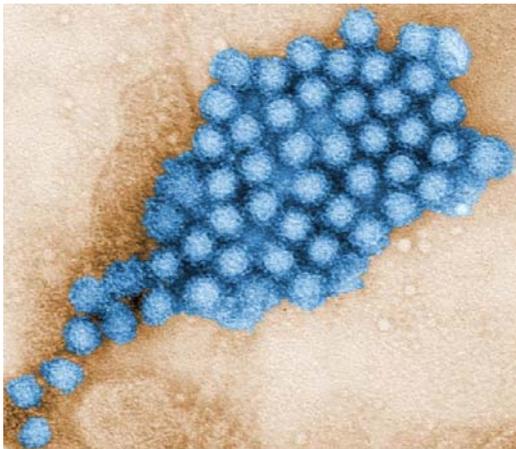


Viral Gastroenteritis: Awareness and Symptoms

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headaches and fatigue.² While these symptoms can last for 24 to 60 hours, up to 30% of people infected remain asymptomatic.³ Present treatment is primarily rehydration and supportive therapies such as anti-nausea medication. Immunity after infection is strain-

specific and appears to be limited in duration to a period of several weeks.⁴

Identification of the virus is relatively time consuming and costly. The disease has probably been around for thousands of years, ever since people began to help spread the disease by living in groups. But it has only been since 1972 that norovirus, rotavirus and others were actually observed in fecal specimens submitted by persons suffering from AGE. Viruses in general were not originally discovered until 1937 with the invention of the electron microscope. The genus norovirus is a single-stranded RNA that is non-enveloped. It belongs to the family Calcivirus and can be grouped into 5

genogroups (GI through GV) and then further into 34 genotypes. Human disease is primarily caused by GI, GII and GIV noroviruses³. Presently, rotaviruses are the leading cause of childhood AGE worldwide. Sensitive molecular assays have been developed to identify particular strains of virus. From such DNA analysis, vaccination trials are underway. There is a candidate norovirus vaccine approaching a phase 3 efficacy trial and could be potentially licensed within the next 5 to 7 years.⁵ The University of Cincinnati conducted a study with a vaccine they created that reduced symptoms in 52% of the participants.⁶

Norwalk virus was the first to be isolated. It was called Norwalk virus because it was identified from an outbreak that occurred at the Bronson Elementary School in Norwalk, Ohio. Since then, Norwalk viruses have been reclassified as noroviruses. Some people prefer the term Norwalk-like viruses (NLVs) since in Japan and elsewhere there are many families with

One hundred years ago it was called “winter vomiting disease” because the symptoms of vomiting and diarrhea occurred primarily in the winter months from November to April, peaking in January. More recently it has been referred to as “the stomach flu.” It should not be confused with the “flu” which is short for influenza, a respiratory illness caused by a different virus, the influenza virus. Now it has been named “viral acute gastroenteritis” (AGE) which includes illnesses caused by norovirus (NoV) and rotavirus, since they both cause severe inflammation of the stomach and intestines.¹

Symptoms include non-bloody diarrhea, vomiting, nausea, stomach cramping, body aches, low-grade fever, chills,



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the name of Noro that were offended. There are other similar viruses that include rotaviruses, astroviruses, enteric adenoviruses and classic human calciviruses which are also called sapoviruses. A recent sapovirus outbreak infected 500 persons at a Las Vegas marathon when ungloved volunteers dipped cups into plastic-lined containers filled with water supplied by the local fire department. One of the problems with trying to study norovirus, is that only some of these other enteric viruses, which are shed in lower quantities, can now be grown in cultures. For twenty years, electron microscopy was how they were all identified and in just a few labs worldwide⁵. More recently, inexpensive immunoassays have replaced electron microscopy. Around 1990, a major break-through occurred when the genetic sequences of the viruses were decoded. This opened up the way for new molecular diagnostics and a process called reverse transcription-polymerase chain reaction (RT-PCR) assay.¹ Kaplan's Criteria⁷ provides an easier option to diagnose gastrointestinal outbreaks likely to be associated with NLV. The

four criteria are:

- Stools negative for bacterial pathogens.
- A mean or median duration of illness of 12-60 hours.
- A mean or median incubation period of 24-48 hours.
- Vomiting in at least 50% of cases.

Hedberg and Osterholm⁸ proposed that having more cases with vomiting than fever in an outbreak could also be used as a further epidemiological criterion for NLV outbreaks.

Noroviruses appear to be most prevalent in young children and adults, especially the elderly, and are now recognized as the most common cause of outbreaks and hospitalizations for gastroenteritis in industrialized countries. At least 50% of all gastroenteritis outbreaks worldwide are caused by human norovirus.⁹ It is estimated that norovirus causes an average of 510 to 800 deaths, 56,000 to 71,000 hospitalizations, 400,000 emergency room visits, 1.7 to 1.9 million hospital outpatient visits and 19 to 21 million total

illnesses per year in the U.S. alone.⁵ That means that about 1 in 15 Americans will get norovirus illness each year.² and the average person will suffer five bouts of the disease during their lifetime.⁵ Persons over 65 are at the greatest risk for death while children under five have the highest rates of norovirus-associated medical care visits.

Economically, NoVs cost approximately \$625 per case - equivalent to \$3.7 billion each year with respect to US food-borne illnesses attributable to NoVs.¹⁰ Diarrhea is second only to the common cold as a cause of lost working time, with about 25 days lost from work or school each year for every 100 Americans.¹¹ According to the American Journal of Infection Control, norovirus accounts for 65% of ward closures and 18.2% of all infection outbreaks. A norovirus outbreak can potentially cost a facility up to \$65,000. The usual peaks of the disease seen in winter can be increased by up to 50 percent when new pandemic (worldwide) strains emerge.⁵ These estimates may still be low because viral gastroenteritis is not reportable in all states (although it is in Ohio).

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The mode of transmission for one of the Norwalk-like viruses called rotavirus is not clearly understood. But through genetic fingerprinting of its strains, outbreaks can often be traced back to fecal contaminated food or water and person-to-person transmission (food handlers). Norovirus is highly infectious and can be transmitted through a variety of routes, including direct contact with infected individuals, ingestion of contaminated food or water, and fomites (objects able to transmit the pathogen).^{12,13} Lamhoujeb reported that NoVs can persist on stainless steel and polyvinylchloride (PVC) surfaces from 1 to more than 7 weeks, depending on the surface, temperature, and relative humidity.¹⁴ Studies now have shown that some people naturally have more immunity against norovirus than others. But even though the strain diversity is so great, an effective cross-general protection of the population from people previously infected or from other strains does not occur due to the rapid mutations of the viruses that are observed. RT-PCR and quantitative PCR can detect even a few viral particles

but infected persons can shed the virus in small numbers for months. This complicates diagnosing illness because it is not known whether the viruses detected were the cause of the illness or were just still being shed from an earlier infection from which the patient had already recovered.

Norovirus takes from 12 to 48 hours to incubate in the human body with a mean of around 33 hours.¹⁵ A person is most contagious while actively ill and for three days afterward and will shed billions of viruses for up to two weeks. During an episode, a person may also vomit up to 20 times. It has been estimated that over 30 million virus particles can be liberated during vomiting.¹⁶ Respiratory spread is unlikely as no evidence has been found of replication of NLVs in respiratory mucosal cells. The contribution to secondary spread by airborne transmission may be important through the inhalation and subsequent swallowing of aerosolized viruses and is more likely if there has been projectile vomiting in a confined space.¹⁵ Because the viruses are so small and the air indoors during the winter

gets so dry, they can become airborne and float for up to eight hours. This is why it is also important to be careful not to aerosolize vomit during cleanups. The use of disposable gloves, aprons and shoe covers is recommended. An EPA-registered antiviral disinfectant should be used to treat contaminated surfaces. The US EPA guidelines require at least a 4-log reduction in the titer of the surrogate virus feline calicivirus (FCV) used for testing purposes to demonstrate virucidal efficacy of products against NoV. A 4-log reduction in titer is also required by the US Code of Federal Regulations (40 CFR 141.72) to prove virucidal efficacy of treatments for drinking water disinfection.¹⁷

By comparison, in 2008 the Foodborne Diseases Active Surveillance Network of the U.S. Centers for Disease Control (CDC) confirmed the following reported illnesses; *Salmonella spp.* (16.2%), *E. coli* (1.57%) and *Cyclospora spp.*, a tropical/subtropical parasite (0.04%). Approximately 40% of foodborne illnesses in the U.S. result from a lack of proper hand washing such

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as with Hepatitis A and *Shigella* bacteria. The CDC stated that 70% of all foodborne illness outbreaks originate from the food service sector. In 2009, the FDA's Model Food Code approved "cool air" hand dryers although a recent study showed that they can actually concentrate airborne germs from the restroom air onto just washed hands. In general, the most effective measures for preventing and controlling NoV infection outbreaks are proper hand hygiene, disinfection of environmental surfaces, and isolation of infected individuals.^{9, 18}

Most people recover in 1 - 2 days (hence the term "the 24 hour flu bug"), but ill individuals can become dangerously dehydrated if they cannot replenish lost fluids. Dehydration symptoms include a decrease in urination, dry mouth and throat (complicated even more by the dry air of buildings in the winter) and dizziness when standing up. Dehydrated infants may cry but produce few or no tears and be unusually sleepy or fussy. Severe dehydration may require hospitalization and intravenous (IV)

replacement fluids. The best way to self-hydrate is with oral rehydration fluids. Other drinks that do not include caffeine or alcohol will help with mild dehydration but these types of drinks may not replace important electrolytes (nutrients such as vitamins and minerals) that are lost due to excessive vomiting and diarrhea³.

The most commonly implicated foods causing norovirus outbreaks in the U.S. include leafy greens, fresh fruits (such as raspberries), shellfish (like oysters), drinking water and ice. But realistically, any food item served raw or improperly handled after being cooked can become contaminated with norovirus. It should be noted that norovirus is not killed by all cooking methods. Quick steaming used to prepare raw oysters may not reach the required 140°F necessary to deactivate the virus.

Norovirus can spread quickly from person to person in crowded, closed places like the institutional settings of schools, college dorms, military quarters, daycare centers, long-term-care facilities such as hospitals and nursing homes, leisure settings like day or summer camps, hotels, and cruise

ships. Restaurants, banquet halls, large family dinners, office parties and other places of catered meals can also be major sources of infection if food becomes contaminated.³ The viruses enter our bodies when we consume contaminated food or drink or by directly placing our own contaminated fingers into our mouths. Do not smoke or chew fingernails after touching contaminated surfaces such as door knobs, sink faucets, grocery cart handles and shared office equipment like telephones and copiers. It can be spread in sufficient quantity to cause illness from one contaminated person's fingers through a succession of six different people touching six additional different surfaces.¹⁹ because it only takes 18 viral particles to be an infectious dose.¹³ The viruses can still cause infection after being on an object or surface even weeks later. One study showed that pathogenic microorganisms become airborne when a toilet without a lid is flushed. The highest amount is right after the first flush, but even successive flushes result in further distribution of micro-

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organisms into the air, although the numbers declined after each flush.²⁰ Ironically, most hospital toilets do not have toilet lids in an attempt to prevent cross contamination when handling the toilet seat.

Antibiotics are used to treat bacterial infections and are ineffective against viruses.³ *Clostridium difficile* (which can develop after receiving a treatment of antibiotics) and noroviruses are not inactivated by most alcohol-based hand sanitizing gels. According to a joint ODA/ODH hand hygiene information sheet, alcohols have very poor activity against bacterial spores, protozoan oocysts and certain non-enveloped, nonlipophilic viruses. Scientific research questions the efficacy of alcohol on moist hands and hands contaminated with proteinaceous material.²¹ Hand washing alone can produce a significant reduction in the numbers of viruses. Alcohol-based hand sanitizers are less effective than hand washing with soap and water. Ethanol-based hand sanitizers also appear to have limited efficacy against NoV surrogates.¹² The primary mechanism of action

through which alcohol-based sanitizers inactivate viruses is thought to be capsid protein denaturation.²¹ Water is necessary to allow protein denaturation which is why highly concentrated ethanol sanitizers have limited efficacy.²² There is a new ethanol-based hand sanitizer made by GOJO Industries that contains a synergistic blend of polyquaternium polymer and organic acid that can reduce the infectivity of nonenveloped viruses (norovirus surrogates hepatitis A virus, poliovirus-1, feline calicivirus-9, and murine NoV-1) by greater than 3 log₁₀ after a 30 second exposure.²³ Use a disposable paper towel to turn off the water and to open the restroom door. If sick, do not prepare food for two to three days (48 to 72 hours) after symptoms have stopped. Contaminated items to be handled must never be agitated or shaken to avoid aerosolizing the viral particles. Soiled items to be laundered should also be handled carefully with rubber or disposable gloves and be washed with detergent on the longest available wash cycle and then machine dried.² Wash fruits and vegetables and cook seafood (especially oysters) thoroughly since the

virus can survive freezing and temperatures up to 140°F. Clean and disinfect contaminated surfaces with a chlorine bleach solution of 1,000 ppm (5 tablespoons per gallon of water) to 5,000 ppm (25 tablespoons or 1.5 cups per gallon of water) or use an EPA-registered antiviral product. Other possible effective products being researched are ozone, hydrogen peroxide and antimicrobial surface coatings such as titanium oxide (TiO₂). Clorox now offers Healthcare® Hydrogen Peroxide Cleaner disinfectants that are EPA-registered to kill norovirus in 3 minutes (wipes) and 1 minute (sprays). Clorox's bleach wipes and sprays are each EPA-registered to kill norovirus in 1 minute. When enhanced hygiene measures were instituted to limit an outbreak at an international scouting jamboree²⁴, it was determined that even after instructing participants about proper hand hygiene and using soap pumps and disposable towels, assigning separate toilets for sick participants, not allowing sick participants to prepare food until 3 days after their

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last symptoms, requiring persons working in the field hospital to wear gloves, aprons and surgical masks, minimizing the number of patients per nurse and cleaning toilets and contaminated surfaces with a 1,000 ppm chlorine solution, it was still not enough to prevent the continued spread of the disease. But the use of very high concentrations of hypochlorite (5,000 ppm) has been successfully used during other outbreaks.¹² The problem with using such a high concentration of chlorine in a food service is that it is above the FDA Food Code's maximum chlorine concentration of 200 ppm for use on food contact surfaces. This high amount would require a potable water rinse that then must be followed by a final wipe of up to 200 ppm chlorine. Unfortunately,

the original high chlorine strength needed to kill the virus may damage the common stainless steel food contact surfaces by oxidizing them.²⁵ One study found that by wiping a contaminated surface with a cloth and liquid soap (a cleaning step) followed by a wipe of a cloth containing a 1,000 ppm chlorine solution (a sanitizing step) and providing a contact time of 5 minutes resulted in lowering NoV to below an infectious dose on hard surfaces.²⁶ Another concern exists regarding reducing levels of viruses on contaminated dishware. The present food code in Ohio requires a 5-log reduction for bacteria only. The maximum levels of sanitizer allowed in mechanical dishwashers and in manual triple sinks do not significantly reduce the

amount of viruses from what is achieved from detergent washing alone.²⁷ Knowing that noroviruses are inactivated by temperatures above 140°F, using a dishwasher that sanitizes with hot water above that level would be more effective.

In 2012, a new strain of norovirus was detected in Australia called GII.4 Sydney and has since spread to the United States. It has now become the leading cause of U.S. norovirus outbreaks. Hospitalization and mortality from infections associated with this new norovirus strain has continued to occur most frequently among elderly persons, young children and immune-compromised patients.²⁸ Every 2 to 3 years, a new strain of GII.4 emerges. From September to December 2012, according to an electronic laboratory surveillance network called CalciNet, 51% of GII.4 Sydney outbreaks were from direct person-to-person transmission (such as within families, between co-workers, among teammates and by patients to caregivers). Also, 20% were foodborne, 1% was

Number of confirmed Norovirus outbreaks 1994-2006	
Long term care facilities	240
Restaurants, parties and events	200
Cruise ships and vacations	100
Schools, child care centers and communities	90

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waterborne and unknown transmission was 28%. Long-term-care facilities and restaurants were the most frequently reported settings at 65% and 13%, respectively.²⁸

Although as stated earlier, norovirus infections usually last 1 to 3 days without treatment, they can last longer (4 to 6 days) in children under five, adults over 65 and hospitalized patients. Chronic diarrhea can develop in immunosuppressed individuals and chronic post infection Irritable Bowel Syndrome (IBS) has been reported. The virus can be detected in stool after 4 weeks following infection although peak viral shedding occurs 2 to 5 days after infection²⁹ (up to 100 billion viral copies per gram of feces - enough to infect 5 billion people while vomit can contain up to 1 million viral copies per gram).³⁰ With up to 30% of individuals with norovirus infections being asymptomatic, controlling the spread of an outbreak is even more difficult, even though asymptomatic persons shed a weaker form of the virus.²⁹

In finger pad studies, soap

and water used for 20 seconds have been demonstrated to reduce norovirus counts by 0.7 to 1.2 log₁₀ as determined by RT-PCR assay, whereas alcohol-based hand sanitizers did not demonstrate any appreciable reduction of viral RNA. Whether the viruses that remained were inactivated could not be determined because human norovirus cannot yet be cultivated in a petri dish. Studies using the cultivatable (able to culture) surrogate viruses of murine norovirus (MNV) and feline calicivirus (FCV) have demonstrated that formulations containing 70% ethanol (ethyl alcohol) were able to reduce infectious MNV by 2.5 log₁₀ after 30 seconds. FCV is sensitive to low pH, so a

citrus oil/ethanol hand sanitizer product may be the best choice, but is still not a substitute for the effectiveness of hand washing with soap and water.²⁹

The Ohio Food Code has much to say regarding Person-in-Charge (PIC) responsibilities in dealing with employees with norovirus symptoms or when they have been exposed to suspected outbreaks. Employees can be “excluded” from the food service or be “restricted” from food handling duties.

The type of activities conducted in food services may lead to increased potential for fatty and proteinaceous materials to be on the hands. The fatty and proteinaceous materials

Number of reported food borne disease outbreaks reported to the CDC 2006-2007	
Norovirus	850
Bacterial	625
Parasites	20
Chemical	125
Other/Multiple	90
Unknown	725

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may or may not be visible on the hands. Proteinaceous material is known to interfere with and neutralize alcohol efficacy. Fatty substances can coat and protect pathogens from the action of alcohol. For these reasons, hand sanitizers may only be used after proper hand washing in RFE's and FSO's. In health-care settings, nosocomial bacterial pathogens and lipophilic viruses predominate and therefore alcohol-based hand gels are a suitable alternative to handwashing for health-care personnel.²¹

The CDC has reviewed other components of outbreak prevention and containment programs for healthcare settings but has not found that strong evidence exists in the published literature that any particular strategy is more influential than another, but when instituted together may be key to controlling disease transmission.

Isolation and cohorting, the grouping of patients with similar symptoms/illnesses together, is often employed. Patients are cared for in single occupancy (e.g., private) rooms, physically grouped into cohorts of symptomatic, exposed but asymptomatic, or unexposed within a ward, or alternatively, with entire wards placed under contact

precautions. Patient movement can be restricted within a ward, group activities like Bingo and dining together are suspended, and special times can be set for therapy or other medical appointments during periods of outbreaks. Similarly, staff cohorting and the exclusion of nonessential staff and volunteers can be implemented. Nursing, medical, environmental services and paramedical staff can be kept from working with unexposed patients until 48 hours after their last exposure. During an outbreak, ill staff members should be granted 48 hours of sick leave from the time of symptom resolution, perhaps even 72 hours. The acceptability of allowing recovered staff to work with ill patients would be based on confirmation that a staff member's illness was from the same strain as the patient of the outbreak, otherwise reinfection could be a possibility. In extreme circumstances based on the size of an outbreak and the facility's resources, entire wards have been closed to transfers in and out of the wards. Thorough environmental cleaning and disinfection (working from areas of low contamination

risk to areas of highest risk, changing mop heads once every three rooms, and steam cleaning carpets and upholstered chairs) is performed 48 hours after the resolution of the last case before reopening. While discharges home can occur 48 hours after a patient's last symptom, transfers to long-term care or assisted living may be held for five days after their symptoms have resolved. Finally, screening of visitors for outbreak symptoms, restricting or suspending all visitor privileges to only immediate family or from accessing multiple clinical areas and the posting of educational literature and providing staff and community trainings are other options that should be considered.¹⁸

Works Cited

1. Payne D, Parashar V. Rapid advances in Understanding Viral Gastroenteritis from Domestic Surveillance. *Emerg Infect Dis.* 2013;19(8):1189
2. Prevent the Spread of Norovirus. 2013. Available at: <http://www.cdc.gov/features/norovirus/>. Accessed June 6, 2013.
3. Norovirus in Healthcare Facilities Fact Sheet. 2011. Available at: <http://www.cdc.gov/C5216887-ANorvirusFactSheet>. Accessed June 6, 2013.
4. Atmar RL, Estes MK. The Epidemiologic Importance of Norovirus Infection. *Gastroenterol Clin North Am.* 2006;35(2):275-290.
5. Hall A, Lopman B, Payne D, Patel M, Gastanaduy P, Vinje, Parashar U. Norovirus Disease in the United States. *Emerg Infect Dis.* 2013;19(8):1198-1205.
6. Norovirus Vaccine Reduces Symptoms by Half. 2013. Available at: <http://www.medicalnewstoday.com/prINTERfriendlynews.php?newsid=267086>. Accessed October 7, 2013.
7. Kaplan JE, Feldman R, Campbell DS, Lookabaugh C, Gary GW. The Frequency of a Norwalk-like Pattern of Illness in Outbreaks of Acute Gastroenteritis. *Am J. Public Health.* 1982;72(12):1329-1332.
8. Hedberg CW, Osterholm MT. Outbreaks of Food-borne and Waterborne Viral Gastroenteritis. *Clin Microbiol Rev.* 1993;6:199-210.
9. Centers for Disease Control and Prevention, National Center for Immunization and Respiratory Diseases, Division of Viral Diseases. 2011. Updated Norovirus Outbreak Management and Disease Prevention Guidelines. *Morb Mortal Wkly Rep Recomm Rep* 60:1-18. Available at: http://www.cdc.gov/hicpac/Disinfection_Sterilization/acknowledg.html.
10. Scharff RL. 2012. The Economic Burden from Health Losses due to Foodborne Illness in the United States. *J Food Prot.* 75:123-131.
11. Safety in Numbers. 2007. Food Safety Solutions. Page 6.
12. Said MA, Perl TM, Sears CL. 2008. Healthcare Epidemiology: Gastrointestinal Flu: Norovirus in Healthcare and Long-term Care Facilities. *Clin Infect Dis.* 47:1202-1208.
13. Teunis PF, Moe CL, Liu P, Miller SE, Lindesmith L, Baric RS, Le Pendu J, Calderon RL. 2008. Norwalk Virus: How Infectious Is It? *J Med Virol* 80:1468-1476.
14. Lamhoujeb S, Fliss I, Ngazoa SE, Jean J, 2009. Molecular Study of the Persistence of Infectious Human Norovirus on Food-contact Surfaces. *Food Environ Virol* 1:51-56.
15. Marks PJ, Vipond IB, Carlisle D, Deakin D, Fey RE, Caul EO. Evidence for Airborne Transmission of Nowalk-like Virus (NLV) in a Hotel Restaurant. *Epidemiol Infect.* 2000;124(3):481-487.
16. Caul EO. Small Round Structured Viruses: Airborne Transmission and Hospital Control. *Lancet.* 1994;343:1240-1242.
17. Hoelzer K, Fannselle W, Pouillot R, VanDoren J, Dennis S. 2013. Virus Inactivation on Hard Surfaces or in Suspension by Chemical Disinfectants: Systematic Review and Meta-Analysis of Norovirus Surrogates. *J Food Prot.* 2013;76(6):1006-1016.
18. MacCannel T, Umschied CA, Agarwal RK, Lee I, Kuntz G, Stevenson KB, Healthcare Infection Control Practices Advisory Committee. 2011. Guideline for the Prevention and Control of Norovirus Gastroenteritis Outbreaks in Healthcare Settings. *Infect Control Hosp Epidemiol.* 32:939-969. Available at: <http://www.cdc.gov/hicpac/pdf/norovirus/Norovirus-Guideline-2011.pdf>.
19. Barker J, Vipond IB, Bloomfield SF. Effects of Cleaning and Disinfection in Reducing the Spread of Norovirus Contamination via Environmental Surfaces. 2004. *J Hosp Infect.* 58(1):42-49.
20. Barker J, Jones MV. 2005. The Potential Spread of Infection Caused by Aerosol Contamination of Surfaces After Flushing a Domestic Toilet. *J Appl Microbiol.* 99:339-347.

21. Information Regarding Hand Hygiene from FDA and CDC. Ohio Department of Agriculture and Ohio Department of Health. May 9, 2003. Original article available at: <http://www.cfsan.fda.gov/~comm/jandhyg.html>.
22. Ali Y, Dolan MJ, Fendler EJ, Larson EL. 2000. Alcohols. P. 229-254. In S. S. Block (ed.), *Disinfection, Sterilization, and Preservation*. 5th ed. Lippincott Williams & Wilkens, Philadelphia.
23. Macinga D, Sattar S, Jaykus L, Arbogast J. Improved Inactivation of Nonenveloped Enteric Viruses and Their Surrogates by a Novel Alcohol-Based Sanitizer. *Appl Environ Microbiol* 74:5047-5052.
24. Heijne J, Teunis P, Morroy G, Wijkmans C, Oostveen S, Duizer E, Kretzschmar M, Wallinga J. Enhanced Hygiene Measures and Norovirus Transmission During and Outbreak. *Emerg Infect Dis*. www.cdc.gov/eid. 2009;15(1):24-30.
25. Gibson K, Crandall P, Ricke S. 2012. Removal and Transfer of Viruses on Food Contact Surfaces by Cleaning Cloths. *Appl Environ Microbiol*. 78(9):3037-3044.
26. Tuladhar E, Hazeleger W, Koopmans M, Zwietering M, Beumer R, Duizer E. Residual Viral and Bacterial Contamination of Surfaces After Cleaning and Disinfection. *Appl Environ Microbiol*. 2012;78(21):7769-7775.
27. Pascall M. The Survivability of Norovirus on Tableware After Regularly Used Dish Washing Protocols. 2013. As presented at the summer meeting of the Ohio Association for Food Protection.
28. Notes From the Field: Emergence of New Norovirus Strain GIL4, Sydney - United States, 2012. *Morb Mortal Wkly Rep*. 2013;62(03):55.
29. Updated Norovirus Outbreak Management and Disease Prevention Guidelines. *Morb Mortal Wkly Rep*. 2011;60(RR03):1-15.
30. Mokhtari A, Jaykus LA. Quantitative Exposure Model for the Transmission of Norovirus in Retail food Preparation. *Int J Food Microbiol*. 2009;133:38-47.
31. Ohio Uniform Food Safety Code. OAC 3717-1. 2013.

Additional references

- Weinstein R, Schweizer M, Reisinger H, Ohl M, Formanek M, Blevins A, Ward M, Perencvich E. Searching for an Optimal Hand Hygiene Bundle: A Meta-analysis. *Clin Infect Dis*. 2014;58(2):248-259.
- Moe C. Preventing Norovirus Transmission: How Should We Handle Food Handlers? *Clin Infect Dis*. 2009;48:38-40.