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## Shiga toxin-producing *E. coli* (STEC) and Shiga toxin positive, unknown organism

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## Shiga toxin-producing *E. coli* (STEC) and Shiga toxin positive, unknown organism

### **Overview** <sup>(1,2,3)</sup>

Shiga toxin-producing *Escherichia coli* (STEC) is the term used to refer to a group of *E. coli* bacteria that produce powerful toxins, which can cause severe illness. Most cases in North America are caused by *E. coli* O157:H7, but other serotypes of *E. coli* can also express Shiga toxins. The other most common Shiga toxin producing serotypes in North America include O26, O111, O103, O45, and O121. The CDC estimates approximately 70,000 cases of STEC associated illnesses occur in the United States each year.

The symptoms often include abdominal cramping and diarrhea that can vary from mild and nonbloody to stools that are virtually all blood. There is usually little or no fever, and the illness lasts about a week. Severe infection can result in hemorrhagic colitis. The most severe clinical manifestations are hemolytic uremic syndrome (HUS) and thrombotic thrombocytopenic purpura (TTP). In general, HUS is diagnosed in children and TTP is diagnosed in adults. Ninety percent of HUS cases occur in children. Up to 20% of children with *E. coli* O157:H7 diarrhea progress to HUS, which causes kidney failure requiring dialysis in approximately 50% of patients. A total of 3-5% of patients diagnosed with HUS die. Children under 5 years of age are at greatest risk of developing HUS, although the elderly are also at increased risk of complications. See the HUS manual section for more details.

The incubation period for STEC is 1-10 days, averaging 3-4 days. Adults excrete the pathogen for about one (1) week or less, however, one third of children can potentially excrete the bacteria for three (3) weeks. Prolonged carriage is uncommon. Treatment consists of preventing dehydration and electrolyte imbalance. No benefit has been proven from antibiotic therapy. Several sensitive, specific, and rapid enzyme immunologic assays (EIA) and polymerase chain reaction (PCR) tests are available to detect the presence of Shiga toxin or the genes that encode the Shiga toxin production. Most *E. coli* O157:H7 can be readily identified through culture of the bacteria with selective media however, selective and differential media are not available for the culture of other non-O157 STEC. Simultaneous culture of stool for O157 STEC and EIA testing for Shiga toxin is more effective for identifying STEC infections than the use of either technique alone.

Cattle are the most important reservoir of STEC, although sheep, deer, goats and other ruminants can carry the organism. The major source of exposure has been contaminated undercooked ground beef, but other foods have also been implicated, including unpasteurized milk, juice, and contaminated raw fruits and vegetables. Direct contact with animals and their environment is also a risk factor. Waterborne transmission has occurred through consumption of inadequately chlorinated water and swimming in contaminated lakes and pools. Person-to-person transmission occurs readily and can be difficult to control among families and in childcare centers. The infectious dose is very low, and person-to-person transmission is common during outbreaks.

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Basic control measures include managing slaughterhouse operations to minimize contamination of meat; pasteurization of milk and dairy products; careful washing of fruits and vegetables (preferably peeling them if eaten raw); good hygiene with frequent handwashing; chlorination of drinking water and swimming pools; and thorough cooking of beef to an internal temperature of 160° F.

For a complete description of STEC, refer to the following texts:

- *Control of Communicable Diseases Manual*. (CCDM), American Public Health Association. 19th ed. 2008.
- American Academy of Pediatrics. *Red Book: 2009 Report of the Committee on Infectious Diseases*. 28th ed. 2009.

### **Case Definition** <sup>(4)</sup>

Shiga toxin-producing *Escherichia coli* (STEC)

***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 for diagnosis:***

- 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:***

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

***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.

***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*.

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

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## **Information Needed for Investigation**

**Verify the diagnosis.** Obtain demographic, clinical and laboratory information on the case from the attending physician, hospital, and/or laboratory. Obtain the information necessary to complete the “Disease Case Report” (CD-1), and the “Record of Investigation of Enteric Illness” (CD-2C, 10-09 revision) from the patient. In addition, it may be important to determine if the isolate or Shiga toxin positive specimen was forwarded to the SPHL for confirmation, serotyping, and pulsed field gel electrophoresis (PFGE).

**Establish the extent of illness.** Ask about illnesses among household, childcare, hospital, long term care, and other close contacts. Determine if the case provided child or patient care, or prepared food for anyone outside the household. Determine whether the case is associated with a food recall. Review surveillance data to determine whether there have been other cases in the same geographic area or institution. When cases related by person, place, time, or PFGE pattern are identified, efforts should be made to identify a common source.

When investigating a suspected outbreak of gastrointestinal illness of unknown etiology, see the [Outbreak Investigation](#) section of the CDIRM.

**Identify the most likely source of infection and risk factors for spread of the disease,** in order to prevent other cases.

- Does the case or a member of the case's household attend a child care center or nursery school?
- Does the case or a member of the case's household work as a food handler or healthcare provider?
- Identify symptomatic household and other close contacts and obtain stool specimens.
- Has the case traveled to an area where there is a known outbreak occurring?
- Has the case had contact with livestock or other animals?
- Has the case prepared or consumed undercooked hamburger?
- Has the case consumed unpasteurized milk, other dairy products, or fruit juices?
- Has the safety of the drinking water been determined?
- If the safety of the drinking water is in doubt, has the Department of Natural Resources been notified (public water supply) or the DHSS Bureau of Environmental Health Services (private water supply) and has a boil order-been issued?
- Does the case engage in other practices that would put them or others at increased risk?

## **Notification**

Immediately contact the [District Communicable Disease Coordinator](#), or the [Senior Epidemiology Specialist for the District](#), or the Department of Health and Senior Services’ Situation Room (DSR) at 800-392-0272 (24/7), if an outbreak\* of STEC is suspected. If the case is in a high-risk setting or job such as food handling, child care or health care, contact the District Communicable Disease Coordinator and the appropriate Bureau(s) as listed below.

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- Contact the Bureau of Environmental Health Services (BEHS) at (573) 751-6111, and the Section for Child Care Regulation at (573) 751-2450, if a case is associated with a child care facility.
- Contact BEHS at (573) 751-6111, if a case is a foodhandler.
- Contact the Section for Long Term Care Regulation at (573) 526-8505, if a case is associated with a long-term care facility.
- Contact the Bureau of Health Services Regulation at (573) 751-6303, if a case is associated with a hospital or hospital-based long-term care facility, or an ambulatory surgical center.
- Contact the Department of Natural Resources, Public Drinking Water Branch, at (573) 751-1187, if cases are associated with a public water supply, or DHSS's Bureau of Environmental Health Services at (573) 751-6111, if cases are associated with a private water supply.

\*Outbreak is defined as the occurrence in a community or region, illness(es) similar in nature, clearly in excess of normal expectancy and derived from a common or a propagated source.

## **Control Measures**<sup>(2,3)</sup>

**General control measures** to prevent additional cases should include:

- Education of infected persons about the importance of good handwashing with soap and warm water after defecation or handling diapers or feces, and before handling food or caring for children or patients. Supervise hand washing of toddlers and small children after they use the toilet.
- Dispose of soiled diapers properly and wash, rinse, and sanitize diaper changing areas after each use.
- Keep children with diarrhea out of child care settings.
- Do not prepare food for others while ill with diarrhea.
- All ground beef should be cooked thoroughly to an internal temperature of at least 160°F.
- Avoid consuming unpasteurized (raw) milk or dairy products and unpasteurized apple juice products.
- Avoid swallowing water from ponds, lakes, or inadequately treated swimming pools.
- Infected persons should refrain from recreational water venues (i.e., swimming pools, water parks) for two week after symptoms resolve.
- Contact precautions are recommended for hospitalized patients.
- If there are multiple cases, search intensively for the specific transmission vehicle (food or water), evaluate potential for ongoing person-to-person transmission, and develop specific control measures based on the epidemiologic investigation.

## **Control Measures for High-Risk Settings**

**Food Employees:** A food employee should be excluded from the food establishment, if any of the following are reported:

- A food employee is diagnosed with a STEC or Shiga toxin positive, unknown organism, and is symptomatic. OR
- A food employee is ill and epi-linked to a person with STEC or Shiga toxin positive, unknown organism. OR

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- A food employee is diagnosed or suspected of having an infection from STEC or Shiga toxin positive, unknown organism and is now asymptomatic. OR
- A food employee, through testing, is found to be positive for STEC or Shiga toxin positive, unknown organism, but is asymptomatic.

The excluded food employee may be reinstated with written medical documentation showing the food employee is free of infection due to STEC or Shiga toxin positive, unknown organism based on negative results from follow-up testing conducted by the State Public Health Laboratory (SPHL). To be considered free from infection, two consecutive stool specimens that meet the following criteria must test negative at the SPHL:

1. Taken at least 24 hours after diarrhea ceases, and
2. Not earlier than 48 hours after discontinuation of antibiotics, if given, and
3. At least 24 hours apart.

In the absence of follow-up testing of stool specimens at the SPHL, the excluded food employee may be reinstated after symptoms of vomiting and/or diarrhea resolve and more than seven (7) calendar days have passed since the food employee became asymptomatic. For the food employee identified through testing who did not develop symptoms and did not provide specimens for follow-up testing, reinstatement can occur when more than seven (7) calendar days have passed since the food employee was diagnosed.

Note: If two or more cases of STEC or Shiga toxin positive, unknown organism, meeting either the suspect, probable, or confirmed case definition, are associated with a restaurant or other food service entity then transmission at the facility must be considered. Therefore, when two or more cases are associated with a food service entity, all food handlers meeting the suspect, probable, or confirmed case definition for STEC or Shiga toxin positive, unknown organism should be excluded from the facility. All excluded food employees will only be reinstated with written medical documentation showing they are free of infection due to STEC or Shiga toxin positive, unknown organism based on the results of follow-up testing conducted by the SPHL per the testing criteria described above (medical documentation is required for both asymptomatic and symptomatic cases).

**Child Care:** Due to the potential of the spread of STEC or Shiga toxin positive, unknown organisms in child care facilities, special measures are recommended when cases are identified in a child care attendee or staff member. In addition, increased surveillance within the child care facility to identify others, including both children and staff with diarrheal illness, is essential. It is also important to remember that child care staff who prepare food, should not change diapers, or assist with children in using the toilet.

If the child care attendee or staff is a) diagnosed with STEC or Shiga toxin positive, unknown organism, and is symptomatic, or b) is ill and epi-linked to a person with STEC or Shiga toxin

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positive, unknown organism, or c) is now asymptomatic though through testing is found to be positive for STEC or Shiga toxin positive, unknown organism, recommendations should include the following:

- Exclude the child care attendee or staff member from the child care facility until the individual is asymptomatic and determined to be free of infection due to STEC or Shiga toxin positive, unknown organism based on negative results from follow-up testing conducted by the SPHL. To be considered free from infection two consecutive stool specimens that meet the following criteria must test negative at the SPHL:
  - 1 Taken at least 24 hours after diarrhea ceases, and
  - 2 Not earlier than 48 hours after discontinuation of antibiotics if given, and
  - 3 At least 24 hours apart.
- All other attendees and staff members experiencing symptoms consistent with STEC associated illness should be excluded from the facility. In addition, the symptomatic attendees and staff members should be tested for the presence of STEC or other Shiga toxin producing bacteria.
- Infected persons should refrain from recreational water venues (i.e., swimming pools, water parks) for two week after symptoms resolve.
- During an outbreak in a child care center, the center should be closed to new admissions and care should be taken to prevent transfer of exposed children to other centers. Hand hygiene is very important but may not prevent further transmission.
- Other measures of prevention may be necessary based on the findings from the case investigation.

**HealthCare Providers:** Due to the potential transmission of STEC or Shiga toxin positive, unknown organism from an infected health care worker, special measures are recommended when cases are identified in a health care provider.

If the health care worker is a) diagnosed with STEC or Shiga toxin positive, unknown organism and is symptomatic, or b) is ill and epi-linked to a person with STEC or Shiga toxin positive, unknown organism, or c) is now asymptomatic though through testing is found to be positive for STEC or Shiga toxin positive, unknown organism, recommendations should include the following:

- Exclude the health care provider from patient care duties until diarrhea ceases and the individual is free of infection due to STEC or Shiga toxin positive, unknown organism based on negative results from follow-up testing conducted by the SPHL. To be considered free from infection two consecutive stool specimens that meet the following criteria must test negative at the SPHL:
  - 1 Taken at least 24 hours after diarrhea ceases, and
  - 2 Not earlier than 48 hours after discontinuation of antibiotics if given, and
  - 3 At least 24 hours apart.
- Other control measures previously noted are applicable. Additional measures of prevention may be necessary based on the findings from the case investigation.

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## **Laboratory Testing**<sup>(5)</sup>

There are a variety of test methods available for testing for the presence of *E. coli* O157:H7 and other STEC. It should be noted that multiple test methods may be necessary to determine the presence of STEC. For example, cultures specific for *E. coli* O157:H7 will often not detect the non-O157 STEC and Shiga-toxin testing could miss approximately 5% of *E. coli* O157:H7 cases. Therefore, follow-up testing at the SPHL is required for cases that are associated with a high-risk setting (foodhandler, child care, health care providers). **Note:** Follow-up testing for STEC at the SPHL will include methods to detect both *E. coli* O157:H7 and other STEC. To ensure the appropriate test methods are used, the required follow-up testing of persons in high- risk settings should be conducted at the SPHL.

No testing method for STEC is 100% sensitive or specific and discordant results can occur when specimens are tested at different laboratories using different methods. Testing conducted at the SPHL for the presence of STEC includes PCR testing for the presence of Shiga toxin producing genes. Occasionally, the specimen that tests positive at the hospital or reference laboratory subsequently tests negative for the presence of Shiga toxin producing genes at the SPHL. In these situations the case will be classified as “Suspect” per the national reporting case definition.

For these suspect cases associated with a high-risk setting, the initial negative specimen at the SPHL can be counted as the first of the two required negative tests. One additional stool specimen submitted to the SPHL that tests negative for STEC will still be required for return to the high-risk setting. Please contact the Communicable Disease Coordinator or Senior Epidemiology Specialist in your district for guidance.

**Specimens:** Collect specimens in Cary-Blair media using the Enteric Specimen collection kit supplied by the SPHL. Specimens should be shipped refrigerated. The only clinical specimen the SPHL will test for STEC is a stool sample. Blood specimens and rectal swab specimens are not acceptable specimens for analysis by the SPHL. The SPHL will identify *E. coli* O157:H7, other STEC’s, and Shiga toxin positive, unknown organisms from culture isolates or other appropriate specimens submitted by other laboratories. For epidemiological purposes, the isolated STEC will be further characterized by the SPHL. The SPHL does this testing at no charge to the submitter.

**Environmental specimens:** The SPHL can perform testing on food and other specimens that are linked to clinical specimens. Food should be refrigerated, *but not frozen*. Contact the [Environmental Bacteriology Unit](#) for guidance prior to collecting and submitting specimens.

## **Reporting Requirements**

*E. coli* O157:H7, other Shiga toxin producing *E. coli* (STEC) and Shiga toxin positive, unknown organisms, are Category 2(A) diseases and reportable to the local health authority or the Missouri Department of Health and Senior Services within one (1) calendar day of first knowledge or suspicion by telephone, facsimile, or other rapid communication.

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1. For confirmed and probable cases, complete a “[Disease Case Report](#)” (CD-1), and a “[Record of Investigation of Enteric Infection](#)” (CD-2C, rev. 10/09).
2. Entry of the completed CD-1 and CD-2C into the WebSurv database negates the need for the forms to be forwarded to the District Health Office.
3. All outbreaks or suspected outbreaks must be reported immediately (by phone, fax or e-mail) to the [Communicable Disease Coordinator](#) or the [Senior Epidemiology Specialist](#) for the District. This can be accomplished by completing the [Missouri Outbreak Surveillance Report](#) (CD-51).
4. Within 90 days from the conclusion of an outbreak, submit the final outbreak report to the District Communicable Disease Coordinator.

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### **Other Sources of Information**

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