Shiga Toxin-Producing *E. coli* (STEC) Infection

Summary

Shiga toxin-producing *E. coli* (STEC) are diarrhea-causing strains of a group of bacteria called *Escherichia coli*. *E. coli* O157:H7 (*E. coli* O157 or "O157" for short), considered the most well-known type of STEC, along with multiple other types that can cause illness in humans. While STEC infection has traditionally been associated with animal products, outbreaks associated with contaminated produce have become more common. Symptoms last a few days to a few weeks and may include diarrhea (often with blood), abdominal pain, and occasionally low-grade fever.
Treatment is usually supportive, and prevention is key. Complications such as Hemolytic Uremic Syndrome (HUS) can be deadly.

Agent

There are many different types of *E. coli*, only some of which are pathogenic to humans.

- STEC is sometimes referred to as enterohemorrhagic *E. coli* (EHEC) or verocytotoxic *E. coli* (VTEC). EHEC produces toxins called Shiga toxins (similar to the toxin produced by *Shigella*) and for this reason, these *E. coli* are commonly referred to as STEC.
- In addition to *E. coli* O157, other types can cause illness such as *E. coli* O26, *E. coli* O45, *E. coli* O103, *E. coli* O111, *E. coli* O121, and *E. coli* O145.

Transmission

The infectious dose for STEC is very low, which facilitates transmission in a variety of settings.

Reservoir:

Cattle are the most common reservoir of STEC; can also include deer, sheep, and goats. STEC can be picked up from the environment by pigs and birds. Humans may also serve as a reservoir for person-to-person transmission.

Mode of transmission:

- Occurs mainly by ingestion of contaminated food; most often due to inadequately cooked beef (especially ground beef). Raw milk, cheese made from raw milk, unpasteurized apple cider vinegar, and raw fruit or vegetables contaminated with feces may cause infection as well.
- Transmission directly from person-to-person via fecal-oral route commonly occurs in families, restaurants, childcare centers, and custodial institutions.
- Waterborne transmission has also been documented from contaminated drinking water and recreational water such as rivers, lakes, pools, etc.
- Outbreaks have been implicated in petting zoos/farm animals as well.

Period of communicability:

STEC is typically excreted for a week or less in adults but can persist for up to three weeks in one-third of infected children. Prolonged carriage is uncommon.

Clinical Disease

Incubation period:

Variable; for *E. coli* O157:H7 usually 3-4 days with a range of 1-10 days.

Illness:

Illness caused by STEC often begins as non-bloody diarrhea, but usually progresses to diarrhea with visible or occult blood. Severe stomach cramps and vomiting are common. Fever occurs in less than one third of cases and is usually not very high (less than 101°F). Most people recover in 5-7 days. However, 5-10% of diagnosed cases can develop hemolytic-uremic syndrome (HUS). HUS causes destruction of red blood cells, nephropathy/possible renal failure, and post diarrheal thrombotic thrombocytopenic purpura (TTP) – most recover within a few weeks but some suffer permanent damage or die.

Laboratory Diagnosis

E. coli O157:H7 can be identified presumptively or specifically by appropriate stool cultures. Clinical laboratories can screen for *E. coli* O157:H7 by using MacConkey agar base with sorbitol substituted for lactose. Approximately 90% of human intestinal *E. coli* strains rapidly ferment sorbitol, whereas *E. coli* O157:H7 strains do not. These sorbitol-negative *E. coli* then can be serotyped, using commercially available antisera, to determine whether they are O157:H7.

Screening tests for *E. coli* O157 cannot be used to identify other types of STEC. An enzyme immunoassay (EIA) test is available directly test stool specimens or broth culture of stool for the presence of Shiga toxins, and therefore screen for all types of STEC. However, the Shiga-toxin EIA test only tests for the presence of Shiga-toxin in stool and does not require culturing of the *E. coli* organism. If only the EIA test is performed, there will be no isolate available for serotyping and pulsed-field gel electrophoresis (PFGE). Since serotype and PFGE information are crucial to the public health investigation of STEC and the identification of clusters and outbreaks, culture confirmation of specimens positive for Shiga-toxin by EIA tests is recommended.

Culture Independent Diagnostic Testing (CIDT) is becoming a common method for diagnoses. CIDT is a PCR test with approximately 1-hour turnaround time, which makes it appealing. However, the PCR is run as a GI panel and often results in detection of several conditions. Investigations and reflex culture are required to confirm these results.

Clinical laboratories that detect a diarrhea-associated STEC strain (whether an isolated case or in an outbreak situation) should send the isolate and/or Shiga-toxin EIA positive broth to the NMDOH Scientific Laboratory Division (SLD) for isolate confirmation and serotype identification.

Serum can be sent through a state public health laboratory to CDC for serological testing for antibodies to some STEC serogroups.

Hemolytic-Uremic Syndrome (HUS): For all patients with HUS, stool specimens should be cultured for *E. coli* O157:H7 and, if results are negative, for other STEC serotypes. However, the absence of STEC in feces ***does not*** preclude the diagnosis of STEC-associated HUS, since HUS typically is diagnosed one week or more after onset of diarrhea (when the organism may no longer be detectable). For any patient with HUS without a culture-confirmed STEC infection, stool can be sent to a public health laboratory

or to CDC for immunomagnetic separation (IMS) techniques that can increase the sensitivity of culture.

Treatment

Dehydration and electrolyte abnormalities should be corrected. Orally administered solutions usually are adequate although some experts recommend IV volume expansion during the first four days to reduce the risk of renal injury. Feeding, including breastfeeding, should be continued for young children. Antimotility agents ***should not*** be administered to children with inflammatory or bloody diarrhea. Careful follow-up of patients with hemorrhagic colitis (including complete blood cell count with smear, platelet count, blood urea nitrogen level, and creatinine level) is recommended to detect changes suggestive of HUS. If patients have no laboratory evidence of hemolysis, thrombocytopenia, or nephropathy by three days after resolution of diarrhea, their risk of developing HUS is low.

The role of antimicrobial therapy in patients with hemorrhagic colitis caused by STEC is uncertain. Antibiotic therapy is associated with HUS development; antibiotics should not be used for the treatment of STEC infection.

Surveillance

Case Definition:

- Confirmed case: A case that meets confirmatory laboratory criteria.
- Probable case:
    1. A case with isolation of *E. coli* O157 from a clinical specimen without confirmation of H antigen, detection of Shiga toxin or Shiga toxin genes; **or**
    2. Clinically compatible illness in a person with elevated antibody titer against a known Shiga toxin-producing serogroup of *E. coli*; **or**
    3. A clinically compatible illness in a person with Shiga toxin or Shiga toxin genes using CIDT and no known isolation of *Shigella*; **or**
    4. A clinically compatible illness in a person with *E. coli* O157 or STEC/EHEC using CIDT; **or**
    5. A clinically compatible case that is epidemiologically linked to a confirmed or probable case with laboratory evidence; **or**
    6. A clinically compatible illness in a person that is a member of a risk group defined by public health authorities during an outbreak.
- Suspect case:
    1. Elevated antibody titer against a known Shiga toxin-producing serogroup of *E. coli* with no known clinical compatibility; **or**
    2. Detection of Shiga toxin or Shiga toxin genes using CIDT and no known isolation of *Shigella* from a clinical specimen in a person with no known clinical compatibility; **or**
    3. Detection of *E. coli* O157 or STEC using CIDT from a clinical specimen in a person with no known clinical compatibility; **or**
    4. A case diagnosed with post diarrheal HUS or TTP.

Clinical Criteria:

An infection of variable severity characterized by diarrhea (often bloody) and/or abdominal cramps. Illness may be complicated by HUS.

Laboratory Criteria:

Confirmatory laboratory evidence:

- Isolation of E. coli O157:H7 from a clinical specimen, **or**
- Isolation of E. coli from a clinical specimen with detection of Shiga toxin or Shiga toxin genes.

Supportive laboratory evidence:

- Isolation of E. coli O157 from a clinical specimen without confirmation of H antigen, detection of Shiga toxin, or detection of Shiga toxin genes, **or**
- Identification of an elevated antibody titer against a known Shiga toxin-producing serogroup of E. coli, **or**
- Detection of Shiga toxin or Shiga toxin genes in a clinical specimen using a culture-independent diagnostic test (CIDT) and no known isolation of Shigella from a clinical specimen. **or**
- Detection of E. coli O157 or STEC/ Enterohemorrhagic E. coli (EHEC) in a clinical specimen using a CIDT.

Epidemiologic Linkage:

- A clinically compatible illness in a person that is epidemiologically linked to a confirmed or probable case with laboratory evidence **or**
- A clinically compatible illness in a person that is a member of a risk group as defined by public health authorities during an outbreak.

Comments:

Asymptomatic infections and infections at sites other than the gastrointestinal tract in people (1) meeting the confirmatory laboratory criteria for diagnosis or (2) with isolation of E. coli O157 from a clinical specimen without confirmation of H antigen, detection of Shiga toxin, or detection of Shiga toxin genes, are considered STEC cases and should be reported.

Although infections with Shiga toxin-producing organisms in the United States are primarily caused by STEC, in recent years an increasing number are due to infections by Shiga toxin-producing Shigella. Persons with (1) detection of Shiga toxin or Shiga toxin genes using a CIDT and (2) isolation of Shigella spp. from a clinical specimen should not be reported as an STEC case.

Due to the variable sensitivities and specificities of CIDT methods and the potential for degradation of Shiga toxin in a specimen during transit, discordant results may occur between clinical and public health laboratories. Persons with (1) detection of Shiga toxin or Shiga toxin genes using a CIDT and (2) the absence of isolation of Shigella from a clinical specimen, should be classified as a suspect or probable case, regardless of whether detection of Shiga toxin or Shiga toxin genes is confirmed by a public health laboratory.

Reporting:

Report all suspected or confirmed cases of STEC to the Center for Health Protection (CHP) at 1-833-796-8773. Information needed includes: patient's name, age, sex, race, ethnicity, home address, home phone number, occupation, and health care provider. If a source of contamination can be discerned (e.g., a food product or restaurant is suspected to have caused the infection), that information should be included as well.

Case Investigation:

- Complete the NMDOH STEC Questionnaire and send to the Center for Health Protection, P.O. Box 26110, Santa Fe, New Mexico 87502-6110, or fax to 505-827-0013.
- Investigation information should also be entered into NM-EDSS per established procedures.

Control Measures

Control measures for CIDT cases that tested positive for more than one condition should be prioritized as follows:

*Vibrio> **STEC**> Cryptosporidium> Salmonella> Shigella> Campylobacter> Cyclosporidium> Giardia*

For a summary of work and daycare exclusion criteria for all enteric pathogens see Appendix 8.

1. Case management

   1.1. Isolation:

   1.1.a During acute illness, implement contact precautions. During outbreaks, contact precautions for infants with diarrhea caused by STEC should be maintained until cultures of stool are negative.

   1.1.b Infected patients should not handle food or provide direct child or patient care at their place of employment until two successive negative stool cultures greater than 24 hours apart and at least 48 hours after last dose of antimicrobial therapy are obtained.

   1.1.c People with STEC infection should not use recreational water venues (e.g., swimming pools) when ill with diarrhea. Incontinent children should not use recreational water venues until one week after symptoms resolve.

   1.1.d On a case-by-case basis, infected patients may return to work with modified duties that do not include handling food or providing direct child or patient care before two successive negative stool cultures are obtained. Decisions to allow patients to return to work will be made in consultation with CHP, local/regional public health staff, employee and employer.

2. Contact management

   2.1. Isolation:

   2.1.a Investigation of contacts should generally be limited to food handlers, staff and children in childcare centers and other situations where the spread of infection is particularly likely.

   2.1.b Symptomatic contacts should be excluded from handling food and providing direct child or patient care until two negative stool culture has been obtained. If the symptomatic contact is taking antibiotics, the specimen should be obtained 48 hours after the last dose of antimicrobial therapy is taken.

2.1.c On a case-by-case basis, symptomatic contacts may return to work with modified duties that do not include handling food or providing direct child or patient care before two successive negative stool cultures are obtained. Decisions to allow contact to return to work will be made in consultation with CHP, local/regional public health staff, employee and employer.

2.1.d Thorough hand washing after using the bathroom and before food handling or child or patient care should be emphasized for all contacts.

2.2. Prophylaxis: Not applicable.

3. Prevention

3.1. General guidelines for preventing foodborne illness include:

- Emphasize good hand hygiene practices. Wash hands properly with soap and water after using the toilet, changing diapers, handling animals/pets, before preparing and/or eating food, and after handling food.
- Always treat raw poultry, beef, and pork as if they are contaminated and handle accordingly.
- Wrap fresh/raw meat in plastic bag to prevent blood/fluids from dripping onto other foods or surfaces.
- Refrigerate foods promptly and minimize the time kept at room temperature.
- Ensure that the correct internal cooking temperature is reached, particularly when cooking using a microwave.
  - Ground meat (beef, veal, lamb, and pork) should be cooked to 160°F.
  - Whole cuts/other meats (beef, veal, and lamb) should be cooked to 145°F ***followed*** by a 3-minute rest time (the time the meat remains at the final temperature after being removed from heat).
  - Poultry (whole or ground chicken or turkey) should be cooked to 145°F.
- Wash (or preferably peel) raw fruits and vegetables prior to consumption. Keep these items away from uncooked meat.
- Avoid raw/unpasteurized products such as milks, cheeses, and apple cider vinegar.
- Immediately wash cutting boards, knives/other utensils, and counters used for preparation to prevent cross contamination with other foods.
- Promptly clean contaminated surfaces with chlorine bleach-based cleaner.
- Showering before swimming, taking children to the restroom frequently, and changing diapers at designated diaper stations can limit transmission through recreational water.
- If a swimming-associated outbreak is suspected, close pools or beaches until chlorinated or shown to be free of fecal contamination.

3.2. Immunization: Not applicable.

Management of STEC Diarrhea in Childcare Centers

1. In an outbreak of diarrhea due to STEC and/or HUS in a childcare facility, immediate involvement of public health authorities is critical. Infection by STEC is reportable, and rapid reporting of cases can lead to intervention to prevent further disease.
2. Management of isolated case

   2.1. Infected childcare center attendees should be excluded until two successive negative stool cultures are obtained greater than 24 hours apart and at least 48 hours after antimicrobial therapy is completed, if used; stools should be contained in the diaper or the child must exhibit continence, and stool frequency is no more than 2 stools above the child's normal frequency.

   2.2. Infected childcare center staff members should not handle food or provide direct childcare until two successive negative stool cultures are obtained greater than 24 hours apart and at least 48 hours after antimicrobial therapy is completed, if used.

   2.2.a On a case-by-case basis, infected childcare center staff members may return to work with modified duties that do not include handling food or providing direct childcare before two successive negative stool cultures are obtained. Decisions to allow the staff member to return to work will be made in consultation with CHP, local/regional public health staff, employee and employer.

   2.3. Per childcare licensing regulations, a center should notify parents or guardians in writing of a case of STEC in the facility (Subsection D of 8.16.2.20 NMAC). See Appendix 7 for a template of a notification letter.

   2.4. Stool specimens from other symptomatic attendees and staff members should be cultured.

   2.4.a Symptomatic attendees should be excluded until two successive negative stool cultures are obtained greater than 24 hours apart and 48 hours after last dose of antimicrobial therapy.

   2.4.b Symptomatic childcare center staff members should not handle food or provide direct childcare until two successive negative stool cultures are obtained greater than 24 hours apart and 48 hours after last dose of antimicrobial therapy.

   2.4.c On a case-by-case basis, symptomatic childcare center staff members may return to work with modified duties that do not include handling food or providing direct childcare before two successive negative stool cultures are obtained. Decisions to allow the staff member to return to work will be made in consultation with the Center for Health Protection (CHP), local/regional public health staff, employee and employer.

3. The childcare center should review its infection control protocols with staff, and emphasize the following:

   - Standard precautions should be followed: Strict hand-washing routines for staff and children as well as routines for handling fecally-contaminated materials.
   - Frequently mouthed objects should be cleaned and sanitized **daily**. Items should be washed with dishwashing detergent and water, and then rinsed in freshly prepared household bleach solution (dilute 1 cup bleach in 9 cups of water) daily.
   - Food-handling areas and diaper changing areas should be physically separated and cleaned minimally **daily, as well as after each use**.

- Diaper changing surfaces should be nonporous and cleaned with a freshly/daily prepared household bleach solution (dilute 1 cup bleach in 9 cups of water). Cleaning of diaper changing surfaces **after each use** is required and diapers should be disposed of promptly/properly. If available, nonporous gloves should be worn when changing diapers.
- Animals in the childcare center with diarrhea should be isolated from children and taken to a veterinarian for diagnosis and treatment.

4. The daycare operator should be instructed to call the local public health office (PHO) or CHP (depending on collaborative plan developed for surveillance and follow up) immediately if new cases of diarrhea occur. The daycare center should be called or visited once ***each* week for two weeks** after onset of the last case to verify that surveillance and appropriate hygienic measures are being carried out.

5. Outbreak

5.1 If an outbreak of STEC diarrhea (i.e., two or more cases) is suspected in a childcare facility, CHP should be notified immediately. Outbreaks of STEC in this situation would ordinarily be controlled by exclusion and evaluation of symptomatic children and staff. Stool cultures for asymptomatic contracts may aid in controlling spread. Strict hand hygiene may be insufficient to control transmission; during an outbreak, the center should be closed to new admissions and exposed children should not transfer to other centers.

References

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See STEC Fact Sheets (ENGLISH) (SPANISH)