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Brief Report

Are hospital floors an underappreciated reservoir for transmission of health care-associated pathogens?

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In a survey of 5 hospitals, we found that floors in patient rooms were frequently contaminated with pathogens and high-touch objects such as blood pressure cuffs and call buttons were often in contact with the floor. Contact with objects on floors frequently resulted in transfer of pathogens to hands.

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Effective disinfection of contaminated surfaces is essential to prevent nosocomial transmission of pathogens such as *Clostridium difficile*, methicillin-resistant *Staphylococcus aureus* (MRSA), and vancomycin-resistant enterococci (VRE).[1,2] Efforts to improve disinfection usually focus on surfaces that are frequently touched by the hands of health care workers or patients (eg, bed rails and call buttons). Although health care facility floors are often heavily contaminated,[3-5] limited attention has been paid to disinfection of floors because they are not frequently touched. However, floors are a potential source of transmission because they are often contacted by objects that are subsequently touched by hands (eg, shoes and socks). In a recent study, it was reported that nonslip socks worn by hospitalized patients were frequently contaminated with MRSA and VRE.[6] Moreover, Koganti et al[7] demonstrated that a nonpathogenic virus inoculated onto floors in hospital rooms rapidly disseminated to the hands of patients and to high-touch surfaces inside and outside the room. Here, we assessed the frequency of contamination of isolation room floors with *C difficile*, MRSA, and VRE and examined the potential for transfer of these pathogens from floors to hands.

METHODS

The study protocol was approved by the institutional review boards for each of the 5 participating Cleveland-area hospitals. Hospital personnel were not made aware of the study. For each hospital, environmental services personnel cleaned high-touch surfaces in *C difficile* infection (CDI) isolation rooms daily with bleach wipes, whereas floors were cleaned during admission only if visibly soiled and were mopped with a quaternary ammonium-based disinfectant after patient discharge. One of the 5 hospitals used an ultraviolet-C room decontamination device as an adjunct to standard cleaning after discharge of CDI patients.

For each hospital, premoistened BBL CultureSwabs (Becton Dickinson, Cockeysville, MD) were used to sample 1-sq ft areas of the floor in the bathroom and adjacent to the bed in CDI isolation rooms and in 2 or 3 randomly selected non-CDI rooms on the same ward as the CDI isolation rooms. Rooms were cultured either during the patient stay or after completion of cleaning after patient discharge. After swab collection, a 2×2 cm premoistened gauze pad was used to sample an adjacent 1-sq ft area for *C difficile* broth enrichment cultures.[8] Cultures were processed for MRSA, VRE, and *C difficile* as previously described.[8] At least 30 rooms were cultured in each hospital.

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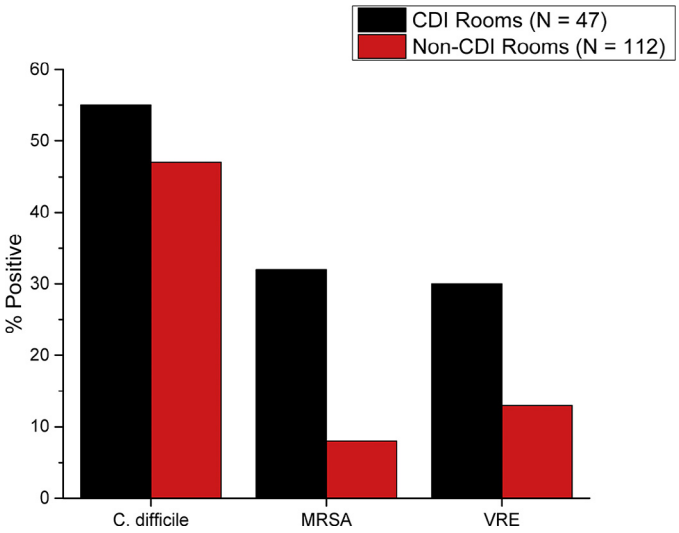

Fig 1. Recovery of *Clostridium difficile*, methicillin-resistant *Staphylococcus aureus*, and vancomycin-resistant enterococci from floors in patient rooms from 5 hospitals in northeast Ohio.

To assess the frequency with which high-touch objects were present on floors, a point prevalence survey was conducted in which observers determined the number and type of high-touch objects on floors in randomly selected patient rooms in each facility. To assess potential for transfer of pathogens from the floor to hands via fomites, research personnel picked up items in direct contact with the floor using either their bare hands (nonisolation rooms) or sterile gloves (CDI or other isolation rooms). Using premoistened CultureSwabs, bare hands were cultured before and after contact with the objects, whereas gloved hands were cultured only after contact.

RESULTS

A total of 318 floor sites were sampled in 159 patient rooms (2 sites per room). As shown in Figure 1, floor contamination was common in CDI and non-CDI rooms, and *C difficile* was the most frequently recovered pathogen. MRSA and VRE were recovered significantly more often from floors in CDI versus non-CDI rooms ($P < .05$), whereas recovery of *C difficile* was similar in CDI and non-CDI rooms ($P = .6$). The frequency of contamination was similar for each of the 5 hospitals and from room and bathroom floor sites. In comparison to rooms cultured during the patient stay (n = 109), rooms cultured after postdischarge cleaning (n = 50) had less contamination with MRSA and VRE (69 out of 536 sites [13%] vs 35 out of 100 sites [35%]; $P < .001$), but not *C difficile* (44 out of 100 sites [44%] vs 114 out of 218 [53%]; $P = .2$).

Of 100 occupied rooms surveyed (n = 10-25 per hospital), 41 (41%) had 1 or more high-touch objects in contact with the floor (range, 1-4 objects per room). The high-touch objects included personal items (eg, clothing, canes, and cellular telephone chargers), medical devices or supplies (eg, pulse oximeter, call button, heating pad, urinal, blood pressure cuff, wash basin, and heel protector), and bed linen or towels (eg, bed sheets, pillow, and towels).

For 31 of the high-touch objects present on floors, bare or gloved hand cultures were collected to determine the frequency of transfer of pathogens to hands after picking up the objects. Of the 31 hand or glove cultures, MRSA, VRE, and *C difficile* were recovered from 6 (18%), 2 (6%), and 1 (3%), respectively.

DISCUSSION

In a survey of 5 hospitals, we found that floors in patient rooms were frequently contaminated with health care-associated pathogens and it was not uncommon for high-touch objects such as medical devices, personal items, and linens to be in direct contact with the floor. Touching these objects frequently resulted in transfer of pathogens to hands. These results suggest that floors in hospital rooms could be an underappreciated source for dissemination of pathogens.

Our findings have several implications for infection control. First, because floors are frequently contaminated, it would be reasonable to educate health care personnel and patients that they should avoid placing high-touch objects on the floor when possible. Second, studies are needed to examine the efficacy of current floor cleaning and disinfecting strategies in removing potential pathogens from floors. In particular, because *C difficile* spores were frequently recovered from floors in CDI and non-CDI rooms, there is a need to identify approaches that are effective in reducing the burden of spores on floors. Sporicidal disinfectants are not typically used on floors. Ultraviolet-C room decontamination devices have been shown to reduce floor contamination with health care-associated pathogens[5]; these devices were used in only 1 of the study hospitals and only in CDI rooms. Finally, studies are needed to assess the potential for other modes of dissemination from floors (eg, shoes, wheelchairs, and other wheeled equipment). A recent study suggested that wheelchairs could be a source of pathogen dissemination in health care facilities.[9]

Our study has some limitations. We only studied *C difficile* spores and 2 gram-positive vegetative pathogens. Additional studies are needed to investigate contamination of floors with gram-negative pathogens and viruses. None of the hospitals used sporicidal agents on floors and therefore the frequency of *C difficile* spore contamination is likely to be higher than in facilities that use sporicidal agents. We did not determine whether non-CDI rooms with positive floor cultures for *C difficile* had recently housed CDI patients. Finally, our results may underestimate the frequency of MRSA and VRE contamination on floors because the culture swab method is less sensitive than the gauze pad with broth enrichment method that was used for *C difficile* cultures.[8]

CONCLUSIONS

We found that floors in patient rooms were frequently contaminated with health care-associated pathogens and demonstrated the potential for indirect transfer of pathogens to hands from fomites placed on the floor. Further studies are needed to investigate the potential for contaminated hospital floors to contribute to pathogen transmission.

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