, 1996 – 2009



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E. coli O157

- **Primary reservoir = cattle**
  - **Other ruminants (sheep, goats, deer, elk)**
- **Ground beef most common vehicle, but anything contaminated by cattle feces can be a source**
  - **Direct contact with calves, goats, sheep**
  - **Sprouts, leafy greens, lake water, raw milk and apple cider, etc.**
  - **Spreads readily in child care settings**
    - **person-to-person**

Nontyphoidal *Salmonella enterica*

- Over 2,400 types
- Principal reservoirs = food animals
  - Also reptiles, rodents, other animals
- Typical clinical presentation is fever, diarrhea for up to a week
- 25% hospitalization rate
- Can cause infections of bloodstream, brain, bone, gall bladder, etc.
- A cause of reactive arthritis
  - Usually begins after diarrhea stops

Nontyphoidal *Salmonella enterica* – Food Sources

- **Anything!**
- **Any raw or undercooked food of animal origin**
  - **Poultry, eggs, pork, beef**
  - **Produce: tomatoes, peppers, leafy greens, etc.**
  - **Processed foods, spices, etc.**
- **Infected foodhandlers can contaminate food they touch, even when they are not currently having symptoms**

Campylobacter

- **Most commonly recognized cause of bacterial gastroenteritis in Minnesota, U.S.**
- **Disease similar to *Salmonella*, though not as likely to cause invasive infections**
- **Typical clinical presentation is fever, diarrhea for up to a week**
- **15% hospitalization rate**
  - **A cause of reactive arthritis**
  - **Most common cause of Guillain-Barré syndrome (paralysis)**

Campylobacter – Epidemiology in United States

- **Primary reservoir = poultry**
  - **20-80% of chicken in grocery stores is contaminated with *Campylobacter***
- **Cattle also an important reservoir**
- **Outbreaks occur, but are uncommon**
  - **Poultry, raw milk, unchlorinated water**

Other Foodborne Pathogens

- ***Listeria***
  - **hot dogs, deli meats, unpasteurized cheeses**
  - **rare, but severe**
  - **disease of those with weakened immune systems**
  - **abortions, congenital defects, perinatal disease, bacteremia, CNS disease**
- ***Toxoplasma***
  - **foodborne component: meat (especially pork)**
  - **abortions, congenital defects, ocular disease, encephalitis (AIDS patients)**

Other Foodborne Pathogens

- **Hepatitis A Virus**
  - **human reservoir; primarily person-person**
  - **rarely foodborne (imported produce, raw oysters, foodhandlers)**
- ***Vibrio* spp.**
  - **predominately shellfish (raw oysters)**
- ***Clostridium botulinum***
  - **botulism**
  - **Low acid foods in anaerobic environments; improper canning**

Other Foodborne Pathogens

- *Shigella*
  - mostly person-person (daycares, schools)
  - occasional foodborne outbreaks due to imported produce, foodhandlers
- *Cryptosporidium, Giardia*
  - rarely foodborne
    - Foodhandlers, raw milk and apple cider (crypto)
  - common waterborne agents
  - animal contact, person-person

Other Foodborne Pathogens

- ***Yersinia*** **spp. (e.g., chitterlings, raw milk)**
- ***Cyclospora*** **(e.g., raspberries, basil, snow peas)**
- **Marine toxins (seafood)**
- **Bovine spongiform encephalopathy prion**
- ***Entamoeba histolytica***
- **Hepatitis E virus (pork)**
- **Rotavirus, Astrovirus, Adenovirus**
- ***Clostridium difficile***
- **Many more!**

Most Foodborne Disease Outbreaks are Caused by a Few Errors

- Preparing food while ill/recently ill, and not washing hands thoroughly before handling food
- Time-temperature abuse
  - Improper cooling, holding, reheating
- Undercooking of foods of animal origin
- Cross-contamination from raw foods of animal origin to ready-to-eat foods

Foodborne Disease Outbreak Examples

Clostridium perfringens Outbreak Associated with a Church Festival, 2007

- **September 18: MDH learned of multiple calls (>20) to parish administrator reporting illness after attending church festival**
- **3-day church festival the previous weekend**
- **Event was open to the general public**
- **As many as 1,000 people served at each of two main dinners**
  - **Taco dinner**
  - **Pork roast dinner**

Clostridium perfringens Outbreak Associated with a Church Festival, 2007

- 49 attendees/volunteers interviewed
  - 23 (47%) ill
- Median duration of illness, 13 hours (3 to 57 hours)
  - 100% diarrhea, 78% cramps, 9% fever
- Stool testing revealed that cause was *Clostridium perfringens*
- Outbreak vehicle: pork roast and gravy made with pork drippings

Clostridium perfringens Outbreak Associated with a Church Festival, 2007

- 350 lbs. of pork loin cooked beginning at 9:00 pm on Saturday night
  - Not divided into smaller portions to facilitate cooling
  - Some stored at room temp. for hours
  - Placed in hot holding units for reheating, stored in chafing dishes for serving
  - Temps. never taken to ensure that proper cooling took place or that hot holding requirements were met

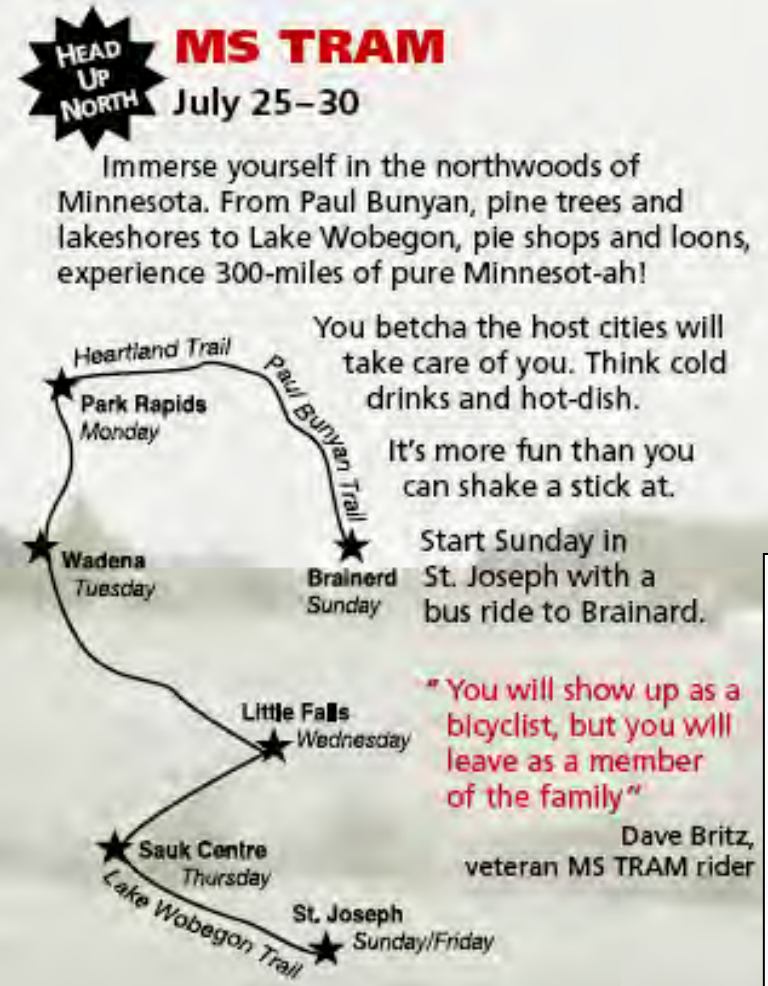
Clostridium perfringens Outbreak Associated with a Church Festival, 2007

- Improper cooling procedures and improper hot- and cold-holding temperatures
  - Allowed bacteria to grow to high levels on food and to survive
- Food was not prepared by a certified food manager

Suspected *C. perfringens* Outbreak Associated with a Church Festival, 2008

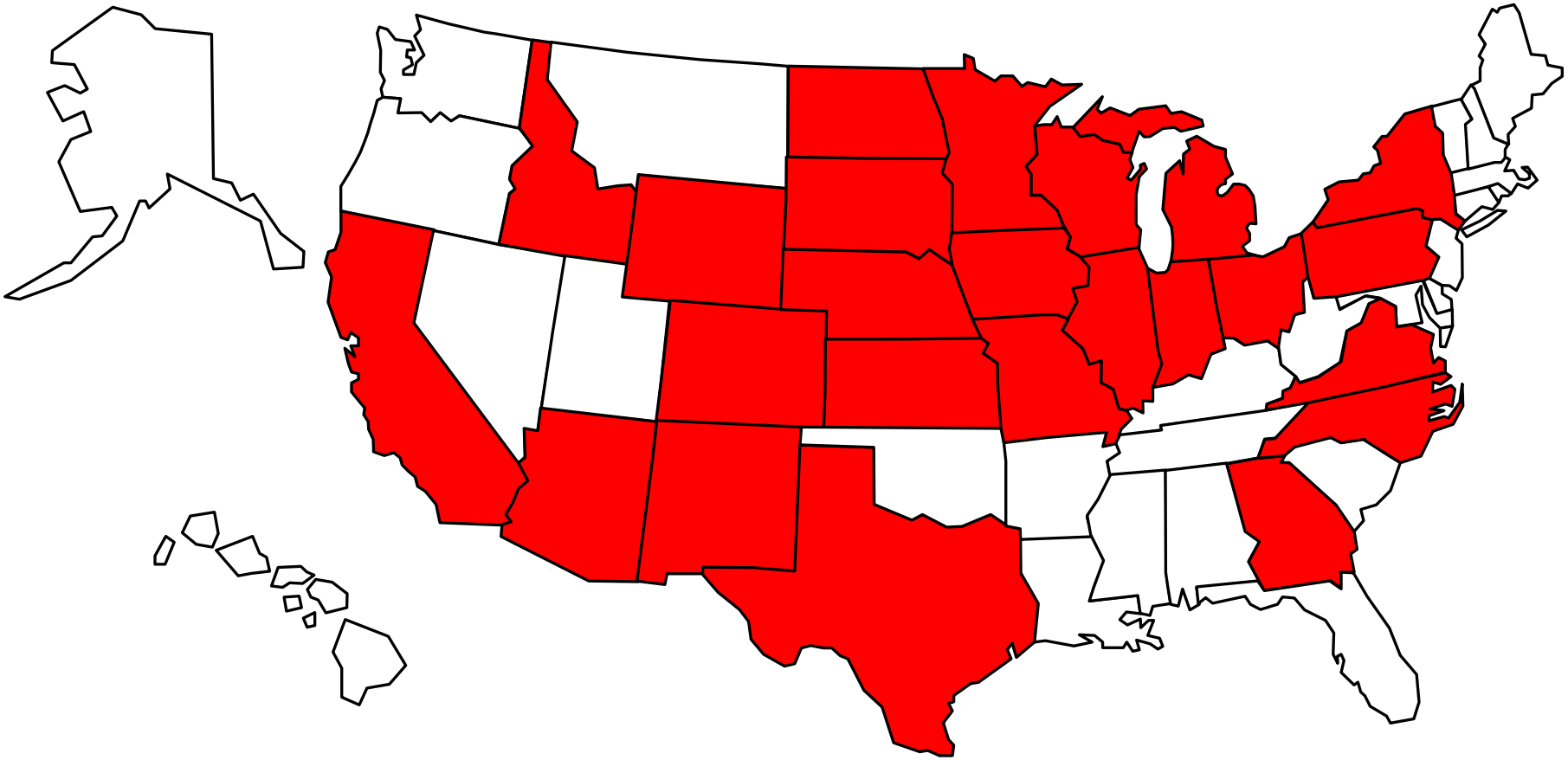
- Estimated 187 illnesses out of 585 paid attendees
- Outbreak vehicle: turkey
- 26 turkeys (20+ lbs.) each placed in individual roasters for 3 hours; meat picked and stored in 2 refrigerators overnight
  - Reheated in ovens; foil pans with Sterno cans beneath used for holding, serving
  - Temperatures never taken
  - Improper cooling procedures and improper hot- and cold-holding temperatures

Outbreak of *E. coli* O157:H7 Infections Associated with the MS Tram, 2004



MS Tram, 2004

980 participants from 24 states (plus Ontario & Saskatchewan)



MS Tram *E. coli* O157:H7 Outbreak, 2004

- 244 participants interviewed
  - 18 (7%) illnesses identified
- Median duration: 4 days (range, 1.5 to 9 days)
- All cases had diarrhea, 9 had bloody diarrhea, 5 had vomiting
- One case hospitalized for 3 days

MS Tram *E. coli* O157:H7 Outbreak, 2004

- Outbreak vehicle: Spaghetti dinner at local church
- Ground beef originated from a local custom slaughter facility
  - Not approved for resale
- Ground beef was partially thawed in microwave, then browned from frozen/partially frozen state before being incorporated into spaghetti sauce

E. coli O157:H7 Outbreak at a Church Smorgasbord Event, 2006

- 300 attendees
- 17 illnesses (13 from church event)
- All 17 had bloody diarrhea
- 9 hospitalized; average stay, 5 days (range, 1 to 27 days)
- 3 HUS cases
- 1 death

E. coli O157:H7 Outbreak at a Church Smorgasbord Event, 2006

- Outbreak vehicle: potato salad, possibly other ready-to-eat food items
- An environmental assessment indicated high potential for cross contamination from raw ground beef to ready-to-eat foods
  - Could have occurred via contamination of surfaces, utensils, or hands of volunteers during handling of raw ground beef
  - Eggs and potatoes for potato salad chopped during meatball preparation

- **Contaminated ground beef used to prepare meatballs**
- **Cross contamination from raw ground beef to potato salad**

Thank You