



# Infection Prevention and Control for Healthcare Facilities

## Healthcare Associated Infections

Healthcare associated infections (HAIs) are complications of healthcare which affect, on average, 10 percent of patients admitted to hospitals worldwide, causing 100,000+ deaths annually. Each year, about 1 in 25 U.S. hospital patients is diagnosed with at least one infection related to hospital care alone; additional infections occur in other healthcare settings. Many HAIs are caused by the most urgent and serious antibiotic-resistant (AR) bacteria and may lead to sepsis or death. CDC uses data for action to prevent infections, improve antibiotic use, and protect patients.<sup>1</sup>

HAIs have serious public health implications by changing the quality of life of patients, sometimes causing disability or even death.<sup>1</sup> 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. A HAI is defined as an infection appearing 48 hours or more after admission or within 30 days of discharge.

## Defining Infection Prevention/Control

Infection prevention and control is the discipline concerned with preventing nosocomial or healthcare-associated infection, a practical (rather than academic) sub-discipline of epidemiology. It is an essential, though often under recognized and under supported, part of the infrastructure of health care. Infection prevention and control and hospital epidemiology are akin to public health practice, carried out within the confines of a healthcare delivery system rather than directed at society.

Infection prevention and control addresses factors related to the spread of infections within the healthcare setting (whether patient-to-patient, from patients to staff and from staff to patients, or among-staff), including prevention (via hand hygiene/hand washing, cleaning/disinfection/sterilization, vaccination, and surveillance), monitoring/investigation of demonstrated or suspected spread of infection within a

particular health-care setting (surveillance and outbreak investigation), and management (interruption of outbreaks).

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. Other bacteria and viruses are also significant for consideration in surface material specifications and maintenance protocols.<sup>2</sup>

## Defining Common Pathogens in Healthcare Settings and their Approximate Lifespans<sup>2</sup>

<u>Pathogen</u>	<u>Lifespan</u>
C. Difficile	>5 months
MRSA	2 weeks
Staphylococci	7 months
VRE	3 months
Acinetobacter	5 months
Norovirus	3 weeks
Adenovirus	3 months
Rotavirus	3 months
SARS1, SARS2, HIV, etc.	Hours to days

## Hazards & Risk Assessment

The incidence of **CDI** (C. Difficile) 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.<sup>3</sup> This pathogen causes intestinal illness, ulcers and colitis. Studies have shown that this pathogen can survive up to 5 months on hospital surfaces.<sup>2</sup> 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.<sup>4</sup>

**VRE** (Vancomycin-resistant Enterococci) 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.<sup>5</sup> In one study, 46% of healthcare workers who touched contaminated surfaces in rooms of colonized patients were found to have contaminated gloves other research has shown that patients can become infected from direct contact with contaminated surfaces within the patient environment.<sup>6, 7</sup> 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.<sup>6</sup>

**MRSA** (Methicillin-resistant Staphylococcus aureus) 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 healthcare associated Staphylococcus aureus and can remain viable for up to 14 days on surfaces; and for up to nine weeks on cotton blanket material.<sup>3, 8</sup> 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. 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.<sup>9</sup>

**Gram-negative bacteria** cause infections including pneumonia, wound and surgical site infections, and meningitis in healthcare settings. Gram-negative bacteria are resistant to many drugs and are increasingly resistant to most available antibiotics; and include infections caused by Klebsiella, Acinetobacter, Pseudomonas, and E. coli, among others.<sup>10</sup> If gram-negative bacteria enter the circulatory system, the resulting effect is a fever, an increased respiratory rate, and low blood pressure. This may lead to life-threatening septic shock.<sup>5</sup>

**Influenza** is primarily a community-based virus infecting 5% to 20% of U.S. residents, many seeking medical care in ambulatory healthcare settings. More than 200,000 persons, on average, are hospitalized for the flu.<sup>10</sup>

**Noroviruses** are a group of viruses that cause gastroenteritis in people. In otherwise healthy people, the norovirus is usually short-lived, but young children, the elderly, and people with other medical maladies are most at risk for more severe or prolonged infection. Like all viruses, noroviruses are not affected by treatment with antibiotics.<sup>10</sup>

Common human **coronaviruses** usually cause mild to moderate upper-respiratory tract illnesses, very much like the common cold. Most people get infected with one or more of these viruses sometime during their lifetime. Symptoms include runny nose, sore throat, headache, fever, cough, and general feeling of being unwell. There is no vaccine, and most treatment options include over-the-counter medications such as pain and fever medications, using a room humidifier to ease sore throat and cough, drinking plenty of fluids, and getting plenty of rest. These coronaviruses are not the same as COVID-19.<sup>11</sup> The SARS1 outbreak of 2003 had a total of 8,098 people in the world who became sick. Of these, 774 died. In the U.S., only 8 people had confirmed cases of the SARS-CoV1 infection. All these people had traveled in other parts of the world where SARS1 was spreading. Symptoms were similar to the flu, including a high fever, headache, body aches, and an overall feeling of discomfort. After several days, patients may develop a cough and most patients developed pneumonia.<sup>12</sup>

**COVID-19**, severe coronavirus disease (COVID-19 is also called severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and is similar to but more contagious than



SARS1. COVID-19 is characterized by unresolved systemic hyperinflammation associated with a life-threatening “cytokine storm syndrome,” leading to multi-organ failure dysfunction in some patients. At this time, new vaccines are getting emergency approval from the FDA for use in the U.S. while treatments remain limited to FDA approved options limited to hospitalized patients. If not hospitalized, the treatment is Acetaminophen for pain and fever, and increased fluids and rest. Recent research has shown that the virus can live on common surface materials from less than 4 hours to up to 7 days in a laboratory controlled environment. Environmental conditions may affect the ability for the virus to remain infections, for instance, increased temperature and relative humidity may increase the rate of decay of SARS-CoV-2, limiting transmission capability.<sup>13</sup>

The current science suggests that COVID-19 is transmitted through close contact from person to person, droplets produced when the infected person speaks, coughs, or sneezes, and fomites, which are objects or materials likely to carry infection, such as clothing, furniture, and utensils.<sup>14</sup> Outbreaks in nursing homes has reinforced that residents with COVID-19 frequently may be asymptomatic or may not have symptoms until days after initial infection. Unrecognized asymptomatic and pre-symptomatic infections likely contribute to transmission in these and other healthcare settings.<sup>15</sup>

SARS-CoV-2 is an envelope virus and is therefore, not difficult to kill outside of a human host. Surfactants in soap products will destroy the virus. Disinfectants that are

### How Does Flooring Impact HAI?

The flooring in a healthcare facility contributes to the overall design influencing patients and visitors perception about the ability of an organization to provide safe, quality and comfortable care.<sup>16</sup> 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 factors in the decision-making process, it may be beneficial to rank the priorities. Several recent studies have indicated that flooring may contribute to transmission of pathogens in the healthcare environment.<sup>17, 18</sup> In this new age of disinfection, it is essential to follow the CDC

guidelines for environmental infection control. Routine cleaning and disinfection procedure using an EPA-registered, hospital-grade disinfectant for appropriate contact times as indicated on the product’s label is appropriate for SARS-CoV-2 in healthcare settings, including patient-care areas.<sup>10</sup>

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 and healthcare worker to healthcare worker). Recently, there is a surge of research that focuses on environmental impact on HAI, many focusing on maintenance and materiality.<sup>17, 19-28</sup> These research studies focus on environmental surface materials including materials used for counters, walls, and flooring.

It is important to understand the terms involved in types of infection prevention/control and to distinguish between high-touch surfaces (doors, handles, bed rails, call buttons) and low-touch surfaces. (floors and ceilings) in a healthcare setting. To sterilize is to make free from live bacteria or other microorganisms. To disinfect is to cleanse to destroy or prevent the growth of disease-carrying microorganisms. Sanitize is to make sanitary, or free of dirt and pathogens that could affect one’s health. Cleaning methods and materials will depend on the type of surface being cleaned.

After appropriate selection of surface materials, strategies to reduce the rates of HAI should focus on thorough environmental cleaning and disinfecting 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 HAI.<sup>27</sup> In one study, the daily disinfection of environmental surfaces was compared by random bacterial monitoring of surfaces. One patient 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. Through the investigative process, researchers found that the detergent was contaminated and by using it alone for cleaning, deposited surfaces with bacteria.<sup>29</sup>



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.<sup>30</sup> 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 of surface materials and housekeeping protocols for a complete solution. Flooring represents a large surface, potentially with a variety of materials that is a complex system 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.
- 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 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)
- 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 replaced.

## Flooring as a Low-Touch Surface and Recommendations on Cleaning

- Vacuum carpeting in public areas of health-care facilities and in general patient-care areas regularly with well-maintained equipment designed to minimize dust dispersion.
- Periodically perform a thorough, deep cleaning of carpeting as determined by facility policy by using a method that minimizes the production of aerosols and leaves little or no residue.
- Avoid use of carpeting in high-traffic zones in patient-care areas or where spills are likely (e.g., burn therapy units, operating rooms, laboratories, and intensive care units).
- Follow proper procedures for managing spills on carpeting.
  - Spot-clean blood or body substance spills (OSHA: 29 CFR 1910.1030 § d.4.ii.A, interpretation)
  - If a spill occurs on carpet tiles, replace any tiles contaminated by blood and body fluids or body substances.
- Thoroughly dry carpeting to prevent the growth of



fungi; replace carpeting that remains wet after 72 hours.

- Following the CDC for routine cleaning and disinfection using an EPA-registered, hospital-grade disinfectant for appropriate contact times as indicated on the product's label is appropriate for healthcare settings, including patient-care areas.<sup>10</sup>
- **No recommendation is offered regarding the routine use of fungicidal or bactericidal treatments** for carpeting in public areas of a health-care facility or in general patient-care areas. (Note: This is still being studied.)
- Do not use carpeting in hallways and patient rooms in areas housing immunosuppressed patients (e.g., PE areas).
- New disinfectant technologies and products may potentially offer expanded options for product selection and maintain a cleaning and disinfecting protocol for floor surfaces. These include UV-C and combination disinfectants, among others.

## Overview of Housekeeping for Healthcare Facilities

- 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.

## Conclusion

While there is limited research on the influence of flooring on HAIs, some findings suggest that flooring plays a role

whether through transmission from flooring to human or from flooring as a low-touch surface in contact with high-touch surfaces.<sup>18, 19, 31, 32</sup> 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 a leading priority. Currently, the research is growing by still lacking evidence to understand the potential for flooring to influence nosocomial infection rates. Further research with better control of the environment and laboratory experiments are necessary to determine the role that flooring plays in the reduction of HAIs. 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 ambient environment and occupants of healthcare facilities.

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