E. Coli is (mostly) harmless
• E. coli is a common intestinal bacterium of mammals
• Many diverse strain types (serotypes)
• Most are harmless or beneficial
• Several serotypes cause disease
• Enterohemorrhagic E. coli
  - Diarrhea, bloody diarrhea, HUS
  - Shiga toxin → STEC

STEC and Foodborne Illnesses
• Diarrheal disease: 47,800,000 / year
  - 3.6% STEC: 110,000 non-O157; 63,000 O157
• Hospitalizations: 128,000 / yr
  - 1.85% STEC: 2,100 O157; 270 non-O157
• Deaths: 3,000 / yr due to foodborne illness
  - 0.7% STEC: 20 due to O157; 0-1 due to non-O157

E. coli O157:H7 as a Case Study
• Ubiquitous
• Broad host range
• Invisible
• Prolific
• Potent
• Hardy

Why is E. coli O157:H7 still a problem, 15 years after “Jack in the Box”?
**E. coli O157 and Cattle Husbandry**

- **E. coli O157 10% (0 – 100%)**
- **E. coli O157 10% (0 – 100%)**

**Pre-harvest Food Safety:**
- “Control of Zoonotic Diseases by Intervention in Animal Husbandry”
- Control / eradication programs for:
  - Bovine tuberculosis
  - Brucellosis
  - Trichinella spiralis (“food safety for our food”)

**Broad host range**

- Animal reservoirs of *E. coli* O157: cattle
  - Cattle as a reservoir
    - No disease!
    - Summertime seasonal peak
    - Short-lived ‘infection’
    - Low fecal shedding
    - <100–100,000 cells/g feces
    - Easily infected: 100-1,000 cells
    - Young animals (1 week - 2 yrs)

**Sources / Routes of human infection**

- Infected cattle and other food animals
- Infected humans
- Infected deer, rabbits, rodents, birds, insects, swine, …
- Contaminated soil, water, meat, milk, produce, etc.
- Human infection

Data from CDC and Stanford et al 2005
**E. coli O157:H7 Cases in the U.S.**

- **Goal:** Eliminate the warm season peaks

**Cattle seasonal shedding due to seasonal exposure**

- S = August; W = February

**Sources / Routes of infection**

- Infected humans
- Infected deer, rabbits, rodents, birds, insects, swine, etc.
- Contaminated soil, water, meat, milk, produce, etc.
- Infected cattle and other food animals

**Whose fault is the E. coli O157:H7 problem?**

**Cattle ranchers and feeders?**

- As of 2013, the best science has to offer ranchers and feeders are interventions like vaccines that will (after multiple doses) reduce (but not eliminate) cattle shedding E. coli O157 in their feces for a limited time.

**Meatpackers?**

- "E. coli path shows flaws in meat inspection"
  - NYT Michael Moss, 10/3/2009

**Factors:**

- Modern plants; larger batch sizes
  - probably unrelated to risk
  - Increase likelihood of detection
- Safety through testing? No way!
- Challenge: 10,000 infected cattle/day (peak summer)
- HACCP: Mandated focus on process improvement
- Large investments in interventions:
  - hide washers, carcass rinses, steam closets, etc.
Consumers?

“If consumers would just cook their food properly the O157:H7 problem wouldn’t exist”

“FSIS reminds consumers of the importance of following food safety guidelines. Ground beef should be cooked to an internal temperature of 160°F or higher.”

Factors:
- Messy packaging
- Cross contamination in the kitchen
- Proper use of meat thermometer
- Salad vegetables

Public health agencies?

- Reporting regulations
- Pulsed field gel electrophoresis
- PulseNet
- FoodNet

Summary

- E. coli O157:H7 – a multi-faceted problem
- No broadly effective controls in animal reservoirs
- No current prospects for an E. coli O157:H7-free food supply or environment

How safe is safe enough?

Cause of death

<table>
<thead>
<tr>
<th>Cause of death</th>
<th>Annual</th>
<th>Lifetime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart disease</td>
<td>652,486</td>
<td>1 in 5</td>
</tr>
<tr>
<td>Cancer</td>
<td>553,486</td>
<td>1 in 7</td>
</tr>
<tr>
<td>Hospital-acquired infection</td>
<td>99,000</td>
<td>1 in 38</td>
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<tr>
<td>Car accident (2009)</td>
<td>44,757</td>
<td>1 in 100</td>
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<tr>
<td>Suicide (2009)</td>
<td>31,484</td>
<td>1 in 121</td>
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<tr>
<td>MRSA (resistant bacterium)</td>
<td>19,000</td>
<td>1 in 197</td>
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<tr>
<td>Drowning</td>
<td>3,306</td>
<td>1 in 4,919</td>
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<tr>
<td>Salmoneillla</td>
<td>378</td>
<td>1 in 9,915</td>
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<tr>
<td>Sun / heat stroke</td>
<td>273</td>
<td>1 in 13,729</td>
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<tr>
<td>Lightning strike</td>
<td>47</td>
<td>1 in 83,930</td>
</tr>
<tr>
<td>E. coli O157:H7</td>
<td>20</td>
<td>1 in 187,403</td>
</tr>
<tr>
<td>Fireworks accident</td>
<td>11</td>
<td>1 in 340,733</td>
</tr>
<tr>
<td>Shark attack</td>
<td>1</td>
<td>1 in 3,748,067</td>
</tr>
<tr>
<td>E. coli non-O157</td>
<td>0-1</td>
<td>≤1 in 3,748,067</td>
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</tbody>
</table>