E. coli O157:H7 Outbreak Associated with Consumption of Unpasteurized Milk, Kentucky, 2014

Association of Food and Drug Officials of the Southern States

Fall Educational Conference
September 15, 2015
Speakers

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- Carrell Rush, MPH
- Pablo Munoz, RS, MS

Special thanks to Jasie Logsdon, MPH, MA for preparing this presentation for Kentucky Public Health Association (KPHA).
Objectives

- Describe STEC infections, complications, routes of transmission, and sources of exposure
- Discuss the outbreak investigation methods
- Describe the collaboration with internal and external partners during the outbreak investigation
- Summarize the strengths and areas of improvement identified during the outbreak investigation
Shiga toxin-producing *E. Coli* (STEC)

- Shiga toxin-producing *Escherichia coli* (STEC) is an infection of variable severity characterized by diarrhea (often bloody) and abdominal cramps.

- Illness may be complicated by hemolytic uremic syndrome (HUS) or thrombotic thrombocytopenic purpura (TTP).

- Asymptomatic infections also may occur and the organism may cause extra-intestinal infections.
Hemolytic Uremic Syndrome (HUS)

5-10% of those diagnosed with STEC develop HUS

- **Symptoms of HUS:**
  - Bloody diarrhea
  - Vomiting
  - Abdominal pain
  - Fever, usually not high and may not be present at all
  - Blood in the urine
  - Decreased urination
  - Sometimes neurological symptoms, such as confusion or seizures, develop as well.

- **Complications of HUS:**
  - Sudden (acute) kidney failure
  - Chronic kidney failure
  - Heart problems
  - Stroke
  - Coma
  - Death
STEC Transmission

- Consumption of contaminated foods
- Consumption of unpasteurized (raw) milk, juice, and other foods
- Ingestion of contaminated water
- Direct contact with infected persons or animals or their environments
Background

- On 9/9/14, KDPH received notification from Kosair Children’s Hospital
  - 4 hospitalized children
  - 3 diagnosed with Hemolytic Uremic Syndrome (HUS)
  - 1 positive for Shiga toxin
Methods - Epidemiologic

- Epidemiologic –
  - Enhanced surveillance
    - State-wide call for post-diarrheal hemolytic uremic syndrome cases
  - Foodborne and Waterborne Illness Investigation Form
  - Collaboration between KDPH and Local Health Department Nurses, Epidemiologists, and Environmentalists
  - Collaboration with local hospitals
    - Infection control practitioners
    - Hospital epidemiologists
  - Conference calls
  - Retrospective review of exposure information for all STEC cases occurring in the weeks prior to identification of this cluster
    - Compared to:
      - FoodNet Pop Survey
      - Cluster exposures
  - Developed a case definition
    - Any individual who has a positive laboratory result of E. coli O157:H7, Shiga toxin detected, E. coli Shiga-like, and/or has a clinically compatible case of Hemolytic Uremic Syndrome (HUS) with illness onset after 8/12/14.
### Meats, Poultry, Fish, Dairy, and Eggs

<table>
<thead>
<tr>
<th>Item</th>
<th>Yes</th>
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<tbody>
<tr>
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<tr>
<td>Ham</td>
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<tr>
<td>Pork (Not Ham or Bacon)</td>
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<tr>
<td>Ground Beef</td>
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<tr>
<td>Chicken</td>
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<tr>
<td>Turkey</td>
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<td></td>
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<tr>
<td>Dalm Meat</td>
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<tr>
<td>Hot dogs</td>
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<tr>
<td>Seafood (besides oysters)</td>
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<tr>
<td>Fish</td>
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<tr>
<td>Oysters</td>
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<td>Did you eat any other Meat Products?</td>
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### Juice/Fruit

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<td></td>
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<tr>
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<td></td>
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<tr>
<td>Blackberries</td>
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<td></td>
<td></td>
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<tr>
<td>Blueberries</td>
<td></td>
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<td></td>
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<tr>
<td>Cantaloupe</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Frozen Fruit</td>
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<td></td>
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<tr>
<td>Grapes</td>
<td></td>
<td></td>
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<tr>
<td>Honeydew</td>
<td></td>
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<tr>
<td>Orange Juice</td>
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<tr>
<td>Pomegranate Seeds</td>
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<td></td>
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<tr>
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<td></td>
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<tr>
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<td></td>
<td></td>
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<tr>
<td>Frozen Berry Blends/Mixtures</td>
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<tr>
<td>Papaya</td>
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### Vegetables

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<tbody>
<tr>
<td>Basil</td>
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<td>Parsley</td>
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<td>Broccoli</td>
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</tr>
<tr>
<td>Cabbage</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Carrot</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Cucumber</td>
<td>Yes</td>
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<td>No</td>
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<td>Lettuce on sandwhich</td>
<td>Yes</td>
<td>No</td>
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<td>Mushrooms</td>
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<td>Onion</td>
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<tr>
<td>Garlic</td>
<td>Yes</td>
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<td>Frozen Vegetables</td>
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<td>No</td>
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<tr>
<td>Pepper (sweet, green, hot)</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Tomatoes</td>
<td>Yes</td>
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<tr>
<td>Bagged/Pre-packaged Salad</td>
<td>Yes</td>
<td>No</td>
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<td>Salad (leafy greens)</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Spinach</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Strawberries</td>
<td>Yes</td>
<td>No</td>
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<td>Unpasteurized Juice/Cider</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Watermelon</td>
<td>Yes</td>
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<td>Unknown</td>
</tr>
<tr>
<td>Other Fresh Vegetable</td>
<td>Yes</td>
<td>No</td>
<td>Unknown</td>
</tr>
<tr>
<td>Other Leafy Greens (kale, collards, swiss chard)</td>
<td>Yes</td>
<td>No</td>
<td>Unknown</td>
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<tr>
<td>Other Fresh Fruit</td>
<td>Yes</td>
<td>No</td>
<td>Unknown</td>
</tr>
<tr>
<td>Other Juice</td>
<td>Yes</td>
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<tr>
<td>Type of Juice</td>
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<tr>
<td>Type of Fresh Fruit</td>
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</tbody>
</table>

### Notes

- End of Page Notes
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- Page 6 of 8
Methods - Environmental

- Environmental investigation
- Environmental sampling
- Trace forward and trace back
- KDPH Milk Safety Branch and Food Safety Branch – Division of Public Health Protection and Safety
- LHD environmentalists
Methods – Laboratory/Clinical

- Stool specimen collection and analysis
- Environmental sample collection and analysis
- Serotyping
- PFGE analysis by 1\textsuperscript{st} & 2\textsuperscript{nd} enzyme
- Facilitation of environmental sample testing at other laboratories
  - USDA Agricultural Research Service in Nebraska
  - CA Dept. of Health – Food and Drug Laboratory
  - Pennsylvania Department of Health Laboratory
Pulsed-Field Gel Electrophoresis (PFGE)

- Generates a DNA “fingerprint”

The Pulsed-field Gel Electrophoresis Process

1. The scientist takes bacterial cells from an agar plate.
2. The scientist mixes bacterial cells with melted agarose and pours into a plug mold.
3. The bacterial cells are broken open with biochemistry, or lysed, so that the DNA is free in the agarose plugs.
4. The scientist loads the DNA gelatin plug into a gel, and places it in an electric field that separates DNA fragments according to their size.
5. The gel is stained so that DNA can be seen under ultraviolet (UV) light. A digital camera takes a photograph of the gel and stores the picture in the computer.

Source: http://www.cdc.gov/pulsenet/pathogens/protocol-images.html#pfge
PFGE Analysis

- DNA “fingerprints” appear as horizontal bands of DNA
- Fingerprints are uploaded to CDC PulseNet
- PulseNet assigns pattern names

EXH X01. 2401
- EXH = Serotype
- X01 = Restriction enzyme
- 2401 = Pattern number
PFGE- BioNumerics
Laboratory Information Sharing

- Contact state lab scientists/epidemiologists
  - Fax micro results and email bundle file to PFGE lab
- CDC PulseNet
  - Network for PFGE scientists to upload and compare isolates and to retrieve pattern names and outbreak codes
- CDC OutbreakNet
  - Network for epidemiologists to share epi and environmental data to conduct outbreak investigations
- SEDRIC/Palantir
  - Searchable (and editable) CDC database that contains microbiology, PFGE, and Epi data for all isolates uploaded to PulseNet

[Links]
http://www2.cdc.gov/spectrum/vol1no4/PulseNet.htm
Results - Epidemiologic

- 5 cases
  - Hardin Co. (4)
  - Oldham Co. (1)
  - 3 separate families
  - 3 Female, 2 male
- Onset dates: 9/1/14 – 9/11/14
- Age range: 18 mo – 6 years
- 5/5 reported consumption of unpasteurized milk
  - All purchased from buying club
  - Supplied by a single dairy
Shiga toxin-producing *E. Coli* and Hemolytic Uremic Syndrome Outbreak, Kentucky 2014
Results - Epidemiologic

- Retrospective case review
  - 21 STEC cases occurring after week 32 (*E. coli* O157, Shiga toxin-producing, or *E. coli* shiga-like laboratory results)
  - 14 case reports had exposure information:
    - Grocery stores reported: Grocery Store A 9/12 (75%); Grocery Store B 7/12 (58%) - 2 cases did not report grocery stores.
    - KY14-096 reports: Grocery Store A (4/4); Grocery Store B (2/4); Grocery Store C (2/4); Buying Club (3/4)
    - Animal exposure: Dog 9/14 (34%)
## Results - Epidemiologic

<table>
<thead>
<tr>
<th>Product</th>
<th>Total Reporting Exposure (%)</th>
<th>Expected (FoodNet Population Survey)</th>
<th>Total from KY14-096 (%)</th>
<th>Binomial Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
<td>4/14 (29%)</td>
<td>78.5%</td>
<td>0/4 (0%)</td>
<td>1 (p value .000214)</td>
</tr>
<tr>
<td>Eggs</td>
<td>7/14 (50%)</td>
<td>88.2%</td>
<td>2/4 (50%) (no exposure info for case 4)</td>
<td>.9290 (p value .06499)</td>
</tr>
<tr>
<td>Yogurt</td>
<td>8/14 (57%)</td>
<td>43.3%</td>
<td>3/4 (75%) (no exposure info for case 4) Yogurt is reported to be purchased from either the buying club or local stores</td>
<td>.2193 (p value .18412)</td>
</tr>
<tr>
<td>Strawberries</td>
<td>6/14 (43%)</td>
<td>45%</td>
<td>3/4 (75%) (no exposure info for case 4) Produce is reported to be purchased from either the buying club or local stores</td>
<td>.2415 (p value .20048)</td>
</tr>
<tr>
<td>Bananas</td>
<td>10/14 (71%)</td>
<td>70%</td>
<td>4/4 (100%) (no exposure info for case 4) Produce is reported to be purchased from either the buying club or local stores</td>
<td>.2401 (p value .24010)</td>
</tr>
<tr>
<td>Peanut Butter</td>
<td>8/14 (57%)</td>
<td>58.1%</td>
<td>3/4 (75%) (no exposure info for case 4)</td>
<td>.4426 (p value .11395)</td>
</tr>
<tr>
<td>Ground Beef</td>
<td>6/14 (43%)</td>
<td>39.8%</td>
<td>1/4 (25%) (no exposure info for case 4)</td>
<td>.8687 (p value .34732)</td>
</tr>
<tr>
<td>Cereal (hot or cold not specified)</td>
<td>9/14 (34%)</td>
<td>69.2% (cold cereal) 45.3% (hot cereal)</td>
<td>3/4 (75%) (no exposure info for case 4)</td>
<td>Cold cereal - .6376 (p value .40825)  Hot cereal - .2455 (p value .20340)</td>
</tr>
<tr>
<td>Watermelon</td>
<td>4/14 (28%)</td>
<td>27.5%</td>
<td>3/4 (75%) (no exposure info for case 4) Produce is reported to be purchased from either the buying club or local stores</td>
<td>.0660 (p value .06031)</td>
</tr>
<tr>
<td>Unpasteurized Milk</td>
<td>4/14 (29%)</td>
<td>3%</td>
<td>5/5 (100%) (case 4 exposure taken from hospital notes)</td>
<td>.0 (p value .0)</td>
</tr>
</tbody>
</table>
Results - Environmental

- No violations at the buying club
- No violations at the dairy
- Environmental samples were collected at the dairy on 2 separate occasions
- Milk and cream from families’ homes collected and tested
- 35 total samples collected
  - Milk (12 samples from homes and bulk tank at dairy)
  - Cream (1)
  - Manure (15)
  - Yogurt (1)
  - Well Water (1)
  - Environmental swabs (5 samples surface)
- Dairy distributes to buying groups in other counties
- Buying club –
  - Sells unpasteurized milk and other dairy products, meat, eggs, produce, etc.
  - Individuals pay a membership fee which allows them to purchase items from the buying club.
- Suspended sales of unpasteurized milk until investigation ended
Results – Clinical

- 3/5 positive for *E. coli* O157:H7, Shiga toxin 2
- 4/5 hospitalized
- 4/5 diagnosed with HUS
- 3/5 on dialysis
Results – Laboratory

- Laboratory
  - Bacteriology: *E. coli* O157:H7, Shiga toxin 2
  - PFGE: pattern combination EXHX01.2401/EXHA26.0071
    - The primary enzyme pattern (XbaI) is extremely rare, appearing in the PulseNet database 18 times (.04% of *E. coli* O157:H7 isolates)
    - The secondary enzyme pattern (BlnI) is rare, appearing the PulseNet database 440 times (1.0% of *E. coli* O157:H7 isolates)
    - The pattern combination has never been seen before
  - All Environmental samples tested negative for *E. coli* O157 and Shiga toxin
Discussion/Conclusion

- The epidemiologic investigation confirmed that an outbreak occurred during September 2014.
- STEC infections are transmitted fecal-oral; this can occur through direct animal contact, consuming contaminated food or water, and from person to person.
- HUS is sometimes a complication of a gastrointestinal infection with *E. coli*.
Discussion/Conclusion

- The specific source for these 5 cases was not confirmed through lab testing. However, epidemiologic evidence and the rare PFGE pattern of the clinical isolates indicates an unusual common source of exposure.
- Animals may shed enteric pathogens without showing signs of infection.
- Negative environmental samples may be a result of the lag-time between exposure and subsequent sample collection and intermittent shedding of the pathogen by animals.
Lessons Learned

- Rapid investigation of ill individuals
- Rapid investigation of suspected source
- Communication and information sharing between local health departments, KDPH, and Division of Laboratory Services
  - Single point of contact for each LHD and KDPH (if possible)
  - Follow information-sharing processes
  - Conference calls
  - Clarify any discrepancies/issues
  - Include all pertinent individuals in communications
- Public Information
- Education about the risks of consuming unpasteurized products
Recommendations

- EDUCATION, EDUCATION, EDUCATION
- Practice proper hand-washing techniques
  - After using toilet or changing diapers
  - After contact with animals or their environment
  - Before, during, and after preparing food or before eating food
- Maintain safe food temps, using a food thermometer to check meats before serving
- Clean food preparation work surfaces, equipment, and utensils with soap and water before, during and after food preparation
- Prevent cross contamination between raw and cooked foods
  - Use separate cutting boards for different food items
  - Do not store raw meats above fresh produce
Recommendations

- Do not eat, drink, or put anything in mouth after direct animal contact
- Avoid consuming raw milk, unpasteurized dairy products, and unpasteurized juices
- Avoid swallowing water from lakes, ponds, and untreated pools
  - Avoid recreational water venues for 2 weeks after symptoms resolve
- Involve Childcare Health Consultant for case enrolled in daycare
Acknowledgements

- Kentucky Division of Laboratory Services
- Lincoln Trail District Health Department
- Oldham Co. Health Department
- Louisville Metro Public Health & Wellness Communicable Disease & Environmental Team
- Barren River District Health Department
- Kentucky Department of Agriculture
- Centers for Disease Control and Prevention
Questions?