Rapid Detection and Investigation of an Outbreak of *Escherichia coli* O157:H7 Infections: Shoe-leather Epidemiology on and Around the Strawberry Farm

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*(See the Major Article by Laidler et al on pages 1129–34.)*

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In this issue of *Clinical Infectious Diseases*, Laidler and colleagues from the Oregon Public Health Division and Washington County describe their investigation of an outbreak of *Escherichia coli* O157:H7 infections associated with locally grown strawberries. The report describes how they identified strawberries as a novel vehicle for infection and documents black-tailed deer as the reservoir animal that contaminated the strawberry fields. However, what is most striking about this report is not that strawberries were identified as a novel vehicle, or even that the strawberries were contaminated by deer feces, but that the investigation was performed so rapidly, so thoroughly, and so creatively: classic shoe-leather epidemiology at its best.

Foodborne disease is common, causing an estimated 48 million illnesses, 128,000 hospitalizations, and 3000 deaths in the United States each year [1]. *Escherichia coli* O157:H7 and other Shiga toxin–producing *Escherichia coli* (STEC) are estimated to cause 264,000 illnesses [2], and a mean of 2400 hospitalizations and 20 deaths each year [3]. Most cases of reported foodborne disease are so-called sporadic because they are not able to be linked to a specific source. A small minority of cases are reported as part of an identified outbreak. Identification of outbreaks of enteric infections affords us the opportunity to investigate and learn more about the reservoirs, vehicles, modes of transmission, and strategies for prevention.

Outbreak investigations may not definitively identify a common vehicle or source even when conducted by an experienced investigation team, and are probably less likely to in inexperienced hands. Outbreak investigations are most commonly conducted by state and local health departments, with assistance from the Centers for Disease Control and Prevention’s (CDC) Epidemic Intelligence Service Officers on occasion, as was the case in this outbreak investigation. Even when outbreak investigations do identify a common vehicle, they may or may not be followed by a robust environmental investigation because those investigations are laboratory-resource intensive.

In today’s resource-constrained climate, outbreak investigations may be more likely to conclude after enough evidence has been gathered to direct the immediate public health actions needed to protect the public (eg, notify the public not to consume the strawberries and remove them from sale), and may not invest in the final step, which is thoroughly investigating all of the upstream factors that conspired to cause the outbreak in the first place. This part of the investigation is important to prevent future similar outbreaks.

How unique is the success of the outbreak investigation described by Laidler and colleagues, and what enabled this success? Certainly a robust public health infrastructure is essential to enable detection, control, and prevention of outbreaks. Outbreaks of enteric infections may be detected in a number of ways—by astute clinicians, the public, schools, restaurants, or others in the community—but increasingly are recognized by the public health laboratories that subtype the isolates. Enteric disease outbreaks—be they foodborne, waterborne, or person to person—cannot be effectively investigated without well-functioning public health laboratories and close collaboration with clinical laboratories. Currently, it is a culture-based system. Without a culture and a bacterial isolate to subtype, disease patterns cannot be recognized and outbreaks will be missed.
Oregon is 1 of 10 states that participate in the Foodborne Diseases Active Surveillance Network (FoodNet); all counties are included in the catchment area, thus, the entire state population of 3,871,859 is under active surveillance. FoodNet’s active laboratory-based surveillance includes STEC [4]. Perhaps the relationships built between the public health and clinical laboratories during this project enabled the public health laboratory to quickly receive the E. coli O157:H7 isolates and subtype them, which in turn allowed for detection of the outbreak just short of 2 weeks from the midpoint of when most affected patients became ill. That is extremely fast in public health time.

By contrast, there are a number of challenges in most health jurisdictions that lengthen this time considerably. The cumulative delay between identification of illness (visit to healthcare provider), identification of etiology (diagnostic testing), and forwarding of the “evidence”—the actual bacterial isolate—to the public health laboratory can mean a delay in detection of the outbreak, which may impact the success of the investigation and implementation of effective control measures. One challenge has been that the laboratory information necessary for clinical decision making is often different than the laboratory information needed for public health decision making. Clinical laboratories are increasingly adopting rapid, nonculture-based tests (usually enzyme immunoassay or polymerase chain reaction based) to screen stools for Shiga toxin, and may or may not perform culture on selective media to isolate the organism, which is more costly. The nonculture-based tests have enabled us to detect the non-O157 STEC, but they have made the process of obtaining culture for public health use more complicated and lengthy. Both the CDC [5] and the Association of Public Health Laboratories [6] have argued that isolation of STEC by culture is essential for further characterization and outbreak detection. A new Joint Commission standard requires that all laboratories must use selective or differential media to identify O157 STEC when working up a specimen from a patient with community-acquired diarrhea, and the new Joint Commission standard will benefit public health [7].

How else was this investigation unique? The investigation was conducted by a team of experienced epidemiologists who understood that a rapid investigation can yield more information. Within 3 days of the pulsed-field gel electrophoresis (PFGE) result, they mobilized a team to complete a 450-item hypothesis-generating questionnaire, and initiated a case-control study. One day later, they conducted their initial field sample from farm A that yielded 111 samples positive for the outbreak strain. The investigation was also unique in that it was local. Because of the global nature of the food supply, most outbreak investigations involve a few cases spread over many state and local health jurisdictions and require coordination of multiple agencies and jurisdiction to investigate.

Finally, the team was able to conduct an extensive environmental laboratory investigation that added important information such as the prevalence of the organism in deer pellets and its rapid disappearance, from 20% prevalence in 50 deer pellet samples collected on 6 August to 1.7% of 345 samples collected just 20 days later. Fecal shedding of E. coli O157:H7 by cattle is known to be intermittent or short term [8], and a single strain of E. coli O157:H7 passed through a cow may yield many different PFGE profiles in the stool [9]. If the same holds true for deer, the investigation team likely would not have identified the source had they not been able to initiate the environmental investigation so quickly and accommodate such a large number of samples. Many environmental investigations occur months after the fact and never identify a definitive source.

Reports of 4 cases of hemolytic uremic syndrome and 2 deaths would have been extremely unlikely to have gone unnoticed by any state or local health department, but many state and local health departments would not have been able to detect the outbreak as quickly, investigate it as rapidly, or have the resources to perform such a timely and extensive environmental investigation. Curiosity might have been the final key ingredient that led the team to request and test the vacuum cleaner bag from the home of the case patient identified several months after the outbreak was over. Perhaps vacuum cleaner bags can serve as a proxy for environmental contamination.

The impact of un- or underinvestigated outbreaks may be an unknown number of preventable illnesses, hospitalizations, and deaths, and unidentified reservoirs and vehicles of infection. Outbreaks are naturally occurring experiments, and their thorough investigation can lead to control measures that prevent morbidity and mortality in the short and long term.

Note

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References