

## ENVIRONMENTAL DESIGN FOR INFECTION PREVENTION: HEALTHCARE FACILITY DESIGN

Healthcare or Hospital acquired infections (HAI), also called nosocomial infections is the result of treatment in a hospital or healthcare service unit, whereas the patient acquires an infection that he/she did not have prior to being admitted to the hospital. An HAI is determined based on appearing 48 hours or more after admission or within 30 days of discharge. HAI affects an estimated two million patients in the United States each year with 90,000 or more ending in death. HAI kills more people each year than breast cancer, prostate cancer and AIDS combined. From a cost perspective, HAI result in millions of extra hospital days, an estimated cost of \$30 billion due to multiple drug regimens, additional medical care and loss of productivity.

In a study reported by the Pennsylvania Health Care Cost Containment Council, in 2007 the average number of HAIs reported was 17.7 per 1,000 patients with a mortality rate of 12.2%. The average length of stay attributed to HAI was 19.7 days with a cost per patient of \$191,872. HAI occur in about 20% of very low birth weight infants with an increase of length of stay up to 24 days and an increased cost of up to 20% per patient.

In a literature review of the role of the hospital environment on the occupants, over 120 studies linking the hospital environment to infection were identified. The focus of these studies was on airborne infections: 1) natural and forced ventilation; 2) use of HEPA filters; 3) vehicles of transmission; and 4) hand washing policies and practices. The pathogens linked to contaminated surfaces in hospitals are *Clostridium difficile* (*C. diff.*), Vancomycin-resistant Enterococci (VRE), and Methicillin-resistant *Staphylococcus aureus* (MRSA). *C. diff.* causes intestinal illness, ulcers and colitis. Studies have shown that this pathogen can survive up to 5 months on hospital surfaces. Some common surfaces that have shown contamination include floors, bed rails, bedside table, the telephone and the call button. Transmission occurs via the healthcare worker through hand contamination. This pathogen is one of the most prevalent infections in hospitals. VRE is a blood borne pathogen that causes infection in the urinary tract, heart, brain, and wounds. Again, research has shown a link between patient acquisition of VRE and transmission via the caregiver; other research has shown that patients can become infected from direct contact with contaminated surfaces within the patient environment.

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. This disease causes skin infections, fever, chest pain, fatigue and muscle aches. It has the ability to survive on environmental surfaces for up to 9 weeks after drying. Common materials where this pathogen can be found include carpet and plastic laminate. Transmission occurs direct from environment to patient or through healthcare workers.

Disinfection of patient environments is dependent on collaboration between designer, facility manager, and housekeeper. The right materials must be specified and maintained so that cleaning and disinfecting is productive. There are eight strategies for infection prevention:

1. Target high-touch areas
2. Stress technique over chemicals
3. Follow the directions
4. Consider the risks associated with sporicides
5. Determine the effect chemicals have on materials, patients and staff

6. Assemble multidisciplinary teams (clinical, engineering, housekeeping)
7. Check each other's work
8. Emphasize hand washing among staff and visitors

“Never Events” are serious reportable events that are clearly identifiable, preventable, and serious in their consequences for patients. It is a clear indication that a real problem of safety and credibility exists for the healthcare facility. On October 1, 2008, Medicare and Medicaid stopped reimbursing for never events. Other insurers quickly followed suit with their own policies. Hospitals are prohibited from passing charges on to the patient. This increases costs and liability for the hospital. HAIs are not formally a part of this list, though it is planned to be included in the next round of review. Some hospitals have voluntarily added HAI to their list of never events internally so that hospital acquired infections are given the same significance as other preventable incidents.

Metals are being touted as the next great thing for use as an antimicrobial. Though metals may not be listed as a pesticide like antimicrobials currently used in all kinds of interior finish materials, there are real concerns about the efficacy and potential unintended consequences of using these products in healthcare facilities. Several products have been developed using silver (Ag) such as those manufactured by Agion. This product is used in sportswear, the food industry, air purifiers, and cheese coating (wax). In the interior design industry, they are used in fabrics and paint materials. The silver based disinfectant is reported to kill bacteria and fungi and remain active on surfaces for 24 hours after disinfection. It is colorless, noncorrosive and nonflammable. It has been shown to be effective against MRSA, VRE, HIV, influenza, athlete's foot fungus, etc. The effectiveness of silver to minimize contamination is reliant on the form of silver (threads, salt compounds, etc.) and the amount in the product or disinfectant. Through cleaning and abrasion, products with these added metals may become less effective over time.

Copper is another metal being marketed for use in healthcare facilities. Uncoated copper and copper alloys (brass and bronze) can eradicate pathogens like E. coli, Streptococcus, and Staphylococcus. It has been shown to be effective against MRSA and was recently approved by the EPA as a registered antimicrobial material. Currently new products are in development for healthcare furniture and materials – door hardware, over bed tables, bed rails, armchairs, call buttons and medical equipment like IV stands. However, copper is only effective when it is uncoated and uncoated copper is susceptible to corrosion.

Another buzz word out there is about nanotechnology. Some have misreported nanotechnology as an antimicrobial; however nanoparticles are basically a vehicle for the distribution and adherence of materials (like silver or titanium dioxide) to another material, such as an upholstery fabric. Nanotechnology is clearly a part of our future and to some extent or present; however research is still needed to evaluate potential risks. Recent studies indicate possible unintended consequences. In a study evaluating socks that have silver nanoparticles to reduce foot odor showed that silver was being released in the wash and eventually into our environment. Silver nanoparticles may destroy beneficial bacterial needed to break down organic matter in waste treatment plants and farms. Another study investigated the effects of rats inhaling particles. This study showed that particles settled in the brain and lungs, creating health issues for the rats. It is professed that carbon nanotubes could be as harmful as asbestos when inhaled in sufficient quantities.

Design recommendations for the infection prevention:

1. Design to minimize patient transfers
2. Design to support hand washing – hand washing sinks in every patient room, corridors, etc.
3. Consider the position of the hospital in regard to antimicrobial agents...what is the evidence?
4. Know the science to balance design for infection prevention against the other environmental benefits of interior finishes and furniture
5. Vectors of transmission
  - a. Specify the design to be easy to clean without complicated procedures or chemicals – seamless casework or furniture
  - b. Fabric on seating should provide a barrier to the cushion
  - c. Seating should have a “wipe out” space between the seat and the back or other design feature to reduce the source for bacterial growth.
  - d. Consider carpet tile for soft flooring (for easy removal/cleaning offsite)