

**E.coli o157:h7
outbreak of 2018
from romaine lettuce**



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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 health as it is a Shiga toxin-producing *Escherichia 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.

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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 enterohemorrhagic *E. Coli* (EHEC) 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 70°C 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
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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 160°F 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 health officials alerted the FDA offices in the state on April 4th to the potential outbreak and by April 9th, 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

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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 12th, 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 19th, 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 other 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 25th, 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 2nd, 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 hospitalized 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 15th, 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 30th, 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 4th to June 8th, 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 FDA and CDC on June 28th (FDA, 2018b).

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By June 28th, 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 health 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.

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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.

Table 1:

Summarization Table

<https://assignbuster.com/ecoli-o157h7-outbreak-of-2018-from-romaine-lettuce/>

of the Multistate *E.*

coli O157: H7

Outbreak of 2018

Shiga toxin

producing

Etiologic *Eschericia*

al agent *coli* (SHEC)

serotype

O157: H7

Whole head

and pre-cut

Food

and bagged

source

romaine

lettuce

Location U. S. A : 36

States,

starting in

New Jersey

Source of

contaminate

d food

product:

Yuma,

Arizona

210 people

infected

96 cases

Number

requiring

of

hospitalizati

people

on, 27

infected

developing

HUS

5 deaths

Age range: 1

to 88 years.

Mean age of

Age/

26.

gender

67% of

of

infected

infected

individuals

individua were female.

Is

At least 3

children had

to be

hospitalized

Nature Acute

toxicoinfecti
of ous
disease disease/Leth
al

First Case:

March 13,
2018

Alaskan

outbreak:

April 19th

First Death:

Timeline
of May 2nd

outbreak Other

Deaths: May

15th -May

30th

End out

outbreak:

June 28,

2018

Primary Romaine

reason lettuce was

for contaminate

d by water
from nearby
irrigation
canals that
were found
to have *E.*
coli O157:
outbreak
H7 present.
How the
canal water
became
contaminate
d is still
unknown.

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