Outbreak of *Escherichia coli* O157 Associated with Raw Milk, Connecticut, 2008

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The Outbreak

• July 16, 2008

• Connecticut Department of Public Health

• Two unrelated children with hemolytic uremic syndrome (HUS)
  – Consumed raw milk in week before illness
  – Raw milk produced at Farm X
  – Purchased at Farm X and at retail market

• *Escherichia coli* O157:NM isolated from stool
**E. coli O157**

- Shiga toxin-producing
  - *E. coli* O157:NM — human pathogen

- Illness
  - Non-bloody or bloody diarrhea
  - Systemic complications: HUS or thrombotic thrombocytopenia purpura (TTP)

- Vulnerable — young children and elderly
Transmission of *E. coli* O157

- Person-to-person
- Contact with farm animals or the farm environment
- Swimming in recreational water
- Consumption of contaminated foods
  - Undercooked ground beef
  - Raw milk
Raw Milk: Public Health Threat

- United States
  - <1% of milk consumed
  - >90% of outbreaks where milk is source
  - 25 states allow raw milk sale

- Connecticut
  - Sales legal on farms and in retail markets
  - Past attempts to ban sale unsuccessful
  - Consumer warning labels inadequate
Similar Milk Packaging

Raw Milk

Pasteurized Milk
Objectives

- Identify source
- Determine extent of outbreak
- Recommend control measures
Investigation Components

- Case finding
- Community case-control study
- Household case-control study
- Environmental and laboratory testing
Case Finding

- Conducted statewide notification
  - Infectious disease physicians
  - Emergency departments
  - Clinical laboratories

- Contacted regular customers of Farm X
  - List of names provided by farm
Case Definition

• Confirmed case
  – HUS diagnosis or culture-confirmed *E. coli* O157:NM infection with isolate matching outbreak pulsed-field gel electrophoresis (PFGE) patterns
  – Connecticut resident, June–July 2008

• Probable case
  – ≥2 loose stools / 24-hour period for ≥2 days
  – Farm X customer, June–July 2008
**E. Coli O157 Cases**

(n=14)

<table>
<thead>
<tr>
<th>Week of Onset</th>
<th>Probable (n=7)</th>
<th>Confirmed (n=7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>June</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>August</td>
<td>6</td>
<td>3</td>
</tr>
</tbody>
</table>

### Probable Cases
- June: 1
- July: 6
- August: 3

### Confirmed Cases
- June: 1
- July: 3
- August: 3
## Patient Characteristics (n=14)

<table>
<thead>
<tr>
<th>Demographics</th>
<th>No.</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median age in years (range)</td>
<td>5</td>
<td>(1–81)</td>
</tr>
<tr>
<td>Female</td>
<td>8</td>
<td>(57)</td>
</tr>
<tr>
<td>Symptoms</td>
<td>No.</td>
<td>(%)</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>14</td>
<td>(100)</td>
</tr>
<tr>
<td>Bloody</td>
<td>6</td>
<td>(43)</td>
</tr>
<tr>
<td>Vomiting</td>
<td>5</td>
<td>(36)</td>
</tr>
<tr>
<td>Fever</td>
<td>4</td>
<td>(29)</td>
</tr>
</tbody>
</table>
Patient Outcomes (n=14)

<table>
<thead>
<tr>
<th>Clinical Course</th>
<th>No.</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospitalized</td>
<td>5</td>
<td>(36)</td>
</tr>
<tr>
<td>Median stay in days (range)</td>
<td>16</td>
<td>(1–33)</td>
</tr>
<tr>
<td>HUS or TTP</td>
<td>4</td>
<td>(29)</td>
</tr>
<tr>
<td>Dialysis or plasmapheresis</td>
<td>4 / 4</td>
<td>(100)</td>
</tr>
<tr>
<td>Death</td>
<td>0</td>
<td>(0)</td>
</tr>
</tbody>
</table>
Methods
Community Case-Control Study

- Confirmed cases (n=5)
- 2 matched controls (n=10)
  - Neighborhood
  - Age group (<18 years or ≥18 years)
  - Online phone directory, sequential dialing
- Exposure to sources of *E. coli* O157
  1 week prior to illness onset of case-patients
- Odds ratios, 95% confidence intervals
# Community Case-Control Study

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Cases No. (%)</th>
<th>Controls No. (%)</th>
<th>OR</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw milk</td>
<td>5/5 (100)</td>
<td>0/10 (0)</td>
<td>-</td>
<td>-</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>3/5 (60)</td>
<td>5/9 (56)</td>
<td>1.2</td>
<td>0.1–11.1</td>
<td>1.00</td>
</tr>
<tr>
<td>Swimming</td>
<td>3/5 (60)</td>
<td>8/9 (89)</td>
<td>0.2</td>
<td>0.01–2.9</td>
<td>0.51</td>
</tr>
<tr>
<td>Whole head lettuce</td>
<td>2/4 (50)</td>
<td>2/9 (22)</td>
<td>3.5</td>
<td>0.3–43.2</td>
<td>0.53</td>
</tr>
<tr>
<td>Raw cheese</td>
<td>2/5 (40)</td>
<td>0/10 (0)</td>
<td>-</td>
<td>-</td>
<td>0.10</td>
</tr>
<tr>
<td>Visit farm</td>
<td>2/5 (40)</td>
<td>0/9 (0)</td>
<td>-</td>
<td>-</td>
<td>0.11</td>
</tr>
<tr>
<td>Spinach</td>
<td>1/3 (33)</td>
<td>2/9 (22)</td>
<td>1.8</td>
<td>0.9–30.8</td>
<td>1.00</td>
</tr>
<tr>
<td>Ground beef</td>
<td>1/5 (20)</td>
<td>8/9 (89)</td>
<td>0.03</td>
<td>0.01–0.6</td>
<td>0.02</td>
</tr>
<tr>
<td>Bagged lettuce</td>
<td>1/5 (20)</td>
<td>5/9 (56)</td>
<td>0.2</td>
<td>0.02–2.6</td>
<td>0.30</td>
</tr>
<tr>
<td>Contact farm animal</td>
<td>1/5 (20)</td>
<td>0/8 (0)</td>
<td>-</td>
<td>-</td>
<td>0.38</td>
</tr>
</tbody>
</table>
Methods
Household Case-Control Study

- Assessed for dose-response relation
- Confirmed and probable cases (n=12)
- Well household members as controls (n=21)
- Frequency of raw milk consumption during 1 week prior to illness onset of case-patients
- Chi-square test for trend
## Household Case-Control Study:
### Frequency of Raw Milk Consumption

<table>
<thead>
<tr>
<th>Raw milk Consumed Per Week</th>
<th>Cases (n=12)</th>
<th>Controls (n=21)</th>
<th>P-value Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. (%)</td>
<td>No. (%)</td>
<td></td>
</tr>
<tr>
<td>0 times</td>
<td>1 (8)</td>
<td>9 (43)</td>
<td></td>
</tr>
<tr>
<td>1–3 times</td>
<td>2 (17)</td>
<td>6 (29)</td>
<td></td>
</tr>
<tr>
<td>4–7 times</td>
<td>4 (33)</td>
<td>3 (14)</td>
<td></td>
</tr>
<tr>
<td>≥8 times</td>
<td>5 (42)</td>
<td>3 (14)</td>
<td>0.01</td>
</tr>
</tbody>
</table>
Secondary and Tertiary Transmission

- Two additional confirmed case-patients
- No exposure to raw milk
- Sibling of case-patient who had consumed Farm X raw milk purchased at retail market
- Neighbor with frequent contact to sibling
**E. Coli O157 Cases**

(n=14)

- Probable (n=7)
- Confirmed (n=7)
- R Retail Market
- (S) Secondary
- (T) Tertiary

### Number of Cases

- June:
  - R: 1
  - R(S): 0
  - R(T): 0

- July:
  - R: 6
  - R(S): 1
  - R(T): 0

- August:
  - R: 3
  - R(S): 0
  - R(T): 0

### Week of Onset

- June: 1, 8
- July: 13, 20, 27, 30
- August: 1, 8, 15, 22, 29, 6, 13, 20, 27, 30
Methods

Environmental and Laboratory Testing

• Assessed Farm X dairy practice

• Collected environmental and milk samples, patient and bovine stool specimens
  – Culture for *E. coli* O157
  – Perform PFGE

• Further characterized stool isolates
  – Multiple-locus variable-number tandem repeat analysis (MLVA)
Farm X — Milk Production

Stanchion barn (28 cows) -> Vacuum Pipeline -> Bulk Storage Tank

Stanchion barn (28 cows)

Processing Plant

150 ft.

Bulk Storage Tank

Rubber Hose

Portable Tank
Farm X Dairy Practice

• 1 of 11 workers reported diarrhea
  – Stool negative for *E. coli* O157

• No major regulatory violations
  – Overall milking procedures
  – Disinfection of equipment
Weekly Voluntary Raw Milk Testing

• Using private laboratory
• Elevated level of coliform bacteria
• 3 separate raw milk samples
E. Coli O157 Cases (n=14)

- Elevated coliform level
- Probable (n=7)
- Confirmed (n=7)

Week of Onset:
- June 1
- July 6
- August 13, 20, 27, 3
**E. Coli O157 Cases**  
(n=14)

- **Probable (n=7)**
- **Confirmed (n=7)**

- Elevated coliform level

- Production stopped July 9

<table>
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<th>July</th>
<th>August</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>22</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>29</td>
<td>6</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>13</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

Number of Cases

*Note: The graph shows the number of cases per week, with the production stoppage occurring on July 9, after which the cases sharply decrease.*
E. Coli O157 Cases (n=14)

- Probable (n=7)
- Confirmed (n=7)

Number of Cases

Week of Onset

June 1
June 8
June 15
June 22
June 29
June 30
July 6
July 13
July 20
July 27
August 3

Production stopped July 9

Elevated coliform level

Production stopped July 9
Laboratory Results of Case-Patients

7 Patients
Laboratory Results of Case-Patients

- 7 Patients

  6 Patients
  *E. coli* O157:NM
  (All Shiga toxin positive)
Laboratory Results of Case-Patients

7 Patients

6 Patients
*E. coli O157:NM* (All Shiga toxin positive)

5 Patients
PFGE Pattern A

1 Patient
PFGE Pattern B
Laboratory Results of Case-Patients

7 Patients

6 Patients
*E. coli* O157:NM
(All Shiga toxin positive)

5 Patients
PFGE Pattern A

1 Patient
PFGE Pattern B

3 isolates
1 isolate

Indistinguishable MLVA
Laboratory Results of Case-Patients

- **7 Patients**
  - 6 Patients with Antibody to *E. coli* O157:NM (All Shiga toxin positive)
  - 1 Patient with Antibody to *E. coli* O157

  **6 Patients**
  - 5 Patients with PFGE Pattern A
  - 1 Patient with PFGE Pattern B

  **5 Patients**
  - 3 isolates indistinguishable by MLVA
  - 1 isolate
Laboratory Results of Farm X

- 170 samples tested
- One cow — *E. coli* O157:NM, PFGE Pattern A
Limitations

- List of Farm X customers incomplete
- Potential recall bias in dose-response relation
Conclusions

• Outbreak caused by consumption of Farm X raw milk
• Milk contaminated by asymptomatic shedding of infected cow(s)
• Occurred despite acceptable milking and sanitation practices
• Weekly testing did not prevent outbreak
Actions

- Supported legislation proposed by CT DOA
  - Prohibit non-farm retail sale
  - Strengthen warning labels
  - Increase testing of raw milk for pathogens

- Co-sponsored CSTE position statement
  - Adopt recommendations for states to enact legislation to restrict sale of raw milk
**Actions - Outcomes**

- **Supported legislation proposed by CT DOA**
  - Prohibit non-farm retail sale **DEFEATED**
  - Strengthen warning labels **DEFEATED**
  - Increase testing of raw milk for pathogens **DEFEATED**

- **Co-sponsored CSTE position statement**
  - Adopt recommendations for states to enact legislation to restrict sale of raw milk **DEFEATED**
Recommendations

- Avoid consumption of raw milk or raw milk products
- Pasteurize milk to enhance safety
- Document all outbreaks associated with raw milk or raw milk products
- Increase efforts to educate consumers about risks of raw milk
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CT EIP
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Paula Clogher

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Agricultural Staff

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