PROJECT TITLE:

STRUCTURED ABSTRACT

Purpose: T Œ v • }o v š o] Œ • was conducted š } . o o l Ç l v } Á o P P ‰ •] u ‰] v P À o } ‰ u v š } (š š] } v] v š Œ } o ‰ Œ } µ Œ • (} Œ À } u] š µ • X

Scope: Long-term care ( ] š o]] • U Z } u (} Œ v Œ o Ç î X ñ u] o o] } v ‰ } ‰ o who are r

Methods: Epidemiological and laboratory studies were employed to complete four aims – (1) quantify Œ } o } (À } u] š] v P] v Œ } µ š (š Œ v • u] • •] } v } (À] Œ µ • ; (2) measure dispersion of vomitus into the environment; d š Œ u] v š Z 8 -spectrum Œ }] •] v (} v š š] v P • š Œ š P] • } v Œ ‰ š; and determine norovirus persistence in the environment.

Results: Two epidemiological studies support control measures that limit exposure to vomitus during HuNoV outbreaks in long- š Œ u Œ ( ] o] š] •. The average extent of two-d dispersion of simulated vomitus was 44.8 m^2, spanning a width of 3.6 m and a length of 7.7 m from the source U } v . Œ µ] Œ P Œ v š Œ } u u v (} Œ š] o (š v] Œ P À] u P X o š Z } µ P Z hydrogen peroxide-based disinfectants can serve as an o š Œ v À š } Z o } Œ] v] •] v (š] } v š } Ã ï Ê P Ð

PURPOSE

Human norovirus (HuNoV) is the leading cause of acute gastroenteritis outbreaks in the United States. Long-term care facilities (LTCFs), home for nearly 2.5 million people, mostly older adults, are the most common setting for such outbreaks. Epidemiologic studies have identified vomiting, which occurs among more than 50% of symptomatic norovirus cases, to be a strong risk factor for norovirus transmission. Vomitus can contain over 30,000,000 million viral particles per vomitus event Ud esulting in contamination of environmental surfaces via aerosolization and/or improper clean up. Vomitus clean-up guidelines are available U but the evidence base informing procedures is limited Ud esulting in procedural steps š Z š Œ insufficiently detailed (e.g., radius of clean up and disinfection procedures for porous surfaces, such as carpet). This lack of detail could result in multiple interpretations of how to execute a clean-up step Up ossibly resulting in the ineffective removal of HuNoV. In this multidisciplinary study, we conducted translational research to fill key knowledge gaps impeding development of detailed infection control procedures for vomitus. Sp

•š]u što ‹µ š(Ç]v]À] µ]vo(}š]•v in order to Æ u]v šZ š]}vš Œ( ]µ
À}u]š]vP U] ŒŒZ U v •š]vP š} Œ•]v(vš]}v X A•• }]š]}v•
• Z ŒŒš]•š] • v Z š]u ŵ ere šµ•]vP u µo š]À Œ]v linear mixed model with
]vÀŒ• À Œ] v Á]PZš]vPX

Aim 2: D •µŒ]•‰ Œ•]}v }(À}u]šµ•]vš} šZ vÀ]Œ}vu vš X A scoping re
Æ‰Œ]u vš o •]uµo š]}v• Á Œ }v µ š š} measure the dispersion of vomitus into
environment. First, a scoping literature review was conducted to describe the extent of
knowledge related to the two research questions: (1) What are the determinants of post-
doffing contamination? (2) Where is post-doffing contamination most likely to occur after PPE
doffing? Two databases were searched (PubMed and sciVerse Scopus), v search terms and
inclusion criteria Á Œ defined. Data extraction was based on the matrix method, with
templates constructed in in Microsoft Excel. Extraction was performed by one investigator U v
a second investigator review šZ findings. ^ }v U v Œ Æ‰ Œ]u vš o •]uµo š]}v •šµ Ç Á
‰Œ (}Œu š} ‹µ vš](Ç šZ u Pv]šµ v Æš vš }(v}Œ}À]Œµ• u}v]š}Œ]vP }vš u
À}u]š]vP]v } Œ š}]v(}Œu šZ •‰ š] o (}Œ]vP À}u]šµ• À vš. The]•‰ Œ
}(G µ}Œ contai ning simulated vomitus was measured on surfaces and in air using a life-
•]Ì À}u]š]vP •]uµo š}Œ X &}µŒ Æ‰ Œ]u vš o À}u]š]vP •]uµo š}Œ• o
]•‰ Œ•]}v–head U À}u]šµ•i À}oµu U ‰Œ ••µŒ U v À}u]šµ• À]• }•]š
tested using a blocked randomized design. Fluorescein was measured on 36- G}} Œ • Œ‰ o v
Á]šZ (}µŒ]Œ • u‰o Œ•X

Aim 3: š Œu]v šZ 8 Ç }(Œ} -•‰ šŒµu]•]v(š]}v Ç šZ] 8 Ç •šŒ š P]
of chemical- and non-chemical- •]•]v(š]}v •šŒ š P] • ed Á •tested using se
two norovirus surrogates and X]8] oe. E]v]•]v(š vš•] vš]. (Œ}u >]•š '
Regist Œ v š]u] Œ}] o WŒ} µ š• + š]À P]v•š Eh Œ}À]Œµ• Á Œ
calicivirus (FCV), tulane virus (TuV), and o}•šŒ]}] •]8]o endospores in suspension on
stainless-•š o •µŒ(Œ‰ šX]š]}v ooÇU •š 2 were explored as v ‰Z}š} o
oš Œv š]À • š} Z u] o]•]v(š vš• (}Œ •µŒ(8]•]v(š]}vX /v
Á• .v ð-o}P Œ µ š]}v }(& s v X-o}P 8 endospores on hard (U
nonporous surfaces. As EPA does not recognize TuV as a target agent, 'e 8]}µ•[Á• .v
as a 3-o}P Œ}µ š]}v Œ o À] Œ First, suspension tests were conducted to
screen disinfectants against FCV, TuV, and X]8] endospores. Next, a carrier test on
stainless steel was conducted š} }v.Œu 8 Ç }v v}v‰}Œ}µ• Z Œ ŵ}Œ• ŵ Œ(•X
nylon carpets constructed with water-permeable or water ‰Œ}}.vP l]vP• (}Œ šZ Œ‰
were tested (}Œ]+ Œ v 8 All results from the suspension and stainless steel carrier
testto.776 0 Td -0.084ad89011[te)0Tc <01C80301182.83<3015Aai96n8w (,)Tjd susp(st)Tj0.024 Tc -0.0369ia(nyl

Aim 4: š Œ uv] }vŒ } À] Œ µ • ‰ Œ •] • š] v • À] Œ } v] v šZ X Persistence of HuNoV on porous and nonporous surfaces was determined using a very new culture system for HuNoV available only in two laboratories (Baylor College of Medicine and the U.S. Centers for Disease Control v W Œ š] } v À). The system is based on a novel human-] v š • š] v o } Œ P v }] cell culture v]-gu system. First, the persistence of HuNoV } À Œ š] u • determined (š Œ •] v P } v š } carpet coupons (} o o } Á Ç v š Z] . } v š] } (Z 8 chemical-based disinfectants other than chlorine against HuNoV Œ ‰ š o] } v } v • š] v o • • • š o v Œ ‰ š } µ ‰ } v • X ^ ‰] . Ç U a biosafety cabinet, 10 µL aliquots (replicates) of a pooled virus inoculum } v š] v] v P & s ~ ð Æ í ì ï š À] Œ µ • µ ‰ Œ ò Æ í ì ð š À] Œ µ • ‰ Œ ‰ } •] š u Œ } v š Z } (u] } v . o š Œ µ v] š • í v Z } µ Œ X (} Œ š U í ì ì R > } (either Virasept or (š v š U OxivirTB, Á added onto the virus inoculated areas of the membranes and] v µ š š • ‰] . } v š š] u } ( ] š Z Œ í ì } Œ ï ì u] v µ š • X d Z u u Œ v • Á Œ š Z v Á •] v (} v š] u W D] v] u o š • o v D] µ u ~ D D D • U ¡ U Á] š Z î 9 (š o } À] v • ~ & ^ • X d Z] • Á • (} o o } Á š] } v Ç š í ì ì R > v š] Œ µ P š] } v } (v š] Œ µ • ‰ Œ u] Œ µ u ‰ ‰ o] v ( ] Œ š í • š } Œ u } À] š Z (š v š X d Z } v R v š Œ š ~ í õ š Œ µ v] š • Á Œ š Z v š o v ‰ ‰ v } (the volume was i µ • š š } í u > Á] š Z } w (u š] X • d Z ‰ o • Á - (Œ o í ì Œ] o o Ç] o µ š u] v U] v (Z š] o µ š] ~ í ì -1, 10-2, 10-3 and 10-4) was assayed in quadruplicate to š Œ u] v š Z À] Œ o] v (š] À] š Ç µ •] v P š Z o š µ Œ ð Ð Ã 0 € á ` ‚ Ô 1 %

]v(š]

2.5 log- Œ šµ] } v } (& s v d µ s } v š Z v Ç o } v Œ ‰ š Á] š Z Á š Œ ‰ Œ } }
Œ • ‰ š] À r o r Ç Z] P Z Œ 8 Ç š Z v } v š Z permeable backings (1.3- and š Œ
1.1- Œ šµ] } v U Œ š] À ‰ o Ç • X

] u ð X š Œ u] v v } Œ } À] Œ µ • v ‰] Œ } •] u µ š v š X Results: During previous
experiments, š CDC had shown that two hydrogen peroxide-based products (Virasept and
K Æ] À] Œ d • Œ µ š À] š Ç Z } ( ] v (š Z & s ~ Œ µ ñ X ì - H o } P ð š Œ } P • u] v µ š • } (
} v š š] u } v • š] v o • Œ Œ š] Œ • X / v š Z] • } v š µ Œ Ç U š Z š Z u] } v
} o µ u v • P o š] } v Œ u š Z `yQBV$ } À v †D Œ ‰ š Á] š Z Á a} P 9 !!c#, ñ @ àPœ'A/

Table 1. 8 Ç P fe]ve salicivirus (FCV) and Tulane virus (TuV) } v Œ ‰ š • Á] š Z] + [a] Œ v š l] v P •

Disinfectant	Active ingredient	Concentration Reduction					
		TuV		FCV		X] (( ]] o	
		Suspension	Steel	Suspension	Steel	Suspension	Steel
A	0.5 % Hydrogen peroxide	3.8±0.6[AB]	0.8	5.1±0.6[A]	>5.1[A]	>6.0[A]	3.4±0.4[B]
B	0.88 % Hydrogen peroxide	3.4±0.7[AB]	1.1	4.1±1.4[AB]	>5.1[A]	0.1±0.1[B]	0.2±0.1[D]
C	1.4 % Hydrogen peroxide	3.8±0.8[A]	2.4	5.0±0.4[A]	>5.1[A]	1.4±0.1[C]	1.0±0.3[CD]
D	3.13 % Hydrogen peroxide/0.05 % Peracetic acid	3.9±0.5[A]	>3.1	>5.4[A]	>5.1[A]	>6.0[A]	>6.0[A]
E	5 % Hydrogen peroxide/0.01 % Silver	2.5±0.0[B]	0.8	2.7±0.2[B]	2.2±0.7[C]	1.3±0.2[C]	1.3±0.1[C]
F	Citric acid/Silver	0.2±0.2[C]	1.0	2.2±0.2[B]	>5.1[A]	0.0±0.1[B]	0.1±0.2[D]
'	Chlorine dioxide/QACs/	1.8±0.8[B]	0.9	0.3±0.1[C]	0.2±0.2[B]	0.4±0.3[B]	0.4±0.3[D]
H	QACs/Ethanol/ Isopropanl	3.8±0.6[AB]	1.0	1.9±1.3[B]	>5.1[A]	0.4±0.4[B]	0.3±0.2[D]
I	Ethyl and isopropyl alcohols	4.3±0.2[A]	1.9	5.2±0.8[A]	>5.1[A]	0.0±0.1[B]	0.1±0.1[D]

[a] Contact]u (} Œ & s v d µ s Á • í u] v] v • µ • ‰ v •] } v v ñ u] v } š Z • š] v š • š] u o (} Œ ‰ X v •] 8] endospores was 10 min in suspension and on stainless steel.

d Z š Œ Æ ‰ Œ • • • u š] } v • • š ^ v • • Œ (Œ } u À] µ ‰ o] š •] v Z } (š Á } š Œ] o • } (Æ ‰ o š š Œ • ~] X X U v •] v] š •] P v] . v š] + Œ v • ~ ‰ D ì X ì ñ • Á] š Z] v š Z • u } o µ u v •

Table 2. 8 Ç } (Z u] o] •] v (feline calicivirus (FCV), Tulane virurs (TuV), and X] 8] v } • ‰ } Œ } v Œ ‰ š • Á] š Z] + Œ v š l] v P • X

	Reduction (logs)	
Disinfectant		

Table 4. 8 Ç } (‰ Z] š] FCV, TuV, and X] 8] o } • ‰ } Œ } v] + Œ v š • µ Œ (

Microorganism	Surface	Lighting	Reduction (logs) [a] 60 min	120 min
FCV	Stainless steel	Controlled light	>5.3	n.a.
	Stainless steel	Indoor lighting	2.4±0.3	4.3±0.2
	Color Accent® (water-permeable)	Controlled light	1.3±0.3	n.a.
	Highlight® (waterproof)	Controlled light	2.9±0.5	n.a.
TuV	Stainless steel	Controlled light	3.3±0.3	n.a.
	Stainless steel	Indoor Lighting	0.8±0.1	1.4±0.1
	Color Accent® (water-permeable)	Controlled light	1.1±0.5	n.a.
	Highlight® (waterproof)	Controlled light	2.5±0.7	n.a.
X] (( ]] o	Stainless steel	Controlled light	0.0±0.1	0.5±0.2
	Color Accent® (water-permeable)	Controlled light	n.a.	0.3±0.2
	Highlight® (waterproof)	Controlled light	n.a.	0.3±0.2

[a] The š Œ Œ ‰ Œ • • u v • F • š v À] Œ š] } v • ~ ^ • • (Œ } ‰ š] Z Œ š • (} Œ • š] v o • • • š o } µ ‰ } v • v . À Œ ‰ o] š • (} Œ Œ ‰ š } µ ‰ } v •] experiments. “n.a.” indicates data not available.

Table 5. Viral recovery of Feline calicivirus (FCV) and Tulane virus (TuV) on Amicon column units

Table 6

List of Publications and Products Use

u• ŷµvP 'Ušy µAÇ, Paul P, Marsh Z, Hall AJ, Lopman BA. Quantifying the roles of vomiting, diarrhea, and residents vs. staff in norovirus transmission in U.S. nursing home outbreaks. PLoS Comput Biol. 2020 Mar 25;16(3):e1007271.

Chen Y, Lopman BA, Hall AJ, Kambhampati AK, Roberts L, Mason J, Vilen K, Salehi E, Fraser A, Adams C. Factors driving norovirus transmission in long-term care facilities: A case-level analysis of 1(@E345.058ke.o69(6024 Tw [E)-1.25 (,)]TJ-0l5v.07 w (6>33 (utbr)-9.-0.036 Tw 10.728 0 Td(Ma)Tj-0.024 Tw 4-