LEAD FEATURE

Using continuous cleaning technology to enhance standard disinfection practices

Lisa Croke, Managing Editor

Evidence indicates that the transmission of health care–associated infections (HAIs) is affected by environmental contamination; some pathogens can persist on surfaces for weeks to months.[1,2] Cleaning and disinfection are essential for minimizing patient and personnel exposure to infectious pathogens; however, the effectiveness of traditional methods is dependent on the antimicrobial activity of the disinfectant and the ability of environmental services (EVS) personnel to use the correct agents, formulations, distributions on surfaces, and contact times.[3,4] According to Maureen Spencer, MEd, RN, CIC, infection prevention consultant, Boston, the main contributor to inadequate cleaning and disinfection is a lack of staffing. "There are not enough people on EVS teams to do what is expected of them; in fact, evidence has shown that up to 50 percent of high-touch surfaces in hospitals are inadequately cleaned," she said. "This is the reason behind the increasing interest in continuous cleaning technology that allows for persistent disinfection." This technology, which can decrease the risk of surface recontamination and is safe for use around patients and personnel, includes dry hydrogen peroxide (DHP), some forms of ultraviolet (UV) and visible light, compounds with persistent antimicrobial activity, and antimicrobial surfaces coated with metals (e.g., copper, silver).[3,4]

Dry hydrogen peroxide

Spencer indicated that DHP is a nonaqueous gas produced from the humidity and oxygen present in the environment that can kill microbes, including viruses in smoke plumes. "These systems release DHP and can be standalone units mounted on the ceiling or wall or incorporated into the HVAC [heating, ventilation, and air conditioning] system of the building," she said. "Unlike vaporized hydrogen peroxide, the concentrations of hydrogen peroxide in DHP are below the acceptable safety limits for human exposure and thus can be used continuously, even when staff members or patients are present."

Authors of one study assessed the use of DHP as an adjunct to manual cleaning to reduce contamination in the air and on surfaces in intensive care unit rooms. Two rooms were control rooms and two had DHP units installed. Seven surfaces (e.g., bed, monitor) were swabbed for cultures and adenosine triphosphate (ATP) assay after manual cleaning one week before use of the DHP units and weekly for four weeks after use of the DHP units. Air samples also were obtained at baseline and weekly after use of the DHP units. Surface contamination was significantly decreased in the rooms with the DHP units (5.5 colony-forming units [CFU]) compared with the control rooms (11.77 CFU). Mean relative light units (RLU) were decreased in the rooms with DHP units (172.08 RLU) compared with the control rooms (225.83 RLU); a clean surface was defined as an RLU below 250. The CFUs in the air in the rooms with the DHP units also were reduced compared with the control rooms, but the difference was not statistically significant.[5]

Ultraviolet and visible light

The electromagnetic spectrum includes UV light with a wavelength of 100 to 400 nanometers (nm) and visible light (i.e., violet-blue light) with a wavelength of 400 to 760 nm.[6] "Ultraviolet light works by breaking through the outer membrane of microbes to reach the DNA; when the radiation reaches the DNA, the DNA transmits incorrect information that results in the death of the microbe," Spencer said. Visible violet-blue light works by targeting intracellular porphyrins that absorb the light and produce reactive oxygen species that kill bacteria.[7]

Ultraviolet light

Spencer indicated that because current air recirculation systems in the OR, such as laminar flow and positive pressure, have been shown to only displace airborne pathogens and not deactivate them, there has been recent interest in a novel mobile high-efficiency particulate air (HEPA) recirculation system that has shown effectiveness in orthopedic procedures.

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"This system really gained traction as a result of the 2016 outbreaks of a nontuberculous mycobacterium, called chimaera, that was caused by contaminated heater-cooler machines transmitting the bacteria through the air," she said. "This system cleans the air by circulating it through a UV light and HEPA filtration system and releasing it back into the room." The UV system is internal, which prevents exposure to patients and personnel.[8]

Authors of a retrospective study assessed the effect of this system for reducing periprosthetic joint infections in almost 500 consecutive patients undergoing total joint arthroplasty by the same surgeon in 500-square-foot ORs with 20 air exchanges per hour. The control group (n = 256) consisted of patients whose surgeries took place in ORs with standard turbulent airflow; the intervention group (n = 231) consisted of patients whose surgeries took place in ORs with the system installed. Follow-up occurred for one year after surgery. Five infections were identified, all of which occurred in the control group, making the infection rate in the control group 1.5 percent and in the intervention group 0 percent. The authors concluded that this technology should be considered as an adjunct to standard cleaning and disinfection to help reduce the risk of surgical site infections (SSIs).[8]

Visible light

Visible light disinfection systems are comprised of overhead fixtures containing a combination of visible violet-blue and white lights with a peak output of 405 nm. The white lights alone and combined with the violet-blue lights can safely be used when people are in the room; and the violet-blue lights alone can only be used when the room is unoccupied.[7] "This technology is very applicable to the OR and in areas like the preoperative holding area," Spencer said. "The white lights put out a very small amount of disinfection activity during the day while patients and personnel are present, but at night when the room is vacated, the lights turn to a deep indigo color that provides a higher level of disinfection."

Authors of one study evaluated the effectiveness of a visible light disinfection system for decreasing surface bacteria in an orthopedic OR and reducing SSIs at one hospital. The system was used in conjunction with standard cleaning and disinfection. Samples from 25 surfaces in two ORs that shared an air supply were obtained after manual cleaning and before and after the system was installed in one of the ORs. In addition, SSIs in both ORs were monitored for one year before and after installation of the system. Total CFUs decreased by 81 percent and SSIs decreased by 1 percent in the OR with the system. Total CFUs also decreased by 49 percent and SSIs decreased by 0.9 percent in the OR that shared the air supply of the OR with the system.[9]

Persistent disinfectants

Persistent disinfectants, such as organosilane compounds comprised of a surfactant combined with an antimicrobial (e.g., quaternary ammonium), are designed to maintain their antimicrobial activity on surfaces for weeks or months.[4] "These are approved by the Environmental Protection Agency and are different from standard disinfectants in that covering surfaces with a persistent antimicrobial solution prevents recontamination," Spencer said.

Authors of one study assessed the effectiveness of a persistent isopropyl alcohol/organofunctional silane solution (IOS) for reducing contamination after terminal cleaning of surfaces in four ORs (e.g., computer keyboards). The surfaces were randomized to be treated with the IOS, which was applied once after terminal cleaning, or not (i.e., control). Twice a week for six weeks, ATP testing of the surfaces was performed; an ATP testing result of at least 46 RLU indicated a dirty surface. Cultures also were obtained on alternating weeks. Overall, 29.9 to 57.8 percent of surfaces were considered dirty at baseline. The mean RLU for the control surfaces was 242 compared with 67.6 for surfaces treated with the IOS. Cultures were positive on 80 percent of control surfaces compared with approximately 17 percent of surfaces treated with the IOS. The authors concluded that a single application of the IOS provided persistent disinfectant activity, but that additional studies would help validate these findings.[10]

Antimicrobial surfaces

Surfaces coated with heavy metals (e.g., copper, silver) have natural antimicrobial properties and are designed to reduce bacterial contamination and delay recontamination.[4] Authors of one study evaluated plastic chairs with embedded copper nanoparticles in a hospital waiting room and metal IV poles coated with an organic paint with nanostructured zeolite/copper particles in an OR. Chairs and poles without the added copper were used as controls. Both types of chairs and poles underwent standard cleaning. Samples to determine bacterial count were taken from five control and five copper-containing items each week for 10 weeks. The chairs with copper had 73 percent less bacteria than the controls. The OR IV poles coated in copper had less bacteria than those not coated in copper, although the difference of some results was not statistically significant, namely because of their low initial bacteria concentrations. For at least three weeks, however, the copper-containing poles did have a statistically significant decrease (50 percent) compared with the controls. The authors concluded that these results indicate that copper surfaces are a viable option for reducing contamination in a hospital environment.[11]

Future cleaning technology

Spencer predicts that, in the near future, technology that cleans both air and surfaces will be developed. "What you see with current cleaning technologies is that they reduce airborne contaminants by about 60 percent, meaning the remaining 40 percent of contaminants are going to land on surfaces," she said. "It would be ideal to have cleaning technology that is not only safe for use when people are around, but one that can kill more than 60 percent of contaminants in the air, and then land on the surfaces and kill those contaminants as well. Of course, in a perfect world, this technology also would not be too expensive or require too much maintenance."

Conclusion

Cleaning and disinfection are essential tasks in health care to prevent transmission of pathogens and, subsequently, HAIs. Continuous cleaning technology can be a helpful addition to traditional methods to improve effectiveness; this technology may include different forms of light, DHP, persistent disinfectants, and antimicrobial surfaces. Spencer concluded that even with an ideal technological solution, the EVS team will still be essential to cleaning and disinfection practices. "The goal of this adjunctive technology is to overcome human error and lack of time and staffing, not to replace the need for essential EVS personnel," she said.

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