

# [E.coli o157:h7 outbreak of 2018 from romaine lettuce](https://assignbuster.com/ecoli-o157h7-outbreak-of-2018-from-romaine-lettuce/)

Introduction:

Escherichia coli are enteric bacterium that normally makes up part of the normal microflora of the large intestines of both humans and many warm-blooded animals, most species of E. coli being harmless benefiting their host by both crowding out pathogenic bacteria as well as synthesizing vitamin K (Bentley & Meganathan, 1982). However, there are many pathogenic strains of E. coli that can cause food borne illness with the most notable of them being E. coli serotype O157: H7. This strain is the most critical in regard to public heath as it is a Shiga toxin-producing Eschericia coli (STEC) which can cause the formation of hemorrhagic colitis as well as the potentially lethal hemolytic uremic syndrome (HUS), a form of kidney failure. E. coli O157: H7 has been estimated by the Centers of Disease Control (CDC) to cause 36% of the estimated annual 265, 000 STEC infections each year ( Centers of Disease Control, 2016). A study conducted by Frenzen, Drake, & Angulo (2005) estimated the cost of E. coli O157: H7 in the U. S. annually to be $405 million.

E. coli O157: H7 was first isolated in 1975 but was identified as pathogenic enterobacteria in 1982, when 47 people in Michigan and Oregon developed hemorrhagic colitis from eating contaminated burgers at McDonalds (Riley et al., 1983). Later cases exhibited how E. coli O157: H7 could lead to the development of hemolytic uremic syndrome in those infected with the disease such as the multistate outbreak of E. coli O157: H7 in 1992 through early 1993 that was the result of consumption of contaminated hamburgers ( Bell et al., 1993). The resulting outbreak caused 501 hospitalizations, 45 cases of HUS, and three deaths. One of the most severe outbreaks in the U. S. occurred in 2006 which was linked to baby spinach that was contaminated with E. coli serotype O157: H7, leading to 199 people becoming infected in 26 states. 51% of those who fell ill became hospitalized, 16% developing HUS, and resulting in 3 deaths. Those who died of HUS were two elderly women and one 2-year old child (CDC, 2006). The most recent outbreak of E. coli O157: H7 occurred from mid-March of 2018 to early June of 2018 that was linked to the consumption of contaminated romaine lettuce.

E. coli O157: H7 is a Gram-negative coliform that is rod shaped and is a facultative anaerobe. It is classified as an enertohemorrhagic E. Coli (ETEC) by its virulence factors serotype involving two antigens; the lipopolysacchride based O- antigen that is located on the cell membrane of the bacteria and the flagellar H-antigens. This is where

The main virulence factor of E. coli O157: H7 is the Shiga toxin it produces which inhibits protein synthesis and can damage ribosomes which can cause “ ribotoxic stress response” that can cause inflammation as well as cell death (Melton-Celsa, A. R., 2014). Shiga toxin comes in two varieties: Stx1a and Stx2a. Stx2a is more responsible for the severe disease symptoms in humans than Stx1a (Melton-Celsa, A. R., 2014). The morphology of E. coli O157: H7 consists of small, circular, and colorless and clear colonies that are slightly raised in elevation, smooth, and translucent. The natural reservoir of E. coli O157: H7 is the GI tract of bovine cattle, with the fecal matter being a major source of contamination (Lim et al. 2006). Other ruminants such as deer, sheep and goats are considered significant carriers of pathogenic E. coli as well (Grauke et al., 2002).

The most common source of E. coli O157: H7 is raw or undercooked beef, present in both ground and whole cuts of beef that is contaminated from the feces of bovines during slaughter and processing. Other sources of the pathogen are raw and unpasteurized milk, unpasteurized juice (Cody et al., 1999), raw cheeses, water that is contaminated from feces containing E. coli O157: H7. Leafy greens such as spinach and lettuce, bean sprouts, and cucumbers are common sources of E. coli O157: H7 that becomes contaminated by either handlers or water with the bacteria already present.

E. Coli O157: H7 infects those who consume food or water contaminated with the bacteria or who are in close proximity to those who have consumed contaminated food or asymptomatic carriers. Only about 10 to 100 CFUs need to be digested to cause illness via colonization of the intestines (Rahal, E. A., 2012). The oral-fecal route is the most common method of person to person transmission as well as through contact with the feces of cows, goats, pigs and other carriers without proper hand washing afterwards. The other main cause of transmission is from eating undercooked beef and unpasteurized milk. However, the rising rates of transmission through consumption of foods typically eaten raw such as various leafy greens and fruits are a growing cause for concern as E. coli O157: H7 is destroyed by cooking foods until all parts are 70⁰C or higher (WHO, 2018).

Once the bacteria reach the digestive tract, they begin to cause symptoms of illness 1-10 days after ingestion of the bacteria with an average incubation period being three to four days. ( Nauschuetz, W., 1998). The symptoms of infection begin as watery diarrhea that is often bloody, crampy abdominal pain and vomiting. These symptoms usually clear up within five to ten days without treatments such as antibiotics (medlineplus. gov, 2016). The Shiga toxin produced by E. coli O157: H7 can damage the intestinal tract and can cause a form of kidney failure known as hemolytic uremic syndrome (HUS) that can form one week after the bloody diarrhea begins to improve in 5-10% of people infected with E. coli O157: H7. Hemolytic uremic syndrome is characterized by decreased urination, darkened urine color that has been described as “ tea-like” (FoodSafety. gov, 2009), exhaustion, and reduced color in the cheeks and undereye area ( CDC, 2018). HUS usually results hospitalization and can cause death in 3-5% of people who develop the complication. However, it mainly affects those with weaker immune systems such as the elderly and very young children.

E. coli O157: H7 is usually diagnosed in people by first taking a stool sample from a person suspected to be infected then is typically isolated on a Sorbitol MacConkey agar streak plate supplemented with MUG (4-methyl-umbelliferyl-D-glucuronide). The colonies of E. coli O157: H7 appear clear on the agar due to its inability to ferment the sorbitol in the growth medium. The E. coli serotypes are further confirmed by latex agglutination assays (Lim, 2010). However, these methods are time consuming and time is critical in treatment of individuals infected with E. coli O157: H7 so alternative methods of detection such as antibody detection methods as well as Polymerase Chain Reactions (PCR) to identify Shiga toxin producing genes ( Gerritzen, A., 2011) coupled with DNA extraction from the stool samples are quickly becoming more widely used due to their swift achievement of results, leading to appropriate treatment being administered sooner to patients which can save lives.

Most cases of E. coli O157: H7 infections resolve themselves in most people with five to ten days without the need of treatment. However, consistent consumption of fluids with electrolytes can help ease symptoms of the diarrhea associated with the disease and reduce the risk of developing HUS (Goldwater, P. N., Bettelheim, K. A., 2012). Antibiotics actually have been found to actually be ineffective or harmful to those suffering bloody diarrhea and are not advised to be taken when these symptoms are present ( NIH, 2011). Antibiotics may even increase the chances of an individual developing HUS. Those who do develop HUS should be hospitalized due to the risk of kidney failure that can result in death. 90% of people who develop HUS recover fully due to it being self limiting so general treatment via intravenous hydration is the most effective. Those with incomplete recovery of renal functions may require maintenance dialysis and transplantation (Kavanagh, D., 2014).

Prevention of E. coli O157: H7 is mainly about hygiene, with hand washing before and after preparing food, interacting with carrier animals such as cows and goats and their environment (foodsafety. gov, 2009). Another effective strategy is cooking beef to 160⁰F and avoiding any pink flesh in burgers or other cuts of beef. People should avoid consuming high risk foods such as bean sprouts, raw or undercooked beef, raw or unpasteurized milk, cheeses made from raw milk, and raw/ unpasteurized juices. Also thoroughly washing leafy greens and buying heat treated bean sprouts can reduce chances of infection. Drinking water that has been treated with an adequate and effective amount of chlorine is another preventative measure as many cases of E. coli O157: H7 infection comes from water contaminated with infected feces or untreated water sources (wonder. cdc. gov, 2016). Swimming in or swallowing water in natural bodies of water and swimming pools is also advised to prevent infection as the oral-fecal route is the most common route of person-to-person transmission of E. coli O157: H7.

Outbreak Details:

The E. coli O157: H7 outbreak of 2018 that was linked to romaine lettuce began in mid-March, with the first reported case being in March 13 but the first group of reported illness occurred in New Jersey with 8 people ending up hospitalized by early April. New Jersey heath officials alerted the FDA offices in the state on April 4 th to the potential outbreak and by April 9 th , the cases has spread to 7 states and 17 people reporting the same illness and 6 people becoming hospitalized and one developing hemolytic uremic syndrome (HUS). The age range of the afflicted was 12-84 with the median being 41 and 61% of the infected were female (CDC, 2018). At this early point in the outbreak, it was unknown what caused the outbreak but many restaurants and fast food joints, including Panera Bread, were under investigation (CNBC, 2018). Officials working at the New Jersey Department of Health also supplied the CDC and FDA with diagnostic tests from many of the infected individuals showing that they were sick with E. coli . CDC officials began using PulseNet to attempt to identify what serotype the obviously pathogenic strain of E. coli was (CDC, 2018a).

PulseNet is a network for collecting and sharing pulsed field gel electrophoresis (PFGE) fingerprints of microorganisms to help identify and distinguish strains of pathogens around the country that is operated and managed by the CDC. Pulsed field gel electrophoresis is used in conjunction with whole genome sequencing (WGS) to develop a DNA “ fingerprint” of microorganisms to use within PulseNet to identify microorganisms across the country that may be part of an overall outbreak.

By April 12 th , the number of cases had increased to 35 people over 11 states with no deaths yet occurring. The age range of victims was from 12 to 84 with a median age of 29 and 69% of victims being female. The number of people hospitalized with hemolytic uremic syndrome had increased to 22 individuals over the entire period this had taken place. A survey of 28 of the infected people conducted by the CDC found that 93% of people reported consuming romaine lettuce a week before developing symptoms. This is in line with the incubation period typical of E. coli. Most of those interviewed cited salads they had eaten at restaurants with bagged romaine lettuce being the only leafy green in common amongst the various establishments. This is also typical of E. coli as it is becoming increasingly more of a common source of the bacteria. PulseNet and other investigations pointed to the origin of the lettuce being Yuma, Arizona. This is not surprising as much as 90% of the lettuce grown in the winter season(from November to late March) in the U. S. comes from Yuma as well as most of the agricultural land in Yuma County being dedicated to lettuce (Nolte, K. D.). Later investigation found the lettuce to be contaminated with E. coli O157: H7. At this time the CDC advised many retailers, restaurants, doctors, and consumers about the outbreak and what they could do if they developed symptoms and how to prevent illness as well as how to treat the disease ( CDC, 2018b)

On April 19 th , Alaskan state health officials announced through a press release that it had been discovered that eight cases of gastroenteritis in inmates in Nome, Alaska had been linked to E. coli O157: H7 (Alaska DHSS, 2018). It was found that the inmates at the Anvil Mountain Correctional Facility had been sickened through the consumption of whole head romaine as well as romaine lettuce hearts grown in Yuma, Arizona. No prisoners were hospitalized or died as a result of the E. coli O157: H7 and no over cases were reported in the state of Alaska. After this information came to light, the CDC changed its recommendations to avoid all forms of romaine lettuce, not just bagged and pre-chopped romaine lettuce. After this announcement, the FDA was able to trace back the lettuce from the Alaskan correctional facility that had caused illness to a farm, Harrison Farms, in the Yuma, Arizona area (Sun, L. H. & Achenbach, J., 2018). The farm was growing any more lettuce by the time the FDA made the confirmed connection of the farm to the Alaskan outbreak.

By April 25 th , 84 people, ranging in age from 1 to 88 had been infected with E. coli O157: H7 with 65% of them being female. 42 people had been hospitalized by this time and no deaths had yet occurred. A subsequent interview of 67 people who had been infected found that 96% people had consumed romaine lettuce a week before they had fallen ill.

On May 2 nd , the FDA received information that the final harvest date of the contaminated romaine lettuce in Yuma, Arizona was April 16, 2018. By this time, 121 people had been infected with E. coli O157: H7, with 52 being hospitals and 14 of those people had developed HUS. A death was reported from California by no information was released by either the FDA or the CDC (Stobbe, M., 2018).

By May 15 th , a total of 172 people had been infected with E. coli O157: H7 with the age range of people being affected being 1-88 with the median age being 29. 75 people were hospitalized is HUS and no other deaths had been reported yet. The CDC and FDA reported to the public that any of the contaminated lettuce from Yuma, Arizona was unlikely to be in stores or restaurants so lettuce should be safe to eat again.

By May 30 th , a total of 197 people were infected in 35 states with the median age of infection being 29, 89 people being hospitalized for HUS and the death count going up to 5 individuals. Their information was not released by either the FDA or the CDC but the dead were from California, New York, Arkansas and two from Minnesota. Another survey was taken of 158 of those who had been affected, with 89% of them confirming they had consumed romaine lettuce a week before falling ill. Many of those who did not eat romaine lettuce actually got sick from close personal contact from someone who had and was infected.

From June 4 th to June 8 th , the FDA conducted environmental testing in the Yuma, Arizona area to help locate the source of the E. coli O157: H7 (FDA, 2018a). No single farmer or supplier had been found to be the source of the outbreak. However it was found that 3 samples of water from irrigation canals in growing areas of Yuma, Arizona were indeed the source of the outbreak as it contained E. coli O157: H7 and it was made public in an announcement by the FDAand CDC on June 28th (FDA, 2018b).

By June 28 th , the outbreak was declared over by the CDC as no new cases had come up in 2-3 weeks, which is how long it takes on average for someone to become sick and then it be reported to the CDC.

E. coli O157: H7 outbreaks have become very common in the U. S. since the initial outbreak in 1982, an example of this being how there was another E. coli O157: H7 right before the outbreak discussed in this paper and now another outbreak, related to beef, has started a few months after the outbreak caused by romaine lettuce. E. coli O157: H7 is far more common though in developing countries due to the lack of access to sanitary water as well as more lax rules on food sanitation.

If the water in the irrigation canals had been properly sanitized, say by using UV light to irradiate the water, then that could have killed off a lot of the pathogenic bacteria. Also, with the prepackaged lettuce, they should have been thoroughly washed and also irradiated to help kill off any bacteria that could have still be on it. However, in the future the sanitation of irrigation water needs to be monitored and controlled much more rigorously.

The main group of consumers who were affected were women. This could have been because women are often more heath conscious than men and tend to both eat out and eat more salads than men and salads were identified as a food many of the initial victims ate before falling ill. Due to the bad publicity that comes from causing a food borne illness outbreak, I believe that the business of the area will suffer as people may be hesitant to buy lettuce from that area again or will buy different leafy greens, avoiding romaine lettuce.

I believe that government facilities such as the FDA and CDC need to continue to find the source of the E. coli bacteria before they can draft and enforce new rules that could help eliminate this from happening again. However, I believe in 10 years that new environmental regulations could be passed to eliminate or reduce contamination of irrigation canals and enforce regular testing of these waterways not in just Yuma, Arizona, but all over the country.

Conclusion:

In conclusion, the E. coli O157: H7 outbreak resulting from contaminated romaine lettuce is merely one of a quickly growing number of outbreaks related to this bacteria. Its ease of infection and low number of bacteria needed to infect a person with a potentially fatal illness makes this illness a large threat to the continuing health and safety of not only the United States, but the world as a whole. With leafy greens fast becoming near equal to beef as being the main source of this potentially lethal microbe, it is imperative for both growers and the FDA to work on how to reduce the sources of contamination as well as post- growth processes to reduce the bacterial load of the product. Many produce growers need to become more compliant with FSMA and work closer with the federal and state governments to make sure what they are supplying to consumers is safe to eat as well as delicious. With another E. coli outbreak already occurring with beef, it’s only a matter of time before the cycle repeats itself.

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| Table 1: Summarization Table of the Multistate E. coli O157: H7 Outbreak of 2018  |
| Etiological agent  | Shiga toxin producing Eschericia coli (SHEC) serotype O157: H7  |
| Food source  | Whole head and pre-cut and bagged romaine lettuce  |
| Location  | U. S. A : 36 States, starting in New Jersey Source of contaminated food product: Yuma, Arizona  |
| Number of people infected  | 210 people infected 96 cases requiring hospitalization, 27 developing HUS 5 deaths  |
| Age/gender of infected individuals  | Age range: 1 to 88 years. Mean age of 26. 67% of infected individuals were female. At least 3 children had to be hospitalized  |
| Nature of disease  | Acute toxicoinfectious disease/Lethal  |
| Timeline of outbreak  | First Case: March 13, 2018 Alaskan outbreak: April 19th First Death: May 2 nd Other Deaths: May 15 th -May 30th End out outbreak: June 28, 2018  |
| Primary reason for outbreak  | Romaine lettuce was contaminated by water from nearby irrigation canals that were found to have E. coli O157: H7 present. How the canal water became contaminated is still unknown.  |

References:

       Bell, BP., et al. (1994) A Multistate Outbreak of Escherichia coli O157: H7—Associated Bloody Diarrhea and Hemolytic Uremic Syndrome From Hamburgers. JAMA 272 : 1349. doi: 10. 1001/jama. 1994. 03520170059036

* –Bentley, R. & Meganathan, R. (1982). Biosynthesis of vitamin K (menaquinone) in bacteria. Microbiological revie ws vol 46, 3. (pp 241-80). U. S. National Library of Medicine.
* –Centers of Disease Control and Prevention (2016). Eschericia coli (E. coli) Factsheet. https://www. cdc. gov/ecoli/pdfs/CDC-E.-coli-Factsheet. pdf

       Centers of Disease Control and Prevention (CDC) (2018a) E. coli (Escherichia coli). Centers for Disease Control and Prevention. https://www. cdc. gov/ecoli/2018/o157h7-04-18/index. html.

       Centers of Disease Control and Prevention (CDC) (2018b) E. coli (Escherichia coli). Centers for Disease Control and Prevention. https://www. cdc. gov/ecoli/2018/o157h7-04-18/advice-consumers. html.

* –CDC Wonder. (1993) Preventing Foodborne Illness: Escherichia coli O157: H7. Centers for Disease Control and Prevention. https://wonder. cdc. gov/wonder/prevguid/p0000417/p0000417. asp.

       Cody, S. H., et al. (1999) An Outbreak of Escherichia coli O157: H7 Infection from Unpasteurized Commercial Apple Juice. Annals of Internal Medicine 130 : 202–209. doi: 10. 7326/0003-4819-130-3-199902020-00005

* –Food and Drug Administration (2018a) FDA Investigated Multistate Outbreak of E. coli O157: H7 Infections Linked to Romaine Lettuce from Yuma Growing Region. U S Food and Drug Administration Home Page. https://www. fda. gov/food/recallsoutbreaksemergencies/outbreaks/ucm604254. htm.
* –Food and Drug Administration (2018b) Press Announcements – Statement from FDA Commissioner Scott Gottlieb, M. D., on findings from the romaine lettuce E. coli O157: H7 outbreak investigation and FDA’s efforts to prevent future outbreaks. In: U S Food and Drug Administration Home Page. https://www. fda. gov/NewsEvents/Newsroom/PressAnnouncements/ucm624867. htm.

       Foodsafety. gov (2009) E. coli. FoodSafety. gov. https://www. foodsafety. gov/poisoning/causes/bacteriaviruses/ecoli/index. html

* –Frenzen PD, Drake A, Angulo FJ (2005). Economic Cost of Illness Due to Escherichia coli O157 Infections in the United States. Journal of Food Protection 68 : 2623–2630. doi: 10. 4315/0362-028x-68. 12. 2623
* –Gerritzen, A., Wittke, J. W., Woldd, D. (2011). Rapid and sensitive detection of Shiga toxin-producing Eschericia coli directly from stool samples by real-time PCR in comparison to culture, enzyme immunoassay and Vero cell cytotoxicity assay. Clinical Laboratory, 57(11-12). pp 993-998.

       Goldwater P. N., Bettelheim K. A., (2012). Treatment of enterohemorrhagic Escherichia coli (EHEC) infection and hemolytic uremic syndrome (HUS). BMC Medicine. doi : 10. 1186/1741-7015-10-12

       Grauke LJ, Kudva IT, Yoon JW, et al (2002) Gastrointestinal Tract Location of Escherichia coli O157: H7 in Ruminants. Applied and Environmental Microbiology 68 : 2269–2277. doi: 10. 1128/aem. 68. 5. 2269-2277. 2002

* –Kavanagh, D., Raman, S., & Sheerin, N., S. (2014). Management of hemolytic uremic syndrome. F1000Prime Rep, 6. Doi: 10. 12703/P6-119.

       Lim JY, Li J, Sheng H, et al (2006) Escherichia coli O157: H7 Colonization at the Rectoanal Junction of Long-Duration Culture-Positive Cattle . Applied and Environmental Microbiology 73 : 1380–1382. doi: 10. 1128/aem. 02242-06

 Lim JY, Yoon JW, Hovde CJ (2010). A Brief Overview of Eschericia coli O157: H7 and Its Plasmid O157. Journal of microbiology and biotechnology. https://www. ncbi. nlm. nih. gov/pmc/articles/PMC3645889/#R13 .

       medlineplus. gov (2018) E. Coli Infections. MedlinePlus. https://medlineplus. gov/ecoliinfections. html#summary.

       Melton-Celsa, A. R., (2014) Shiga Toxin (Stx) Classification, Structure, and Function. Microbiology Spectrum. doi: 10. 1128/microbiolspec. ehec-0024-2013

 National Institute of Allergy and Infectious Diseases (NIH) (2018) Shiga Toxin-Producing E. coli (STEC). https://www. niaid. nih. gov/diseases-conditions/shiga-toxin-producing-e-coli.

* — Nolte, K. D., Winter Lettuce Production: Yuma, Arizona. University of Arizona Lectures. https://cals. arizona. edu/fps/sites/cals. arizona. edu. fps/files/Lettuce%20Production%20Presentation. pdf
* — Nauschuetz, W., (1998). Emerging foodborne pathogens: enterohermoragic Eschericia coli . Clin Lab Sci 11: 298-305.

       Office of the Commissioner (2018) Press Announcements – Statement from FDA Commissioner Scott Gottlieb, M. D., on findings from the romaine lettuce E. coli O157: H7 outbreak investigation and FDA’s efforts to prevent future outbreaks. U S Food and Drug Administration Home Page. https://www. fda. gov/NewsEvents/Newsroom/PressAnnouncements/ucm624867. htm.

       Rahal EA, Kazzi N, Nassar FJ, Matar GM (2012) Escherichia coli O157: H7—Clinical aspects and novel treatment approaches. Frontiers in Cellular and Infection Microbiology . doi: 10. 3389/fcimb. 2012. 00138

* –Riley LW, Remis RS, Helgerson SD, et al (1983.) Hemorrhagic Colitis Associated With A Rare Escherichia Coli Serotype. New England Journal of Medicine 308 : 681–685. doi: 10. 1056/NEJM198303243081203

       Stobbe, M., (2018) First death reported in national E. coli outbreak linked to romaine lettuce. The Seattle Times. https://www. seattletimes. com/life/food-drink/1st-death-reported-in-romaine-lettuce-e-coli-outbreak/.

       Sun L. H., Achenbach, J., (2018). 22 states now affected by dangerous outbreak of E. coli illness from romaine lettuce. The Washington Post . https://www. washingtonpost. com/news/to-your-health/wp/2018/04/25/dangerous-e-coli-outbreak-from-romaine-lettuce-expands-with-19-states-affected/? noredirect= on&utm\_term=. 841b8afd0cbb.

       Whitten, S. (2018) E. coli outbreak in New Jersey could be tied to Panera Bread, report says. CNBC. https://www. cnbc. com/2018/04/06/e-coli-outbreak-in-new-jersey-could-be-tied-to-panera-bread-report-says. html.

* –World Health Organization (2018) E. coli fact-sheet . http://www. who. int/news-room/fact-sheets/detail/e-coli