

Preventing Foodborne Illness: Norovirus¹

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What are noroviruses?

Noroviruses are non-enveloped, single-stranded RNA viruses that belong to the *Caliciviridae* family. The most common cause of foodborne illness in the United States, these viruses are responsible for 20 million reported cases of acute gastroenteritis, or stomach flu, each year (CDC 2014a). These viruses can be found worldwide and are known only to infect human hosts. In addition to “Norovirus,” previous designations for this pathogen have included “Norwalk virus,” “Norwalk-like virus” (NLV), “winter vomiting disease,” and “acute non-bacterial gastroenteritis.”

What causes norovirus induced foodborne illness?

Contact with as few as 100 norovirus particles is sufficient to cause illness (CDC 2014b). However, unlike other foodborne pathogens, noroviruses (like all viruses) require a living host in order to replicate and are therefore incapable of multiplying in food. The viruses must be transmitted either directly through person-to-person contact or indirectly through ingestion of fecally contaminated food or water or contact with aerosolized vomitus droplets. Global surveillance data indicates that approximately 14% of all norovirus outbreaks are primarily foodborne (Verhoef et al. 2015). However, a single outbreak is often characterized by multiple transmission routes because the highly contagious

nature of the pathogen allows for rapid secondary person-to-person or environmental transmission.

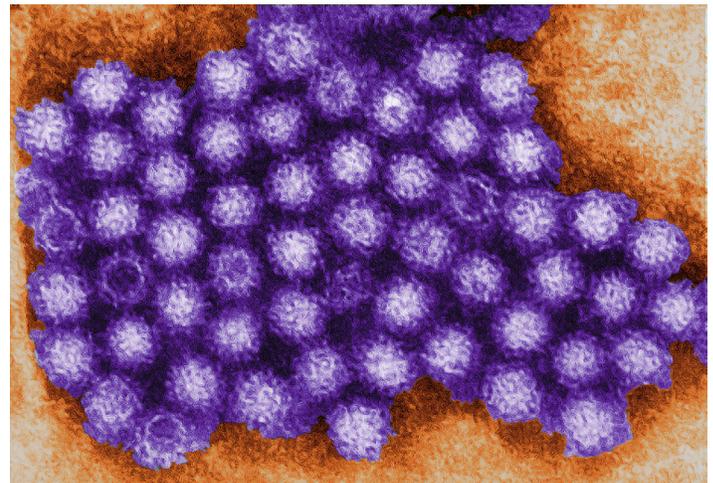


Figure 1. Transmission electron micrograph of norovirus particles
Credits: CDC/ Charles D. Humphrey

What are the symptoms associated with noroviruses?

Norovirus infection causes acute gastroenteritis. Although symptoms typically begin within 12 hours of ingestion of contaminated food or beverage, some may manifest as late as 48 hours after exposure. Such symptoms may include:

- Nausea

1. This document is FSHN0518, one of a series of the Food Science and Human Nutrition Department, UF/IFAS Extension. Original publication date September 2005. Revised April 2009 and June 2015. Visit the EDIS website at <http://edis.ifas.ufl.edu>.
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- Vomiting
- Diarrhea
- Abdominal cramps
- Headaches
- Fever/chills
- Muscle aches

Symptoms are usually self-limiting (resolve without medical intervention) and can persist for up to 48 hours. However, it is important to note that even after symptoms end, the infected individual will continue to shed infectious virus in his or her stool for several weeks.

Who is at risk?

Anyone exposed to contaminated food products is at risk for norovirus infection. However, immuno-compromised individuals, infants, and the elderly may require hospitalization for dehydration and electrolyte abnormalities because in these cases the infection can become severe and prolonged (Karst 2010). Due to the highly contagious nature of the pathogen, individuals in semi-closed communities such as hospitals, day care centers, retirement centers for the elderly, schools, prisons, and cruise ships are at higher risk for large-scale outbreaks (Karst 2010).

A suitable vaccine for norovirus is not currently available. Development of a norovirus vaccine is challenging because infection with this virus does not bring about the typical protective immune responses normally produced by the human body. Because norovirus is constantly undergoing genetic mutation, once a vaccine is developed it will likely require continual reformulation similar to the way the flu vaccine is reformulated each flu season.

What foods have been commonly associated with norovirus?

In 2011, outbreak surveillance data indicated that 58% of foodborne illness in the United States was caused by norovirus (Scallan et al. 2011). Most foodborne outbreaks of norovirus occur in restaurant or catering settings and are the result of contamination that takes place during food preparation. Food service workers may contaminate food by neglecting proper hand-washing, handling ready-to-eat (RTE) foods with bare hands, and working while ill (Hall et al. 2014). Examples of RTE foods include sandwiches, salads, and baked goods. Liquid items that do not require further processing such as cake icing or salad dressing often cause widespread outbreaks because the virus becomes evenly distributed throughout the product.

Additionally, filter-feeding shellfish such as oysters and clams present an elevated hazard because they ingest norovirus if it is present in surrounding water and concentrate it to much higher levels. Although norovirus cannot reproduce in marine water, it can survive in the environment once introduced. Sources of norovirus contamination to marine water can include faulty wastewater treatment facilities, storm water runoff, dumping of raw sewage, and overboard discharge of vomit near shellfish harvest beds (DOHWa 2013). Acute gastroenteritis outbreaks associated with contaminated shellfish have been reported all over the world. In 2013, norovirus was detected in 9% of oysters collected on the French market over a period of 16 months (Schaeffer et al. 2013). In the UK, 76.2% of oyster samples tested across 50 harvesting areas were positive for norovirus (FSA 2011).

Table 1 outlines recent norovirus outbreaks in the United States

How do noroviruses spread?

Infection and spread may occur by:

- Eating or drinking contaminated foods or beverages
- Touching surfaces or objects contaminated with norovirus, and then using unsanitary/bare hands in food preparation
- Direct contact with a person who is infected (for example, when caring for someone who is ill or sharing the food or utensils)
- Improper personal hygiene after using the restroom (i.e., not washing hands with soap and water) and then touching surfaces or food to be used by others

What sanitation methods are used to prevent infection?

Prevention of foodborne norovirus infection is based on the provision of safe food and water. Noroviruses are relatively resistant to environmental challenge: they are able to survive freezing temperatures as well as temperatures as high as 140°F (60°C) and have even been associated with illness from steamed shellfish. Noroviruses can survive in up to 10 ppm chlorine solution, which is well in excess of levels routinely present in municipal water (~1 ppm). Despite these resistances, relatively simple measures such as correct handling of cold foods and frequent hand washing may substantially reduce foodborne transmission of noroviruses. While such practices are easily achievable, they are ineffective if not enforced.

The following are examples provided by the CDC on how to prevent infection caused by norovirus:

- Since norovirus is found in the feces and fluids of infected individuals, it is imperative that proper hand washing techniques (see below) be followed after using the restroom and before preparing, handling, or consuming foods.
- Infected persons should not prepare or handle food.
- Food, clothing, or other surfaces potentially exposed to noroviruses should be immediately disinfected.
- Raw fruits and vegetables should be properly washed before consumption or use in food preparation.
- Raw sewage, including soiled diapers, should be properly and sanitarily disposed off.
- Shellfish should be properly cooked prior to consumption. According to the National Fisheries Institute (NFI) and the Food and Drug Administration (FDA), to prevent norovirus infection shucked shellfish (clams, mussels, and oysters without shells) should be boiled for three minutes, fried in oil at 375°F (191°C) for 10 minutes, or baked at 450°F (232°C) for 10 minutes.
- Many local and state health departments require that food handlers with gastroenteritis not work until two or three days after their symptoms improve—be aware of your local regulations.
- Businesses should keep sick children or children in diapers away from food preparation areas.
- Wash hands, utensils, and food contact surfaces (FCSs) with hot soapy water after they contact raw meat or seafood, before food preparation, and after using the bathroom.

How can food handlers prevent the spread of norovirus infection?

The number one method of avoiding contamination of food with viral, bacterial, and parasitic disease is for all food handlers to regularly and properly wash their hands. While regular hand washing is recommended, some events that should always be followed by thorough washing with soap and warm water for 20 seconds include:

- Before handling, preparing, or serving food

- Before handling clean utensils or dishware
- After using the restroom
- After touching your face, cuts, or sores
- After smoking, eating, or drinking
- After handling raw meat—especially poultry
- After touching unclean equipment, working surfaces, soiled clothing, soiled wiping cloths, etc.
- After collecting and taking out the garbage
- Before and after assisting someone with diarrhea, after cleaning the bathroom, and after changing diapers

What is the proper procedure for hand washing?

1. Wet your hands with warm water
2. Apply soap and wash your hands for 20 seconds.
 - Pay attention to hard-to-reach areas like knuckle creases, between fingers and under finger nails
 - Include the forearm past the wrist as you wash.
3. Rinse and then dry with a single-use paper towel. Some other hygienic tips are:
 - Do not share food, drinks, spoons, or straws.
 - If you have a child in day-care who has diarrhea, inform the day-care providers; they can make sure germs are not spread to other children.
 - Do not let anyone who has diarrhea use a pool or swim in a pond while they are sick.

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Table 1. Significant Norovirus Outbreaks in the US

Year	Location	Cases	Source/Restaurant
2010		1865 (12.0%) ^z	Cruise Ships
2010	Illinois	57	Wedding Banquet Hall
2010	Colorado	50	Summer Camp
2010	North Carolina	40	Church Potluck
2011		1183 (5.8%) ^z	Cruise Ships
2011	Florida	100	Kally K's Restaurant
2011	US	21	NBA Players
2011	Massachusetts	200	Restaurant Brunch
2011	Washington	3	Frozen Oysters
2012		3064 (7.2%) ^z	Cruise Ships
2012	California	100	Middle School
2012	Illinois	39	Steakhouse
2012	Oregon	90	Zoo Event
2012	Indiana	90	Subway
2012	Wyoming	167	Golden Corral
2012	Indiana	90	Jimmy John's
2013	Kansas	209	Jimmy John's
2013	Michigan	200	Tough Mudder Event
2013	Ohio	79	Health Convention
2013		1435 (8.4%) ^z	Cruise Ships
2013	Arkansas	300	Middle School
2014	Indiana	130	Elementary School
2014		1693 (7.5%) ^z	Cruise Ships
2014	Georgia	89	Unknown
2014	California	60	Hotel Banquet
2015	Kansas	123	Meals on Wheels
2015	Pennsylvania	154	East Stroudsburg University
2015	Oregon	16	Maggie's Buns
2015 ^y		357 (7.5%) ^z	Cruise Ships

^zTotal number of passengers reported ill on all cruise ships participating in the CDC Vessel Sanitation Program (VSP) for each year indicated. Percentages represent averages out of total number of passengers onboard (CDC 2015).
^yStatistic incomplete at the time of publication