

SHIGA TOXIN-PRODUCING *ESCHERICHIA COLI* (STEC) INFECTION

✓ DISEASE AND EPIDEMIOLOGY

Clinical Description:

Shiga Toxin-producing *Escherichia coli* can cause a range of clinical disease from relatively mild diarrhea to grossly bloody diarrhea. Most diagnosed cases present with bloody diarrhea 6–48 hours after the onset of non-bloody diarrhea. Abdominal pain, abdominal cramps, nausea, and vomiting may also be present. Fever is usually absent. The most severe clinical manifestations of this infection are hemolytic uremic syndrome (HUS) and thrombotic thrombocytopenic purpura (TTP), which can result in renal failure and death. HUS is a serious disease in which red blood cells are destroyed and the kidneys fail. Transfusions of blood or blood clotting factors as well as kidney dialysis may be needed. A prolonged hospital stay is often required.

Causative Agent:

Escherichia coli is a gram negative bacterium that is a part of the normal flora of the bowels. There are over one hundred different serotypes of *E. coli*, most of which are harmless. Some *E. coli*, however, contain genes that produce Shiga toxins (cytotoxins similar to those carried by *Shigella*) which give the bacteria the ability to attach to epithelial cells and cause disease. These strains are usually referred to as Enterohemorrhagic *E. coli* (EHEC) or Shiga-toxin producing *E. coli* (STEC).

Differential Diagnosis:

Salmonella, *Campylobacter*, *Shigella*, *Yersinia enterocolitca*, and bacterial food poisoning may show similar signs and symptoms.

Laboratory identification:

There are a variety of laboratory tests and algorithms for the diagnosis of STEC. Some laboratories will perform a screen for STEC as part of their routine enteric pathogen cultures, but in other laboratories a separate test must be ordered. *E. coli* O157 is a common strain of STEC, but other strains, such as O121 and O26 can cause significant disease and/or HUS. Many labs only screen for O157 and will not be able to identify O121 or other strains.

EIA:

Identifies the presence of Shiga toxin in the stool. This test will identify most STEC cases and is the most sensitive test available to diagnose STEC. Laboratories employing this method typically send positive stool to the Unified State Laboratories: Public Health to see if the specific causative agent can be identified.

Culture:

Some laboratories culture for O157, but not for other strains of STEC. Studies in Utah show that roughly 50% of the STEC isolates are strains other than O157. Therefore, a negative test for O157 does not rule out the possibility of STEC infection.

It is important to test for this organism so that outbreaks can be identified and controlled. Public health can fingerprint the isolates to determine outbreak linkages.

USL:PH: The Unified State Laboratories: Public Health accepts stool specimens for culture isolation and serotyping, EIA, and verotoxin assay. All isolates must be submitted to USL:PH.

Laboratory Result Interpretation			
Laboratory	Result	What it means	Case classification
USL:PH	<i>E. coli</i> O157:H7, O26, O11, O91:H14, O103:H2, O103:H25, O121:H19, O145:NM, O121:NM, etc	USL:PH's laboratory techniques identify particular antigens on the <i>E. coli</i> O and H antigens. These are Shiga toxin-producing <i>E. coli</i> .	Regardless of clinical symptoms, these are all confirmed (case status = 1).
Clinical laboratory	Possible or Presumptive <i>E. coli</i> O157:H7	Laboratories look to see if the <i>E. coli</i> colonies ferment sorbitol. Most <i>E. coli</i> O157 do not ferment sorbitol. These (sorbitol negative) isolates are sent to USL:PH for confirmation. The clinical laboratory test reported as "possible" is not conclusive.	Not a case (case status = 4) unless confirmed by USL:PH.
Any	Enterohemorrhagic <i>E. coli</i> , positive for Shiga like toxins	This is an EIA for the toxin themselves.	If clinically compatible, these are suspect (case status = 3).
Any	<i>Entamoeba coli</i>	This is a nonpathogenic parasite and is not reportable. It is a different species than <i>Entamoeba histolytica</i> , the causative agent of amebiasis, a reportable disease.	Not a case (case status = 4).

Treatment:

Some studies have shown a weak association between antibiotic therapy for STEC and the subsequent development of HUS. A meta-analysis of studies was inconclusive. Until further studies are completed, antibiotic therapy for STEC is not recommended.

Case fatality:

More than 10% of patients that develop HUS from *E. coli* infection die and an additional 25% may have significant long-term sequelae.

Reservoir:

Cattle appear to be a reservoir of significant public health importance; however, other animals, such as deer, are also known to carry STEC. In addition, humans may also serve as a reservoir.

Transmission:

STEC transmission can be foodborne, waterborne, or person-to-person through fecal-oral transmission. Foodborne transmission occurs by eating food containing the bacteria. The

bacteria live in the intestine of some healthy cattle, and contamination of the meat may occur in the slaughtering process. Eating meat, especially ground beef that is rare or not fully cooked is the most common way of getting the infection. Other possible foodborne causes are drinking unpasteurized milk or eating unwashed fruits or vegetables that have been fertilized with cow manure. Waterborne transmission can occur by drinking or swimming in water that is contaminated with sewage. Person-to-person transmission can occur if infected persons do not wash their hands after using the toilet or after changing diapers. Sexual contact has also been shown to transmit the bacteria. Transmission requires a low infectious dose and large outbreaks can occur. Secondary transmission can occur.

Susceptibility:

All age groups can be infected with STEC, but young children, the elderly, and those with compromised immune systems are the most severely affected. Peak incidence of disease occurs in the summer months.

Incubation period:

The symptoms usually appear about 3-4 days after exposure, with a range of one to nine days.

Period of communicability:

The illness usually lasts 5 to 10 days (about two weeks in cases of HUS) and most people are not infectious about a week after diarrhea stops. However, in young children the organism can persist in the stool for weeks.

Epidemiology:

The most commonly isolated STEC serotype in North America is *E. coli* O157:H7, which is considered an important cause of bloody diarrhea throughout the world. Over the past 5 years, an average of 57 *E. coli* O157:H7 infections and 25 *E. coli* non-O157:H7 infections have been reported in Utah annually. Outbreaks in the US have been associated with ground beef, unpasteurized milk and apple cider, and other food products. In 2006, an outbreak of *E. coli* O157:H7 sickened 199 persons in 26 states, including 19 persons in Utah. The source of the outbreak was determined to be contaminated spinach.

PUBLIC HEALTH CONTROL MEASURES

Public health responsibility:

- Investigate all suspect cases of disease and fill out and submit appropriate disease investigation forms.
- Provide education to the general public, clinicians, and first responders regarding disease transmission and prevention
- Identify clusters or outbreaks of this disease and determine the source.
- Identify cases and sources to prevent further transmission.

Prevention:

Environmental Measures

Implicated food items must be removed from consumption. A decision about testing implicated food items can be made in consultation with the enteric epidemiologist at UDOH and USL:PH.

The general policy of USL:PH is to test only food samples implicated in suspected outbreaks, not in single cases (except when botulism is suspected). If holders of food implicated in single case incidents would like their food tested, they may be referred to a private laboratory that will test food or store the food in their freezer for a period of time in case additional reports are received. However, in certain circumstances, a single, confirmed case with leftover food that had been consumed within the incubation period may be considered for testing.

Personal Preventive Measures/Education

To avoid exposure to *E coli*, persons should:

- Always wash their hands thoroughly with soap and water before eating or preparing food, after using the toilet, after changing diapers, and after contact with animals, especially cattle.
- Wash their own hands as well as the child's hands after changing a child's diaper, and dispose of diapers in a closed-lid garbage can..
- Wash their hands thoroughly and frequently when ill with diarrhea, or when caring for someone with diarrhea. Hands should be scrubbed for at least 15–20 seconds after cleaning the bathroom; after using the toilet or helping someone use the toilet; after changing diapers; before handling food; and before eating.
- Keep food that will be eaten raw, such as vegetables, from becoming contaminated by animal-derived food products. (Wash fruits and vegetables thoroughly, especially those that will not be cooked.)
- Do not eat hamburger or other ground beef products that have not been fully cooked. Cook all ground beef and hamburger thoroughly. Make sure the cooked meat is brown throughout (not pink), and the juices run clear. If served an undercooked hamburger or other undercooked ground beef product in a restaurant, send it back for further cooking.
- Cook all ground beef and hamburgers thoroughly.
- Drink only pasteurized milk, juice, or cider.
- Water which is possibly infected (when pipes leak or are undergoing repairs, for example) should be treated with adequate levels of chlorine or other effective disinfectants or boiled to guard against chance contamination.

Discuss transmission risks that may result from oral-anal sexual contact. Latex barrier protection (e.g., dental dam) may prevent the spread of *E. coli* to a case's sexual partners and may prevent exposure to and transmission of other fecal-oral pathogens.

Food Handling Measures

General Handling:

- Ground beef should be frozen or refrigerated at 45°F or less as soon as possible after it is purchased and kept refrigerated until it is used.
- Ground beef should be packaged and stored so that its juices (blood) do not drip onto other foods.
- Never reuse packaging materials.

- Be careful not to recontaminate meat by placing cooked meat on the same platter or surface that held the raw meat, or by using utensils which have been contaminated by raw meat.
- Utensils, dishes and surfaces which come in contact with raw meat should be washed with soap and water before they are used again.

Storing:

- Ground beef should be stored at 45°F or below.
- Ground beef may be stored frozen for up to four months and in the refrigerator for 1-2 days.

Cooking:

- Cook ground beef until it is completely cooked throughout (no pink in the middle) and the juices run clear. Ground beef should be cooked to 155°F or above. Do not cook ground beef in a microwave oven because cooking may be uneven.
- Any cooked hamburger left at room temperature for more than 2 hours should be discarded.
- After cooking, ground beef can be stored in the refrigerator for 3-4 days or frozen for up to 3 months.

Reheating:

- Reheat fully cooked ground beef and hamburger patties to 165°F or above.

Chemoprophylaxis:

None.

Vaccine:

None.

Isolation and quarantine requirements:

Isolation: Food handlers with *E. coli* infection must be excluded from work.

After diarrhea has resolved, food handling facility employees may only return to work after producing two negative stool specimens collected 24 hours apart. If a case has been treated with an antimicrobial, the stool specimen shall not be collected until at least 48 hours after cessation of therapy.

NOTE: A food handler is any person directly preparing or handling food. This can include a patient care or childcare provider.

Hospital: Enteric precautions.

Quarantine: Contacts who have diarrhea and are food handling facility employees shall be considered the same as a case and shall be handled in the same fashion. In outbreak circumstances involving a facility, asymptomatic contacts who are food handling employees may be required to submit stool specimens for testing.

✓ CASE INVESTIGATION

Reporting:

All cases of STEC (including O157:H7 and other strains) are reportable to public health.

Case definition:

Shiga toxin-producing *Escherichia coli* (2005)

Clinical description

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 extraintestinal infections.

Laboratory criteria

Isolation of Shiga toxin-producing *Escherichia coli* from a clinical specimen. *Escherichia coli* O157:H7 isolates may be assumed to be Shiga toxin-producing. For all other *E. coli* isolates, Shiga toxin production or the presence of Shiga toxin genes must be determined to be considered STEC.

Case classification

Suspect: A case of postdiarrheal HUS or TTP (see HUS case definition), or identification of Shiga toxin in a specimen from a clinically compatible case without the isolation of the Shiga toxin-producing *E. coli*.

Probable: A case with isolation of *E. coli* O157 from a clinical specimen, without confirmation of H antigen or Shiga toxin production, or a clinically compatible case that is epidemiologically linked to a confirmed or probable case, or identification of an elevated antibody titer to a known Shiga toxin-producing *E. coli* serotype from a clinically compatible case

Confirmed: A case that meets the laboratory criteria for diagnosis. When available, O and H antigen serotype characterization should be reported.

Comment

For users of the legacy National Electronic Telecommunications System for Surveillance (NETSS), laboratory-confirmed isolates are also reported via the Public Health Laboratory Information System (PHLIS), which is managed by the Foodborne and Diarrheal Diseases Branch, Division of Bacterial and Mycotic Diseases, National Center for Infectious Diseases, CDC. The National Electronic Disease Surveillance System (NEDSS) or NEDSS compatible systems will eventually replace PHLIS and NETSS; users of NEDSS or compatible systems which report to CDC should not report via PHLIS.

Both asymptomatic infections and infections at sites other than the gastrointestinal tract, if laboratory confirmed, are considered confirmed cases that should be reported.

Case Investigation Process:

- Food handlers should be excluded from work until diarrhea has resolved and two stool specimens are negative.
- Assure isolate submission to USL:PH.

Outbreaks:

CDC defines a food-borne outbreak as, “an incident in which two or more persons experience a similar illness resulting from the ingestion of a common food”. In order to confirm an outbreak of STEC, the same *E. coli* species must be isolated from clinical specimens from at least 2 ill persons or the species must be isolated from an epidemiologically implicated food. The source of the infection should be identified and measures to identify additional ill persons and/or to remove the source from consumers should be taken.

Identification of case contacts and management:

Daycare

Since Shiga toxin-producing *E. coli* may be transmitted from person to person through fecal-oral transmission, it is important to follow up on cases of STEC in a daycare setting carefully. (If a case of HUS is diagnosed in a daycare, please see the **Hemolytic Uremic Syndrome (HUS)** disease plan). General recommendations include:

- Children with STEC infection who have diarrhea should be excluded until their diarrhea is resolved.
- Children with STEC who have no diarrhea and are otherwise not ill may be excluded or may remain in the program if special precautions are taken.
- Since most staff in childcare programs are considered food handlers, those with STEC in their stools (symptomatic or not) can remain on site, but they must not prepare food or feed children until their diarrhea is resolved and they have 2 negative stool tests taken at least 24 hours apart and submitted at least 48 hours after completion of antimicrobial therapy, if treatment is received.

School

Since Shiga toxin-producing *E. coli* may be transmitted from person to person through fecal-oral transmission, it is important to follow up on cases of STEC in a school setting carefully. (If a case of HUS is diagnosed in a daycare, please see the **Hemolytic Uremic Syndrome (HUS)** disease plan). General recommendations include:

- Students or staff with STEC infection who have diarrhea should be excluded until their diarrhea is resolved.
- Students or staff with STEC who do not handle food, have no diarrhea or mild diarrhea, and are not otherwise sick, may remain in school if special precautions are taken.
- Students or staff who handle food and have STEC infection (symptomatic or not) must not prepare food until their diarrhea is resolved and they have 2 negative stool tests taken at least 24 hours apart and submitted at least 48 hours after completion of antimicrobial therapy, if treatment is received.

Community Residential Programs

Actions taken in response to a case of Shiga toxin-producing *E. coli* in a community residential program will depend on the type of program and the level of functioning of the residents.

In long-term care facilities, residents with Shiga toxin-producing *E. coli* should be placed on standard (including enteric) precautions until their symptoms subside and they have 2 negative stool specimens for *E. coli* taken 24 hours apart. Staff members who give direct patient care (e.g., feed patients, give mouth or denture care, or give medications) are considered food handlers and are subject to food handler restrictions. In addition, staff members with Shiga toxin-producing *E. coli* infection who are not food handlers should consider not working until their diarrhea is resolved.

In residential facilities for the developmentally disabled, staff and clients with STEC must refrain from handling or preparing food for other residents until their diarrhea has subsided and they have 2 negative stool specimens for *E. coli* taken 24 hours apart (and collected at least 48 hours after completion of antibiotic therapy, if antibiotics are given). In addition, staff members with Shiga toxin-producing *E. coli* infection who are not food handlers should consider not working until their diarrhea is resolved.

✓ REFERENCES

Centers for Disease Control, Case Definitions for Infectious Conditions Under Public Health Surveillance. MMWR 46 (RR-10), 1997.1

Control of Communicable Diseases Manual (19th Edition), Heymann, D.L., Ed; 2008.

Red Book: 2003 Report of the Committee on Infectious Diseases (26th Edition), Larry K. Pickering MD, Ed; 2003.

Principles and Practice of Infectious Disease (6th Edition), Gerald L. Mandell, John E. Bennett, and Raphael Dolin Eds; 2005.

Massachusetts Department of Public Health, Guide to Surveillance, Reporting and Control, 2006.

Council of State and Territorial Epidemiologists Position Statements.
<http://www.cste.org/ps2009/09-ID-30.pdf>