



Infection Prevention

Description of the Problem

Hospital or healthcare acquired infections (HAI) are complications of healthcare which affect, on average, 10 percent of patients admitted to hospitals worldwide. HAIs have serious public health implications by changing the quality of life of patients, sometimes causing disability or even death.¹ An HAI is the result of treatment in a hospital or healthcare service unit, where the patient acquires an infection that he/she did not have prior to being admitted to the hospital. This infection is also referred to as a nosocomial infection. An HAI is defined as an infection appearing 48 hours or more after admission or within 30 days of discharge. In 2011, 721,800 known HAI occurred in the U.S. leading to 75,000 deaths.² HAIs cost in excess of \$45 billion each year spent on extra hospital days, multiple drug regimens, additional medical care and loss of productivity.^{2,3} In 2010, the average cost of each HAI was estimated by AHRQ to be \$43,000.⁴

At the beginning of 2015, the Centers for Medicare and Medicaid Services (CMS) began measuring *Clostridium difficile* (CDI) and Methicillin-resistant *Staphylococcus aureus* (MRSA) infections as key performance standards in the Value Based Purchasing (VBP) and Hospital Acquired Condition (HAC) Reduction Programs.⁵ By 2017, five percent of hospital inpatient Medicare reimbursement will depend on performance in these programs, along with the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) surveys, which directly impact reimbursement, costing hospitals millions of dollars annually.

Bacteria account for more than 90% of the causes of HAI, which is associated with their worldwide occurrence. Three pathogens often linked in the literature to contaminated surfaces in hospitals are CDI, Vancomycin-resistant enterococci (VRE), and MRSA.

Hazards & Risk Assessment

The incidence of CDI has been increasing for years, but the recent emergence and spread of strains that produce much higher levels of the potent toxin have made control even more urgent.⁶ This pathogen causes intestinal illness, ulcers and colitis. Studies have shown that this pathogen can survive up to 5 months on hospital surfaces.⁷ Some common surfaces that have shown contamination include floors, bed rails, bedside tables, the telephone and the call button. Transmission occurs via the healthcare worker through hand contamination. This pathogen is one of the most widespread infections in hospitals; where prevalence of hand contamination is proportional to environmental contamination suggesting the importance of the role of the physical environment in the transmission of this pathogen.⁸

VRE is a blood borne pathogen that causes infection in the urinary tract, heart, brain, and wounds. Transmission of VRE from environmental surfaces to the hands or gloves of healthcare workers is well documented. In one study, 46% of healthcare workers who touched contaminated surfaces in rooms of colonized patients were found to have contaminated gloves⁹; other research has shown that patients can become infected from direct contact with contaminated surfaces within the patient environment.¹⁰ VRE can survive for up to 2 months on countertops, 7 days on fabric chairs and up to 3 months or more on cotton bed sheets, plastic and dry polyvinyl chloride (PVC) surfaces.¹¹

MRSA is probably the best known pathogen due to the coverage in the news when this HAI also became classified as a community acquired illness (CA-MRSA), with a growing number of infections acquired among athletes, students, and military personnel without healthcare exposure. It is a prevalent pathogen in healthcare environments. This disease causes skin infections, fever, chest pain, fatigue and muscle aches. MRSA accounts for more than 50% of all hospital



acquired *Staphylococcus aureus* 6 and can remain viable for up to 14 days on surfaces; and for up to nine weeks on cotton blanket material.^{12, 13} Common materials where this pathogen can be found include carpet, plastic laminate, and polyester, a material commonly used in hospital privacy curtains. Transmission occurs directly from environment to patient or through healthcare workers.⁹ Studies that demonstrate the transmission via healthcare workers show that 42% of nurses contaminated their gloves by touching objects in the room of patients with MRSA without ever having touched the patient.¹¹

How Does Flooring Impact HAI?

The flooring in a healthcare facility contributes to the overall design and patients and visitors perception about the ability of an organization to provide safe, quality and comfortable care.¹⁴ Those charged with specifying flooring are faced with competing safety and comfort factors, such as reducing the risk of falling and injury, noise, staff fatigue, surface contamination and risk of HAI; and contributing to improved indoor air quality, occupant satisfaction, and return on investment. With competing components to the decision making process, it may be beneficial to rank the priorities. Interestingly, there is no evidence linking flooring to HAI.¹⁴ Regardless, it is important to make appropriate flooring selections with consideration for contamination, cleaning, disinfecting, and maintenance.

Most research on HAI have focused on behavioral (e.g. staff compliance of hand washing policies and consistency in housekeeping cleaning), source (e.g. equipment contamination) and transmission of infection (e.g. transmission from healthcare worker to patient). Recently, there is a surge of research that focuses on environmental impact on HAI, many focusing on maintenance and materiality.¹⁵⁻¹⁸ The majority of these focus on surfaces such as counters, walls, and upholstery with only a few focusing on flooring.

After appropriate selection of surface materials, strategies to reduce the rates of HAI should focus on thorough environmental cleaning and disinfecting¹⁹ practices and the development of systematic standards for hospital hygiene, which could provide a method for further evidence that

cleaning is a cost-effective intervention for controlling and preventing HAI20. In one study, the daily disinfection of environmental surfaces not contaminated with biological fluids was compared by random bacterial monitoring of surfaces. In this study, one unit used a detergent disinfectant for daily cleaning of the floors; the other unit used only a detergent at the beginning of the study, then changed to a rotation of detergent, dust attracting disposable dry mops and disinfectant. The use of detergent alone was associated with a significant increase in bacterial colony counts. The researchers found that the detergent was contaminated and by using it alone for cleaning, actually deposited surfaces with bacteria.²¹

However, another study evaluated floors in surgical units and found that floors and other horizontal surfaces showed a rapid accumulation of bacteria, increasing over time on uncleaned areas.²² In this study, the regular use of a disinfectant did not reduce the level of bacteria on the floor. Shoes transferred pathogens from contaminated to clean areas and the use of tacky and disinfectant mats did not reduce the transfer of bacteria. With contradictory results, more research is needed to determine the role of flooring (selection, cleaning, disinfecting, and maintaining) in the fight against HAI.

Recommendations

Recommendations for flooring include selection and housekeeping for a complete solution for a complex system that is significant to the functioning of the hospital environment. The focus is on infection prevention, but still considering other factors that contribute to safe and comfortable healthcare facilities.

Flooring Selection

- Flooring of all types, hard and soft, have merit for the right place and the right population
- Appropriate selection of flooring should consider housekeeping and maintenance during the selection process
- Patient, visitor and staff perception, acoustics, mobility, comfort and safety are critical criteria for the selection of flooring



- Flooring should be compatible with recommended cleaning and disinfecting practices (dry and wet)
- Surface materials and adjacent cove base should be impermeable
- Resilient floors may provide some relief for fatigue, acoustic properties, and ease of maintenance
- Carpet may provide some relief for fatigue, has shown to reduce sound levels, and act as a sink (holding contamination in the carpet, rather than becoming airborne)
- Resilient or hard surface materials should be used in areas where spills are likely to occur and where patients may be at greater risk for infection (e.g. burn units, ICUs, and operating rooms)²³
- Seamless flooring should be specified in high risk areas to minimize the risk of sustained contamination
- When specifying carpet, carpet tiles with impermeable backing are recommended by the CDC for easy removal of contaminated floor surface, cleaned and disinfected off-site to be reused, or discarded and replaced²³
- Antimicrobial treatments have not been found to directly impact the rate of HAI.

Housekeeping

- A multidisciplinary team should establish cleaning procedures and frequencies, reviewed periodically, revised as necessary, and made readily available
- For resilient and hard surfaces, the use of a detergent and FDA approved disinfectant should be used for regular cleaning
- Regular cleaning and removal of soil and dust will reduce the persistence of bacteria that thrive in dry conditions
- Standardized protocols for regular, terminal and spot cleaning should be implemented to maximize the reduction of contamination

- The use of appropriate cleaning methods and agents should be used to minimize the risk of slipping
- Keep flooring in good condition and repair when necessary to maintain the integrity of the floor surface

Flooring is one of the most predominant surfaces in healthcare environments. It is literally everywhere. Flooring affects the quality of the healthcare environment and influences perception of patients and visitors on the ability of the healthcare organization to provide safe, comfortable quality care. While many factors impact the selection of flooring surface materials, infection prevention is clearly a priority. Currently, the research is lacking evidence to understand the potential for flooring to influence nosocomial infection rates. Further research with better control of the environment is necessary to determine the role that flooring plays in the reduction of HAI. For now, based on the evidence available, due diligence to select the proper flooring for a variety of applications in healthcare facilities and housekeeping practices to minimize contamination is the best course of action to balance the impact on the environment and occupants.



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