

Norovirus Infection in Older Adults

Epidemiology, Risk Factors, and Opportunities for Prevention and Control

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KEYWORDS

• Norovirus • Gastroenteritis • Long-term care • Vaccine • Older adults

KEY POINTS

- Estimates indicate that a vast majority (90%) of norovirus-associated deaths in the United States occur among persons greater than or equal to 65 years of age.
- In the United States, long-term care facilities are the most commonly reported setting for norovirus outbreaks.
- Norovirus can spread through many routes, including person-to-person contact, contact with contaminated surfaces, and airborne dissemination of vomitus.
- Transmission-based precautions are among the most effective means of interrupting transmission.
- Antiviral therapy is not yet available for norovirus gastroenteritis, but research to identify antiviral treatment strategies for norovirus is in progress.

BACKGROUND

Norovirus is the leading cause of acute gastroenteritis across all age groups in the United States.¹ It is also a frequent cause of outbreaks in health care settings, including long-term care facilities (LTCFs) and acute care hospitals.² The total burden of disease is high; norovirus is estimated to cause approximately 21 million total illnesses annually across all age groups in the United States.¹ Certain populations

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are at higher risk of infection and severe illness, including those at the extremes of age. In high-income and upper-middle-income (HI/UMI) countries, between 2000 and 13,000 norovirus-associated deaths occur in older adults greater than 65 years of age.³ Infection with norovirus is also costly to society. Annual hospitalization costs in the United States are estimated at \$493 million⁴ and outpatient and emergency department visits at \$284 million.⁵ For patients greater than 65 years of age, total hospitalization costs for norovirus and gastroenteritis are higher compared with younger age groups.⁴ Additionally, all foodborne norovirus illness, including productivity losses, are estimated at \$2 billion per year in the United States.⁶ This review summarizes knowledge on norovirus infection in older adults.

VIROLOGY AND VIRAL DIVERSITY

The norovirus genome is composed of a linear, positive-sense RNA that is approximately 7.6 kb in length.⁷ The 3 open reading frames (ORFs), ORF-1, ORF-2, and ORF-3, encode 8 viral proteins (VPs); ORF-2 and ORF-3 encode the structural components of the virion, VP1 and VP2. ORF-1 encodes nonstructural proteins, including the norovirus protease and RNA-dependent RNA polymerase.⁸

Noroviruses belong to the family *Caliciviridae* and are divided into 7 genogroups based on the viral capsid gene. Three of these genogroups, GI, GII, and GIV, include strains that infect humans. Noroviruses are classified further into genotypes, and there are at least 21 genotypes in GII and 8 genotypes in GI.⁹ Globally, GII.4 viruses are the predominant pathogen, include new variants that emerge every 2 to 4 years, and are associated with greater symptom severity in the young and elderly, resulting in more hospitalizations and deaths.^{10,11} In the most recent United States norovirus season, from September 1, 2016, to April 21, 2017, of 502 samples tested, the predominant strain was GII.P16-GII.4 Sydney, accounting for 60% of outbreaks; other strains included GII.2 (14% of outbreaks), GI.3 (7% of outbreaks), GII.6 (4% of outbreaks), and GII.Pe-GII.4 Sydney (3% of outbreaks); other genotypes accounted for the remaining 12%.¹²

CLINICAL PRESENTATION AND DISEASE COURSE

After an incubation period of 12 hours to 48 hours,¹³ the classic symptoms of norovirus disease include sudden onset of vomiting, abdominal cramps, and watery diarrhea.^{14,15} Constitutional symptoms, including low-grade fever, generalized myalgias, malaise, headache, and chills, frequently accompany the gastroenteritis.¹³ Vomiting and diarrhea are usually present together, but either can be seen alone.¹⁶ Most patients experience a brief, self-limited infection with symptoms resolving within 2 days to 3 days. The clinical spectrum of illness is varied, however, and up to one-third of those infected are asymptomatic.¹⁷ On the other end of the spectrum, the most vulnerable include those with underlying medical conditions, the very young, the elderly, and the immunocompromised, who are at greater risk for severe symptoms and complications,¹⁸ such as acute renal failure leading to hemodialysis, cardiac complications including arrhythmias, acute graft organ rejection in transplant recipients, and death.^{19,20}

Complications among healthy adults are less common. Transient postinfectious inflammatory bowel syndrome has been reported up to 3 months postonset of symptoms compared with controls²¹ as well as long-term sequelae among US military recruits who experienced gastroenteritis during norovirus outbreaks, including dyspepsia, constipation, and gastrointestinal reflux disease.²² Neurologic symptoms are rare but have been observed. Headache, neck stiffness, photophobia, and

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