

***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**



Kentucky Public Health
Prevent. Promote. Protect.



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.*



Where (Name and Address/Cross Street/Landmark): _____
 When: ___/___/___ Time: _____ Foods Eaten: _____

Where (Name and Address/Cross Street/Landmark): _____
 When: ___/___/___ Time: _____ Foods Eaten: _____

Where (Name and Address/Cross Street/Landmark): _____
 When: ___/___/___ Time: _____ Foods Eaten: _____

3. Now I am going to ask you about the specific foods and beverages you may have consumed at home or away from home in the 5 days before your illness.

We are specifically talking about meals consumed on the following days (date range): _____

Limited Food Recall

Meat, Poultry, Fish, Dairy, and Eggs.

Bacon	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Ham	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Pork (Not ham or bacon)	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Beef (not ground)	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Ground Beef	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
*If you ate ground beef in the 5 days prior to illness onset:	Date of Purchase: ___/___/___	Location of purchase: _____	Type and Brand of Beef (e.g. package size, percent lean)
Chicken	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
*If you ate chicken in the 5 days prior to illness onset:	Date of Purchase: ___/___/___	Location of purchase: _____	Type and brand of chicken (e.g. breast, whole, ground, grilled)
Turkey	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
*If you ate turkey in the 5 days prior to illness onset:	Date of Purchase: ___/___/___	Location of purchase: _____	Type and brand of turkey (e.g. breast, whole, ground, grilled)
Deli Meats	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Hot dogs	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Seafood (besides oysters)	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
*If you ate seafood in the 5 days prior to illness onset:	Date of Purchase: ___/___/___	Location of purchase: _____	Type and brand of seafood (e.g. lobster, shrimp, calamari, etc.):
Fish	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
*If you ate fish in the 5 days prior to illness onset:	Date of Fish Purchase: ___/___/___	Location of Purchase: _____	Type and preparation of fish (e.g. canned, smoked, grilled, etc.):
Oysters	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Wild Game (deer, pheasant, rabbit, fish)	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
*If you ate any wild game in the 5 days prior to illness onset:	What type was it?	Where did you acquire it?	How was it prepared?
Did you eat any other Meat Products?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
*If you ate any other meat products in the 5 days prior to illness onset:	Date Eaten: ___/___/___	Location of purchase: _____	Type and brand of meat (e.g. lamb, goat, etc.):
Block cheese	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Mexican Style Cheese (Queso Fresco, Queso Blanco)	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown

End of Page Notes _____

Pre sliced Cheeses	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Ricotta	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Cheese made with raw or unpasteurized milk	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Other cheeses (e.g. soft cheeses)	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Eggs	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Cottage Cheese	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Ice Cream	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Milk	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
*If you drank any milk in the 5 days prior to illness onset:	Date of Purchase: ___/___/___	Location of purchase: _____	Type and brand of milk (e.g. whole milk, 2% milk, skim milk):
Soy Milk	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Unpasteurized (Raw) Milk	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
*If you drank any unpasteurized milk in the 5 days prior to illness onset:	Date of Purchase: ___/___/___	Location of purchase: _____	Type and brand of milk
Yogurt	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Raw Foods from Animal Origin (raw eggs, raw meat, raw shellfish)	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
*If you ate any raw food from animal origin in the 5 days prior to illness onset:	Date of Purchase: ___/___/___	Location of purchase: _____	Type and brand of raw food

Juice/Fruit

Vegetables

Apple	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown	Basil, Parsley or Cilantro	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Apple Juice	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown	Broccoli	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Bananas	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown	Cabbage	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Blackberries	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown	Carrot	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Blueberries	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown	Cucumber/zucchini/squash	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Cantaloupe	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown	Frozen Vegetables	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Frozen fruit	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown	Lettuce on sandwich	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Grapes	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown	Mushrooms	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Honeydew	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown	Onion/Garlic	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Orange Juice	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown	Potatoes	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Pomegranate Seeds	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown	Pepper (sweet, green, hot)	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Pomegranate Juice	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown	Type of Pepper: _____			
Frozen Berries	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown	Tomatoes	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Frozen Berry Blends/Mixtures	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown	Salad (leafy greens)	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Papaya	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown	Bagged/Pre-packaged Salad	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Pineapple	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown	Brand: _____ Type: _____			
Raspberries	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown	Location of purchase: _____			
Strawberries	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown	Spinach	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Unpasteurized Juice/Cider	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown	Sprouts	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Watermelon	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown	Other Fresh Vegetable	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Other Fresh Fruit	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown	Type of Vegetable: _____			
Type of Fresh Fruit: _____				Other Leafy Greens (kale, collards, swiss chard)	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Other Juice	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown	Type: _____			
Type of Juice: _____				Any Prepackaged fresh foods? (precut apples, salad kits)	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
				Type: _____			

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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



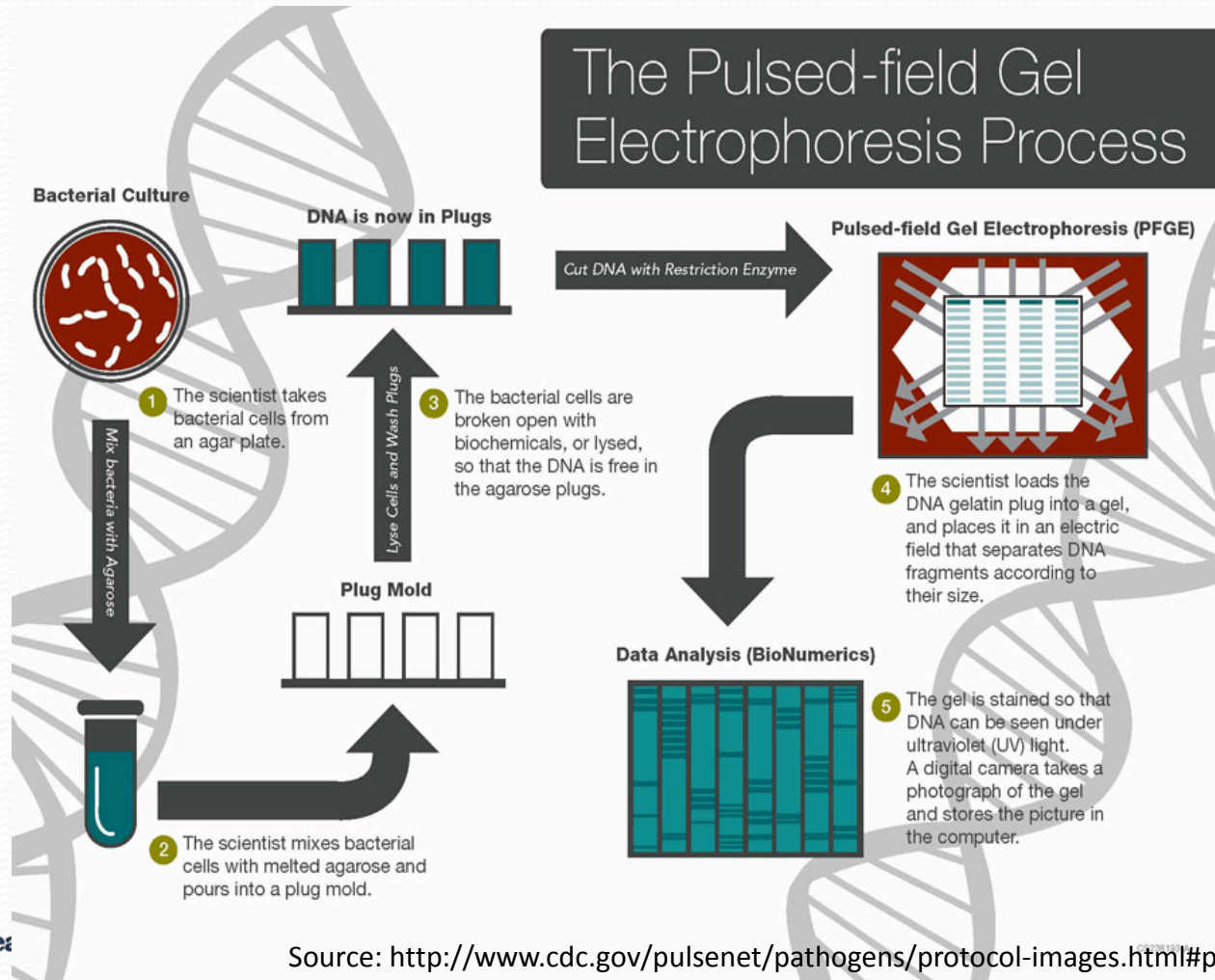
Methods – Laboratory/Clinical

- Stool specimen collection and analysis
- Environmental sample collection and analysis
- Serotyping
- PFGE analysis by 1st & 2nd 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”

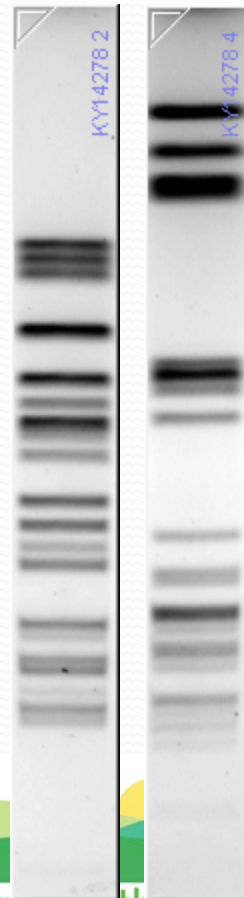


PFGE Analysis

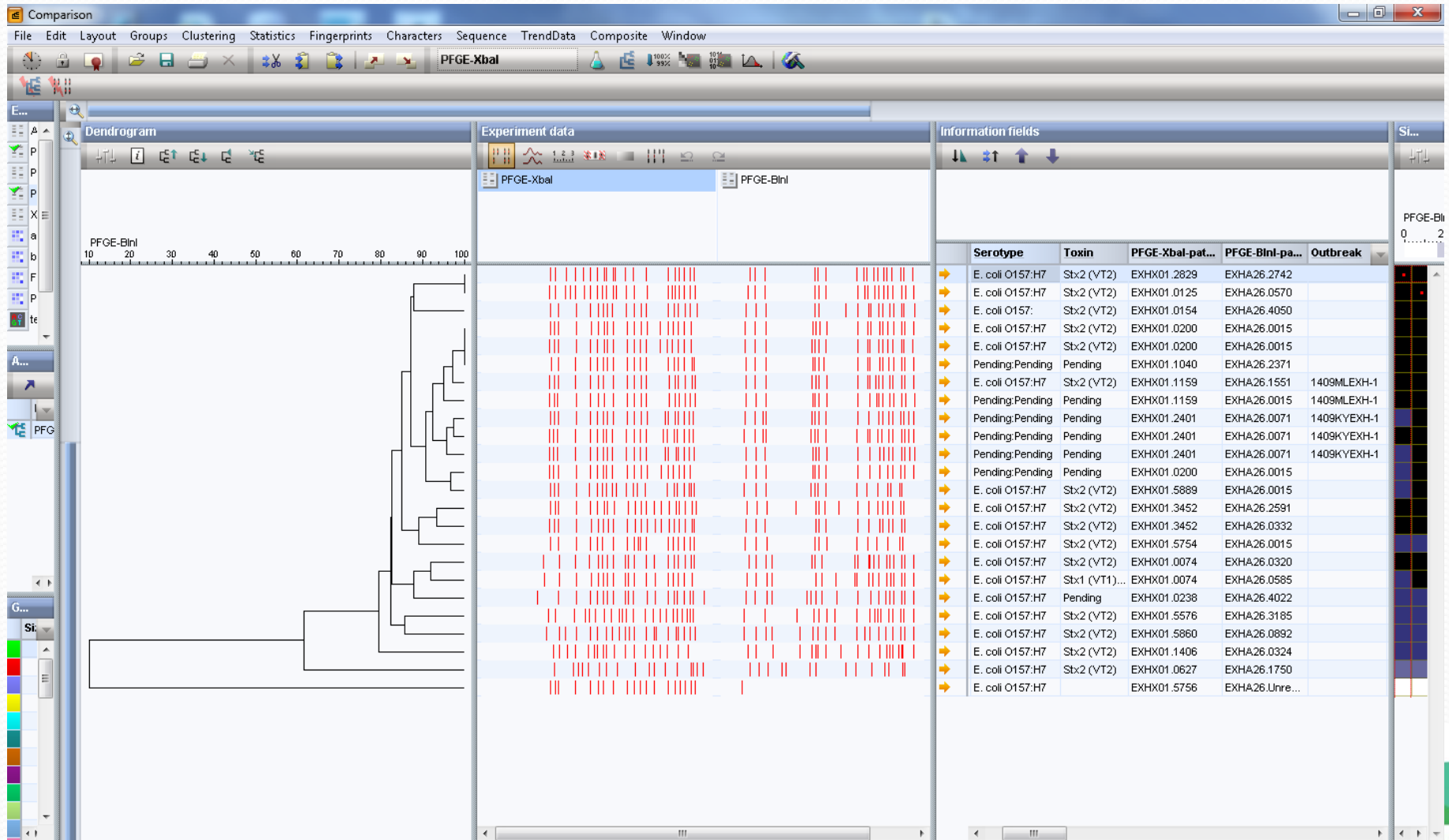
- DNA “fingerprints” appear as horizontal bands of DNA
- Fingerprints are uploaded to CDC PulseNet
- PulseNet assigns pattern names

EXHX01. **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

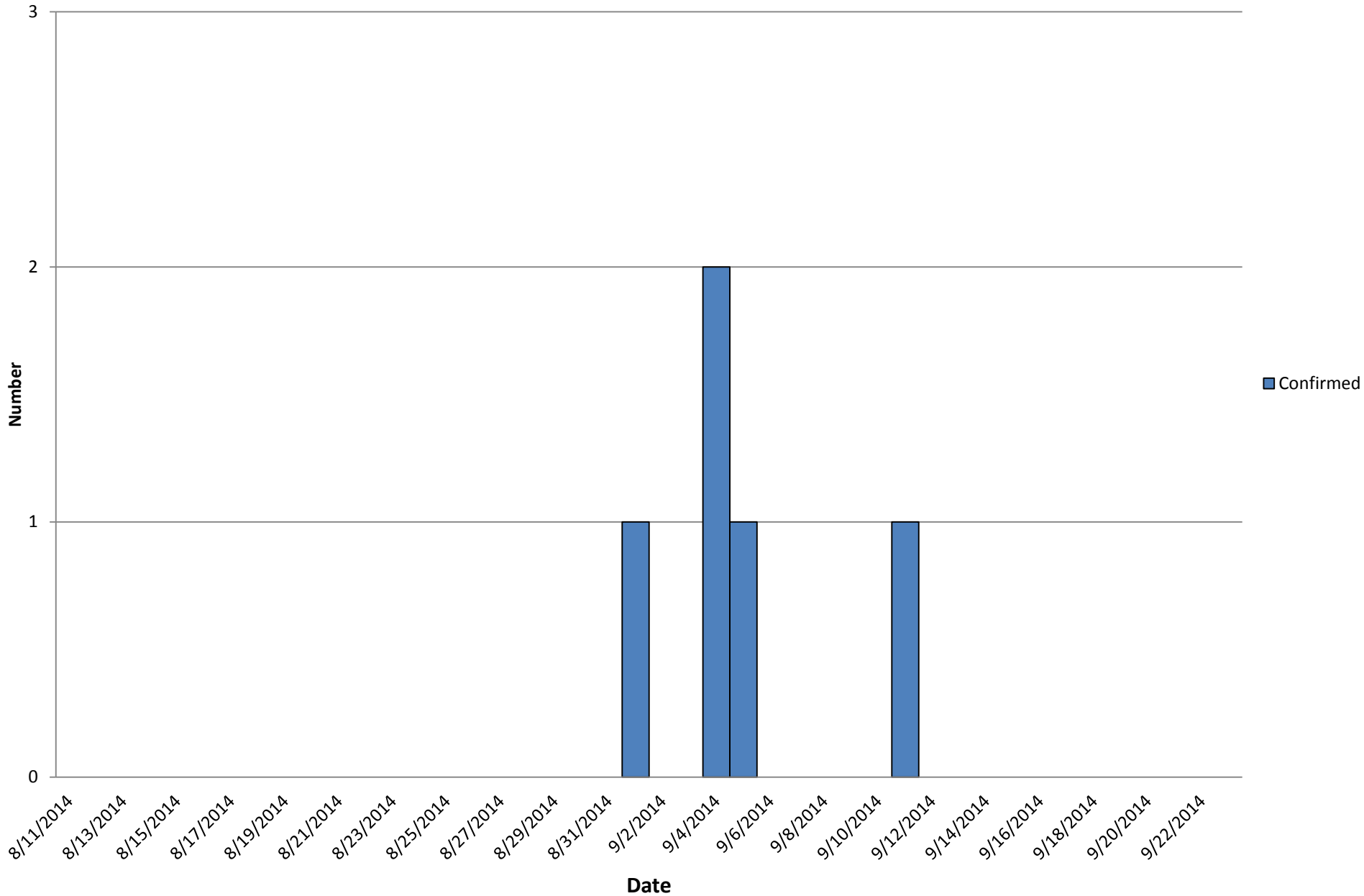


Results - Epidemiologic

- 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

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

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.



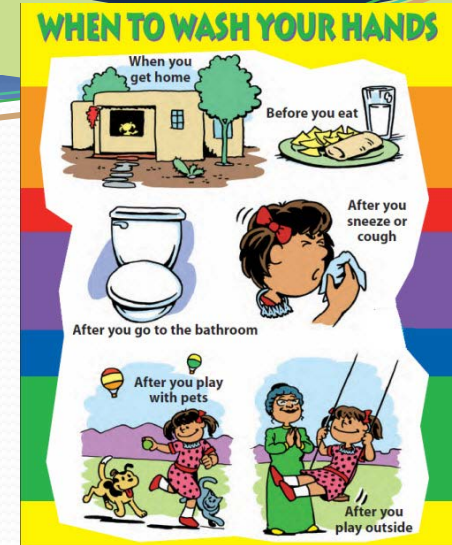
Lessons Learned

- 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?



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