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
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
Many Different Germs/Agents Can Cause Foodborne Disease

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

<table>
<thead>
<tr>
<th>Agent</th>
<th>Cases</th>
<th>% Food-related</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norovirus</td>
<td>20,865,058</td>
<td>26</td>
</tr>
<tr>
<td>Campylobacter</td>
<td>1,322,137</td>
<td>80</td>
</tr>
<tr>
<td>Salmonella</td>
<td>1,229,007</td>
<td>94</td>
</tr>
<tr>
<td>Giardia intestinalis</td>
<td>1,221,564</td>
<td>7</td>
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<tr>
<td>Clostridium perfringens</td>
<td>969,342</td>
<td>100</td>
</tr>
<tr>
<td>Cryptosporidium</td>
<td>748,123</td>
<td>8</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>241,994</td>
<td>100</td>
</tr>
<tr>
<td>Shigella</td>
<td>494,908</td>
<td>31</td>
</tr>
<tr>
<td>Non-O157 STEC</td>
<td>168,698</td>
<td>82</td>
</tr>
<tr>
<td>Yersinia enterocolitica</td>
<td>116,716</td>
<td>90</td>
</tr>
<tr>
<td>Toxoplasma gondii</td>
<td>173,995</td>
<td>50</td>
</tr>
<tr>
<td>E. coli O157:H7</td>
<td>96,534</td>
<td>68</td>
</tr>
</tbody>
</table>
### Estimated Food-Related Cases of Selected Pathogens in U.S. (Per Year)

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<thead>
<tr>
<th>Agent</th>
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<tr>
<td>Norovirus</td>
<td>5,461,731</td>
<td>58</td>
</tr>
<tr>
<td><em>Salmonella</em></td>
<td>1,027,561</td>
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<td>241,148</td>
<td>3</td>
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<tr>
<td><em>Shigella</em></td>
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<td>1</td>
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<tr>
<td><em>Giardia intestinalis</em></td>
<td>76,840</td>
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<tr>
<td><em>Bacillus cereus</em></td>
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<td><em>E. coli O157:H7</em></td>
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Foodborne Disease is Often More than Just Vomiting/Diarrhea that Goes Away in a Day or 2
<table>
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<tr>
<th>Pathogen</th>
<th>Cases</th>
<th>Deaths</th>
<th>CFR%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonella</td>
<td>45,970</td>
<td>215</td>
<td>0.5</td>
</tr>
<tr>
<td>Listeria</td>
<td>1,063</td>
<td>173</td>
<td>16.3</td>
</tr>
<tr>
<td>Campylobacter</td>
<td>46,354</td>
<td>52</td>
<td>0.1</td>
</tr>
<tr>
<td>Vibrio</td>
<td>762</td>
<td>44</td>
<td>5.8</td>
</tr>
<tr>
<td>E. coli O157</td>
<td>4,829</td>
<td>40</td>
<td>0.8</td>
</tr>
<tr>
<td>Shigella</td>
<td>21,048</td>
<td>22</td>
<td>0.1</td>
</tr>
<tr>
<td>Yersinia</td>
<td>1,576</td>
<td>11</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>121,602</td>
<td>557</td>
<td>0.5</td>
</tr>
</tbody>
</table>
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%
Confirmed Foodborne Outbreaks, Minnesota, 1995-2010

Year of Outbreak

No. Outbreaks
Confirmed Foodborne Outbreaks by Etiology, Minnesota, 1999-2010 (n=600)

- Norovirus: 59%
- Salmonella: 13%
- E. coli O157:H7: 10%
- Bacterial intoxications: 10%
- Scombroid: 5%
- Other/unknown: 3%
## Etiologies of Confirmed Foodborne Outbreaks, Minnesota, 2010 (n=69)

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>No.</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norovirus</td>
<td>39</td>
<td>(57%)</td>
</tr>
<tr>
<td><em>Salmonella</em></td>
<td>13</td>
<td>(19%)</td>
</tr>
<tr>
<td><em>E. coli</em> O157:H7</td>
<td>4</td>
<td>(8%)</td>
</tr>
<tr>
<td><em>Clostridium perfringens</em></td>
<td>2</td>
<td>(3%)</td>
</tr>
<tr>
<td><em>Vibrio</em></td>
<td>2</td>
<td>(3%)</td>
</tr>
<tr>
<td>Suspected bacterial toxin</td>
<td>2</td>
<td>(4%)</td>
</tr>
<tr>
<td>Scombroid toxin</td>
<td>1</td>
<td>(1%)</td>
</tr>
<tr>
<td>Non-O157 STEC</td>
<td>1</td>
<td>(1%)</td>
</tr>
<tr>
<td><em>Campylobacter jejuni</em></td>
<td>1</td>
<td>(1%)</td>
</tr>
<tr>
<td><em>C. jejuni + Cryptosporidium</em></td>
<td>1</td>
<td>(1%)</td>
</tr>
<tr>
<td>Unknown</td>
<td>3</td>
<td>(4%)</td>
</tr>
</tbody>
</table>
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

- More common in winter months
- Some years are worse than others
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 2-3 weeks after symptoms have resolved
  – 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

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Campylobacter</td>
<td></td>
</tr>
<tr>
<td>Salmonella</td>
<td></td>
</tr>
<tr>
<td>E. coli O157:H7</td>
<td></td>
</tr>
</tbody>
</table>

Number of Cases

Year

2001 2002 2003 2004 2005 2006 2007 2008 2009 2010

MINNESOTA DEPARTMENT OF HEALTH
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

- **0-4** years: 11.8%
- **5-9** years: 8.0%
- **10-19** years: 4.2%
- **20-29** years: 0.4%
- **30-39** years: 1.5%
- **40-49** years: 1.3%
- **50-59** years: 3.9%
- **60-69** years: 2.4%
- **70+** years: 4.3%
- **All Ages**: 5.8%
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, food handlers)

• *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
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