Norovirus

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INTRODUCTION

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Norovirus is one of the leading causes of acute gastroenteritis (AGE) outbreaks and a main cause of childhood-endemic AGE worldwide. The first outbreak was described in Norwalk, Ohio, in 1968 [1,2]. Illness due to norovirus was initially described as "winter vomiting disease" due to its seasonal predilection and preponderance of patients with vomiting as a primary symptom.

The epidemiology, virology, clinical manifestations, diagnosis, pathogenesis, and prevention of norovirus will be reviewed here. Issues related to management of acute viral gastroenteritis in adults are discussed separately. (See "Acute viral gastroenteritis in adults", section on 'Treatment'.)

EPIDEMIOLOGY

Burden of disease

— Norovirus is the most common viral cause of epidemic gastroenteritis worldwide; it is also a common cause of endemic diarrhea in community settings [3-6]. The highest frequency of norovirus infection occurs among infants less than 12 months of age [7].

Each year in the United States, norovirus causes 19 to 21 million illnesses, including 900 deaths, 103,000 hospitalizations, 460,000 emergency department visits, and 2.6 million outpatient visits [8]. In one surveillance study between 2014 and 2016 in the United States, the estimated incidence of medically attended episodes was 5.5 per 1000 person-years; the incidence was highest among children <5 years (20.4 per 1000 person-years) followed by adults ≥ 65 years (4.5 per 1000 person-years) [9].

In a meta-analysis including nearly 150,000 patients with acute gastroenteritis, the overall norovirus detection rate was 17 percent [10]. Birth cohort studies in low- and middle-income countries have demonstrated that up to 90 percent of the children experience at least one norovirus infection, and up to 70 percent experience norovirus-associated diarrhea in early childhood [6].

In most countries where rotavirus vaccines have been included in the national immunization program, norovirus has become the most common cause of gastroenteritis in children <5 years of age [4,11-15].

Seasonality

— Norovirus infection can be acquired at any time of year; some studies in temperate climates have noted a peak in incidence during the winter months [16,17]. As an example, in a study of over 1600 stool specimens collected from patients presenting with gastroenteritis to Veterans Affairs Medical Centers in the United States, 6 percent overall were positive for norovirus, with a higher medical prevalence of norovirus from November to April compared with the rest of the year (9 versus 3 percent) [18].

Transmission

- **Person-to-person** – Person-to-person transmission of norovirus occurs via the fecal-oral route, with an incubation period of 24 to 48 hours [19]. A small inoculum (<100 viral particles) is required for transmission [20-22].

Norovirus shedding in stool is maximal over the first 24 to 48 hours after illness; the mean duration of viral shedding is four weeks after onset of illness [23-30]. In immunocompromised hosts, viral shedding in stool can persist for months following infection [24,31].

Norovirus transmission occurs more frequently among symptomatic patients than asymptomatic shedders, and nosocomial transmission is common [32,33].

- **Environmental transmission** – Spread of norovirus infection can occur via airborne droplets of vomitus containing viral particles or fomite contamination [20,34-42]. Norovirus is extremely stable in the environment; it resists freezing temperatures, heating to 60°C, and disinfection with chlorine or alcohol [43].

  Norovirus transmission can also occur by consumption of contaminated food and water. Foods linked to outbreaks have included shellfish (including oysters), leafy greens, produce items (such as celery, melon, and raspberries), and frosting; however, specific food items can be implicated in the minority of outbreaks [44,45]. In the United States, annual summaries of foodborne outbreaks are reported by the United States Centers for Disease Control and Prevention (CDC). (See "Causes of acute infectious diarrhea and other foodborne illnesses in resource-abundant settings".)

Outbreaks

— Norovirus outbreaks have occurred in a wide range of settings, including [1,16,46-56]:

- Restaurants and catered events
- Hospitals and long-term care facilities
- Schools, childcare settings, and community centers
- Municipal water contamination and recreational water exposure
- Cruise ships and resorts
- Military populations
- Athletic teams
- Rafters and backpackers
- Natural disasters
- Prisons

During 2021 and 2022, the 12 Norovirus Sentinel Testing and Tracking Network sites (NoroSTAT) reported 992 norovirus outbreaks to the CDC in comparison with 1056 and 343 norovirus outbreaks during the 2019 to 2020 and 2020 to 2021 surveillance years, respectively. The number of norovirus outbreaks reported by these states during prepandemic surveillance years ranged from 1219 (2015 to 2016) to 1471 (2018 to 2019). Norovirus outbreak characteristics during 2021 and 2022 were similar to those reported during prepandemic years. Most outbreaks (82 percent) were due to person-to-person spread, and the majority (59 percent) occurred in long-term care facilities. Among laboratory-confirmed outbreaks with typing information during 2021 and 2022, 43 percent were GII.4 Sydney(P16), which has been the predominant norovirus strain since its emergence during 2015 to 2016 [57].

Outbreaks of norovirus can be difficult to contain given the small inoculum required for transmission and its environmental stability.

In the United States, suspected outbreaks should be reported to public health authorities and to the CDC [3]. Features that should prompt suspicion for norovirus outbreaks are discussed below. (See 'Clinical suspicion and presumptive diagnosis' below.)

VIROLOGY

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Norovirus is a genus within the Caliciviridae family of small nonenveloped ribonucleic acid (RNA) viruses, which also includes *Sapovirus*. The *Norovirus* and *Sapovirus* genera contain viruses infecting humans and other animals [1].

Noroviruses are subdivided into multiple genogroups [58-60]. Genogroups GI, GII, GIV, GVIII, and GIX include human pathogens; multiple genotypes are recognized within each genogroup [61]. Frequent recombination between strains and point mutations contribute to rapid changes in genetic diversity; many recombinants are as infectious and virulent as prototype strains [62-64]. The illnesses caused by viruses in each genogroup are clinically indistinguishable despite differences in genetic sequence, genomic recombination between strains, and receptor-binding characteristics.

The most common cause of human norovirus infection is GII (mostly GII.4, followed by other types such as GII.2 and GII.17), followed by GI and GIV. GII.4 viruses have been highly predominant and are associated with more severe outcomes than other norovirus genotypes, including higher hospitalization and death rates [48,65-70].

GII.4 strains have mutations occurring in one or more antigenic sites which increase the probability of immune escapes and emergence of new variants. Two GII.4 variants were responsible for outbreaks in Australia and New Zealand from 2005 to 2006 [71]. Subsequently, one of these strains was linked to approximately one-fourth of the outbreaks reported in the United Kingdom. In 2012, GII.4 Sydney strain (named for the location in Australia where it was first isolated) replaced GII.4 New Orleans as the predominant strain in the United States [72]. The proportion of outbreaks attributed to this new strain increased from 19 to 58 percent between September and December 2012. Prior GII infection appears to protect against subsequent infection, which has important significance for vaccine development [73]. GII.4 genotypes remain predominant in the United States and most of the world. GII.4 genotypes remain predominant in the United States and most of the world [74].

In 2014, a GII.17 variant emerged in China and has spread worldwide [75-79]. Its clinical presentation is indistinguishable from that of previously predominating strains.

PATHOGENESIS

- **Immunity** – The role of humoral and/or cellular immunity in infection and disease prevention remains partially understood. Reinfections throughout a lifetime are extremely common; nevertheless, during childhood, symptomatic reinfection with the most common genotype (GII.4) is uncommon, suggesting that protective efficacy of a previous infection occurs against the same genotype and possibly against different genotypes within the same genogroup. However, the protective efficacy seems to be less with exposure to a norovirus that belongs to a different genogroup (and thus is less genetically similar) [80,81]. Exposure over time to a diversity of norovirus strains thus results in repeated infections, many of which will be asymptomatic [82].

- **Host susceptibility** – Human noroviruses recognize and bind to blood group antigens in a strain-specific manner; such antigens may serve as receptors or cofactors for infection [83].

  The blood group antigens recognized may vary by virus genogroup [84-87]. It has been suggested that genogroup GI viruses may bind preferentially to blood group A and O antigens, while genogroup GII viruses may bind preferentially to blood group A and B antigens [88].

  However, in contrast with the above observations, a study of two norovirus outbreaks among Israeli military recruits noted no association between genogroup GII norovirus infection and ABO blood group antigens, suggesting that GII viruses are capable of infecting individuals regardless of blood type [88,89]. The ability of GII.4 genotypes to infect individuals with different secretor antigens and varying levels of expression may be a factor accounting for their predominance in the human population. Nevertheless, only a few in vivo studies support the hypothesis that different GII.4 variants have different secretor antigen affinity, and additional studies are required to clarify the ability of different secretor antigens, such as ABO, to affect susceptibility to GII.4 genotypes in a strain- or variant-dependent manner [90].

  Individual norovirus strains may be capable of infecting only a subset of the human population; however, given the diverse binding profiles found among the norovirus genogroups, nearly all individuals are likely susceptible to infection. In addition, recurrent infection can occur given the diversity of norovirus strains and the lack of full cross-strain or long-term immunity.

- **Intestinal physiology** – Diarrhea induced by norovirus is associated with transient malabsorption of D-xylose and fat [91] and with decreased activity of brush-border enzymes including alkaline phosphatase and trehalase [92]. Absorption and brush-border

enzyme levels return to normal values within two weeks after infection.

The mechanisms of norovirus-induced vomiting and diarrhea are uncertain [93]. Gastric emptying is markedly delayed in normal adults challenged with norovirus, but the degree of delay is not correlated with the severity of vomiting, and norovirus infection has not been associated with detectable enterotoxin production [94].

Acute norovirus infection produces a reversible histopathologic lesion in the jejunum, with apparent sparing of the stomach and rectum [92,95-98]. The villi are blunted, but the mucosa is otherwise intact. Mononuclear and polymorphonuclear leukocytic infiltrations are seen in the lamina propria. On electron microscopy, the epithelial cells are intact, microvilli are shortened, and the intercellular spaces are widened.

These histopathologic changes appear within 24 hours after virus challenge (whether symptomatic or subclinical), are present at the peak of illness, and persist for a variable period of time after the illness. They generally clear within two weeks after the onset of illness, although some jejunal changes have been noted as late as six weeks after challenge.

CLINICAL MANIFESTATIONS

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Norovirus infection produces a spectrum of clinical manifestations, from mild illness with fever and watery diarrhea to more severe illness with fever, vomiting, headache, and constitutional symptoms [29,80,99-102]. Asymptomatic infections are common throughout an individual's lifetime.

Symptomatic infection

Incubation period and duration

— The incubation period is generally 24 to 48 hours (range 12 to 72 hours), and onset of symptoms is typically abrupt [29]. Symptoms typically last for 48 to 72 hours with rapid recovery.

Norovirus shedding in stool is maximal over the first 24 to 48 hours after illness; the mean duration of viral shedding is four weeks after onset of illness. In immunocompromised hosts, viral shedding in stool can persist for months following infection [23-28,31,73].

Typical clinical features

— Symptoms include nausea and vomiting (nonbloody, nonbilious), watery diarrhea (nonbloody), and abdominal pain.

Vomiting is more prominent in the setting of norovirus infection than in gastroenteritis caused by most other viruses [1]. If diarrhea is present, it is generally moderate (approximately four to eight stools over a period of 24 hours). Stools lack mucous, and fecal leukocytes are not seen.

Generalized myalgias, malaise, and headache are prominent. Fever occurs in approximately half of cases. In general, patients are uncomfortable but usually do not appear severely ill, although severe dehydration can occur.

In one study including 224 children in Chile with norovirus infection, nearly 90 percent had vomiting and 60 percent had fever; watery diarrhea lasted 5 to 7 days [103]. In another study including 1637 children acute gastroenteritis in Chile, Brazil, Thailand, and the Philippines, norovirus was observed in 23.8 percent of outpatients and 17.9 percent of hospitalized patients; vomiting was more common among patients with gastroenteritis due to norovirus (88 versus 57 percent), while fever was less common (61 versus 76 percent) [15].

The white blood cell count is generally normal or may be slightly elevated; relative lymphopenia may be observed at the height of the illness. Kidney function is generally normal unless dehydration ensues.

Norovirus infection cannot easily be distinguished clinically from other causes of acute gastroenteritis, in particular rotavirus. (See 'Differential diagnosis' below.)

Severe disease and complications

— Severe manifestations have been observed among older adults, children <12 months, and among immunocompromised patients [46,104-108]. In patients with severe disease, fever occurs more commonly and illness may last several days longer than in healthy individuals.

Neurologic complications have been reported in children. In infants, norovirus infection has been associated with benign convulsions [109]. In one study from Taiwan, 20 percent of 250 pediatric norovirus infections were associated with seizure [110]. Encephalitis has been sporadically reported, mainly in Japanese children with norovirus acute gastroenteritis, and carries a poor prognosis [111,112].

Chronic sequelae

— The most commonly reported chronic sequela of norovirus infection is chronic diarrhea among immunocompromised individuals, which can last for many months, leading to wasting or failure to thrive [109]. Individuals with leukemia, lymphoma, solid organ or hematopoietic cell transplantation, or graft-versus-host disease may have profuse and prolonged watery diarrhea [113-115]. Among transplant patients, norovirus infection has been associated with histopathologic changes such as disorganization and flattening of the intestinal epithelium [116]. Stool shedding may occur for several months among immunocompromised individuals [117-119].

Other postinfectious sequelae may include dyspepsia, constipation, and/or reflux [120].

Asymptomatic infection

— Stool shedding of norovirus infection in asymptomatic individuals is common, especially in children [1,121,122]. In one meta-analysis including 81 studies, the overall prevalence of asymptomatic norovirus shedding was 7 percent and was higher among children than adults (8 versus 4 percent) [122].

Asymptomatic shedding of norovirus has diagnostic implications, since diarrhea due to another cause in an asymptomatic carrier may be misattributed to norovirus infection. In addition, asymptomatic shedding has epidemiologic implications; as an example, asymptomatic food handlers can potentially transmit infection to others, as viral loads on the hands of asymptomatic and symptomatic food handlers during outbreaks are similar [123].

DIAGNOSIS

Clinical suspicion and presumptive diagnosis

- **Clinical suspicion** – The possibility of norovirus infection should be suspected in all patients with acute onset of vomiting and/or watery diarrhea, especially if they reside in middle- or high-income countries where rotavirus vaccines are routinely used. The diagnosis of norovirus is usually presumptive in such patients; the likelihood of norovirus is higher in the setting of an outbreak or during the winter months in temperate regions.

- **Approach to laboratory testing** – Confirming the diagnosis with stool testing is generally not necessary, although it may be useful in immunocompromised patients with severe or persistent symptoms; identification of norovirus as the cause of symptoms could help inform discontinuation of therapies for other pathogens. Identifying the etiology can also be helpful for public health purposes during outbreaks of gastroenteritis. Multi-pathogen molecular tests for gastrointestinal pathogens are becoming more widely available and used in patients with acute diarrhea, and norovirus can be identified on these tests. (See 'Laboratory tools' below.)

  In a patient with watery diarrhea with a stool molecular test positive for only norovirus, the diagnosis of norovirus acute gastroenteritis is likely. However, because of the frequency of asymptomatic norovirus shedding, molecular diagnosis of norovirus does not necessarily confirm that the symptoms are due to norovirus, particularly if other pathogens are also identified on testing. In patients with a positive norovirus test but atypical symptoms, such as dysentery/bloody diarrhea or voluminous watery stools, other pathogens (eg, bacterial causes of diarrhea, including cholera in endemic regions) should be ruled out before attributing these clinical features to norovirus. (See "Approach to the adult with acute diarrhea in resource-abundant settings", section on 'Evaluation'.)

- **When to suspect an outbreak** – Two or more similar illnesses resulting from a common exposure should raise suspicion for a norovirus outbreak and prompt involvement of public health officials for laboratory testing and epidemiologic investigation [124]. Criteria that should raise suspicion for an outbreak caused by norovirus include prominent vomiting, lack of fever, and absence of frank blood in stools [125,126]. In one study including more than 10,000 outbreaks, these criteria were 86 percent sensitive and 92 percent specific for association with norovirus detected by reverse-transcriptase polymerase chain reaction (RT-PCR) [126]. (See 'Outbreaks' above.)

Laboratory tools

— Laboratory confirmation of norovirus is generally not necessary in clinical settings, although it may be useful in select situations (see 'Clinical suspicion and presumptive diagnosis' above).

Laboratory testing is used by public health laboratories for outbreak detection and to monitor the success of interventions to interrupt transmission.

Laboratory tools for detection of norovirus include genomic amplification via RT-PCR and antigen detection via enzyme immunoassays.

- **Stool RT-PCR** – Stool RT-PCR is the mainstay of laboratory diagnosis; noroviruses and other viral causes of gastroenteritis are readily detectable with this tool [127-131]. Carefully selected primers within divergent capsid regions can be used for genotypic differentiation of viral strains [132]. PCR techniques are also used widely for viral detection in food and environmental samples [84,86,133-136]. Viral detection by RT-PCR in stool may be limited by low virus concentration, improper specimen storage, inefficient viral RNA extraction, and/or presence of reverse-transcriptase inhibitors [137]. Gene amplification diagnostic tests for stool, based on rapid nucleic acid detection are highly sensitive and specific [138]. Multiplex PCR assays may screen for multiple bacterial and viral pathogens. In some cases, more than one pathogen may be detected; in these circumstances, clinical judgment is required to determine the likely causative microorganism.

  Interpretation of a positive RT-PCR or immunoassay in a patient with acute diarrhea may be difficult since asymptomatic shedding is common and RT-PCR can detect a low viral load (<100 particles/gram), which may not necessarily establish norovirus as the etiology of illness. Diagnostic tests for noroviruses must be interpreted together with epidemiologic and clinical factors. This is especially relevant with the increasing use of highly sensitive, multipathogen molecular techniques, which commonly detect multiple potential pathogens in the same sample [139].

- **Antigen detection** – A number of antigen-detection enzyme immunoassays have been developed; these assays have lower sensitivity and specificity than RT-PCR [140-145]. Their utility is limited for diagnosis of sporadic cases of gastroenteritis, but they can be useful in outbreak settings for which multiple samples are available for testing [142,146-148].

DIFFERENTIAL DIAGNOSIS

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The differential diagnosis of norovirus infection includes other causes of viral gastroenteritis as well as other causes (infectious and noninfectious) of gastrointestinal symptoms. Routine laboratory testing is not required to establish a specific etiology for acute gastroenteritis. (See "Acute viral gastroenteritis in adults", section on 'Differential diagnosis' and "Acute viral gastroenteritis in children in resource-abundant countries: Clinical features and diagnosis", section on 'Etiology'.)

Other causes of viral gastroenteritis include:

- **Rotavirus** – Rotavirus infection most commonly occurs in children between six months and two years of age [149,150]. In temperate northern climates, it occurs in the fall and winter; in tropical climates, and to some extent in countries in the Southern Hemisphere, it occurs throughout the year. Rotavirus infection can be difficult to distinguish from norovirus infection; moderate-to-severe gastroenteritis (characterized by vomiting in over 80 percent, watery diarrhea lasting five to seven days, and fever in over 60 percent) is common for both pathogens [103]. Dehydration and need for hospitalization are more common in rotavirus than norovirus acute gastroenteritis. (See "Clinical manifestations and diagnosis of rotavirus infection".)

- **Enteric adenovirus** – Enteric adenoviruses (adenovirus serotypes 40 and 41) are infrequent causes of endemic gastroenteritis among children in temperate climates [151-154]. Distinguishing features include absence of vomiting, incubation period up to 10 days, and duration of symptoms up to two weeks [19,155].

- **Astrovirus** – Astroviruses include eight serotypes (HAstV-1 to HAstV-8) and have a worldwide distribution [156-158]. Astrovirus infection occurs in individuals of all ages; it appears to be less pathogenic among adults than norovirus infection [159,160]. In temperate regions, there is a peak in infection during winter months; in tropical regions, infection occurs most frequently during rainy seasons [161,162]. Sporadic astrovirus gastroenteritis occurs primarily in children younger than four years. The incubation period is three to four days. Clinical manifestations include low-grade fever, diarrhea, headache, malaise, and nausea; vomiting occurs relatively infrequently [163-165]. Symptoms generally last two to three days.

- **Sapovirus** – Sapovirus infection has a similar age distribution as norovirus and occurs year-round. It is generally detected at significantly lower levels compared with noroviruses. The incubation period is not well defined. Outbreaks of sapovirus infection can occur but are not characterized by high secondary attack rates (in contrast with norovirus infection).

- **Other viruses** – Other viruses that have been associated with gastroenteritis include coronavirus [166,167], parechovirus (types 1 and 2 were previously referred to as the enterovirus "echovirus" types 22 and 23) [168-170], picobirnavirus [171,172], bocavirus (a parvovirus) [173,174], and Aichi virus [175,176]; it is uncertain whether all of these have a true pathogenic role in gastroenteritis. These viruses could potentially cause illnesses with clinical manifestations similar to illness caused by norovirus [177-181]. In addition, human parechovirus has been associated with severe extraintestinal disease in neonates [182]. (See "Enterovirus and parechovirus infections: Clinical features, laboratory diagnosis, treatment, and prevention", section on 'Clinical features of parechovirus infections'.)

Nonviral etiologies of vomiting or diarrhea are discussed further separately. (See "Causes of acute infectious diarrhea and other foodborne illnesses in resource-abundant settings" and "Approach to the adult with nausea and vomiting" and "Approach to the infant or child with nausea and vomiting" and "Approach to the adult with acute diarrhea in resource-abundant settings" and "Diagnostic approach to diarrhea in children in resource-abundant settings".)

TREATMENT

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The management of norovirus infection is as described for other types of viral gastroenteritis; this is discussed separately. (See "Acute viral gastroenteritis in adults", section on 'Treatment' and "Acute viral gastroenteritis in children in resource-abundant countries: Management and prevention".)

PREVENTION AND CONTROL

- **Health care settings** – In inpatient settings, use of contact precautions is warranted for patients with vomiting and/or diarrhea [3,183-185]. (See "Infection prevention: Precautions for preventing transmission of infection", section on 'Isolation precautions'.)

  Norovirus is not killed by alcohol; therefore, hand hygiene for caregivers of patients with gastroenteritis should consist of washing hands with soap and water rather than use of alcohol-based hand disinfection [186,187]. (See "Infection prevention: Precautions for preventing transmission of infection", section on 'Hand hygiene'.)

- **Environmental cleaning** – Norovirus is not eliminated by disinfection with standard cleaning agents. Therefore, contaminated surfaces should be disinfected with bleach (5 to 25 tablespoons of household bleach per gallon of water) or other disinfectant approved by the Environmental Protection Agency [3,188]. In addition, individuals who clean clinical care areas that are heavily contaminated with stool or vomitus should wear protective equipment (ie, mask, gloves, and gown). (See "Infection prevention: General principles", section on 'Cleaning and disinfection'.)

- **Additional guidance for specific patient groups**:

- **Health care workers** – Health care workers who have symptoms consistent with norovirus should be excluded from work until 48 to 72 hours after symptom resolution [3,189].

- **Children** – Children should be excluded from child care centers until stools are contained in a diaper or when toilet-trained children no longer have accidents using the toilet, and when stool frequency becomes no more than two stools above that child's normal frequency, even if the stools remain loose [187].

- **Food handlers** – Individuals with norovirus infection should not prepare food for others until at least two days after resolution of symptoms [188].

The Centers for Disease Control and Prevention (CDC) provides information regarding prevention of norovirus infection [190].

Efforts for development of effective vaccination are underway [191,192].

SOCIETY GUIDELINE LINKS

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Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Acute diarrhea in adults" and "Society guideline links: Acute diarrhea in children".)

INFORMATION FOR PATIENTS

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UpToDate offers two types of patient education materials, "The Basics" and "Beyond the Basics." The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on "patient info" and the keyword(s) of interest.)

- Basics topics (see "Patient education: Viral gastroenteritis in adults (The Basics)" and "Patient education: Diarrhea in children (The Basics)" and "Patient education: Diarrhea in teens and adults (The Basics)" and "Patient education: Food poisoning (The Basics)")

- Beyond the Basics topics (see "Patient education: Acute diarrhea in adults (Beyond the Basics)" and "Patient education: Acute diarrhea in children (Beyond the Basics)" and "Patient education: Foodborne illness (food poisoning) (Beyond the Basics)")

SUMMARY AND RECOMMENDATIONS

- **Epidemiology** – Norovirus is one of the leading causes of acute gastroenteritis (AGE) outbreaks worldwide and a main cause of childhood-endemic AGE. Norovirus infection can be acquired at any time of year; some studies in northern temperate climates have noted a peak in incidence during the winter months. (See 'Epidemiology' above.)

- **Transmission** – Person-to-person transmission of norovirus infection occurs via the fecal-oral route, via airborne droplets of vomitus containing viral particles, fomite contamination, or consumption of contaminated food and water. Outbreaks of norovirus can be difficult to contain given the small inoculum required for transmission (<100 viral particles) and the ability of the virus to survive in the environment; it resists freezing temperatures, heating to 60°C, and disinfection with chlorine or alcohol. (See 'Transmission' above.)

- **Virology** – The most common cause of human norovirus infection is GII (mostly GII.4 followed by GII.17 and GII.2) followed by GI and GIV. GII.4 viruses have been associated with epidemic infection and more severe outcomes than other norovirus genotypes,

including higher hospitalization and death rates. (See 'Virology' above.)

- **Clinical manifestations** – (see 'Clinical manifestations' above):
  - **Incubation period and duration** – The incubation period of norovirus infection is generally 24 to 48 hours (range 12 to 72 hours), and onset of symptoms is typically abrupt. Symptoms typically last for 48 to 72 hours with rapid recovery. Norovirus shedding in stool is maximal over the first 24 to 48 hours after illness; the mean duration of viral shedding (detected via polymerase chain reaction) is four weeks after onset of illness. In immunocompromised hosts, viral shedding in stool can persist for months following infection. (See 'Incubation period and duration' above.)
  - **Typical clinical features** – Symptoms of norovirus infection include nausea and vomiting (nonbloody, nonbilious), watery diarrhea (nonbloody), and abdominal pain. Vomiting is more prominent in the setting of norovirus infection than in gastroenteritis caused by other viruses. If diarrhea is present, it is generally moderate. Generalized myalgias, malaise, and headache are prominent. Fever occurs in approximately half of cases. In general, patients are uncomfortable but usually do not appear severely ill, although dehydration can occur. (See 'Typical clinical features' above.)
  - **Severe disease** – Severe manifestations have been observed among older adults, children <12 months, and among immunocompromised patients. Asymptomatic norovirus infection also occurs and can be associated with transmission. (See 'Severe disease and complications' above.)
- **Diagnosis** – The possibility of norovirus infection should be suspected in patients with acute onset of vomiting and/or watery diarrhea. Norovirus is usually diagnosed presumptively in such patients. Confirming the diagnosis with stool testing is generally not necessary, although it may be useful in immunocompromised patients with severe or persistent symptoms. (See 'Diagnosis' above.)
- **Outbreaks** – Two or more similar illnesses resulting from a common exposure should raise suspicion for a norovirus outbreak and prompt involvement of public health officials for laboratory testing and epidemiologic investigation. Criteria that should raise suspicion for an outbreak caused by norovirus include prominent vomiting, lack of fever, and absence of frank blood in stools. (See 'Clinical suspicion and presumptive diagnosis' above and 'Outbreaks' above.)
- **Management** – The clinical management of norovirus infection is as described for other types of viral gastroenteritis; this is discussed separately. (See "Acute viral gastroenteritis in adults", section on 'Treatment'.)
- **Prevention and control** – Norovirus is not killed by alcohol or standard cleaning agents. Therefore, hand hygiene for caretakers of patients with gastroenteritis should consist of washing hands with soap and water (rather than use of alcohol-based hand disinfection), and contaminated environmental surfaces should be disinfected with bleach. In addition, individuals with norovirus infection should not prepare food for others until at least two days after resolution of symptoms. (See 'Prevention and control' above.)

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