E. coli O157:H7 -- Illness trends and recent data from outbreak investigations, United States

Shiga Toxin –Producing E. coli
Addressing the Challenges, Moving Forward with Solutions. USDA/FSIS
April 9, 2008

Robert V Tauxe, M.D., M.P.H.
Foodborne, Bacterial and Mycotic Disease Division,
Centers for Disease Control and Prevention,
Atlanta, GA
Estimated annual number of *E. coli* O157 infections, United States

- 73,000 infections
- 2,000 hospitalized
- 60 deaths

*Mead et al. EID 1999*
Sequence of events in *E. coli* O157:H7 infection

*E. coli* O157 ingested

3-4 days

non-bloody diarrhea, abdominal cramps

1-2 days

bloody diarrhea

92%
6 days
8%

resolution

HUS
Public health surveillance for foodborne diseases: FoodNet

- **FoodNet**: The sentinel site surveillance system for foodborne diseases.
  - Active surveillance - contact all labs in area
  - Diagnoses of major foodborne infections
  - Survey population for illness and exposures
  - Provides our best data on burden of illness, trends
  - Useful information for risk assessment

- 10 state health departments, CDC/USDA/FDA

- Annual report a benchmark for food safety
Expansion of FoodNet sites: 1996 - 2007

1996 – 14 million -- 5% of U.S. population

2007 – 46 million -- 15% of U.S. population
Incidence of *E. coli* O157 infections, FoodNet

- Incidence = # illnesses per 100,000 persons per year
- Baseline 1996-98: 2.4 per 100,000
- Healthy People 2010 objective: 1.0
- Recent years
  - 2003: 1.06
  - 2004: 0.90
  - 2005: 1.05
  - 2006: 1.31
  - 2007: See MMWR April 11, 2008
Relative rate
(compared with 1996–1998 baseline period)
of *E. coli* O157 infections, by year, FoodNet

<table>
<thead>
<tr>
<th>Year</th>
<th>Relative rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996-1998</td>
<td>1.0</td>
</tr>
<tr>
<td>1999</td>
<td>0.9</td>
</tr>
<tr>
<td>2000</td>
<td>0.8</td>
</tr>
<tr>
<td>2001</td>
<td>0.7</td>
</tr>
<tr>
<td>2002</td>
<td>0.6</td>
</tr>
<tr>
<td>2003</td>
<td>0.5</td>
</tr>
<tr>
<td>2004</td>
<td>0.4</td>
</tr>
<tr>
<td>2005</td>
<td>0.3</td>
</tr>
<tr>
<td>2006</td>
<td>0.2</td>
</tr>
</tbody>
</table>
Relative rate
(compared with 1996–1998 baseline period)
of E. coli O157 infections, by year, FoodNet

14% decline from baseline, not a statistically significant difference
Percent of clinical labs screening all diarrheal stools for *E. coli* O157

- **National sample**
- **FoodNet sites**

Western states outbreak


% of labs: 0, 20, 40, 60, 80, 100

Boyce, J Clin Micro 1995; Voetsch CID 2004; and unpublished preliminary data

66%
Percent of people reporting consumption of ground beef in the 7 days before interview, FoodNet Population Surveys, 1996-2007

Based on weighted estimates
Percent of ground beef consumers reporting consumption of undercooked (pink) ground beef, in the 7 days before interview, FoodNet Population Surveys, 1996-2007

* Based on weighted estimates
Laboratory communication network in PulseNet

Public health laboratories

PFGE patterns

National database
Submissions to PulseNet of all pathogens continue to rise

PFGE patterns submitted to PulseNet Databases 1996-2007

In 2007, ~30,000 patterns in *E. coli* O157 database
Role of PulseNet

- Detects clusters of illness with matching DNA “fingerprints”
  - A match suggests that the infections might have a common origin
  - facilitates early identification of outbreaks
- Assists epidemiologists in investigating outbreaks
  - persons with the outbreak “fingerprint” are likely to be part of the outbreak
  - A match between an isolate in a suspect food and a patient can help confirm an outbreak
Coordinating multi-state investigations - “OutbreakNet”

- PulseNet: Clusters of possibly linked infections
- Outbreak coordination team at CDC in regular communication with counterparts in every state
- Goal:
  - systematic investigation of cases
  - coordinated investigation of multi-state outbreaks

- Working relationships with FSIS and with FDA, as well as with States

- Systematic collection and review of foodborne outbreaks reported by state health departments (~1200 investigated per year)

- **E. coli O157 became nationally notifiable**
- **PulseNet created**
- **Stimulated reporting from States**
- **Large western states outbreak**

---

*Rangel, Emerg Infect Dis, 2005 and unpublished preliminary CDC data*
Proportion of illnesses due to each mode of transmission in 350 *E. coli* O157 outbreaks, U.S., 1982-2002

<table>
<thead>
<tr>
<th>Mode</th>
<th>Illnesses in outbreaks (N=8,598 illnesses)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foodborne</td>
<td></td>
<td>61</td>
</tr>
<tr>
<td>Drinking water</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Unknown</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>Person-to-person</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Animal contact</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Recreational water</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Lab acquired</td>
<td></td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

Rangel, *EID*, 2005
Proportion of illnesses in foodborne *E. coli* O157 outbreaks due to various foods, 1982-2002

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Illnesses in foodborne outbreaks (N=5,269 illnesses)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground beef</td>
<td>33%</td>
</tr>
<tr>
<td>Other beef</td>
<td>11%</td>
</tr>
<tr>
<td>Produce</td>
<td>34%</td>
</tr>
<tr>
<td>Other</td>
<td>4%</td>
</tr>
<tr>
<td>Dairy products</td>
<td>6%</td>
</tr>
<tr>
<td>Unknown</td>
<td>12%</td>
</tr>
</tbody>
</table>

*Rangel, EID 2005*
Percent of foodborne *E. coli* O157 outbreaks due to beef, 1982 - 2006

% of outbreaks

Rangel EID 2005, and CDC unpublished data

Major outbreaks due to spinach and lettuce

25%
E. coli O157:H7 and baby spinach - 2006

Traceback to four farms
One farm environment had outbreak strain of E. coli O157
Beef cattle, stream, wild pigs, soil

Cattle 0.5 mile from field
? Spring flooding into irrigation wells
? Wild pigs traversing spinach fields

http://www.dhs.ca.gov/ps/fdb/
**E. coli** O157:H7 and shredded lettuce - 2006

2006 outbreak: 36 cases, 2 states  
Taco Chain Y  
Shredded lettuce from California farm

Fields adjacent to two dairy farms  
10 samples with outbreak strain of O157  
- from both dairies  
- from three fields  
Pipes could connect manure lagoons and irrigation system

http://www.dhs.ca.gov/ps/fdb/
Number of *E. coli* O157 outbreaks associated with beef recalls, 2005-2008

*as of January 16, 2008*
**E. coli O157 outbreaks associated with beef recalls, by month of onset, 2007**

![Bar chart showing the number of recalls by month of first illness onset.](chart.png)
**E. coli** O157 outbreaks associated with beef recalls, 2007

(N = 9 outbreaks)

- 5 multi-state, 4 single state (PA, CA, MN, IL)
- Location of exposure
  - home (7 outbreaks)
  - restaurant (1)
  - concession stand (1)
- Average # persons ill: 10 (range, 2-45)
- Age of ill persons: <1 to 85 years

2 more recalls were related to 1 ill person
**E. coli O157 outbreak in United States and Canada - 2007**

- September 2007: PulseNet in several states finds a cluster of pattern X
- *E. coli* O157 identified in frozen ground beef patties from patients’ freezers, and from retail samples
- More than one pattern in the meats sampled
- 6 different PFGE patterns in meat and in humans
- 43 cases in 10 states with one of those patterns from July 5 – October 29
- 88% reported they consumed ground beef
- 92% reported Brand X frozen ground beef patties
- Beef from Producer A in Canada
- Large scale recall all Brand X for 2007

* Preliminary information
E. coli O157 outbreak in United States and Canada – 2007 (continued)

- September 2007: PulseNet Canada found 4 cases with Pattern X
- Did not import frozen beef patties from the US source
- Identified same Pattern X in meat from producer A, along with other patterns
- Ultimately: 47 cases (30 with Pattern A)
- Eating ground beef, other cuts from Producer A
- Recall of all production of Producer A for 1 month

* Preliminary information
Number of non-O157 STEC identified in FoodNet sites, 2000-2006

![Bar chart showing the number of non-O157 STEC isolates from 2000 to 2006. The chart shows a significant increase in the number of isolates from 2004 onwards.](chart.png)

- **2000**: 0 isolates
- **2001**: 50 isolates
- **2002**: 100 isolates
- **2003**: 150 isolates
- **2004**: 200 isolates
- **2005**: 250 isolates
- **2006**: 300 isolates

**Legend:**
- Yellow = non-O157 STEC
- Light blue = O antigen undetermined STEC

**Source:** CDC
Human isolates of non-O157 STEC, by serogroup, FoodNet sites, 2000-2006

N=575 isolates*

83%

42 serogroups <1.5% each

*preliminary data; an additional 54 isolates had missing O group information
Shigatoxin producing *E. coli* other than O157

- Increasing diagnosis with a new test
- Illness similar to, though milder than O157
- 6 serogroups account for
  - 70% of strains referred to CDC reference laboratory
  - 83% of cases in FoodNet
  - 95% of 22 outbreaks 1990-2007
- 10 of those outbreaks were foodborne

- O26, O45, O103, O111, O121, O145
E. coli O157 epidemiologic observations: Conclusions

- Recent trends in surveillance
  - Earlier decline reversed in 2005-6
  - Not accounted for by change in lab practices or consumption patterns
  - Outbreaks have continued at same level
  - Beef and produce are main sources, varying by year
  - More recalls associated with outbreaks in 2007

- Outbreak investigations
  - Complex pre-harvest ecologies
  - Linkages between reservoirs in beef and produce
  - Can have an outbreak with multiple patterns
  - Multinational outbreak: North American market
Thank you

The findings and conclusions in this presentation are those of the author and do not necessarily represent the views of the Centers for Disease Control and Prevention
Incidence of *E. coli* O157 infections, by state, 1999-2002

<table>
<thead>
<tr>
<th>State</th>
<th>Isolates / 100,000 pop/ year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.0 – 6.2</td>
</tr>
<tr>
<td></td>
<td>1.7 – 2.9</td>
</tr>
<tr>
<td></td>
<td>0.9 – 1.6</td>
</tr>
<tr>
<td></td>
<td>0.2 – 0.8</td>
</tr>
</tbody>
</table>

Isolates / 100,000 pop/ year

- **Black**: 3.0 – 6.2
- **Yellow**: 1.7 – 2.9
- **White**: 0.9 – 1.6
- **Orange**: 0.2 – 0.8

[Image of a map showing the incidence of *E. coli* O157 infections by state, 1999-2002]
Incidence of *E. coli* O157 infections, by setting, United States, 1993-1996

Cases/ 100,000 persons/ year

CDC, National Surveillance Data, unpublished