A randomized trial to determine whether wearing slippers reduces transfer of bacteriophage MS2 from floors to patients and surfaces in hospital rooms

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Abstract

In a randomized trial, patients wearing slippers whenever out of bed transferred bacteriophage MS2 from hospital room floors to patients and surfaces significantly less often than controls not provided with slippers. Wearing slippers could provide a simple means to reduce the risk for acquisition of healthcare-associated pathogens from contaminated floors. Registration: ClinicalTrials.gov; NCT04935892

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At 24 and 48 hours after MS2 inoculation, sterile, premoistened, BBL CultureSwabs (Becton Dickinson, Franklin Lakes, NJ) were used to sample high-touch surfaces (bed rails, bedside table, call button, telephone), personal items (cell phone, reading material, water bottles), bed linen in the location of the patients’ feet, and the patients’ hands and the soles of the feet and/or socks. For large surfaces, a 30×30-cm area was sampled; for smaller surfaces the entire surface area was sampled. Swabs were processed for culture of bacteriophage MS2. Negative control swabs were processed at baseline and at 24 and 48 hours. The microbiologist processing the cultures was blinded to the study group.

Information on demographics, medical conditions, devices, and mobility was obtained through chart review. The primary outcome was acquisition of bacteriophage MS2 on a composite of all sites, including the percentage of sites contaminated and the average log_{10} PFU. We anticipated that at least 1 site would be contaminated with MS2 in ~60% of control group participants. A power calculation indicated that 17 patients per group would provide 80% power to detect a 75% reduction in contamination from 60% to 15%. Linear and generalized linear mixed-effects models controlling for collection time and contamination site were used to compare differences in the characteristics of the participants in the 2 groups (Table 1). Based on interviews, 3 (18%) participants in the intervention group noted at least 1 episode of noncompliance because they forgot to put on the slippers. An additional intervention participant stated that he did not wear his slippers during a physical therapy session at the request of hospital personnel; this participant was observed by research personnel holding his socks after the session and had a positive hand culture.

Figure 1 shows the percentage of sites positive for bacteriophage MS2 and the log_{10} PFU recovered for the control and intervention groups. The number of participants in each group was 17 at 24 hours but decreased to 14 and 11 at 48 hours due to hospital discharges in the control and intervention groups, respectively. In comparison to the control group, the intervention group had significant reductions in the percentage of contamination (odds ratio [OR], 0.17; 95% confidence interval [CI], 0.05–0.50; P < .01) and in the log_{10} PFU recovered (β = −2.48; 95% CI, −3.78 to −1.16; P < .01). These models also demonstrated significantly increased contamination of socks and/or feet in comparison to other sites (P < .05).

### Results

Supplementary Figure 1 provides a flow diagram of study enrollment. Of 36 participants, 18 were randomized to the slipper intervention and 18 to the control group; 17 participants in each group were eligible for analysis. We did not detect any significant differences in the characteristics of the participants in the 2 groups (Table 1). Based on interviews, 3 (18%) participants in the intervention group noted at least 1 episode of noncompliance because they forgot to put on the slippers. An additional intervention participant stated that he did not wear his slippers during a physical therapy session at the request of hospital personnel; this participant was observed by research personnel holding his socks after the session and had a positive hand culture.

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### Discussion

Floors are increasingly recognized as a potential source for transmission of healthcare-associated pathogens. However, repeated cleaning and disinfection of floors is not practical because contamination reaccumulates rapidly and few alternative approaches have been considered. In the current study, a benign virus inoculated on the floor in hospital rooms was frequently acquired on socks or feet of patients and transferred to high-touch surfaces and hands. Acquisition of the virus was significantly reduced in patients randomized to wear slippers whenever out of bed. These results suggest that having patients wear slippers could provide a simple and low-cost intervention to decrease the risk for acquisition of pathogens from floors.

Although wearing slippers was effective, it did not eliminate all transfer of bacteriophage MS2. The contamination in these cases is
Fig. 1. Percentage of sites positive for bacteriophage MS2 (A) and the concentration (log_{10} plaque-forming units [PFU]) recovered (B) for control versus slipper intervention groups. HTS, high-touch surfaces.
likely attributable to participants occasionally forgetting to wear slippers or inadvertently contacting the floor while donning slippers. Further evaluations are needed to determine whether additional education or wearing slippers in conjunction with floor decontamination might be effective in reducing these occurrences. Encouraging patient hand hygiene after contact with slippers or socks may also be beneficial.

Our study had some limitations. The study was conducted in a single institution, and most participants were male and elderly with normal or slightly limited mobility. Compliance of participants with the intervention was not monitored. The transfer of bacteriophage MS2 was studied rather than transfer of healthcare-associated pathogens. However, in simulations bacteriophage MS2 and Clostridioides difficile spores transferred at similar frequencies from a contaminated mannequin to environmental surfaces. Future studies are needed to determine whether preventing transfer of pathogens from floors to high-touch surfaces will reduce the risk for acquisition of healthcare-associated pathogens.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/ice.2021.475

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References