

# Shiga toxin-producing *Escherichia coli*

## BASIC EPIDEMIOLOGY

### Infectious Agent

Shiga toxin-producing *Escherichia coli* (STEC) bacteria. *E. coli* are Gram-negative, rod-shaped bacteria that naturally exist in the mammalian digestive system. Over a hundred serotypes exist, however the most common serogroups isolated from person with diarrheal illness in North America are O157, O26, O111, O103, O45, O145, and O121. *E. coli* O157 and other serotypes produce potent cytotoxins called Shiga toxins. Shiga toxin-producing genes commonly identified are *stx1* and *stx2*.

### Transmission

Transmission occurs via the fecal-oral route and can occur through the ingestion of food or water that has been contaminated with human and animal feces. Transmission can also occur via direct contact with an infected person, fomite, animal or an animal's environment. Person to person spread is common within households and daycare centers.

### Incubation Period

STEC is shed in the stool of an infectious person for a variable amount of time after diarrhea has resolved, however, shedding typically occurs for 1 week or less in adults, but up to 3 weeks in one-third of infected children. Prolonged carriage is uncommon.

### Communicability

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.

### Clinical Illness

Symptoms can vary but predominant symptoms include severe abdominal pain and non-bloody diarrhea which can become bloody after 3 to 4 days.

### Severity

Hemolytic uremic syndrome (HUS) is a serious complication of STEC infections and can begin as symptoms resolve, usually within 3 weeks of infection. About 15% of young children and a smaller proportion of adults with *E. coli* O157 diarrhea develop HUS. HUS typically requires dialysis and death can occur in 3 to 5% of cases.

## DEFINITIONS

### Clinical Case Definition

An infection of variable severity characterized by diarrhea (often bloody) and abdominal cramps. Illness can be complicated by hemolytic uremic syndrome (HUS) or thrombotic thrombocytopenic purpura (TTP); asymptomatic infections can also occur, and the organism can cause extra-intestinal infections.

### Laboratory Confirmation

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

### Notes:

- As required by TAC, all cases of Shiga toxin-producing *E. coli* infections, including *E. coli* O157:H7, and cases where Shiga toxin activity is demonstrated, must submit isolates or specimens to the DSHS laboratory.
- *Escherichia coli* non-O157:H7 isolates must also have Shiga toxin-production verified to qualify for the "confirmed" case status. Shiga toxin can be demonstrated by EIA or PCR testing.

**Case Classifications**

- **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 the H antigen or detection of Shiga toxin or Shiga toxin genes, **OR**
  - A clinically compatible illness in a person with identification of an elevated antibody titer to a known Shiga toxin-producing *E. coli* serotype **OR**
  - A clinically compatible illness in a person with detection of Shiga toxin or Shiga toxin genes in a clinical specimen using a CIDT and no known isolation of *Shigella* from a clinical specimen, **OR**
  - A clinically compatible illness in a person with detection of *E. coli* O157 or Shiga toxin-producing *E. coli* in a clinical specimen using a CIDT, **OR**
  - A clinically compatible case that is epidemiologically linked to a confirmed or probable case with laboratory evidence, **OR**
  - A clinically compatible illness in a person that is a person that is a member of a risk group as defined by public health authorities in an outbreak
- **Suspect:**
  - Identification of an elevated antibody titer against a known Shiga toxin-producing serogroup of *E. coli* in a person with no known clinical compatibility **OR**
  - Detection of Shiga toxin or Shiga toxin genes in a clinical specimen using a CIDT and no known isolation of *Shigella* from a clinical specimen in a person with no known clinical compatibility, **OR**
  - Detection of *E. coli* O157 or Shiga toxin-producing *E. coli* in a clinical specimen using a CIDT with no known clinical compatibility, **OR**
  - A person with a diagnosis of post diarrheal HUS/TTP

**Notes:**

- EIA and/or PCR positive results for Shiga toxin-production, in the absence of an isolate, can only qualify a case as “probable”.
- Cases meeting confirmed or probable criteria for both STEC and HUS should be reported separately under each condition.
- A case should not be counted as a new case if a positive laboratory result is reported within 180 days of a previously reported positive laboratory result in the same individual, **OR**  
When two or more different serogroups are identified in one or more specimens from the same individual each serogroup/serotype should be reported as a separate case.

**SURVEILLANCE AND CASE INVESTIGATION****Case Investigation**

Local and regional health departments should promptly investigate all reports of Shiga toxin-producing *E. coli* infections. Investigations should include an interview of the case or a surrogate to get a detailed exposure history. Please use the Shiga Toxin-Producing *Escherichia coli* (*E. coli*) and/or Hemolytic Uremic Syndrome (HUS) Investigation Form available on the DSHS website: <http://www.dshs.state.tx.us/idcu/investigation/>.

**Case Investigation Checklist**

- Confirm laboratory results meet the case definition.
- Verify that the laboratory has forwarded an isolate or specimen from cases where Shiga toxin activity is demonstrated to the DSHS laboratory. If an isolate has not been sent, please request a specimen be submitted as required.
- Review medical records or speak to an infection preventionist or healthcare provider to verify case definition, identify possible risk factors and describe course of illness.
- Interview the case to get a detailed exposure history and risk factor information.
  - Use the **Shiga Toxin-Producing *Escherichia coli* (*E. coli*) and/or Hemolytic Uremic Syndrome (HUS) Investigation Form** to record information from the interview.

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- If the case is not available or is a child, conduct the interview with a surrogate who would have the most reliable information on the case, such as a parent or guardian.
- Provide education to the case or his/her surrogate about effective hand washing, food safety practices, and animal contact/handling precautions. See Prevention and Control Measures.
- Fax completed forms to DSHS EAIDU at **512-776-7616** or email securely to [FoodborneTexas@dshs.texas.gov](mailto:FoodborneTexas@dshs.texas.gov).
  - For lost to follow-up (LTF) cases, please complete as much information obtained from medical/laboratory records (e.g., demographics, symptomology, onset date, etc.) on investigation form and fax/email securely to DSHS EAIDU, noting case is LTF.
  - For HUS cases, please also submit the medical record along with the completed form
- Identify whether the case needs to be excluded based on occupation or attendance in a group setting.
- Examples include food handlers, child-care or health-care workers, or attend child-care as long as they have diarrhea. See Exclusions.
- If case is part of an outbreak or cluster, see Managing Special Situations section.
- All confirmed, probable and suspect case investigations must be entered and submitted for notification in the NEDSS Base System (NBS). Suspect cases are not included in the overall case counts but are included for programmatic review. Please refer to the *NBS Data Entry Guidelines* for disease specific entry rules.

### Prevention and Control Measures

- Routine hand washing with soap and warm water, especially:
  - Before preparing, handling or eating any food.
  - After going to the bathroom.
  - After changing a diaper.
  - After caring for someone with diarrhea.
  - After handling raw food, especially poultry and beef.
  - After any contact with animals, their living areas or their food.
- Avoid consuming raw milk, unpasteurized dairy products, and unpasteurized juices (like fresh apple cider). Prolonged heat treatment is required to destroy Shiga toxin.
- Follow food safety principles in the kitchen, especially:
  - Restrict any food preparation for other individuals until symptoms have resolved
  - Cook ground beef thoroughly. Ground beef and meat that has been needle-tenderized should be cooked to a temperature of at least 160°F (70°C). Use a thermometer to verify the temperature, as color is not a very reliable indicator of how thoroughly meat has been cooked.
  - Prevent cross-contamination in food preparation areas by thoroughly washing hands, counters, cutting boards, and utensils after handling raw meat and switching to items consuming raw such as vegetables
  - Wash fresh leafy greens, fruits and vegetables thoroughly with water.
- Avoid swallowing water when swimming and playing in lakes, ponds, streams, swimming pools, and backyard "kiddie" pools.
- Avoid participating in recreational water activities such as swimming while diarrhea is present and for two weeks after diarrhea has resolved.

### Exclusions

School/child-care: No exclusion specified for Shiga toxin-producing *E. coli* but the standard exclusion for diarrhea or fever applies:

- Children with diarrhea should be excluded from school/child-care until they are free from diarrhea for 24 hours without the use of diarrhea suppressing medications.
- Children with a fever from any infection should be excluded from school/child-care for at least 24 hours after fever has subsided without the use of fever suppressing medications.

Food Employees: Symptomatic food employees infected with Shiga toxin-producing *E. coli* are to be excluded from work. Asymptomatic food employees diagnosed with an infection from Shiga toxin-producing *E. coli* are to be excluded from working in a food establishment serving a highly susceptible population or restricted if

they do not serve a highly susceptible population.

Food employees can be reinstated with approval from the Regulatory Authority and if one of the following conditions is met:

- Medical documentation stating that the food employee is free of infection from Shiga toxin-producing *E. coli* based on test results showing two consecutive, negative stool specimen cultures. The stool specimens should be collected at least 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.) OR
- More than 7 days have passed since the food employee became asymptomatic (without the use of diarrhea suppressing medications) OR
- The food employee did not develop symptoms and more than 7 days have passed since being diagnosed.

Please see Guide to Excluding and Restricting Food Employees in Appendix A.

## MANAGING SPECIAL SITUATIONS

### Outbreaks

If an outbreak is suspected, notify the DSHS Emerging and Acute Infectious Disease Unit (EAIDU) at (512) 776-7676, or email an EAIDU foodborne epidemiologist at [FoodborneTexas@dshs.texas.gov](mailto:FoodborneTexas@dshs.texas.gov).

The local/regional health department should:

- Interview all cases suspected as being part of the outbreak or cluster.
- Request medical records for any case in your jurisdiction that died, is lost to follow-up, was too ill to be interviewed, or for whom there are no appropriate surrogates to interview.
- Prepare a line list of cases in your jurisdiction. Minimal information needed for the line list might include patient name or other identifier, DSHS or laboratory specimen identification number, specimen source, date of specimen collection, date of birth, county of residence, date of onset (if known), symptoms, underlying conditions, treatments and outcome of case, and risky foods eaten, foods eaten leading up to illness, or other risky exposures, such as animal contact and travel, reported by the case or surrogate.

Line list example:

ID	Name	Age	Sex	Ethnicity	Onset	Symptoms	Food	Animal	Notes
1	NT	34	F	W/N	2/4/16	Bl. D, F	Chicken, eggs	Dog	Dog food
2	PR	2	M	U/U	1/30/16	V,D,F	Chicken, spinach	None	Brother ill

- If the outbreak was reported in association with an apparent common local event (e.g., party, conference, rodeo), a restaurant/caterer/home, or other possible local exposure (e.g., pet store, camp), contact hospitals in your jurisdiction to alert them to the possibility of additional STEC cases.
- If isolates have not already been submitted to the DSHS laboratory for confirmation and whole genome sequencing, request hospital/clinical labs submit isolates for confirmation and whole genome sequencing testing. See Laboratory Procedures.
- Work with regulatory staff to conduct an environmental assessment, if needed.
  - Collect information on the implicated facility including:
    - Food safety practices, operations, anything that was unusual about the time period in question
    - Obtain names and contact information of those present at facility during

outbreak time frame, e.g., employees, food workers, customers, residents, students, etc.

- If food is suspected:
  - Obtain menus
  - Interview food employees for illness history and job duties.
  - Collect food samples or embargo food, if necessary.
    - Decisions about testing implicated food items can be made in consultations with an EAIDU foodborne epidemiologist.
  - Identify and correct any items that may have contributed to the outbreak
- Work with any implicated facilities to ensure staff, students, residents, and volunteers receive hand hygiene education, and review hygiene and sanitary practices currently in place including:
  - Policies on, and adherence to, hand hygiene
  - Storage and preparation of food
  - Procedures for changing diapers and toilet training
  - Procedures for environmental cleaning
- Recommend that anyone displaying symptoms seeks medical attention from a healthcare provider.
- Exclude individuals from handling food, engaging in child-care, healthcare work, or attending child-care, as long as they are symptomatic. See Exclusions in Case Investigation section.
- Enter outbreak into NORS at the conclusion of the outbreak investigation. See Reporting and Data Entry Requirements section.

#### Whole Genome Sequencing clusters:

- For clusters of cases that meet the cluster definition based on allele differences detected by CDC/PulseNet and/or the DSHS laboratory, a member of the DSHS Central Office EAIDU foodborne team will notify appropriate DSHS regional and/or local health department epidemiologists.
- Local/regional health departments with cases in their jurisdiction should:
  - Interview the case patient, even if they have already been interviewed as part of a routine disease investigation, using the cluster specific questionnaire attached in the email notification.
    - Fax the completed questionnaire promptly within timeframe designated in the cluster notification to DSHS EAIDU at **512-776-7616** or email securely to an EAIDU foodborne epidemiologist.
  - If the health department having jurisdiction of a case is unable to reach a case-patient after 3 attempts during normal working hours, and they are not able to call after hours, please call the DSHS regional office or DSHS EAIDU to discuss further.
  - If an interview is unattainable or the case is lost to follow-up, fax the completed coversheet and any case information to DSHS EAIDU.
  - Local/regional health department with cases will be notified by the EAIDU foodborne team of any CDC or DSHS conference calls and may participate, if able.

#### Notes:

- If a food item or food establishment is implicated, an EAIDU foodborne epidemiologist will notify appropriate state and/or federal partner agencies regarding the outbreak and the possibility of a common contaminated food source for the cases.
- Decisions about testing implicated food items can be made after consultation with an EAIDU foodborne epidemiologist and the DSHS Laboratory. The general policy is to test only food samples implicated in suspected outbreaks, not in single cases.

## REPORTING AND DATA ENTRY REQUIREMENTS

### Provider, School, Child-Care Facility, and General Public Reporting Requirements

Confirmed, probable, and clinically suspected cases are required to be reported **within 1 week** to the local or regional health department or DSHS EAIDU at **(512) 776-7676**.

### Local and Regional Reporting and Follow-up Responsibilities

Local and regional health departments should:

- Enter the case into NBS and submit an NBS notification on all **confirmed, probable, and suspect** cases.
  - Please refer to the *NBS Data Entry Guidelines* for disease-specific entry rules.
  - A case should not be counted as a new case if a positive laboratory result is reported within 180 days of a previously reported positive laboratory result in the same individual, unless additional information is available indicating a separate infection such as different serotypes/serogroups.
  - A notification can be sent as soon as the case criteria have been met. Additional information from the investigation may be entered upon completing the investigation.
- Fax completed forms to DSHS EAIDU at **512-776-7616** or email securely to [FoodborneTexas@dshs.texas.gov](mailto:FoodborneTexas@dshs.texas.gov).

When an outbreak is being investigated, local and regional health departments should:

- Report outbreaks within 24 hours of identification to the regional DSHS office or to EAIDU at **512-776-7676**.
- Enter outbreak information into the **National Outbreak Reporting System (NORS)** at the conclusion of the outbreak investigation.
  - For NORS reporting, the definition of an outbreak is two or more cases of similar illness associated with a common exposure.
  - The following should be reported to NORS:
    - Foodborne disease, waterborne disease, and enteric illness outbreaks with person-to-person, animal contact, environmental contact, or an indeterminate route of transmission.
  - Enter outbreaks into NORS online reporting system at <https://wwwn.cdc.gov/nors/login.aspx>
  - Forms, training materials, and other resources are available at <http://www.cdc.gov/nors/>
- To request a NORS account, please email [FoodborneTexas@dshs.texas.gov](mailto:FoodborneTexas@dshs.texas.gov)
  - Please put in Subject Line: NORS User Account Request
  - Information needed from requestor: name, email address, and agency name
  - After an account has been created, a reply email will be sent with a username, password, and instructions for logging in.

## LABORATORY PROCEDURES

All cases of Shiga toxin-producing *E. coli* infections, including *E. coli* O157:H7, and cases where Shiga toxin activity is demonstrated must be submitted to the DSHS laboratory.

In an outbreak or other special situation, the DSHS Laboratory can culture raw stool or stool in transport medium (e.g., Cary-Blair media) for Shiga toxin-producing *E. coli*. Contact an EAIDU foodborne epidemiologist prior to submitting raw stool or stool in transport medium for culture.

### Specimen Collection

- Submit pure cultures on an agar slant at ambient temperatures.
- If a pure culture is not available but Shiga toxin activity is demonstrated,
  - Submit stool specimen in Cary-Blair, Aimes, or Stuarts transport, on wet ice packs, OR
  - Submit stool specimens on broth or MacConkey broth, < 7 days old on wet ice packs, > 7 days old on dry ice.
- For raw stool or stool in transport medium, please refer to table below:

Specimen type	Transport time to lab from time of collection	Transport temperature
Raw stool	≤24 hours	4°C (ice pack)
Raw stool	>24 hours	Freeze immediately at ≤-70°C. Ship on dry ice.

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Stool in transport solution/medium	Time of collection to ≤3 days	Room temp or 4°C (ice pack)
Stool in transport solution/medium	>3 days	Freeze immediately at ≤-70°C. Ship on dry ice.
All	*The above transport times are optimal for recovery of pathogenic organisms. In the interest of public health, specimens will be accepted up to 30 days from date of collection.	*The above transport temperatures are optimal for the recovery of pathogenic organisms. In the interest of public health, specimens will be accepted at non-optimal temperature transport.

\* Note: Pathogen recovery rates decrease over time. For best results, submit ASAP.

**Submission Form**

- Use DSHS Laboratory G-2B form for specimen submission.
- Make sure the patient's name, date of birth and/or other identifier match exactly what is written on the transport tubes and on the G-2B form.
- Fill in the date of collection and select the appropriate test.
- If submitting as part of an outbreak investigation, check “Outbreak association” and write in name of outbreak.
- Payor source:
  - Check “IDEAS” to avoid bill for submitter.

**Specimen Shipping**

- Ship specimens via overnight delivery.
- DO NOT mail on Friday, or public holiday, unless special arrangements have been pre-arranged with an EAIDU foodborne epidemiologist or DSHS Laboratory.
- Ship specimens to:

Laboratory Services Section, MC-1947  
 Texas Department of State Health Services  
 Attn. Walter Douglass (512) 776-7569  
 1100 West 49th Street  
 Austin, TX 78756-3199

**Causes for Rejection:**

- Incorrect source of specimen
- Specimen not in correct transport medium
- Missing or discrepant information on form/specimen
- Transport media was expired
- Specimen too old

**FOOD SAMPLES AND ENVIRONMENTAL SWABS:**

Testing of food and environmental swabs is available at the DSHS laboratory.

For *E. coli* O157:H7, the DSHS laboratory can test:

- Environmental Swabs
- Foods

For the “Big 6” STECs (O26, O45, O103, O111, O121, and O145), the DSHS laboratory can test::

- Environmental Swabs
- Meat Samples
- Milk Samples

- Other Foods- decisions to test other food samples not listed above would be evaluated a case by case basis

Decisions about testing implicated food items can be made after consultation with an EAIDU foodborne epidemiologist and the DSHS Laboratory.

#### General policy

- Test only food samples or environmental swabs from facilities implicated in a suspected outbreak (not associated with single cases).
- In outbreaks, the DSHS lab will not test food samples or environmental swabs unless a pathogen has been identified in a clinical specimen.
- Food samples or environmental swabs must be **collected by a registered sanitarian.**

For further questions, please contact an EAIDU foodborne epidemiologist to discuss further.

## REVISION HISTORY

December 2021

- Updated Definitions, Managing Special Situations, and Surveillance and Case Investigation sections

March 2021

- Entire section