

# Shiga toxin-producing *Escherichia coli* (STEC) (including *E. coli* serotypes O157:H7 and non-O157)

## 1. DISEASE REPORTING

### A. Purpose of Reporting and Surveillance

1. To identify outbreaks and potential sources of ongoing transmission.
2. To prevent further transmission from such sources.
3. To educate people about how to reduce their risk of infection.

### B. Legal Reporting Requirements

1. Health care providers: **immediately notifiable to local health jurisdiction.**
2. Health care facilities: **immediately notifiable to local health jurisdiction.**
3. Laboratories: Shiga toxin-producing *E. coli* (enterohemorrhagic *E. coli* including, but not limited to, *E. coli* O157:H7) and Shiga-toxin positive stool assays **immediately notifiable to local health jurisdiction**; submission of stool specimen or isolate to the Washington State Department of Health (DOH) Public Health Laboratories (PHL) is required (2 business days).
4. Veterinarians: Suspected human cases **notifiable immediately to the local health jurisdiction**; animal cases may be notifiable to Washington State Department of Agriculture (see: <http://apps.leg.wa.gov/WAC/default.aspx?cite=16-70>).
5. Local health jurisdictions: notifiable to DOH Communicable Disease Epidemiology (CDE) within 7 days of case investigation completion or summary information required within 21 days.

### C. Local Health Jurisdiction Investigation Responsibilities

1. Begin investigation upon receipt of case report.
2. Report all confirmed, probable and suspect cases to CDE (see Case Definition in Section 3). Complete the Shiga toxin-producing *Escherichia coli* DOH case report form, (<http://www.doh.wa.gov/notify/forms/stec.pdf>) and enter the data into the Public Health Issues Management System (PHIMS).
  - a) Report Shiga toxin-producing *E. coli* with Hemolytic Uremic Syndrome (HUS) as Shiga toxin-producing *E. coli* (STEC).
  - b) Report post-diarrheal HUS as suspect Shiga toxin-producing *E. coli* (STEC).
  - c) Beginning 2011, HUS without a preceding diarrheal illness is no longer reportable.
3. Assure that labs forward the first isolate from each patient to the Public Health Laboratories (PHL) for confirmation of serotype and molecular sub-typing. If a laboratory identifies Shiga toxin in a stool specimen *but does not perform stool culture*, assure that a stool specimen in broth be sent to PHL for culture.

## 2. THE DISEASE AND ITS EPIDEMIOLOGY

### A. Etiologic Agents

*E. coli* are Gram-negative bacteria classified into serotypes by antigens in their cell wall (“O”) and in their flagella (“H”); most serotypes are non-pathogenic. Enterohemorrhagic *E. coli* are now referred to as “Shiga toxin-producing *E. coli*” (STEC) or sometimes “Verotoxin-producing *E. coli*” (VTEC). In Washington the most common STEC is *E. coli* O157:H7 but other less common STEC strains can cause similar illnesses. Non-motile O157:H7 and non-O157 STEC (e.g., O126, O111, O103) are less commonly identified causes of enterohemorrhagic infection, but are increasing among reported cases as laboratory testing methods evolve. The information in these guidelines is primarily based on studies of O157:H7 infections and outbreaks.

### B. Clinical Manifestations

Mild, non-bloody diarrheal illness is common and asymptomatic STEC infections occur; these clinical manifestations will be rarely diagnosed if they are not part of an outbreak. Most persons with confirmed STEC report bloody stools which typically begin 6–48 hours after the initial onset of non-bloody diarrhea. Diarrhea will likely be accompanied by abdominal pain and cramps; pain and cramps may be severe and may sometimes be the chief complaint. Nausea and vomiting are common. Fever is generally absent or low-grade in contrast to other bacterial enteric infections. Complications include thrombotic thrombocytopenic purpura (TTP) and hemolytic uremic syndrome (HUS).

HUS complicates 2–15% of diagnosed *E. coli* O157:H7 cases depending on age, and occurs less commonly after infections due to non-O157 STEC. Children under 5 years are most frequently affected.\* HUS is characterized by acute onset of microangiopathic hemolytic anemia, renal injury, and low platelet count. Early clinical signs of HUS may include decreased urine output, pallor, and lethargy. The degree and duration of renal failure in patients with the syndromes variable but long-term dialysis may be needed. In addition, there is an increased risk of stroke and other thrombosis-related complications. TTP, another complication of *E. coli* O157:H7 infection which primarily affects adults, resembles HUS but includes fever and neurologic signs such as seizures or confusion.

\*Clin Infect Dis 2009 Nov 15;49(10):1480-5

### C. Shiga toxin-producing *E. coli* in Washington State

DOH receives 140–200 reports of STEC each year. *E. coli* O157:H7 was first identified in Washington during 1986 outbreaks in Seattle, Spokane, and Walla Walla. Sources implicated in *E. coli* O157:H7 outbreaks in Washington have included animal exhibits, beef, produce, raw milk, and recreational water. Six to eighteen cases of HUS have been reported annually in Washington in recent years.

### D. Reservoirs

*E. coli* are ubiquitous in the intestines of warm-blooded vertebrates. Cattle are the best characterized reservoir species for *E. coli* O157:H7 and up to 50–80% of cattle herds (beef and dairy) may be colonized. The organism does not cause illness in bovines. There is no effective method to eradicate the organism from herds. Other potential sources of human infection include deer, elk, sheep, and goats. There have been rare reports of *E.*

*coli* O157:H7 being isolated from other species including dogs, horses, flies and seagulls. The reservoirs for non-O157 STEC are not well characterized.

### E. Sources and Modes of Transmission

Fecal-oral transmission is the most common mode. For *E. coli* O157:H7, ingestion of contaminated food or direct contact with animals on farms or at petting zoos is common. Undercooked beef (especially hamburger), foods cross-contaminated from raw beef, and raw milk contaminated with cattle feces are the prototypical sources of common-source outbreaks. Venison is another potential source.

Contaminated produce, including leafy greens, alfalfa sprouts, and unpasteurized apple cider are other recognized exposure sources. Person-to-person transmission can occur directly (households, child care centers, institutions) or indirectly (contaminated drinking or recreational water).

In all of these modes of transmission, the infectious dose is very low.

### F. Incubation Period

1–8 days; usually 2–6 days (longer incubations are possible but uncommon)

### G. Period of Communicability

Adults will typically excrete *E. coli* O157:H7 for up to a week but up to one third of children will excrete the pathogen for as long as 3 weeks. Prolonged carriage is uncommon, but can occur.

### H. Treatment

Supportive therapy with hydration is usually sufficient to treat this infection. Most people recover within 5–10 days without antibiotics and most experts do not recommend the use of antibiotics for treatment. Some studies have shown that the use of antibiotics is associated with the development of HUS. Antidiarrheal agents, such as loperamide (Imodium<sup>®</sup>), should also be avoided.

Data from the Foodborne Diseases Active Surveillance Network found young children have an increased risk of HUS after *E. coli* O157 infection, while elderly have the highest rate of death associated with *E. coli* O157 infection, regardless of developing HUS.

These findings support recommendations that young children and elderly persons should receive aggressive supportive care during early stages of illness due to *E. coli* O157:H7.\*

Although the O157:H7 serotype may be more likely to cause hospitalization and HUS, non-O157 *E. coli* infections do result in bloody diarrhea, hospitalization, and HUS. In several small case series, up to 20-30% of identified non-O157 infections resulted in HUS. Consequently, non-O157 *E. coli* infections should be treated as aggressively as disease due to O157:H7 infections.\*\*

Children with bloody diarrhea should be closely monitored for the development of HUS. If a complete blood cell count with smear, blood urea nitrogen and creatinine are normal 3 days after the resolution of diarrhea, it is unlikely HUS will develop.

\*Clin Infect Dis 2009 Nov 15;49(10):1480-5

\*\* Clin Infect Dis 2006 Dec 15;43(12):1587-95

### 3. CASE DEFINITION

#### A. Clinical Criteria for Diagnosis

STEC infections are characterized by diarrhea of variable severity and abdominal cramps. Diarrhea is often bloody but non-bloody diarrhea does occur. Illness may be complicated by HUS or TTP and can lead to neurological complications, intestinal perforation or stroke. Asymptomatic infections can also occur.

#### B. Laboratory Criteria for Diagnosis

A laboratory diagnosis is made by isolating STEC from a clinical specimen. *E. 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.

#### C. Case Definition

##### 1. Suspect

A clinically compatible case with Shiga toxin identified from a clinical specimen OR  
A case of post-diarrheal HUS or TTP.

##### 2. Probable

Isolation of *E. coli* O157 from a clinical specimen, without confirmation of H7 antigen or Shiga toxin production OR

A clinically compatible case that is epidemiologically linked to a confirmed or probable case OR

A clinically compatible case with an elevated antibody titer to a known Shiga toxin-producing *E. coli* serotype (*serology is not available commercially*).

##### 3. Confirmed

Isolation of *Escherichia coli* O157:H7 or a Shiga toxin-producing *E. coli* from a clinical specimen. The O and H antigen serotypes should be reported when available.

### 4. DIAGNOSIS AND LABORATORY SERVICES

#### A. Diagnosis

STEC infection is confirmed by isolation of *E. coli* that produces Shiga toxin or is identified as the specific O157:H7 serotype from a clinical specimen. Many STEC infections are missed due to testing policies at commercial laboratories. It is recommended that all stool specimens submitted for diagnosis of community-acquired diarrhea be simultaneously cultured for *E. coli* O157 on selective and differential agar and assayed for non-O157 *E. coli* with tests that detect shiga toxin. This should be done regardless of patient age, season of the year, or presence or absence of blood in the stool.

Stools should be tested as early as possible in the course of the illness, since bacteria and/or Shiga toxin may be difficult to detect in the stool after one week of illness. Early detection of STEC contributes to proper patient management, especially among young children and elderly persons.

All STEC isolates should be forwarded to PHL for confirmation, serotyping (determining the type of O and H antigens), and pulsed-field gel electrophoresis (PFGE) subtyping as soon as possible. Laboratories that only use non-culture assays, such as enzyme immunoassay (EIA), should submit a stool specimen in broth for culture.

### **B. Tests Available at Washington State Public Health Laboratories (PHL)**

PHL can perform stool culture for STEC and/or confirm the identification of an isolate. Enzyme immunoassays (EIA) are used to detect the presence of Shiga toxin (Verotoxin). Non-O157 STEC are presumptively serotyped and then sent to CDC for confirmation.

All STEC isolates are sub-typed by Pulsed field gel electrophoresis at PHL. Isolates with indistinguishable PFGE patterns are consistent with, but do not prove a common source. Isolates with dissimilar PFGE patterns are likely to be from different sources.

Serologic tests for anti-O157 antibody levels are available at CDC for special circumstances.

Food samples from suspected outbreaks can be tested for STEC at PHL if approved by Communicable Disease Epidemiology. Try to obtain original food packaging.

Note that PHL require all clinical specimens have two patient identifiers, a name **and** a second identifier (e.g., date of birth) both on the specimen label and on the submission form. Due to laboratory accreditation standards, specimens will be rejected for testing if not properly identified. Also include specimen source and collection date.

### **C. Specimen Collection**

For stool culture, use a sterile applicator swab to collect stool, insert the swab into Cary-Blair transport medium, push the cap on tightly, label the tube, and mail immediately. Enclose a completed PHL Enteric Bacteriology form (available at: <http://www.doh.wa.gov/EHSPHL/PHL/Forms/Microbiology.pdf>) with all isolates and stool specimens.

Instructions for handling food specimens can be found in the PHL Directory of Services: <http://www.doh.wa.gov/EHSPHL/PHL/Forms/DirServ30.pdf>

## **5. ROUTINE CASE INVESTIGATION**

### **A. Identify Potential Sources of Infection**

Take a detailed 8-day food history using a standard supplemental STEC food history questionnaire, which can be found on the DOH website at: <http://www.doh.wa.gov/notify/forms/stec-hx.pdf>. Ask about possible exposures during the 8 days before onset of symptoms (longer incubations are possible but uncommon), including:

1. Household members or other contacts with a diarrheal illness. If one is identified, obtain the name, phone number or address and clinical information of the ill person. Anyone meeting the suspect or probable case definition should be reported and investigated in the same manner as a confirmed case.
2. Handling or eating beef. Ask about consumption of undercooked hamburger (pink or red) but, because of the possibility of cross-contamination, any ground beef consumption is

potentially an exposure. Get details about any beef consumed such as stores where purchased, dates of purchase, type of meat (e.g., lean or extra-lean hamburger, frozen patties), packaging, and how handled/cooked. Any raw beef is potentially a source of kitchen contamination, but intact cuts of meat (e.g., steaks, roasts) sold at retail are less likely to cause multi-household outbreaks.

3. Consumption of unpasteurized milk and unpasteurized dairy products. Identify the brands and/or sources, and find out when this consumption began. If a commercial unpasteurized product is named, notify Communicable Disease Epidemiology (CDE) immediately.
4. Dried meats (particularly home prepared) or activities related to deer or elk hunting (slaughtering, processing, or consuming game meat.)
5. Restaurant or other food service meals. Obtain the name and location of the restaurant and date of the meal.
6. Public gathering where food was consumed. Obtain the date, location, and sponsor of the event.
7. Raw, potentially contaminated produce, including sprouts, leafy greens, and unpasteurized apple juice or cider.
8. Source(s) of drinking water as well as water from streams or lakes (either consumed purposefully or accidentally during work or sports activity). Water used only after boiling need not be included. If a public water supply is implicated, consult CDE.
9. Recreational water exposure. This includes swimming, playing, or other exposure to lakes, streams, swimming pools, water parks or wading pools where water may have been swallowed.
10. Contact with livestock, especially cattle, or animals such as at a petting zoo.
11. Contact with diapered children with diarrhea, or children in child care or other setting for preschool children.
12. Occupational exposures. Evaluate the potential for exposure to human or animal excreta.
13. Travel outside Washington or the United States, or contact with others who have traveled outside the United States. Determine dates of travel.

### **B. Identify Contacts who Work in Sensitive Occupations**

Determine if any household member or close contact attends or works at a child care facility; or works as a food handler or health care worker. If so, see Sections 6 and 7.

### **C. Environmental Evaluation**

None, unless a commercial food service facility, child care center, or water supply is suspected as the source of infection.

## **6. CONTROLLING FURTHER SPREAD**

### **A. Infection Control Recommendations**

Although the O157:H7 serotype is more likely to cause serious illness and HUS, non-O157 *E. coli* infections do result in hospitalization and HUS. In several small case series, up to 20-30% of identified non-O157 infections resulted in HUS. Consequently, infection

control measures for non-O157 *E. coli* infections should be aggressive as those measures used to control O157:H7 infections.\*

\*Clin Infect Dis. 2006 Dec 15;43(12):1587-95

1. Hospitalized patients should be treated with standard precautions. Contact precautions should be used for diapered or incontinent persons for the duration of the illness or to control institutional outbreaks.
2. Cases should be educated regarding effective hand washing, particularly after using the toilet, changing diapers, and before preparing or eating food. The importance of proper hygiene must be stressed, as excretion of the organism may persist for several weeks.
3. School Restrictions: Children should not attend school as long as they have diarrhea.
4. Work and Child Care Restrictions: Food handlers, child care attendants, child care attendees, and healthcare workers require two negative stool specimens before returning to work or child care. The stool specimens should be collected 24 hours apart and not sooner than 48 hours after the last dose of antibiotics, if antibiotics were given. (Antibiotics are not recommended for treating illness due to STEC or asymptomatic carriage of STEC.) Persons may continue to be infectious for several weeks after diarrhea resolves and should be cautioned accordingly especially with regards to hand washing.

The Washington State Retail Food Code requires food-handlers to report STEC infections to their employer and requires employers to restrict STEC-infected workers from areas where unwrapped food or beverages are prepared and sold (if serving general populations) or to exclude them from the establishment (if serving highly susceptible populations). Such workers with confirmed STEC can only be cleared to return to work by the local health authority (WAC 246-215-251) (5).

5. If a suspected source of infection is identified and has the potential for transmitting infection to a defined population, advise persons who come in contact with this source on measures to avoid exposure (e.g., boil water or drink bottled water until private well is decontaminated).

## B. Case Management

Stool specimens to document that fecal shedding of the organism has stopped are not routinely indicated, except for the purpose of lifting work and child care restrictions.

## C. Contact Management

1. Symptomatic contacts: All contacts with symptoms compatible with STEC should be referred to a healthcare provider for assessment and laboratory testing. Persons in contact with a probable or confirmed case of STEC are probable cases, and should be managed and reported as such using separate forms.
2. Asymptomatic contacts: Testing an asymptomatic household member or other close contact who works as a food handler, healthcare worker, child care worker, or attends child care should be considered.
3. Education: All contacts should be educated about transmission routes, symptoms, and effective hand washing, particularly after using the toilet, changing diapers, and before preparing or eating food.

## D. Environmental Measures

If indicated, give advice on proper cooking and food handling practices to prevent infection.

## 7. MANAGING SPECIAL SITUATIONS

### A. Possible Foodborne or Waterborne Outbreaks

Call Communicable Disease Epidemiology immediately if you suspect a common-source outbreak.

### B. Case Attends or Works in a Child Care Facility

1. Interview the operator and inspect the written attendance records to identify other possible cases among staff or attendees during the previous month. Note: WAC170-295-3030 specifies that the operator keep a log of illnesses.
2. Review food handling, hand washing techniques, and diaper changing practices with the operator and staff.
3. If other cases are suspected, refer those currently ill to a health care provider for assessment and collect stool specimens from attendees and staff with a history of diarrheal illness in the past 3 weeks. This is important because STEC illnesses may be mild, and diarrhea may be non-bloody.
4. Exclude cases (including those who are asymptomatic) from child care facilities until they have two negative stool specimens collected at least 24 hours apart and at least 48 hours after discontinuation of antibiotics (Note: Antibiotics are not recommended for the treatment of illness due to STEC or asymptomatic carriage of STEC).
5. Parents of children in the same child care group as an STEC case should be notified of the occurrence of STEC illness in the group. Day care operators are required to notify these parents that their child was exposed to a communicable disease through a letter or posted notification (WAC 170-295-3030). The local health jurisdiction may use this notification as an opportunity to ask parents about gastrointestinal symptoms (especially diarrhea) in their child and add the following elements to the notification:
  - Children should be monitored carefully for signs of illness such as diarrhea, cramps, nausea and vomiting.
  - Medical care should be sought if such symptoms occur and the provider informed of the occurrence of STEC illness in the facility.
  - The daycare operator or local health jurisdiction should be notified should symptoms occur.
  - A symptomatic child should not be brought to the daycare facility nor placed in any other group of children.
  - Information on the illness and how transmission can be prevented.
6. If more than one case is suspected among attendees or workers, LHJs should inspect the facility.
7. Instruct the day care operator to call the LHJ immediately if new cases of diarrhea occur.

8. LHJs should follow-up with the child care center to ensure that surveillance and appropriate prevention measures are being carried out. Manage newly symptomatic children as outlined above.
9. Closure of the facility should be considered if it has been shown that transmission is occurring within the facility and if exclusion and sanitation controls are not adequate to stop ongoing transmission. Before closing a facility, the LHJ should assess the potential for spread to other day care settings in the community by dispersal of the children. Parents should be cautioned regarding placing their children in other child care groups, since asymptomatic shedding of the organism may occur.

### **C. Cases Linked to Raw Milk Products**

Environmental evaluation of the dairy will be a necessary part of any further investigation. Dairy investigations will be conducted by the Washington State Department of Agriculture.

### **D. Case Resides at a Health Care or Residential Care Facility**

Determine if there has been any unusual incidence of diarrheal illness within the past month. If so, investigate these reports to identify possible common-source outbreaks or continuing sources of exposure. If indicated, conduct a sanitary inspection of the facility. The extent of further investigation depends on circumstances.

## **8. ROUTINE PREVENTION**

**A. Vaccine Recommendations:** None.

### **B. Prevention Recommendations for STEC and Other Enteric Illnesses**

Advise individuals on measures to avoid further or future exposures including:

1. Avoid eating raw or undercooked meat, especially hamburger. Hamburger prepared at home should be cooked to an internal temperature of at least 160° F. While it is best to use a thermometer, cook at least until there is no red or pink remaining and meat juices have no color.
2. Avoid cross-contamination with meat or other potentially contaminated foods.
3. Wash fruits and vegetables thoroughly before consumption. Peel when possible.
4. Wash hands after caring for diapered children or incontinent persons, after using the toilet, and after handling soiled clothing or linens.
5. Wash hands after handling pets, fowl, other animals, raw meat, and raw poultry, and always before food preparation.
6. Avoid unpasteurized milk, and other unpasteurized products including soft cheese, juices, and cider.
7. Avoid drinking or swallowing untreated surface water. Untreated water should be boiled or otherwise disinfected before consumption.
8. Persons with diarrhea should not use recreational water venues (e.g., pools, lakes, interactive fountains, water parks) until 2 weeks after symptoms resolve.
9. Persons with diarrhea should not prepare food for others.

**ACKNOWLEDGEMENTS**

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**UPDATES**

**10/9/07** Section 8B (8): Persons with STEC should not use recreational water venues until 2 weeks after symptoms resolve.

**9/1/2010** General terminology: Shiga toxin-producing *E. coli* (STEC) replaces most references to EHEC to reflect updated usage.

Section 1B.3 Organism identification immediately notifiable by laboratories anticipated 2011.

Section 1C.2 HUS without preceding diarrheal disease no longer notifiable anticipated 2011.

Section 2H: Young children and elderly should receive aggressive supportive therapy during the early stages of STEC O157 disease as they are at higher risk of death regardless of whether or not they develop HUS.

Section 3B: Updates to laboratory criteria for diagnosis.

Section 4A: Updates to guidelines for clinical laboratory diagnosis of STEC.

Section 5A: Added request to complete standardized supplemental STEC food history form.

Section 7B: Added to recommendations for management of cases in a child care facility.

**January 2011:**

The Legal Reporting Requirements section has been revised to reflect the 2011 Notifiable Conditions Rule revision.

**November 2011:**

Section 6A: Language was clarified regarding exclusion of persons in high risk occupations.