



Major article

Control of the spread of viruses in a long-term care facility using hygiene protocols



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Background: Approximately 50% of norovirus cases in the United States occur in long-term care facilities; many incidences of rotavirus, sapovirus, and adenovirus also occur. The primary objectives of this study were to demonstrate movement of pathogenic viruses through a long-term care facility and to determine the impact of a hygiene intervention on viral transmission.

Methods: The coliphage MS-2 was seeded onto a staff member's hands, and samples were collected after 4 hours from fomites and hands. After 3 consecutive days of sample collection, a 14-day hygiene intervention was implemented. Hand sanitizers, hand and face wipes, antiviral tissues, and a disinfectant spray were distributed to employees and residents. Seeding and sampling were repeated postintervention.

Results: Analysis of the pre- and postintervention data was performed using a Wilcoxon signed-rank test. Significant reductions in the spread of MS-2 on hands ($P = .0002$) and fomites ($P = .04$) were observed postintervention, with a >99% average reduction of virus recovered from both hands and fomites.

Conclusion: Although MS-2 spread readily from hands to fomites and vice versa, the intervention reduced average MS-2 concentrations recovered from hands and fomites by up to 4 logs and also reduced the incidence of MS-2 recovery.

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Within the last 2 decades, contaminated fomites have become recognized as one of the primary mechanisms for the spread of health care-associated infections (HAIs). In many community and health care facility outbreaks, environmental surfaces have been identified as the primary reservoirs for pathogens, including various enteric viruses, such as norovirus and rotavirus. Viruses are often transferred throughout a health care facility on the hands of health care workers.^{1,2} Pathogenic organisms are transmitted to

workers either directly from colonized or infected patients or from contaminated patient surfaces. Many health care-associated pathogens have the ability to survive on hands or gloves from 2 minutes-1 hour.³

Once settled on a surface, viruses can remain in the environment for prolonged periods of time. Studies have shown that norovirus is frequently transferred from contaminated surfaces to fingertips and then to other surfaces, such as toilet lids, door handles, and telephones.⁴ In addition to norovirus, other enteric viruses have also been identified as being transferred from fomite to fomite.⁵ Under optimal conditions of pH, relative humidity, and temperature, a virus can remain virulent on a surface for several days.^{2,5,6} Although inactivation and desiccation do occur, human exposure to even low doses of most viruses (10^1 - 10^2 virus particles) can cause infection.^{7,8}

In previous studies, surrogate organisms have been used to model movement of pathogens through different environments. In a

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study design by Beamer et al, a surrogate organism was inoculated onto a door handle in an office work place. After a period of time, surfaces in the office and a group of volunteers were sampled for the tracer. The study then implemented a healthy workplace initiative in efforts to reduce the spread of pathogenic viruses throughout office settings.⁹ Similarly, Sifuentes et al, inoculated 2 distinct tracer organisms, MS-2 and ϕ x-174, into a hotel environment. The tracers were allowed to spread, and then after the given time period, they were found throughout the hotel facility. Because the tracers were found in areas outside of the inoculation site, the spread was attributed to contact with both housekeeping staff and guests of the hotel.¹⁰ Tracer studies using surrogate organisms are an efficacious way to learn more about the dynamics of viral dispersion in different environments where the extent of pathogen spread and the associated risks of exposure may not be easily determined.^{9,10}

Numerous pathogens have been identified on fomites in health care settings. In 2010, Weber et al,² defined the general characteristics of a pathogen that increase transmission and risk in a health care facility. The characteristics are as follows: prolonged survival on surfaces (days to months), retained virulence, frequent contamination of environmental surfaces, transient ability to colonize health care workers' hands, and transmission via health care worker hands.²

The spread of HAIs can be particularly detrimental in long-term care facilities (LTCFs) because of the vulnerable nature of the population. In the United States, approximately 12 million individuals rely on some form of long-term care (LTC) service, with older adults (≥ 65 years) comprising just over 50% of this group at >1.5 million residing in LTCFs.¹¹ Unfortunately, hand hygiene compliance among workers in these facilities is often inadequate. Studies have reported hand hygiene compliance rates as low as 14.7%¹² and 17.5%¹³ in LTCFs. Between 1.6 and 3.8 million infections are reported in U.S. LTCFs every year.¹⁴ Although the Centers for Disease Control and Prevention and the World Health Organization published protocols for hand hygiene designed for application in all health care facilities, LTC workers face different challenges and exposure scenarios than workers in typical hospital or acute care settings.

Schwee and Kirk outline various moments of unexpected patient contact that occur in LTCFs because of their home-like environments, which limit the practice of hand hygiene prior to contact with patients.¹⁵ In some cases, a worker could experience a moment of patient contact without the opportunity to wash their hands after direct contact with a previous patient. LTC workers frequently experience unexpected moments of patient contact, such as hugging, kissing, and handholding. Other events that require immediate staff attention include emergency situations, such as safety alarms that need to be addressed quickly, body alignment or readjustments, and fixing clothing.¹⁵

The combination of unique contact moments and lower-than-average hand hygiene compliance by LTC workers and high infection rates suggests the need for adjustments to hygiene routines in LTCFs. Sustainable improvements in patient and staff hygiene behaviors and attitudes are expected to decrease pathogen exposures and infection risks in LTCFs.¹⁵ In this study, staff and patient hygiene practices in a Southwestern United States LTCF were modified through a hygiene intervention consisting of product addition and replacement (hand sanitizers, gloves, face and hand wipes, disposable clothes, tissues, and disinfectant) and personnel education. The primary objectives of this study were to characterize movement of pathogenic viruses (via MS-2) throughout an LTCF and to quantitatively determine how a hygiene intervention impacts on the spread of these viruses. The bacteriophage MS-2 was chosen as a surrogate because it is of similar size and shape of multiple nonenveloped, human enteric viruses of clinical importance in LTCFs. MS-2 is also environmentally stable.¹⁶

Table 1
Sample location sites

Location	Items sampled
Entryway-lobby	Elevator button Hand railing—entry Hand railing—hallway Medicine cart 1 Medicine cart 2 Medicine room door handle
Dining room	Coffee table Door handle Chair 1 Chair 2
Nurses' station	Large table Small table Records binder Medical chart Desk Stapler Phone
Team room	Door handle Table Chair 1
Patient rooms	Light switch Door handle Dresser Bedside table Bathroom door handle Remote call button
Activity room	Staff refrigerator door handle Faucet handle Food tray table Chair
Shower room	Game table Door handle—inside Door handle—outside Faucet handle Hand rails

METHODS

Sampling site selection

The study was performed in an LTCF skilled nursing unit with a maximum capacity of 67 patients. The unit was composed of primarily semiprivate rooms (2 beds), with some private and isolation rooms. The facility also had various shared community rooms, including a craft and activity room, therapy room, and dining room. In this ward, there were 3 staff-only rooms, 5 offices, 2 patient shower rooms, and a storage room.

A total of 37 fomites (Table 1) were chosen for sampling over the duration of the study. The site selection was based on observed staff member touch frequency, patient movement, and visitor movement over a period of 2 hours. In addition to sampling of fomites, 10 nursing and administrative staff volunteers were selected for hand contamination monitoring. Housekeeping staff were not included in the study because their direct contact with patients, visitors, and other staff was limited.

Study design

Sampling was conducted during pre- and postintervention periods consisting of 3 consecutive sampling days that served as replicates. During the preintervention phase, the spread of the viral surrogate throughout the facility was evaluated before the intervention. After the preintervention sampling, the 14-day intervention was implemented and immediately followed by 3 consecutive days of postintervention sampling.

In a single-blinded design, the hands of 1 volunteer were seeded with 100 μ L of MS-2 (starting concentration 10^{12} plaque forming

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