1 **Prevention and Control Practices for Human Noroviruses in Long-term Care Facilities in**
2 **South Carolina**

3
4 Cortney M. Leone, MS,^a Lalani Jayasekara, BS,^a Julia Sharp, PhD,^b and Angela Fraser, PhD^a

5
6 **Affiliations:** ^a Department of Food, Nutrition, and Packaging Sciences, Clemson University,
7 Clemson, SC; ^b Department of Mathematical Sciences, Clemson University, Clemson, SC

8
9 **Address correspondence to:** Angela M. Fraser, PhD, Department of Food, Nutrition, and
10 Packaging Sciences, 206 Poole Agriculture Center, Clemson University, Clemson, SC 29634.
11 Email: afraser@clemson.edu
12 Phone: 864-656-3652
13

ABSTRACT

Background: Long-term care facilities (LTCF) are the most common setting for human norovirus (HuNoV) outbreaks. Our study aimed to determine gaps in prevention and control practices for HuNoV in LTCF in South Carolina (SC).

Methods: Two researchers visited a convenience sample of 26 LTCF in SC during July-November 2013. Directors were interviewed to determine facility prevention and control practices. Relative frequencies and means were calculated using SAS 9.3.

Results: Most Directors had little knowledge of proper sanitizing and disinfecting products and reported missing written procedures for cleaning staff/visitor bathrooms. Only 18 had recommendations for when residents should wash hands. Many used the wrong products for pathogen removal after vomit/fecal events, had no written procedures for cleaning contaminated soft surfaces, did not remove other individuals during clean-up of vomit/fecal episodes, and did not clean a large area surrounding vomit/fecal episodes. Eighteen did not assign specific staff to care for sick; 16 did not designate specific toilets for sick; and 15 did not restrict visitors during an outbreak.

Conclusion: Directors' responses indicated gaps in prevention and control practices for HuNoV in LTCF in SC.

Key Words: long-term care, human noroviruses, prevention, control, infectious disease

licensed by the state of SC, operate year round, primarily serve older adults ≥ 60 years, be a residential facility, not provide care only for a specific population such as Alzheimer's patients, and prepare and serve meals in a cafeteria or to individual rooms. After the initial Internet search, 34 LTCF were excluded.

The 163 eligible facilities were called up to 4 times and asked to participate. Thirty-nine (39) were not interested, 11 stated their corporate offices did not allow participation in research studies, and 78 never responded. Eight stated they were interested but could not schedule a site visit for various reasons. A total of 27 facility visits were performed. One facility only served mentally ill patients, so our final sample size was 26 LTCF, which is a participation rate of 16% (26/163).

Interviews

Interviews with facility directors and/or their designees (e.g., infection control nurse, director of nursing, or head of housekeeping) were conducted between July and November 2013. During a 60-minute interview, directors/designees (hereafter called Directors) answered 44 questions that focused on infection prevention and control practices. Specifically, we asked questions related to prevention (general hygiene and sanitation), control (handling of vomit and fecal matter), and infectious disease control during an outbreak. All questions were based on the U.S. Centers for Disease Control and Prevention (CDC) recommended best practices for preventing norovirus infections in healthcare facilities.⁶ Responses were hand-recorded as "yes" or "no" and comments noted. If a Director reported their facility had a written policy or procedure, they were asked to show it to the interviewer. The Director also independently completed a questionnaire about facility characteristics, worker training, and personal demographics.

Data Management and Analysis

All interview and questionnaire responses were coded and entered into a Microsoft Excel spreadsheet as numeric values. Handwritten comments captured during the interview were categorized into themes, which were then converted to numeric values. Relative frequencies were calculated for categorical variables, and means were calculated for continuous variables using SAS 9.3 for Windows (SAS Institute Inc., Cary, NC). Proportions of responses between for-profit and non-profit facilities were compared using Fisher's Exact Test because the sample size was small. A significance level of 0.05 was used for all tests of significance.

RESULTS

Our results include a description of facility and Director characteristics. We also present the frequency of responses about practices for all facilities as well as for non-profit and for-profit facilities to determine if practices were associated with facility type.

Facility and Director Characteristics

Sixteen Directors indicated their facility was a skilled nursing facility, 9 a continuing care community, 8 a nursing home, and 3 an assisted living facility. This number is greater than 26 because respondents could select more than one choice for this questionnaire item. Most (19) facilities were for-profit (corporate or independently owned); 6 were non-profit (government or faith-based) institutions; and 1 did not select a facility type. Directors reported an average of 117 staff (range 44-225) (e.g., health care, food service, and custodial), 89 residents (range 16-254), and 102 beds (range 30-282). All provided training on infectious disease control.

In 5 facilities, the facility director was interviewed and in 15 the interview was conducted with the director of nursing or the infection control nurse. In 6, both the director and the infection

control nurse were interviewed. Sixteen Directors had 1-5 years of experience and 10 had completed an associate's degree or bachelor's degree.

Practices: General Hygiene and Sanitation

Our study findings indicated 3 gaps in general cleaning and sanitation practices: 1) improper use of sanitizing or disinfecting products after contamination events, 2) no written procedure for cleaning staff/visitor bathrooms to prevent transmission of HuNoV, and 3) no list of contamination events after which residents should wash hands. All Directors reported their facility followed a general schedule for cleaning and 18 reported some type of deep cleaning. Half (13) reported their facility was cleaned during the first shift only, and an additional 13 cleaned during the second or third shifts. For hard, food-contact surfaces, 13 reported using quaternary ammonium-based sanitizers, 5 chlorine-based sanitizers, and 4 sanitizers with other active ingredients (data not reported). Four Directors stated "I don't know" or "unsure" when asked about the type of sanitizer used on hard, food-contact surfaces. For other hard surfaces, 11 reported using quaternary ammonium-based sanitizers or disinfectants, 10 chlorine-based, and 3 sanitizers or disinfectants with other active ingredients. One reported using both chlorine-based and quaternary ammonium-based sanitizers and disinfectants for other hard, non-food-contact surfaces and 1 did not know. Twenty-two (22) facilities reported having written procedures for cleaning resident bathrooms, including bedside commodes, but only 1 had a written procedure for cleaning staff/visitor bathrooms (Table 1).

123 **Table 1: General Hygiene and Sanitation at Long-term Care Facilities in South Carolina**

Characteristics	For-profit (n=19)*						Non-profit (n=6)*						All facilities (N=26)					
	Yes		No		Other		Yes		No		Other		Yes		No		Other	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Bathroom Cleaning and Laundry																		
<i>Written procedures for:</i>																		
Resident bathrooms	15	79.0	3	15.8	1	5.3	6	0.0	0	0.0	0	0.0	22	84.6	3	11.5	1	3.9
Staff/visitor bathrooms	0	0.0	17	89.5	2	10.5	1	16.7	5	83.3	0	0.0	1	3.9	23	88.5	2	7.7
Washing laundry	17	89.5	1	5.3	1	5.3	6	100.0	0	0.0	0	0.0	24	92.3	1	3.9	1	3.9
<i>Laundry practices</i>																		
Laundry rooms separated from other areas	19	100.0	0	0.0	0	0.0	6	100.0	0	0.0	0	0.0	26	100.0	0	0.0	0	0.0
Soiled and non-soiled laundry transported separately	19	100.0	0	0.0	0	0.0	6	100.0	0	0.0	0	0.0	26	100.0	0	0.0	0	0.0
Bleach/other sanitizing agents added to wash cycle	17	89.5	0	0.0	2	10.5	6	100.0	0	0.0	0	0.0	24	92.3	0	0.0	2	7.7
Personal Hygiene																		
<i>Written procedures for:</i>																		
Dress code	19	100.0	0	0.0	0	0.0	6	100.0	0	0.0	0	0.0	26	100.0	0	0.0	0	0.0
Fingernail grooming	17	89.5	1	5.3	1	5.3	6	100.0	0	0.0	0	0.0	24	92.3	1	3.9	1	3.9
Jewelry†	16	84.2	2	10.5	0	0.0	6	100.0	0	0.0	0	0.0	23	88.5	2	7.7	0	0.0
<i>Hand hygiene practices</i>																		
Employees wash hands/use hand sanitizer after certain activities	19	100.0	0	0.0	0	0.0	6	100.0	0	0.0	0	0.0	26	100.0	0	0.0	0	0.0
Employees use hand sanitizer when hand hygiene is not required	19	100.0	0	0.0	0	0.0	6	100.0	0	0.0	0	0.0	26	100.0	0	0.0	0	0.0
Residents wash hands after certain activities	13	68.4	5	26.3	1	5.3	4	66.7	2	33.3	0	0.0	18	69.2	7	26.9	1	3.9

124 *One facility did not indicate the business type.

125 †Some directors did not provide an answer.

All Directors reported laundry was washed on site with 9 washing resident clothing only and 16 washing linens and mop heads in addition to resident clothing. Across all facilities, laundry rooms were separate from resident rooms, kitchens, and serving and commons areas. When transporting laundry throughout the facility, all reported using covered carts to separate clean and dirty laundry as well as contaminated and non-contaminated laundry. Nearly all (24) reported having written procedures for how to wash laundry. Of those 24, all required adding a sanitizing agent to the wash cycle, but only 15 specified a sanitizer, such as chlorine bleach.

All had a written dress code and allowed employees to arrive to work in their uniform. Nearly all (23) had recommendations on wearing jewelry and fingernail grooming. Hand hygiene of workers after certain activities was required by all, with 18 identifying activities after which residents needed to wash their hands.

Practices: Handling of Vomit/Fecal Matter

Gaps (5) were also found in practices related to handling vomit/fecal matter. These included: 1) no written procedures for cleaning bathrooms after a vomit/fecal episode, 2) use of ineffective products for pathogen removal after a vomit/fecal episode, 3) no written procedures for cleaning contaminated soft surfaces, 4) not removing other individuals during clean-up of a vomit/fecal episode, and 5) not cleaning a large area surrounding a vomit/fecal episode.

Nearly all (25) reported vomit and diarrheal episodes occurred outside a bathroom. Most stated that episodes of vomit (20) and diarrhea (24) occur most often in resident rooms. Twenty-four (24) reported they had a facility policy on incontinence care, but only 19 had procedures for clean-up of vomit or fecal matter on environmental surfaces (Table 2). Eighteen had written procedures for cleaning linens contaminated with vomit or feces as well as written procedures for cleaning hard, non-porous surfaces after exposure to vomit or fecal matter. Nearly half (12) had

149 **Table 2: Handling of Vomit/Fecal Matter at Long-term Care Facilities in South Carolina**

Characteristics	For-profit (n=19)*						Non-profit (n=6)*						All facilities (N=26)					
	Yes		No		Other		Yes		No		Other		Yes		No		Other	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Written procedures for cleaning:																		
Soiled resident	17	89.5	2	10.5	0	0.0	6	100.0	0	0.0	0	0.0	24	92.3	2	7.7	0	0.0
Vomit/fecal matter	13	68.4	3	15.8	3	15.8	5	83.3	1	16.7	0	0.0	19	73.1	4	15.4	3	11.5
Contaminated linens/clothing	14	73.7	2	10.5	3	15.8	4	66.7	1	16.7	1	16.7	18	69.2	4	15.4	4	15.4
Contaminated hard surfaces	13	68.4	4	21.1	2	10.5	4	66.7	2	33.3	0	0.0	18	69.2	6	23.1	2	7.7
Contaminated upholstered furniture, carpets, and rugs	7	36.8	11	57.9	1	5.3	4	66.7	2	33.3	0	0.0	12	46.2	13	50.0	1	3.9
Clean-up practices																		
Other individuals removed from room during clean-up	9	47.4	8	42.1	2	10.5	2	33.3	3	50.0	1	16.7	11	42.3	12	46.2	3	11.5
Workers and/or residents changed clothes after an episode	15	79.0	3	15.8	1	5.3	3	50.0	2	33.3	1	16.7	19	73.1	5	19.2	2	7.7
Written procedures on:																		
Cleaning restrooms after vomiting/diarrheal episodes	6	31.6	11	57.9	2	10.5	2	33.3	4	66.7	0	0.0	9	34.6	15	57.7	2	7.7

150 *One facility did not indicate the business type.

written procedures for cleaning upholstered furniture, carpets, and rugs after exposure to vomit or fecal matter, and 9 had different procedures for cleaning bathrooms after vomiting or diarrheal episodes. Less than half (11) reported that other individuals were removed from the room during clean-up of feces and vomit. Eight facilities stipulated a wide area surrounding an episode of vomit/fecal matter be cleaned while 18 cleaned only the vomit/fecal matter episode. Exact dimensions were not provided by any.

Practices: Infectious Disease Control

Most (22) reported they disallowed sick residents in common areas, and 20 disallowed healthy residents to visit sick residents (Table 3). Only 9 designated specific toilets for sick residents. Nearly all (25) excluded sick staff from work, and 8 assigned specific staff members to care for sick residents. Visitors were not allowed to have contact with sick residents in 11 facilities.

All Directors stated employees were required to wear disposable gloves when caring for sick residents. Nearly all (24) required employees to wear plastic aprons or cloth gowns, and 19 required wearing masks when caring for sick residents (Table 3). Only 9 reported using shoe covers when entering the room of sick residents. Employees at 25 facilities were required to remove personal protective equipment before leaving a room and dispose of these articles in biohazard (13) or other specified containers (13).

Our results showed no significant differences between reported practices at for-profit versus non-profit facilities. **MUST BE TWO SENTENCES.**

171 **Table 3: Infectious Disease Control at Long-term Care Facilities in South Carolina**

Characteristics	For-profit (n=19)*						Non-profit (n=6)*						All facilities (N=26)					
	Yes		No		Other		Yes		No		Other		Yes		No		Other	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Practices for handling sick residents																		
Not allowed in the commons areas	16	84.2	1	5.3	2	10.5	5	83.3	1	16.7	0	0.0	22	84.6	2	7.7	2	7.7
Isolated from healthy residents	16	84.2	2	10.5	1	5.3	5	83.3	0	0.0	1	16.7	22	84.6	2	7.7	2	7.7
Not allowed visits from healthy residents	14	73.7	3	15.8	2	10.5	5	83.3	1	16.7	0	0.0	20	76.9	4	15.4	2	7.7
Designated to specific toilets	6	31.6	12	63.2	1	5.3	3	50.0	3	50.0	0	0.0	9	34.6	16	61.5	1	3.9
Practices for handling staff																		
Sick staff excluded from work	18	94.7	0	0.0	1	5.3	6	100.0	0	0.0	0	0.0	25	96.2	0	0.0	1	3.9
Assign specific staff to only care for sick residents	6	31.6	13	68.4	0	0.0	1	16.7	5	83.3	0	0.0	8	30.8	18	69.2	0	0.0
Practices for handling visitors																		
Not allowed to have contact with sick residents	9	47.4	10	52.6	0	0.0	2	33.3	4	66.7	0	0.0	11	42.3	15	57.7	0	0.0
Written procedures on:																		
Cleaning and disinfecting during an outbreak	15	79.0	4	21.1	0	0.0	5	83.3	1	16.7	0	0.0	21	80.8	5	19.2	0	0.0
Practices for wearing PPE [‡] when caring for sick residents																		
Disposable gloves	19	100.0	0	0.0	0	0.0	6	100.0	0	0.0	0	0.0	26	100.0	0	0.0	0	0.0
Apron or gown	18	94.7	0	0.0	1	5.3	5	83.3	1	16.7	0	0.0	24	92.3	1	3.9	1	3.9
Masks	14	73.7	3	15.8	2	10.5	4	66.7	1	16.7	1	16.7	19	73.1	4	15.4	3	11.5
Shoe covers	8	42.1	8	42.1	3	15.8	0	0.0	6	100.0	0	0.0	9	34.6	14	53.9	3	11.5

*One facility did not indicate the business type.

DISCUSSION

Our study aimed to determine prevention and control practices for HuNoV in LTCF in South Carolina (SC) as the evidence on how well LTCF prevent and control HuNoV is limited. Preventing and controlling HuNoV in LTCF is critical because, not only are older adults at a high risk of being infected with HuNoV, they are also at high risk for complications due to HuNoV infections.

Prevention Practices: General Cleaning and Sanitation

No Directors reported using the correct product for pathogen removal (sanitizers or disinfectants) after specific contamination events. Sanitizers reduce, not eliminate, bacteria whereas disinfectants eliminate a wider range of microorganisms including fungi, viruses, and bacteria but not necessarily spores.⁷ Sanitizers are primarily used on food-contact surfaces and soft surfaces whereas disinfectants are used on non-food-contact surfaces and any surface contaminated with vomit or fecal matter.^{1,8} Therefore, sanitizers or disinfectants can be used every day to treat normal contamination events, but disinfectants should always be used if a surface, regardless of its type, is contaminated with vomit and fecal matter.¹

HuNoV can be introduced into health-care settings by ill staff/visitors when they use the bathroom while sick.¹ Only 1 facility had procedures for cleaning staff/visitor bathrooms. Flushing the toilet aerosolizes virus particles allowing them to be deposited onto bathroom surfaces.⁹ Also, when sick individuals do not wash their hands after using the bathroom, they can contaminate surfaces (e.g., door handles, faucet heads, and flush handles).¹⁰ Healthy persons who contact these contaminated bathroom surfaces can become infected. Moreover, because AGE is mostly caused by non-enveloped viruses,¹¹ which are highly resistant to disinfection,¹² it is important that all bathroom surfaces be cleaned then disinfected with high-level disinfectants as

they eliminate all microorganisms except bacterial spores. Low-level disinfectants eliminate most vegetative bacteria, some fungi, and some viruses.¹³

As hands can be a source of HuNoV, proper handwashing is critical for all persons – staff as well as residents. Many LTCF residents are bed-bound, so providing recommendations for them might not be practical, but providing recommendations for all other residents is necessary in preventing HuNoV transmission in a long-term care setting.

Practices: Handling of Vomit and Fecal Matter

To eliminate HuNoV, the CDC recommends using sodium hypochlorite (chlorine bleach) at a concentration of 1000-5000 ppm¹ or a disinfectant registered as effective against HuNoV by the U.S. Environmental Protection Agency.¹⁴ Use of products not effective against HuNoV could result in a failure to eliminate HuNoV on surfaces after a vomit/fecal episode which could cause additional cases of illness or could prolong an existing outbreak.

Less than half of the Directors (10) used chlorine-based products for pathogen removal from hard surfaces with 11 using quaternary ammonium-based products and 3 products with other active ingredients. While quaternary ammonium-based products can be used for general cleaning and sanitizing, they are not effective against HuNoV¹⁰ so should not be used to disinfect after vomit/fecal episodes. To eliminate HuNoV, the CDC recommends using sodium hypochlorite (chlorine bleach) at a concentration of 1000-5000 ppm on hard surfaces.¹ We believe one reason many facilities did not use chlorine bleach is that chlorine-based products are not allowed by the SC Occupational Safety and Health Administration (OSHA) because they are classified as corrosive agents. If a facility uses chlorine-based products, they must properly install an eye wash station.¹⁵ We did not check if facilities in our sample had eye wash stations but presumed most did not. We also believe facilities used quaternary ammonium-based products

because they believe they are not corrosive when in fact they are corrosive.¹⁶ So, if quaternary ammonium products are used, an eye wash station must be installed per OSHA regulations.

Written procedures for treating non-launderable soft surfaces, such as carpets, rugs, and upholstered furniture, is important because these types of surfaces can harbor microorganisms, such as HuNoV, and potentially transmit them to healthy individuals. When HuNoV attach to soft surfaces, they are difficult to eliminate,¹⁷ and chlorine bleach, which is recommended to eliminate HuNoV from hard surfaces, can damage or discolor the material of soft surfaces. Vomit/fecal matter should be removed from upholstery or carpet immediately following an episode. The CDC recommends using a manufacturer-approved cleaning agent followed by steam cleaning to accomplish this.⁶ However, the efficacy of this practice at eliminating HuNoV has not been proven. It is not practical to eliminate all soft surfaces as older adults need a comfortable and home-like environment. One solution is to use easy-to-clean vinyl upholstered furniture or furniture with removable cushions, which are easier to clean and disinfect.

Individuals must also be removed from a room during clean-up of a vomit or diarrheal episode to minimize risk of infection due to exposure.¹⁸ HuNoV particles can become aerosolized as a result of the cleaning process. When aerosolized, they can be ingested by individuals in the surrounding area,¹ so only cleaning staff wearing proper protective equipment (gowns, gloves, face masks, and shoe covers) should be in contaminated rooms, all other individuals must be removed.⁶

The floor can become contaminated via splatter and droplets,¹⁹ and workers shoes could transmit virus particles from that room to other areas. Wearing shoe covers and removing them before leaving the room could prevent introduction of viruses to other areas. Splatter and droplets from projectile vomiting can spread over a large area and contaminate surfaces that look

clean to the naked eye.¹⁹ At this time, there is insufficient evidence on how large of an area can become contaminated. However, it is best to be cautious and clean as wide of an area as possible surrounding the vomit/fecal matter.

Practices: Infectious Disease Control

Separate toilets must be designated for sick and healthy residents to limit opportunities for healthy residents to contact contaminated surfaces as virus particles can become aerosolized after flushing then settle on bathroom surfaces becoming a source of HuNoV.⁹ In addition, specific staff should be assigned to work with sick residents.⁶ One study reported staff spread HuNoV from residents on the second floor, where an outbreak began, to residents on the first floor.²⁰ Assigning specific staff to care only for sick residents decreases the likelihood that staff hands and clothing become contaminated and subsequently infect healthy residents or contaminate fomites in healthy resident's rooms.

Non-essential visitors must also be restricted during an outbreak⁶ which can be difficult to implement as Directors in our sample reported that residents want their relatives to visit them when they are sick. Additionally, the CDC recommends screening and excluding visitors with symptoms consistent with a HuNoV infection⁶ to prevent additional introduction of viruses from the community to long-term care residents.

Limitations

We used a convenience sample of LTCF in SC so our findings cannot be generalized to all LTCF in SC. The length of site visits (2-3 hours) could have been a limitation. Additionally, some Directors might not have wanted to interrupt essential facility activities more than necessary, so they might not have taken the time to find out answers to questions they were unsure of or interrupted staff that might have been better able to answer such questions. Self-

reported practices are not always accurate.²¹ Because the intent of the interviews was to have Directors self-report facility practices, better practices for prevention and control may have been reported than what actually occurs in facilities.

CONCLUSIONS

LTCF cause nearly 60% of HuNoV outbreaks in the U.S. so identifying gaps in prevention and control practices is essential to preventing future cases of illness. In our sample of LTCF in SC, specific gaps included lack of self-reported knowledge about sanitizing and disinfecting products, insufficient recommendations for resident hand washing, insufficient procedures for cleaning up after a vomit/fecal episode, and insufficient infection control practices during an outbreak.

Outbreaks of HuNoV will continue to occur in LTCF if these gaps in prevention and control practices are not addressed. One way to ensure best practices are being followed is to have accurate and up-to-date policies and procedures in facilities. However, the presence of policies and procedures alone is not sufficient to improve practices. Providing evidence-based, practical education or training for practitioners and other personnel in LTCF is also critical in preventing future outbreaks. Training should emphasize proper use of sanitizing and disinfecting products, procedures for cleaning up vomit/fecal matter, and proper infection control practices during outbreaks of enteric illness.

284 **ACKNOWLEDGEMENTS**

285 This material is based upon work supported by the Cooperative State Research, Education and
286 Extension Service, U.S. Department of Agriculture, under agreement no. 2009-51110-05858.

287 Any opinions, findings, conclusions, or recommendations expressed in this publication are those
288 of the author(s) and do not necessarily reflect the view of the USDA.

REFERENCES

1. Hall AJ, Vinjé J, Lopman B, et al. Updated norovirus outbreak management and disease prevention guidelines. *MMWR Morb Mortal Wkly Rep*. 2011;60:1-15.
2. Harris-Kojetin L, Sengupta M, Park-Lee E, Valverde R. Long-term care services in the United States: 2013 overview. Hyattsville, MD: National Center for Health Statistics. 2013.
3. Hall AJ, Wikswo ME, Pringle K, Gould LH, Parashar UD. Vital signs: Foodborne norovirus outbreaks – United States, 2009-2012. *MMWR Morb Mortal Wkly Rep*. 2014;63:491-495.
4. Kirk MD, Veitch MG, Hall GV. Gastroenteritis and food-borne disease in elderly people living in long-term care. *Clin Infect Dis*. 2010;50:397-404.
5. Trivedi TK, DeSalvo T, Lee L, et al. Hospitalizations and mortality associated with norovirus outbreaks in nursing homes 2009-2010. *JAMA*. 2012;308:1668-1675.
6. MacCannell T, Umscheid CA, Agarwal RK, et al. Guideline for the prevention and control of norovirus gastroenteritis outbreaks in healthcare settings. *Infect Control Hosp Epidemiol*. 2011;32:939-969.
7. US Environmental Protection Agency. *OCSPP 810.2000: General Considerations for Uses of Antimicrobial Agents*. Washington DC: US Environmental Protection Agency; 2012.
8. US Environmental Protection Agency. Antimicrobial Pesticide Products. <http://www.epa.gov/opp00001/factsheets/antimic.htm>. Accessed June 22, 2015.
9. Barker J, Jones MV. The potential spread of infection caused by aerosol contamination of surfaces after flushing a domestic toilet. *J Appl Microbiol*. 2005;99:339-347.
10. Barker J, Vipond I, Bloomfield S. Effects of cleaning and disinfection in reducing the spread of norovirus contamination via environmental surfaces. *J Hosp Infect*. 2004;58:42-49.
11. Hall AJ, Lopman BA, Payne DC, Patel MM, Gastañaduy PA, Vinjé J, Parashar UD. Norovirus disease in the United States. *Emerg Infect Dis*. 2013;19(8).
12. Sattar SA. Hierarchy of susceptibility of viruses to environmental surface disinfectants: a predictor of activity against new and emerging viral pathogens. *J AOAC Int*. 2007;90(6):1655-1658.
13. Rutala WA, Weber DJ, the Healthcare Infection Control Practices Advisory Committee (HICPAC). *Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008*. Atlanta, GA: The Centers for Disease Control and Prevention; 2009.
14. US Environmental Protection Agency. List G: EPA Registered Hospital Disinfectants Effective Against Norovirus (Norwalk-like virus). http://www.epa.gov/oppad001/list_g_norovirus.pdf. Accessed June 22, 2015.
15. Occupational Safety and Health Administration. *Occupational Safety and Health Standards* 29 CFR 1910.151(c); 1998.
16. International Programme on Chemical Safety. Chemical Safety Information from Intergovernmental Organizations website. <http://www.inchem.org/documents/pims/chemical/pimg022.htm#SectionTitle:2.1> Main risk and target organs. Accessed March 2, 2015.

- 333 17. Cheesbrough J, Green J, Gallimore C, Wright P, Brown D. Widespread environmental
334 contamination with norwalk-like viruses (NLV) detected in a prolonged hotel outbreak of
335 gastroenteritis. *Epidemiol Infect.* 2000;125:93-98.
- 336 18. Schmid D, Lederer I, Pichler A, Berghold C, Schreier E, Allerberger F. An outbreak of
337 norovirus infection affecting an Austrian nursing home and a hospital. *Wien Klin*
338 *Wochenschr.* 2005;117:802-808.
- 339 19. Booth CM. Vomiting Larry: A simulated vomiting system for assessing environmental
340 contamination from projectile vomiting related to norovirus infection. *J Infect Prev.*
341 2014;15:176-180.
- 342 20. Marx A, Shay DK, Noel JS, et al. An outbreak of acute gastroenteritis in a geriatric long-
343 term-care facility: Combined application of epidemiological and molecular diagnostic
344 methods. *Infect Control Hosp Epidemiol.* 1999;20:306-311.
- 345 21. Al-Wazzan B, Salmeen Y, Al-Amiri E, Abul A, Bouhaimed M, Al-Taiar A. Hand
346 hygiene practices among nursing staff in public secondary care hospitals in Kuwait: self-
347 report and direct observation. *Med Princ Pract.* 2011;20:326-331.