ENVIRONMENTAL SURFACE CLEANING

First Defense Against Infectious Agents

By Kathy Dix and Jennifer Schraag

Infectious organisms lurking on healthcare surfaces contribute to nosocomial infection. Proper management and eradication methods are imperative in striving for a clean environment.

Nosocomial infection — it's deadly, it's prevalent, and the organisms that cause it are found virtually everywhere. Approximately 5.7 percent (2,000,000) of all patients admitted to U.S. hospitals acquire nosocomial infections, of which 3.8 percent prove fatal.[1] That calculates to 70,000 people dying every year from such infections.

Nosocomial infection can be caused by a vast array of organisms. Those most prevalent include chemically resistant organisms such as *Clostridium difficile* (C-difficile), multidrug-resistant organisms (MDROs) such as methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant Enterococcus (VRE).[2] Another group of great concern are extended-spectrum beta-lactamases or ESBL.

Prions and bacterial spores also are extremely resistant and difficult to kill, and it has been determined that intermediate resistance to disinfection is demonstrated by mycobacterium and non-enveloped viruses. Those easier to eradicate from the environment include fungi, vegetative bacteria such as Pseudomonas, and enveloped viruses.

It is known that dry conditions favor the persistence of gram-positive cocci in dust and on surfaces, while moist, soiled environments favor the growth and persistence of gram-negative bacilli.

According to National Nosocomial Infection Surveillance (NNIS) statistics for infections acquired among ICU patients in the United States in 1999, 52.3 percent of infections resulting from *Staphylococcus aureus* were identified as MRSA infections, and 25.2 percent of enterococcal infections were attributed to VRE. These figures reflect a 37 percent and a 43 percent increase, respectively, since 1994 to 1998.

Environmental surfaces of nearly any kind are a possible breeding pool for such infectious organisms. For example, environmental surfaces have been shown to be a potential reservoir for nosocomial transmission of VRE.[3]

VRE is capable of prolonged survival on hands, gloves, and environmental surfaces. In fact, in a study conducted at Northwestern University Medical School, E. faecalis was recoverable from countertops for five days, and E. faecium persisted for seven days. For bedrails, both enterococcal species survived for 24 hours without significant reduction in colony counts. The researchers also found that bacteria persisted for 60 minutes on a telephone hand piece and for 30 minutes on the diaphragmatic surface of a stethoscope.

C. difficile is an anaerobic, gram-positive bacterium.[4] Normally fastidious in its vegetative state, it is capable of sporulating when environmental conditions no longer support its continued growth. The capacity to form spores enables this organism to persist in the environment (e.g., in soil and on dry surfaces) for extended periods of time. Environmental contamination by this microorganism is well known, especially in places where fecal contamination may occur. The environment (especially housekeeping surfaces) rarely serves as a direct source of infection for patients, however, direct exposure to contaminated patient-care items (e.g., rectal thermometers) and high-touch surfaces in patients' bathrooms (e.g., light switches) have been implicated as sources of infection.

Acinetobacter baumannii (A. baumannii) is ubiquitous and has become one of the many recognized healthcare-associated pathogens in hospitals.[5] During a two-month period, an outbreak of pan-drug resistant A. baumannii colonization and infection affecting seven patients occurred in a Taiwan surgical intensive care unit. Extensive environmental contamination was identified, including sites such as bed rails, bedside tables, the surfaces of ventilators and infusion pumps, water for nasogastric feeding and ventilator rinsing and sinks.

In 2002, an outbreak of multidrug-resistant A. baumannii, involving 21 patients, occurred in a trauma intensive care unit at the Hamad Medical Corporation in Qatar.[6] The A. baumannii strain was isolated from the environment, equipment, and hands of healthcare workers (HCWs). The researchers concluded the technique of open suctioning may have resulted in aerosilization and contamination of the immediate patient environment.

ESBL is fast becoming a serious concern in healthcare. The first beta-lactamase was identified in an isolate of *Escherichia coli* in 1940.[7] ESBL represents an impressive example of the ability of gramnegative bacteria to develop new antibiotic resistance mechanisms in the face of the introduction of new antimicrobial agents.[8]

One French study found five ESBL-producing enterobacteria (ESBLE) responsible for urinary tract infections (UTIs) found among 1,584 strains collected from community patients.[9] The aim of this study was to reveal the route of emergence. The researchers ultimately found the same ESBLE and/or an identical or similar ESBL-encoding plasmid in a hospital ward and in a clinic where the patients had previously resided.

"Studies have shown that in rooms of patients who were colonized or infected, 70 percent of environmental surfaces were contaminated with potentially harmful microorganisms," says David Parks, general manager of global infection control products with Kimberly-Clark Health Care. "Once these surfaces become contaminated, without proper disinfection they can remain contaminated for extensive periods of time."

The number and types of microorganisms present on environmental surfaces are influenced by the following factors:[4]

- Number of people in the environment

- Amount of activity
- Amount of moisture
- Presence of material capable of supporting microbial growth
- Rate at which organisms suspended in the air are removed, and
- Type of surface and orientation (i.e., horizontal or vertical).

Gordon Buntrock, director of product development, environmental services for Aramark Healthcare Management Services, points out, “Healthcare delivery and the environment are interdependent; one cannot be achieved without the other. There are a number of organizations such as the Centers for Disease Control and Prevention (CDC) and the Association of PeriOperative Registered Nurses (AORN) that provide guidelines that should be looked at for cleaning within the acute care environment. Documents such as ‘Guidelines for Environmental Infection Control in Health Care Facilities’ from the CDC and ‘Standards, Recommended Practices, and Guidelines’ from AORN are critical readings associated specifically to healthcare cleaning and cleaning of surgical areas.”

It is important to note that although microbiologically contaminated surfaces can serve as reservoirs of potential pathogens, these surfaces generally are not directly associated with transmission of infections to either staff or patients.4 Surfaces contribute to cross-transmission by acquisition of transient hand carriage due to contact with contaminated surfaces or medical equipment.[10] So the transfer of microorganisms from environmental surfaces to patients is largely via hand contact with the surface.[4]

“Hand hygiene may be the single most important factor in ensuring a clean environment and reducing the spread of all types of microbial contamination, such as MRSA and VRE,” affirms Chuck Allgood, PhD, technical support leader with DuPont Safety and Protection.

Rose Hamann, CHESP, director of environmental services and security, and Carleen Orton, an infection control nurse, both of Quincy, Ill.- based Blessing Hospital, agree, warning, “First and foremost for any healthcare worker is the diligent washing or alcohol disinfection of their hands — stop the germs from spreading,” they say.

Orton says the pathogens their facility educates personnel on specifically are VRE, MRSA, and C. difficile. “Also, hepatitis B and C,” she says. “We ensure the staff realizes reactivation may occur if the blood becomes moistened at a later date.”

“Our city had an outbreak of VRE coming from a long-term care nursing facility,” Hamann continues. “We did a huge campaign for handwashing and awareness of disinfecting all areas where patients’ hands would touch. Our infection control nurse did a swab of the chair scales on one of our nursing units and found VRE. We did educational reminders for staff to disinfect all patient equipment, and environmental services was in-serviced on the areas needing disinfection and daily attention in patient care areas. The surfaces such as hand rails, door knobs, and overbed tables were a few of the highlighted areas.”

When attempting to ensure a clean healthcare environment, HCWs must look beyond environmental surface contamination and also focus on portable equipment and protective apparel contamination, as they too play a key role in the spread of infection, according to Parks. “During their daily routine, healthcare workers frequently carry thermometers, blood pressure cuffs, and stethoscopes from one patient’s room to another patient’s room. Each of these pieces of equipment can become contaminated by one patient and lead to the cross-infection of another patient.

“Protective apparel can be another source of contamination,” he continues. “One study found that when caring for patients with MRSA and VRE, 69 percent of healthcare workers’ lab coats were contaminated, and 27 percent of their hands were contaminated after touching their lab coats. Gloves have also been shown to be contaminated with MRSA 42 percent of the time after touching environmental surfaces without having touched the patient.

“So during an average day in a healthcare environment, the surfaces in the patient’s room, the equipment used to treat patients, and even the apparel worn to protect the healthcare workers can all be vehicles in the spread of infection. Therefore, proper disinfection of surfaces and portable equipment, and the use of disposable protective apparel — as well as adherence to proper hand hygiene — are all necessary to minimize the risk of cross-infection.”

According to the CDC, there are three levels of disinfection for the treatment of devices and surfaces that do not require sterility for safe use. They are “high-level,” “intermediate-level,” and “low-level.”[4]

The process of high-level inactivates all vegetative bacteria, mycobacteria, viruses, fungi, and some bacterial spores. High-level disinfection is accomplished with powerful, sporicidal chemicals (e.g., glutaraldehyde, peracetic acid, and hydrogen peroxide) that are not appropriate for use on housekeeping surfaces.

Intermediate-level disinfection does not necessarily kill bacterial spores, but it does inactivate *Mycobacterium tuberculosis* var. M.bovis, which is substantially more resistant to chemical germicides than ordinary vegetative bacteria, fungi, and medium to small viruses (with or without lipid envelopes). Chemical germicides with sufficient potency to achieve intermediate-level disinfection include chlorinecontaining compounds (e.g., sodium hypochlorite), alcohols, some phenolics, and some iodophors.

Low-level disinfection inactivates vegetative bacteria, fungi, enveloped viruses (e.g., human immunodeficiency virus [HIV], and influenza viruses), and some non-enveloped viruses (e.g., adenoviruses). Low-level disinfectants include quaternary ammonium compounds, some phenolics, and some iodophors. Sanitizers reduce the numbers of bacterial contaminants to safe levels.[4]

Buntrock adds that in 1991, CDC proposed an additional category designated “environmental surfaces” to Spaulding’s original classification to represent surfaces that generally do not come into direct contact with patients during care. “Environmental surfaces carry the least risk of disease transmission and can be safely decontaminated using less rigorous methods than those used on medical instruments and devices,” he shares. “Environmental surfaces can be further divided into medical equipment surfaces (e.g., knobs or handles on hemodialysis machines, X-ray machines, instrument carts, and dental units) and housekeeping surfaces (e.g., floors, walls, tabletops).”

“At a minimum, any hard surface disinfectant should be EPA-registered and proven effective against the organisms of concern, and be safe to both those who apply them as well as others who may be exposed,” Allgood says. “The specific area of a healthcare facility (operating rooms, labs, patient rooms, emergency rooms, waiting rooms, neonatal units, etc.), will determine exactly what level of cleaning and disinfecting is needed. In virtually all cases, a broad spectrum disinfectant is preferred.”

In specific circumstances, disinfectants should be effective against expected organisms, for example emergency rooms and labs should use products that meet the OSHA bloodborne pathogen standard, Allgood points out. “Ideally, one would use products applicable in as many areas as possible. These disinfectants have efficacy against a wide range of human pathogens including hepatitis A, B, and C, MRSA, VRE, influenza, RSV, and norovirus. Products that work well in the presence of soil (clean and disinfect in one step) are preferred since some types of disinfectants such as bleach and quaternary ammonium compounds are inactivated under heavy soil load.”

Allgood adds, “Understanding the shelf life, dilution requirements, and compatibility with materials that will be contacted either intentionally or inadvertently are also very important in choosing a disinfectant. For instance, bottles of bleach have a recommended shelf life of three to six months and in-use solution should be made up daily.”

Targeted disinfection of environmental surfaces are established components of hospital infection control.[11] Careful cleaning of patient rooms and medical equipment contributes substantially to the overall control of MRSA, VISA (vancomycin intermediate resistant S. aureus), or VRE transmission.[4] Both MRSA and VRE are susceptible to several EPA-registered low- and intermediate-level disinfectants (e.g., alcohols, sodium hypochlorite, quaternary ammonium compounds, phenolics, and iodophors) at recommended use dilutions for environmental surface disinfection. Additionally, both VRE and vancomycin-sensitive enterococci are equally sensitive to inactivation by chemical germicides, and similar observations have been made when comparing the germicidal resistance of MRSA to that of either methicillin-sensitive *Staphylococcus aureus* (MSSA) or VISA. The use of stronger solutions of disinfectants for inactivation of VRE, MRSA, or VISA is not recommended based on the organisms’ resistance to antibiotics.

This points to another consideration. Keep in mind the repercussions of the use of certain chemicals. “The toxicity and chemical nature of certain disinfectants (fumes) may limit or preclude their use in certain areas, i.e. products with irritating fumes may not be used in areas with young children or respiratory patients,” Allgood points out.

New research is being conducted all the time to reduce any consequences of such cleaning materials. New disinfectants, mainly peroxygen compounds, are showing good sporicidal properties in recent research and will probably evolve to replace the more problematic substances such as chlorine-releasing agents.[11]

Compatibility of the material or surface the disinfectant or cleaner will be used on is another key issue and should be established early on. "For instance, bleach can be very corrosive and damaging to a large number of materials such as stainless steel that need to be disinfected. It also results in collateral damage to fabrics, carpeting, and clothing upon incidental contact," Allgood asserts.

Hamann says her facility alerts staff to use a bleach solution. "If we see an outbreak of *C. difficile*, staff is alerted to use bleach solution in these patient rooms to lessen the chance of cross contamination," she says.

Strategies for cleaning and disinfecting surfaces in patient-care areas should take into account the potential for direct patient contact, degree and frequency of hand contact, and potential contamination of the surface with body substances or environmental sources of microorganisms (e.g., soil, dust, and water).[4]

The factors influencing the choice of disinfection procedure for environmental surfaces include the nature of the item to be disinfected, the number of microorganisms present, the innate resistance of those microorganisms to the inactivating effects of the germicide, the amount of organic soil present, the type and concentration of germicide used, duration and temperature of germicide contact, and if using a proprietary product, other specific indications and directions for use.[4]

"Keep in mind that cleaning is the necessary first step of any sterilization or disinfection process and is needed to render the environmental surface safe to handle or use by removing organic matter, salts, and visible soils — all of which interfere with microbial inactivation," says Robin Morris, customer marketing manager for healthcare with Kimberly-Clark Professional. "In fact, the physical action of scrubbing with detergents and surfactants and rinsing with water removes large numbers of microorganisms from surfaces. Most, if not all, housekeeping surfaces require regular cleaning with soap and water or a detergent/disinfectant and removal of soil and dust, according to the CDC guidelines. High-touch housekeeping surfaces in patient-care areas, such as doorknobs, bedrails, light switches, wall areas around the toilet, and the edges of privacy curtains, should be cleaned and/or disinfected more frequently than surfaces with minimal hand contact. Horizontal surfaces with infrequent hand contact, such as window sills and hard-surface flooring in routine patient-care areas require cleaning on a regular basis, when soiling or spills occur, and when a patient is discharged from the facility."

Orton points out that wiping down the equipment immediately after use helps to cut down on microbial growth. In addition, as Hamann points out, "ES is not routinely responsible for equipment, but we do help others when needed," she says. "We also remind or bring to attention of the nursing staff if we see unclean or dusty equipment. We are all in this together and need to work as a team to help prevent cross-contamination — not only do we protect others, but also ourselves in doing this."

Perhaps the best plan of action, according to Allgood, is to mimic the Hazard Analysis and Critical Control Point (HACCP) plan used in the food industry to control microbes in food production facilities. Allgood advises, "The healthcare industry should develop a similar plan for monitoring and disinfecting critical locations in the hospital environment to minimize the spread of dangerous pathogens. Because cleaning services may not always clean thoroughly, a monitoring program should be initiated to validate the effectiveness of cleaning and disinfection of hospital surfaces. Common errors in dilution of concentrates or in 'topping off' containers of ready-to-use disinfectants with diminished activity need to be corrected immediately and standard operating procedures must be reviewed often."

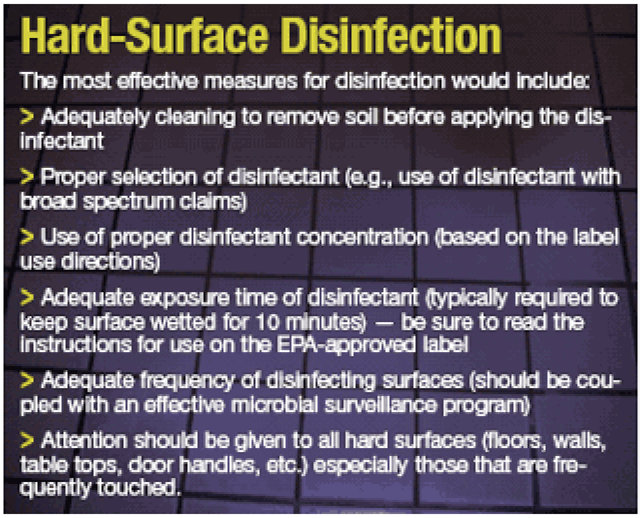
Overall, Allgood says the best plan would combine a regular scheduled cleaning, disinfection, and monitoring program as described above — along with rapid response and containment of "unexpected" events, (i.e. spill of blood/body fluid, fecal accidents) in order to prevent small incidents from developing into major outbreaks.

"Any hard non-porous surface should be considered an area needing cleaning and disinfection," he adds. "The frequency of cleaning and disinfecting depends on a number of factors including likelihood of contamination and potential exposure risk for others. Areas and surfaces frequently contacted by many people, especially those sick (beds, stretchers, hand rails, rest rooms, door knobs, floors throughout the facilities, etc.) would be the highest priority."

"All areas within the hospital are not created equal in the amount of daily cleaning and level of cleaning that has to take place," adds Buntrock. "A strategy has to be created for different areas of the hospital and it is usually determined by a risk assessment. Usually, this is based on the use of the area and the potential for transmission of nosocomial infection. It is important to understand that cleaning in hospitals has to take place with regularity, that housekeeping is focused on the cleaning of environmental surfaces. It is also important to understand that it is important that housekeeping focuses on the removal of microorganisms through routine mechanical action and good detergency. The goal of daily housekeeping is to remove soil, dust, and pathogens. It is also important to know that gravity plays a big role in regards to areas that require the most cleaning. Airborne soils and microorganisms settle on horizontal surfaces more than on vertical surfaces."

Of note, Buntrock points out, "Between those areas and areas that patients touch directly, an EPA-registered detergent/disinfectant should be utilized when cleaning. When using disinfectants/detergents, it is still critical to use good mechanical action and to use absorbent materials to remove soil and microorganisms. If high volumes of soil are visible, it may be necessary to pre-clean the surface with a cleaner that provides greater detergency and then follow-up with the disinfectant.

When disinfectants are utilized in cleaning, it is important that the disinfectant is not dried with a cloth, but allowed to air-dry, providing the product more application time to disinfect. Low-level disinfectants and intermediate-level disinfectants that housekeeping utilizes for cleaning are only active as disinfectant when they are wet."



Source: Chuck Allgood, PhD, technical support leader with DuPont Safety and Protection

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References:

1. DeLoach C. and Brown J. Cleaning for health: Understanding green cleaning. ASHES Conference, Phoenix, AZ. Sept. 25-29, 2005.

2. *Infection Control Today*. A Clean Sweep: Surface Cleaning in the Healthcare Environment. December 2004. www.infectioncontroltoday.com/articles/4c1feat2.html (accessed Oct. 19, 2005).

3. Noskin GA, et al. Recovery of vancomycin-resistant enterococci on fingertips and environmental surfaces. *Infect Control Hosp Epidemiol.* 16(10):577-81, October 1995.

4. Centers for Disease Contraol and Prevention. Guidelines for Environmental Infection Control in Health-Care Facilities." Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC), 2003. www.cdc.gov/ncidod/hip/enviro/Enviro_guide_03.pdf (accessed Oct. 21, 2005).

5. Wang SH, et al. Healthcare-associated outbreak due to pan-drug resistant Acinetobacter baumannii in a surgical intensive care unit. *J Hosp Infect.* 53(2):97-102, February 2003.

6. El Shafie SS, et al. Investigation of an outbreak of multidrugresistant Acinetobacter baumannii in trauma intensive care unit. *J Hosp Infect.* 56(2):101-5, Feb. 2004.

7. Turner PJ. Extended-spectrum beta-lactamases. *Clin Infect Dis.* 15;41 Suppl 4:S273-5, August 2005.

8. Paterson DL, Bonomo RA. Extended-Spectrum {beta}-Lactamases: a Clinical Update. *Clin Microbiol Rev.* 18(4):657-86 October 2005.

9. Arpin C. Clinical and Molecular Analysis of Extended-Spectrum {beta}-Lactamase-Producing Enterobacteria in the Community Setting. *J Clin Microbiol.* 43(10):5048-54, October 2005.

10. Rutala WA, Weber DJ. Surface disinfection: should we do it? *J Hosp Infect.* 48 Suppl A:S64-8, August 2001.

11. Dettenkofer M, Block C. Hospital disinfection: efficacy and safety issues. *Curr Opin Infect Dis.* 18(4):320-5, August 2005.