

# Shiga toxin-producing *Escherichia coli* (STEC) Surveillance Protocol

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## **Provider Responsibilities**

1. Report all cases to your local health department within the time indicated:  
Sporadic case of Shiga toxin-producing *Escherichia coli* (STEC) – should be reported within 24 hours of diagnosis

Outbreaks of STEC – should be reported immediately. An outbreak is defined as greater than expected numbers of cases reported during a certain time frame – OR- 2 or more epidemiologically linked cases from 2 or more households

Foodborne disease outbreak is defined as two or more persons who experience a similar illness after ingestion of a common food. Please note exceptions: one case of botulism, *Vibrio cholerae* or chemical poisoning constitutes an outbreak.

## **Laboratory Responsibilities**

1. Report all positive Shiga toxin tests to the local health department in the patient's county of residence within 24 hours of result. Send or fax a copy of the laboratory result to the local health department in the county of residence of the case patient.
2. Report all positive cultures for STEC to the local health department in the patient's county of residence within 24 hours of result. Send or fax a copy of the laboratory result to the local health department in the county of residence of the case patient.
3. Submit Shiga toxin positive broths and/or cultures to the Office of Laboratory Services (OLS) for serotyping and pulsed field gel electrophoresis (PFGE) at 167 11<sup>th</sup> Avenue, South Charleston, WV 25303. Telephone 304-558-3530. For forms and other information, visit [www.wvdhhr.org/labservices](http://www.wvdhhr.org/labservices) .

See Laboratory Testing section for information on current STEC testing recommendations.

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## **Division of Infectious Disease Epidemiology**

350 Capitol Street, Room 125, Charleston, WV 25301-3715

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## Local Health Responsibilities

1. Educate providers and the public about transmission and prevention of STEC.
2. Educate providers and laboratories to report STEC infections from any site to the local health department in the patient's county of residence within 24 hours of diagnosis.
3. Educate laboratories to submit all Shiga toxin positive broths and cultures to the Office of Laboratory Services (OLS) for serotyping and Pulsed Field Gel Electrophoresis (PFGE).
4. Educate laboratories about appropriate testing and referral of STEC.
5. *For investigation of sporadic cases:*  
Initial report must be filed within 24 hours of first notification.
  - a) Complete all sections of the WVEDSS STEC Reporting Form. Use of the WVEDSS Foodborne Disease Reporting Form will prompt a complete and appropriate investigation, to include:
    - Exposure to animals, including livestock
    - Five day food history
    - Identification of high-risk persons or symptomatic individuals for further investigation
    - Identification of specific behaviors that may be associated with STEC infection.
  - b) Identify other cases, including probable cases (symptomatic persons who are epidemiologically linked to a culture-confirmed case), and investigate completely as in above.
  - c) Enter case investigation and laboratory information into WVEDSS. Print a copy and store according to your local records retention policies. Mail or fax a copy of the laboratory report to Infectious Disease Epidemiology if it was not received by electronic laboratory reporting (ELR).
  - d) If the case developed hemolytic uremic syndrome (HUS), it must also be reported in WVEDSS under that reportable condition as well (i.e. case reported as HUS and STEC). See HUS protocol for information needed for case ascertainment and reporting.

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### 6. Institute appropriate control measures:

If the case works in or attends a day care facility:

- Interview the manager/operator and check attendee records to identify other cases that may have occurred within the past month.
- Provide educational information to the manager/operator and staff regarding proper food handling and hand washing, especially after changing diapers.
- Collect stool samples from all symptomatic staff members and children or attendees who have been ill in the previous month.
- Conduct an environmental inspection if there are any other suspected cases.
- Instruct the manager/operator to notify the local health department if new cases of diarrhea occur. Call or visit once a week for two weeks to verify surveillance and if appropriate hygienic measures are being carried out.
- Exclude symptomatic attendees and staff members. Excluded individuals may be reinstated after diarrhea resolves and test results from 2 consecutive stool cultures taken 24 hours apart are negative for the bacteria. If antibiotics are given, the initial culture must be taken at least 48 hours after the last dose.
- If an outbreak is identified at the facility, it should be closed to new admissions and care exercised to prevent transfer of exposed children to other centers.

If the case works as a food handler:

- Conduct an environmental inspection of the facility. Interview the manager/operator and check employee records to identify suspect cases that occurred the previous month. Ask if there have been any complaints from any patrons during the past month.
- Collect stool samples from any symptomatic employees who have been ill within the last month.
- Exclude/ restrict symptomatic individuals who are involved in food handling. Exclude any individual who tests positive for any STEC species according to the FDA model food code adopted by 64CSR17.

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- All foodhandlers should be counseled on the importance of good handwashing, personal hygiene, and removing themselves from working and notifying their supervisor whenever they have diarrheal illness.
- Excluded food handlers may only return to work after diarrhea resolves and test results from 2 consecutive stool cultures taken 24 hours apart are negative for the bacteria. If antibiotics are given, the initial culture must be taken at least 48 hours after the last dose.

If the case works at a health care or residential care facility:

- Identify any abnormal incidence of diarrheal illness within the past month. If so, identify any common source outbreaks or sources of exposure.
- Conduct an environmental inspection of the facility.
- Exclude symptomatic individuals who are involved in the care of the elderly, immune-compromised, and institutionalized patients. Due to their duties, many fall under category of foodhandler and therefore any should be excluded/ restricted according to the FDA model food code adopted by 64CSR17, who tests positive for any STEC species.
- Excluded care-givers may only return to work after diarrhea resolves and test results from 2 consecutive stool cultures taken 24 hours apart are negative for the bacteria. If antibiotics are given, the initial culture must be taken at least 48 hours after the last dose.

*For investigation of a suspected outbreak:*

Outbreak is defined as greater than expected numbers of cases reported during a certain time frame –OR- 2 or more epidemiologically linked cases from 2 or more households.

Foodborne disease outbreak is defined as two or more persons who experience a similar illness after ingestion of a common food. Please note exceptions: one case of botulism, *vibrio cholerae* or chemical poisoning constitutes an outbreak.

1. Obtain case histories for preliminary reports as in sporadic cases above. Focus on possible common source exposures.
2. Verify the diagnosis
3. Gather a 7 day exposure history (e.g. food, travel, activities).

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4. Contact DIDE and notify of suspected outbreak.
5. Consult outbreak investigation protocol for complete instructions on investigation of an outbreak.

[http://www.dhhr.wv.gov/oeps/disease/FnW/Bacterial/Documents/STEC\\_protocol.pdf](http://www.dhhr.wv.gov/oeps/disease/FnW/Bacterial/Documents/STEC_protocol.pdf)

## **State Health Responsibilities**

1. Prompt and complete reporting of STEC cases to the Centers for Disease Control and Prevention (CDC) through WVEDSS.
2. Provide technical expertise and consultation regarding surveillance, investigation, control measures and prevention of STEC.
3. Notify CDC of suspected outbreaks identified in West Virginia and assist local health jurisdictions in obtaining the knowledge and resources necessary for investigation of a STEC outbreak.
4. Summarize surveillance data for cases of STEC on an annual basis.

## **Disease Control Objectives**

Reduce the risk of secondary or additional cases by:

- Early identification and appropriate exclusion of infected persons from high risk situations (day care, food handling, health care).
- Rapid and complete investigation of outbreaks so that any common source can be identified and removed.
- Education of the risk of STEC infection associated with animal contact (i.e. petting zoos).

## **Disease Prevention Objectives**

Reduce the risk of infection from STEC by:

- Education of the general public about hand washing as a primary means of preventing person-to-person transmission of STEC.
- Education of the general public about proper food handling, including thorough cooking of ground meat and washing of fruits and vegetables prior to consumption, and avoidance of cross-contamination.
- Education of the general public to avoid unsafe foods such as unpasteurized milk, cheese, juice, cider, and untreated water.

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## **Disease Surveillance Objectives**

- To determine the incidence of STEC in West Virginia.
- To identify demographic characteristics of persons with STEC.
- To identify behavioral risk factors associated with STEC.
- To facilitate outbreak identification and investigation by routinely conducting PFGE at OLS on all isolates.

## **Public Health Significance**

There are many types of *Escherichia coli* (*E. coli*) bacteria that normally live in the intestinal tract. There are at least 5 types known to cause diarrheal illness. The most serious of the 5 is the group called Shiga toxin-producing *E. coli* or STEC (previously called Enterohemorrhagic *E. coli* or EHEC). Shiga toxin is a family of toxins produced by a variety of organisms, including *Shigella dysenteriae* type I and Shiga toxin-producing *E. coli*. These toxins have a cytotoxic effect on intestinal epithelial cells that probably causes the characteristic bloody diarrhea. Systemic spread of Shiga toxin causes renal endothelial cell toxicity and may be responsible for hemolytic uremic syndrome. *E. coli* O157:H7 is by far the most infamous STEC, and is also the serotype which causes the most severe disease.

Transmission of most diarrhea associated *E. coli* strains is from food or water contaminated with human or animal feces or from infected symptomatic people. Mainly through ingestion of food contaminated with ruminant feces and direct contact with animals or their environment. Outbreaks, including cases of hemorrhagic colitis, HUS, and death, have occurred from beef (usually as inadequately cooked hamburgers); produce (including lettuce, apple cider, raw spinach, coleslaw, sprouts, and melons); and unpasteurized cows' milk. Outbreaks in children have been associated with petting zoos. Direct person-to-person transmission can occur in families, child care centers, and custodial institutions. Waterborne transmission occurs both from contaminated drinking water and from recreational waters. [The infectious dose is very low. The duration of excretion of the pathogen is typically 1 week or less in adults, but 3 weeks in one-third of children. Prolonged carriage is uncommon. ]

*E. coli* O157:H7 is responsible for numerous outbreaks in the United States each year, some of which are very large and dramatic. The most well-known outbreak occurred

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between 1992 and 1993 resulting in 500 laboratory confirmed infections and four deaths occurring in four states: Washington, Idaho, California and Nevada. This outbreak was due to the consumption of undercooked hamburgers from one restaurant chain. More recently, *E. coli* O157:H7 was responsible for an outbreak in 2009 that resulted in 77 cases in 30 states and was associated with consumption of commercially available raw cookie dough. And routinely between 2 and 4 times multistate outbreaks of STEC are identified each year. Because *E. coli* can cause renal failure and death in previously healthy young children, community outbreaks are extreme public health emergencies and must be investigated rapidly.

## **Clinical Description**

An infection of variable severity characterized by diarrhea (often bloody) and abdominal cramps. Asymptomatic infections also may occur, and the organism may rarely cause extraintestinal infections. The diarrhea may range from mild and non-bloody to stools that are virtually all blood; abdominal cramps are often severe. The most severe manifestation of STEC infection is hemolytic uremic syndrome (HUS), a thrombotic microangiopathy occurring in both children and adults that is characterized by hemolytic anemia, thrombocytopenia, and acute renal dysfunction. The term D<sup>+</sup> HUS is used to describe HUS that follows a diarrheal illness, and it may be associated with neurologic abnormalities. STEC is the primary cause of D<sup>+</sup> HUS.

STEC O157 causes the most D<sup>+</sup> HUS cases worldwide. About 15% of young children and a much smaller portion of adults with STEC O157 diarrhea develop D<sup>+</sup> HUS. Adults with D<sup>+</sup> HUS are often misdiagnosed as having thrombotic thrombocytopenic purpura (TTP), a different thrombotic microangiopathy unrelated to STEC infection. Most D<sup>+</sup> HUS patients with an identified etiology show evidence of infection with STEC that produce shiga toxin 2 (Stx2). Stx2 is produced by virtually all STEC O157 strains causing human illness. The pathogenesis of STEC is complex and involves several virulence factors. In addition to the Shiga toxins, STEC must also express intestinal adherence factors to cause disease. A common adherence factor among STEC is intimin (encoded by *eae*.)

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## **Etiologic Agent**

STEC is a heterogeneous group of bacteria that express potent cytotoxins called Shiga toxins 1 and 2 (Stx1 and stx2 are also called verocytotoxins or verotoxins). Stx1 is essentially identical to the toxin produced by *Shigella dysenteriae* 1. The most common STEC is O157, however over 70 STEC serogroups have been isolated from ill persons. After O157, the most common serogroups isolated from persons with diarrheal illness in North America are O26, O111, O103, O45, O145, and O121. STEC that produce certain Stx2 subtypes (e.g. Stx2a and stx2d) tend to be more virulent. In North America, approximately 70% of D<sup>+</sup> HUS cases have laboratory evidence of antecedent STEC infection; approximately 95% of these are STEC O157. STEC strains vary considerably in their virulence, from strains of no apparent human virulence detected primarily in animals to others causing severe human disease and outbreaks.

## **Reservoir**

Cattle are the most important reservoir of STEC O157; cattle also harbor many other STEC strains as well. Other ruminants, including sheep, goats, and deer, may carry STEC. Humans may serve as a reservoir for person-to-person transmission.

## **Mode of Transmission**

STEC is transmitted via the fecal-oral route, mainly through ingestion of food contaminated with ruminant feces and direct contact with animals or their environment. Direct person-to-person transmission can occur in families, child care centers, and custodial institutions. Waterborne transmission occurs both from contaminated drinking water and from recreational waters. The infectious dose is very low.

## **Incubation Period**

The range is 2-10 days, with a median of 3-4 days for most serotypes.

## **Period of Communicability**

STEC is shed in the stool during the initial period of diarrhea and variably thereafter. Children can shed *E. coli* O157:H7 for two to four weeks after onset. Shedding is typically 1 week or less in adults. Prolonged carriage is not common.

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## **Outbreak Recognition**

An outbreak is defined as greater than expected numbers of cases reported during a certain time frame or when clustered cases of STEC are reported. STEC most commonly occurs from June to August, during the summer months. Outbreak recognition and investigation requires timely and complete epidemiological investigation (risk factors, food history, history of exposure to animals, etc.) paired with timely and complete laboratory investigation (serotyping and pulsed field gel electrophoresis).

Because *E coli* can cause renal failure and death in previously healthy young children, community outbreaks are extreme public health emergencies and must be investigated rapidly. Community-based outbreaks have been linked to individual food handlers, improper preparation of meats and exposure to livestock (petting zoos). National outbreaks have been associated with widespread distribution of contaminated commercial food products, vegetables, and meats.

However, in an outbreak in Germany of a rare enteroaggregative STEC O104: H4 infections, principally among adults, the reported percentage who develop D<sup>+</sup> HUS was 22%. About 55% of patients with STEC O157 D HUS require dialysis and 5% die; rates vary for other serotypes.

## **Laboratory Testing**

All stools submitted for testing from patients with acute community-acquired diarrhea (i.e., for detection of the enteric pathogens *Salmonella*, *Shigella*, and *Campylobacter*) should be cultured for O157 STEC on selective and differential agar. These stools should be simultaneously assayed for non-O157 STEC with a test that detects the Shiga toxins or the genes encoding these toxins. All O157 STEC isolates should be forwarded as soon as possible to the state public health laboratory for confirmation and additional molecular characterization (i.e., PFGE analysis and virulence gene characterization). Detection of STEC or Shiga toxin should be reported promptly to the treating physician, to the public health laboratory for confirmation, isolation, and subsequent testing of the organism, and to the appropriate public health authorities for case investigation. Specimens or enrichment broths in which Shiga toxin or STEC are detected but from which O157 STEC are not recovered should be forwarded as soon as possible to the state public health laboratory.

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## Case Definition

### **Clinical description**

An infection of variable severity characterized by diarrhea (often bloody) and abdominal cramps. Illness may be complicated by Hemolytic Uremic Syndrome (HUS). (Note, some clinicians still use the term thrombotic thrombocytopenic purpura [TTP] for adults with post-diarrheal HUS.); asymptomatic infections also may occur, and the organism may rarely cause extraintestinal infections.

### Laboratory Criteria for Diagnosis

#### *Laboratory confirmed*

- Isolation of STEC from a clinical specimen. *Escherichia coli* O157 isolates that produce the H7 antigen 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.
- Both asymptomatic infections and infections at sites other than the gastrointestinal tract, if laboratory confirmed, are considered confirmed cases that should be reported.

#### *Supportive laboratory results*

- A case with isolation of *E. coli* O157 from a clinical specimen, without confirmation of H antigen or Shiga toxin production
- Identification of an elevated antibody titer to a known STEC serotype from a clinically compatible case
- Identification of Shiga toxin in a specimen from a clinically compatible case without the isolation of STEC

### Case Classification

#### *Suspected*

- A case of postdiarrheal HUS (see HUS case definition) **OR**
- Identification of Shiga toxin in a specimen from a clinically compatible case without the isolation of STEC

#### *Probable*

- A case with isolation of *E. coli* O157 from a clinical specimen, without confirmation of H antigen or Shiga toxin production. **OR**

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- A clinically compatible case who is a contact of an STEC case or is a member of a defined risk group during an outbreak. **OR**
- Identification of an elevated antibody titer to a known STEC serotype from a clinically compatible case

### *Confirmed*

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

### **Preventive Interventions**

1. Wash hands thoroughly and frequently using soap, in particular before eating, and after using the bathroom/changing diapers or contact with farm animals or the farm environment.
2. Pasteurize milk, other dairy products, juices, and ciders.
3. Wash fruits and vegetables, particularly if eaten raw. Peel raw fruits when possible.
4. Avoid consumption of raw sprouts, especially by those most susceptible to severe complications of foodborne infections (young children, the elderly, pregnant women, and persons with compromised immune systems).
5. Cook beef adequately, especially ground beef, to an internal temperature of 70°C (160°F). Do not rely on cooking until all pink color is gone. Use a meat thermometer.
6. Use a separate cutting board to prepare raw meats. Use a clean plate for cooked meat. Never return cooked meat to the same plate used for raw meat.
7. Do not prepare food that will be eaten by others, attend day care, or bathe or swim with others when having diarrhea.
8. Persons with diarrhea due to STEC should not use recreational water venues for 2 weeks after symptoms resolve.
9. Strengthen control measures for exhibits that allow contact with animals or their environment in public settings, such as fairs, farms tours, petting zoos, camps, and schools, and educate populations at risk about the risks associated with attending such events.
10. Ensure adequate hygiene and frequent handwashing with soap in child care centers and in petting zoos and other animal displays.

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### Treatment

No specific therapy will reduce the duration of illness. Most persons recover without antibiotics or other specific treatment in 5 to 10 days. There is no evidence that antibiotics improve the course of disease, and it is thought that treatment with some antibiotics may precipitate kidney complications. Anti-diarrheal agents, such as loperamide (Imodium), should also be avoided. When vomiting or diarrhea is severe, rehydration may be indicated.

Hemolytic uremic syndrome a severe complication of STEC infection is a life-threatening condition usually treated in an intensive care unit. Blood transfusions and kidney dialysis are often required. With intensive care, the death rate for hemolytic uremic syndrome is 3-5%.

### Surveillance Indicators

1. Proportion of cases with complete demographic information.
2. Proportion of cases with complete clinical severity information.
3. Proportion of cases with confirmatory lab testing.
4. Proportion of cases with complete exposure information including:
  - a. Animal contact
  - b. Consumption of fresh produce
  - c. Consumption of raw milk or products made from raw milk
  - d. Consumption of undercooked beef
  - e. Consumption of unpasteurized juice or cider
  - f. Consumption of untreated water
  - g. Outdoor recreational activities (i.e. hiking, camping, swimming)
  - h. Raw meat handling
  - i. Daycare contact
5. Proportion of cases with date of public health action (disease education) recorded.

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