Multistate Outbreak of *Escherichia* Coli O103 Linked to Ground Beef, Kentucky Perspective

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Abstract

Introduction: The Kentucky Department for Public Health (KDPH) began an outbreak investigation of *E.* coli O103 in March 2019, after notification from the Kentucky Division of Laboratory Services (DLS) of an uptick of shiga toxin-producing E. coli and several E. coli O103 isolates that matched by pulsed-field gel electrophoresis (PFGE). When additional cases were identified in surrounding states, CDC took the lead on the multistate investigation.
Materials and Methods: Initial case investigations were conducted using a standard interview form. Newly identified cases were investigated using an outbreak-specific questionnaire and interview data were managed using Epi Info. DLS conducted PFGE and whole-genome sequencing (WGS) on all clinical isolates. The Kentucky Division of Public Health Protection and Safety (PHPS) and local health departments (LHDs) collected food samples for analysis at DLS.
Results: In Kentucky, 76 cases were identified. An inmate sub-cluster was identified at a Federal Medical Facility, and ground beef samples were collected and analyzed by USDA-FSIS. One sample tested positive for *E.* coli, but was not closely related to the outbreak strain. All beef samples collected from restaurants tested negative for *E.* coli at DLS.
Conclusion: This outbreak was unique for Kentucky for several reasons: first test of centralized student interview teams, first test of Rapid Response Team (RRT), and first test of WGS during outbreak investigation.

Introduction

KDPH received funds through the Epidemiology and Laboratory Capacity (ELC) grant OutbreakNet Enhanced Project to centralize interviews of *Salmonella*, shiga toxin-producing *E. coli* (STEC) and *Listeria* (SSL). Graduate assistants were hired in November and December 2018 and began conducting centralized interviews January 2019 for certain local health jurisdictions.

KDPH also received funds from a cooperative agreement with the Food and Drug Administration (FDA) for the development of the Rapid Response Team (RRT) program in October 2018. As a result, KDPH was able to hire a RRT Coordinator to enhance environmental response to outbreak investigations.

On March 21, 2019, DLS notified the Division of Epidemiology and Health Planning (DEHP) of an uptick in *E.* coli O103 isolates. Five *E.* coli O103 cases had been confirmed, with two additional specimens suspected to be *E.* coli O103. Of those five isolates, four were confirmed to match by PFGE; testing was pending for the fifth. DLS also noted that more STEC were in transit to the state public health lab than expected. With this preliminary information, DPH began an outbreak investigation. KDPH notified partners in neighboring states (Ohio and Tennessee) and at CDC, asking if others were also observing an increase in *E.* coli O103 isolates. Following case reports from multiple states, CDC assigned a multistate outbreak number and began an investigation.

Materials and Methods

A case was defined as:

- Having an infection with *E.* coli O103;
- Matching one of 8 PFGE pattern combinations;
- Being highly-related by WGS;
- and isolation date from March 11, 2019 – May 6, 2019

Initial cases were interviewed with the Kentucky Foodborne/Waterborne Illness Investigation Form. Interview data were entered into case investigations in the National Electronic Disease Surveillance System (NEDSS). After CDC assigned a multistate outbreak investigation number and took the lead on the investigation, STEC cases were either interviewed or re-interviewed with an outbreak-specific questionnaire. Questionnaire data were managed, shared with CDC, and analyzed using Epi Info. DLS conducted pulsed-field gel electrophoresis and whole genome sequencing (WGS) on all clinical isolates. PHPS and LHDs collected food samples from four restaurants and sent them to DLS for laboratory analysis via BAX polymerase chain reaction (PCR) and culture. Trace-back investigation was performed.

Results

A total of 76 cases in Kentucky were identified as part of the outbreak. Additional case information is as follows:

- 10 (13%) cases were hospitalized
- 2 HUS cases (3%)
- 0 Deaths Reported
- 40 (53%) of cases were female
- Age range years 1 - 82 years (median 18 years)
- 100% of cases reported diarrhea

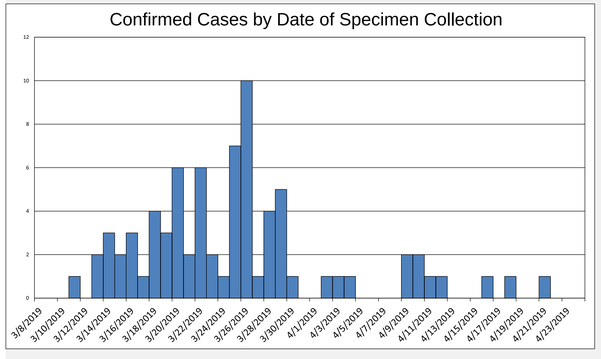
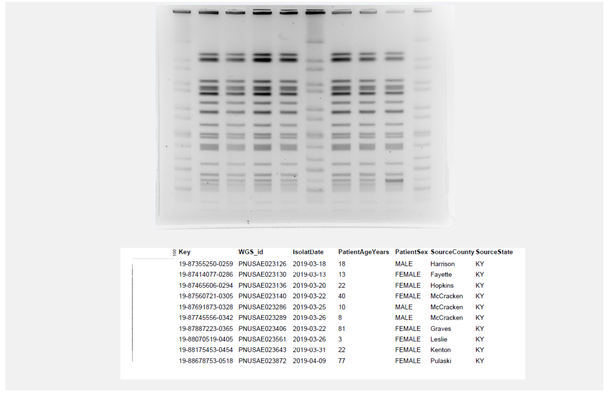


Figure 1. Epidemic Curve

Initial case interviews did not implicate a specific food item, and multiple fast food exposures were noted. When the multistate outbreak was declared, the National Hypothesis Generating Questionnaire (NHGQ) was employed, and CDC later deployed a focused questionnaire with specific questions about ground beef, cheese, and processed chicken products. Subsequent interviews had a strong ground beef signal. Of Kentucky's 76 outbreak-associated cases, 65 reported either "Yes" or "Maybe" to questions about ground beef exposure.

An inmate sub-cluster was identified at a Federal Medical Facility. Cases spent their entire incubation periods in the facility and all reported only eating foods prepared at the facility. USDA-FSIS collected multiple frozen ground beef samples from the facility for testing. No "dead-man's trays" from case incubation periods were available for testing. One specimen tested positive for *E.* coli O103, but was not closely related to the outbreak by WGS. Products were recalled on April 24, 2019.



	Key	WGS_id	IsolatDate	PatientAgeYears	PatientSex	SourceCounty	SourceState
	19-87355250-0259	PNUSAE023126	2019-03-18	18	MALE	Harrison	KY
	19-87414077-0286	PNUSAE023130	2019-03-13	13	FEMALE	Fayette	KY
	19-87465606-0294	PNUSAE023136	2019-03-20	22	FEMALE	Hopkins	KY
	19-87560721-0305	PNUSAE023140	2019-03-22	40	FEMALE	McCracken	KY
	19-87691873-0328	PNUSAE023286	2019-03-25	10	MALE	McCracken	KY
	19-87745556-0342	PNUSAE023289	2019-03-26	8	MALE	McCracken	KY
	19-87887223-0365	PNUSAE023406	2019-03-22	81	FEMALE	Graves	KY
	19-88070519-0406	PNUSAE023561	2019-03-26	3	FEMALE	Leslie	KY
	19-88175453-0454	PNUSAE023643	2019-03-31	22	FEMALE	Kenton	KY
	19-88678753-0518	PNUSAE023872	2019-04-09	77	FEMALE	Pulaski	KY

Figure 2. PFGE Image and WGS phylogenetic tree

Tennessee identified a sub-cluster of cases that reported eating hamburgers from a restaurant chain (Chain A). Ground beef products from that chain were collected and found to be closely related to the outbreak by WGS. Products were recalled on April 23, 2019. During the trace back/ trace forward investigation, TN discovered that the same distributor had supplied product to a separate restaurant chain (Chain B), where several cases in Kentucky reported eating prior to illness onset. PHPS and LHD staff collected ground beef samples from 4 separate Chain B locations in Kentucky. All samples tested negative for *E.* coli at DLS.

Figure 3. Ground beef samples with requisition forms

Discussion and Conclusion

Throughout this investigation, KDPH had several unique experiences.

1. The centralized student interview team was new at KDPH and this outbreak was the first test of their workflow and interview skills. In addition to this being a large outbreak investigation for Kentucky, there was a concurrent multistate outbreak with many cases being interviewed centrally. To accommodate the large volume of case investigations, student workflow was restructured to maximize time spent conducting rapid interviews. KDPH was also able to employ additional interviewers for both outbreak and non-outbreak cases to help keep workloads manageable. Just-in-time training was conducted, and further discussion will lead to having a list of staff at KDPH that are trained and able to assist with interviewers if other large outbreak investigations are undertaken.
2. Throughout this outbreak, DLS was in rapid communication with DEHP about new isolates and food sampling results. In the middle of the outbreak, there was PFGE lab contamination, causing subsequent delays in determining whether cases were outbreak-associated based on the PFGE patterns associated with the outbreak. However, isolates continued to be simultaneously sequenced in-house and were sent to CDC for WGS analysis in real-time. Initial sequencing runs demonstrated relatedness of isolates to the ongoing outbreak. WGS results were provided to KDPH shortly thereafter and was the first real test of WGS during outbreak investigations.
3. Initial interview data were initially transmitted to CDC using the System for Enteric Disease Response, Investigation, and Coordination (SEDRIC). Due to a backlog of paper interview forms being digitized and transmitted, CDC shared with KDPH an Epi Info project for NHGQ data management. All probable STEC cases were interviewed using the NHGQ and/or outbreak-specific questionnaire. Epidemiologists prioritized which cases to enter into Epi Info based on exposures and lab results. While interview form scanning and transmission to CDC was delayed due to case load, the Epi Info project was an efficient way to provide CDC with case information. Data entry was very time-consuming, however, and later case data were not entered into Epi Info for transmission to CDC. As newly identified cases decreased, all outbreak-associated interview forms were be digitized and transmitted to CDC for analysis.
4. This investigation was the first multi-state outbreak that the KDPH RRT responded to. During this outbreak response, the KDPH RRT Coordinator acted as a liaison among the PHPS Food Safety Branch, DEHP Reportable Diseases Section and DLS and was essential to ensure effective and timely communication and coordination of activities occurred among the three divisions.

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