EDUCATIONAL COMMENTARY – *ESCHERICHIA COLI* O157:H7 AND OTHER SHIGA TOXIN–PRODUCING *E. COLI*

**Learning Objectives**

Upon completion of this exercise, the participant should be able to:

- Discuss the advantages and disadvantages of 4 methods used to detect and identify *Escherichia coli* O157:H7 and other Shiga toxin–producing *E. coli* strains (STEC).
- Discuss 5 strategies laboratories use to develop screening protocols for STEC.
- List 4 steps supervisors can take to design stool culture procedures and screening policies that protect the public health.

Also known as enterohemorrhagic *Escherichia coli* (EHEC), Shiga toxin–producing *E. coli* (STEC) are so named because they produce 2 cytotoxins that are identical to or very similar to the Shiga toxin produced by *Shigella dysenteriae* type 1. Shiga toxin–producing *E. coli* can cause hemorrhagic colitis, a condition characterized by severe bloody diarrhea with abdominal cramps and little or no fever. This may progress to hemolytic uremic syndrome (HUS), in which patients suffer kidney failure, low platelet count, and hemolytic anemia. Some experience permanent kidney or neurological damage, and 3% to 5% of patients with HUS die.

First described in 1982, *E. coli* O157:H7 is the best-known STEC serotype. Since 1982, many other STEC serotypes have been linked to hemorrhagic colitis and HUS, including more than 150 non-O157 strains. In the United States, Canada, and Europe, *E. coli* O157:H7 and *E. coli* O157:NM (nonmotile) are the STEC serotypes most often encountered, but non-O157 serotypes are increasingly being implicated in outbreaks.

**Detecting and Identifying STEC**

*Escherichia coli* O157:H7 and other STEC strains can be detected by stool culture with subsequent serotyping, direct detection of Shiga toxin or O157 antigen, the MUG [4-methylumbelliferyl-beta-D-glucuronide] screening test, or serology.

The first method, stool culture with subsequent serotyping, consists of 3 steps:

1. Plate specimens on sorbitol-MacConkey agar (SMAC).
2. Confirm that sorbitol-negative colonies are *E. coli*.
3. Perform serotyping for O157 and H7 antigens.
This method takes advantage of the fact that, unlike other \textit{E. coli} strains, \textit{E. coli} O157 strains ferment sorbitol slowly or not at all, and colonies thus appear colorless on SMAC. The second step, confirmation that sorbitol-negative colonies are \textit{E. coli}, is needed because other non-sorbitol-fermenting bacteria may be present, and these can cross-react with O157 antiserum and thus yield erroneous results. The third step, serotyping with antiserum or latex reagent, determines whether the somatic antigen O157 and the flagellar antigen H7 are present. A disadvantage of culture with SMAC is that this will not detect non-O157 STEC serotypes.

A number of commercially available immunoassays can detect Shiga toxin or O157 antigen directly in feces, enrichment broth cultures, or bacterial colonies. In addition to detecting \textit{E. coli} O157 strains, methods that test for Shiga toxin can also detect non-O157 STEC strains. However, the presence of Shiga toxin or O157 antigen does not identify the STEC subtype or serotype. Because this information is important in investigations of foodborne illness, specimens that test positive for either Shiga toxin or \textit{E. coli} O157 antigen should be cultured so that the organism can be isolated, identified, and serotyped.

Some laboratories use a commercially available MUG assay to help screen for \textit{E. coli} O157 strains. In this test, the enzyme β-glucuronidase cleaves MUG to produce a positive reaction. Unlike most other \textit{E. coli} strains, \textit{E. coli} O157 strains rarely produce β-glucuronidase and thus yield a negative MUG result.

Finally, the presence of STEC may be detected serologically by demonstrating at least a 4-fold rise in Shiga toxin–neutralizing antibody titer.

**Developing Screening Protocols for STEC**

The issue of which specimens to test for \textit{E. coli} O157:H7 and other STEC strains has been controversial, and laboratory practices reflect this. Currently, most laboratories use one or more of the following strategies:

- Test all specimens throughout the year.
- Test all specimens only during the summer.
- Test only grossly bloody specimens.
- Test only when specifically requested.
- Test only specimens from pediatric patients.
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Of these 5 strategies, the practice of testing all specimens throughout the year is most likely to optimize detection of STEC. However, this is also the most expensive option. The remaining strategies are more economical, but they are more likely to fail to diagnose at least some cases of illness caused by STEC. The Association of State and Territorial Public Health Laboratory Directors has recommended that laboratories screen at least all bloody stool specimens for *E. coli* O157:H7, but some experts believe this is inadequate because it is not always possible to determine whether diarrhea is bloody by examining it. Similarly, some experts also believe the practice of screening for STEC only upon request is unsatisfactory because physicians may mistakenly believe the laboratory routinely screens for this pathogen and therefore not request it.

Before deciding which screening strategies to use, a laboratory should at least obtain data about the prevalence of STEC in its patient population. The best approach for acquiring this information is to screen all stool specimens for STEC during the summer months because this is when prevalence is highest. Alternatively, state health laboratories and neighboring laboratories may also be able to provide prevalence data.

**Protecting the Public**

Many public health officials state that *E. coli* O157:H7 and other STEC are underreported in the United States because many laboratories do not routinely screen for these bacteria. Also, many laboratories that do test for STEC appear to lack procedures to adequately detect these pathogens. For example, a study by Edson and colleagues evaluating laboratories’ ability to detect *E. coli* O157:H7 in a proficiency test sample found that only 49% of the surveyed laboratories screened at least all bloody specimens for *E. coli* O157:H7. Moreover, that study reported that 30% of the laboratories that did test for *E. coli* O157:H7 erroneously reported “no stool pathogens isolated” (27%) or “*E. coli*, not O157:H7” (3%).

To protect the public health, laboratory supervisors should review their laboratory’s practices in 4 areas. First, they should ensure that screening protocols adequately meet the needs of the patient population. Second, they should select test methods that reliably detect STEC and ensure that employees are proficient in performing these procedures. Third, they should make sure that physicians understand the laboratory’s stool-testing protocols. Finally, to clarify which pathogens were screened for, the laboratory report should explicitly state which pathogens were detected or ruled out.
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*Suggested Reading*


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