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SPECIAL REPORT

ENVIRONMENTAL CLEANING AND MONITORING FOR INFECTION PREVENTION

There is little dispute that — for some organisms at least — the physical hospital environment plays a significant role in infection prevention. Rigorous and proper environmental hygiene, coupled with the same degree of hand hygiene, is paramount to protecting patients and healthcare workers. Coupled with this thorough and robust cleaning is the necessity of monitoring and evaluating environmental cleaning efforts. We explore these issues and present some strategies to assist infection preventionists and environmental services supervisors in these endeavors.

By Kelly M. Pyrek

Table of Contents

The Importance of Environmental Cleaning and Monitoring for Infection Prevention

By Kelly M. Pyrek

There is little dispute that — for some organisms at least — the physical hospital environment plays a significant role in infection prevention. Rigorous and proper environmental hygiene, coupled with the same degree of hand hygiene, is paramount to protecting patients and healthcare workers. Studies are beginning to demonstrate the dangers that contaminated surfaces and objects in patient rooms pose. As Carling and Huang (2013) observe, "Over the past several years, there has been a growing recognition that contamination of the patient environment by all bacterial and viral pathogens frequently associated with healthcare-associated infections (HAIs) occurs in a wide range of healthcare settings. In the past decade, increasing evidence has emerged to highlight lapses in procedures for and quality of healthcare cleaning and disinfection despite the presence of institutional policies consistent with national guidance. Visual assessment was seen as the gold standard for monitoring the quality of cleaning by environmental services (EVS) workers until several studies consistently demonstrated that residual pathogens were present on patient care surfaces after routine cleaning and that methicillin-resistant Staphylococcus aureus (MRSA) and vancomycin-resistant Enterococcus (VRE) could be transmitted to patients from prior room occupants despite terminal cleaning with high-compliance visual inspection. In addition, the presence of orphan items—mobile healthcare equipment where ownership of cleaning and disinfection is unclear, such as glucometers, intravenous poles, bar-coding scanners, and computers on wheels—highlights further vulnerabilities in adequate cleaning of patient care areas. Despite the many gains, there remains a substantial need to better understand the clinical effectiveness and magnitude of infection prevention and patient reassurance derived from the current array of cleaning practices, various disinfectants and application methods, and evolving technological advances."

Over the past several years, there has been a growing recognition that contamination of the patient environment by all bacterial and viral pathogens frequently associated with healthcare-associated infections (HAIs) occurs in wide range of healthcare settings.

The Role of the Environment and the Importance of Environmental Hygiene

Weber and Rutala (2013) acknowledge that clinical thought has evolved in regard to the role of the environment: "More than 20 years ago, Dr. Robert Weinstein estimated that the source of pathogens causing a healthcare-associated infection in the intensive care unit was as follows: patients' endogenous flora, 40 percent to 60 percent; cross infection via the hands of healthcare personnel (HCP), 20 percent to 40 percent; antibiotic-driven changes in flora, 20 percent to 25 percent; and other (including contamination of the environment), 20 percent. Over the past decade, substantial scientific evidence has accumulated indicating that contamination of environmental surfaces in hospital rooms plays an important role in the transmission of several key healthcare-associated pathogens, including methicillin-resistant Staphylococcus aureus (MRSA), vancomycin-resistant Enterococcus (VRE), Clostridium difficile, Acinetobacter, and norovirus. All of these pathogens have been demonstrated to persist in the environment for hours to days (and, in some cases, months), to frequently contaminate the surface environment and medical equipment in the rooms of colonized or infected patients, to transiently colonize the hands of healthcare personnel (HCP), to be associated with person-to-person transmission via the hands of HCP, and to cause outbreaks in which environmental transmission was deemed to play a role. Furthermore, hospitalization in a room in which the previous patient had been colonized or infected with MRSA, VRE, C. difficile, multidrug-resistant Acinetobacter, or multidrug-resistant Pseudomonas has been shown to be a risk factor for colonization or infection with the same pathogen for the next patient admitted to the room."

Although pathogen transfer from a colonized or infected patient to a susceptible patient most commonly occurs via the hands of HCP, contaminated hospital surfaces and medical equipment (and, less commonly, water and air) can be directly or indirectly involved in the transmission pathways.

Weber and Rutala (2013) continue, "Although pathogen transfer from a colonized or infected patient to a susceptible patient most commonly occurs via the hands of HCP, contaminated hospital surfaces and medical equipment (and, less commonly, water and air) can be directly or indirectly involved in the transmission pathways. These transmission pathways and methods to interrupt transmission have been diagramed. HCP have frequent contact with environmental surfaces in patients' rooms, providing ample opportunity for contamination of gloves and/or hands. Importantly, hand contamination with MRSA has been demonstrated to occur with equal frequency when HCP have direct contact with a colonized or infected patient or through touching only contaminated surfaces. The most important risk factor for HCP hand and glove contamination with multidrug-resistant pathogens has been demonstrated to be positive environmental cultures."

Weber and Rutala (2013) add, "To decrease the frequency and level of contamination of environmental surfaces and medical equipment in hospital rooms, routine and terminal disinfection with a germicide has been recommended. Unfortunately, routine and terminal cleaning of room surfaces by environmental services personnel and medical equipment by nursing staff is frequently inadequate. Multiple studies have demonstrated that less than 50 percent of hospital room surfaces are adequately cleaned and disinfected when chemical germicides are used. Similarly, inadequate cleaning of portable medical equipment by nursing staff has also been

demonstrated. The implementation of enhanced education, checklists, and methods to measure the effectiveness of room cleaning (e.g., use of fluorescent dye) with immediate feedback to environmental services personnel has been found to improve cleaning and lead to a reduction in healthcare-associated infections."

Weber, et al. (2010) emphasize that the role of surface contamination in transmission of healthcare-associated pathogens is an important issue because transmission can be interrupted by appropriate hand hygiene and cleaning/disinfection of environmental surfaces. Additionally, Otter, et al. (2011) remind us that "cleaning is the removal of soil and contaminants from surfaces, whereas disinfection relates to the inactivation of pathogens by use of a disinfectant" and that "Microorganisms vary in their resistance to disinfectants, so agents must be chosen carefully for their effectiveness, particularly for C. difficile spores. Furthermore, the hospital environment is complex and often difficult to clean, and use of a cleaning agent that is not effective against the target organism can spread pathogens to other surfaces." The researchers also note, "Cleaning and disinfection does not always eradicate pathogens from surfaces" and that "…it is difficult to determine whether it is the products, the procedures, or a combination of the two that is responsible for the failure to eradicate pathogens from surfaces."

> Multiple studies have demonstrated that less than **50 percent** of hospital room surfaces are adequately cleaned and disinfected when chemical germicides are used.

Dancer (2011) suggests that "cleaning practices should be tailored to clinical risk, given the wide-ranging surfaces, equipment and building design. There is confusion between nursing and domestic personnel over the allocation of cleaning responsibilities and neither may receive sufficient training and/or time to complete their duties. Since less laborious practices for dirt removal are always attractive, there is a danger that traditional cleaning methods are forgotten or ignored."

Boyce, et al. (2010) acknowledge that substantial variations can be found in the amount of time spent cleaning high-touch surfaces, in the number of disinfectant wipes used in each room, and in the level of cleanliness achieved by housekeepers. They concluded that a number of variables need to be considered when assessing hospital cleaning practices and that providing environmental services staff with continuing education and feedback is necessary to achieve compliance with recommended daily cleaning practices.

This is key, as Carling and Bartley (2010) observe, "It has now been well documented that a wide range of particularly environmentally resilient hospital-acquired infection (HAI) pathogens can be readily cultured from near patient surfaces. Eight recent studies have now confirmed that patients occupying rooms previously occupied by patients with vancomycin-resistant Enterococcus (VRE), MRSA, Clostridium difficile, and Acinetobacter baumannii infection or colonization have on average a 73 percent increased risk of acquiring the same pathogen than patients not occupying such rooms. Over the past four years, eight studies using direct covert observation or a fluorescent targeting method have confirmed that only 40 percent of near patient surfaces are being cleaned in accordance with existing hospital policies. These findings, in the context of the fact that 11 studies have now shown that the thoroughness of disinfection cleaning can be improved to 82 percent

(on average more than 100 percent over baseline) and the fact that such improvement has been associated with an on average 68 percent decrease in environmental contamination of high-risk objects, together support the likely benefit of decreasing environmental contamination of such surfaces.

Suboptimal cleaning of the physical healthcare environment has been shown by a number of researchers; the most prominent of which is Carling and colleagues. According to Carling, et al. (2006), 47 percent of surfaces in patient rooms were still contaminated even after terminal cleaning. Carling, et al. (2008) identified significant opportunities in all participating hospitals to improve the cleaning of frequently touched objects in the patient's immediate environment. The overall thoroughness of terminal cleaning, expressed as a percentage of surfaces evaluated, was 49 percent (the range for all 23 hospitals in the study was 35 percent to 81 percent). There was significant variation in cleaning efficacy with respect to the cleaning of toilet handholds, bedpan cleaners, light switches, and door knobs (mean cleaning rates less than 30 percent); sinks, toilet seats, and tray tables were consistently relatively well cleaned (mean cleaning rates over 75 percent). Patient telephones, nurse call devices, and bedside rails were inconsistently cleaned. Carling, et al. (2010) report that nine studies of thoroughness of cleaning and disinfection which included more than 62,500 high-touch surfaces in 103 different institutions and 142 study sites identified opportunities for improved cleaning in all venues, documenting that cleaning and disinfection must be improved across a broad range of U.S. healthcare settings as part of efforts to prevent transmission of pathogens.

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To understand why contaminated surfaces and ineffective cleaning are a threat to patient and healthcare worker safety, one must return to the principles of the chain of infection and the most common modes of transmission of opportunistic, disease-causing pathogens from inanimate surfaces to susceptible patients. Essentially, studies have shown that a contaminated inanimate surface can transmit pathogens to the hands of healthcare workers and then to patients; there is also direct transmission from the contaminated environmental surfaces to the patient. (Kramer, et al. 2006) In the past, experts believed that the most significant source of hospital-acquired pathogens was the patient's own endogenous flora; however, Weber, et al. (2010) point out that an estimated 20 percent to 40 percent of nosocomial infections have been attributed to cross-infection via the hands of healthcare workers. They add that this hand contamination could in turn result from either direct patient contact or indirectly from touching contaminated environmental surfaces. They also acknowledge that less commonly, a patient could become colonized with a nosocomial pathogen by direct contact with a contaminated environmental surface — they say that in some cases, the extent of patient-to-patient transmission has been found to be directly proportional to the level of environmental contamination. Bhalla, et al. (2004) examined the frequency

of acquisition of bacterial pathogens on investigators' hands after contacting environmental surfaces near hospitalized patients. Hand imprint cultures were positive for one or more pathogens after contacting surfaces near 34 (53 percent) of 64 study patients, with Staphylococcus aureus and vancomycin-resistant Enterococcus being the most common isolates. This is compounded by the fact that compliance with hand hygiene is roughly only 40 percent to 50 percent, so hand hygiene must be supplemented with environmental cleaning in order to begin to control and eliminate healthcare-acquired infections (HAIs).

Another essential principle to grasp is the persistence of pathogens on healthcare environmental surfaces. As Kramer, et al. 2006 found, most Gram-positive bacteria, such as Enterococcus spp.(including VRE) and Staphylococcus aureus (including MRSA), survive for months on dry surfaces. Many Gram-negative species, such as Acinetobacter spp.,Escherichia coli, Klebsiella spp., Pseudomonas aeruginosa, can also survive for months.

Newly cleaned hands touching contaminated environmental sites consistently undermine hand hygiene success."

The concept of pathogen persistence is critical when considering how prior-room occupants can impact acquisition of pathogens. As Otter, et al. (2011) point out, "A number of studies have identified the previous presence of a colonized or infected patient in a side room as a risk factor for the acquisition of the same pathogen by a new occupant, presumably because of residual room contamination that is not removed through terminal cleaning and disinfection. This effect has been shown for VRE, MRSA, C. difficile, multidrug-resistant P. aeruginosa and A. baumannii." Shaughnessy, et al. (2011) determined that prior room occupant with CDI is a significant risk factor for CDI acquisition, independent of established CDI risk factors. Nseir, et al. (2011) concluded that admission to an ICU room previously occupied by a patient with MDR P. aeruginosa or A. baumannii is an independent risk factor for acquisition of these bacteria by subsequent room occupants; this relationship was not identified for ESBL-producing GNB. Carling and Bartley (2010) demonstrated that admission of a patient into a bed previously occupied by an infected patient significantly increases the chance of acquiring the same pathogen, regardless of compliance with hand hygiene. And as Dancer (2010) notes, "Newly cleaned hands touching contaminated environmental sites consistently undermine hand hygiene success." Drees, et al. (2008) found that patients colonized with vancomycin-resistant enterococci (VRE) frequently contaminate their environment, and that prior room contamination, whether measured via environmental cultures or prior room occupancy by VRE-colonized patients, was highly predictive of VRE acquisition. Huang, et al. (2006) asserted that admission to a room previously occupied by an MRSA-positive patient or a VRE-positive patient significantly increased the odds of acquisition for MRSA and VRE. However, this route of transmission was a minor contributor to overall transmission. They noted that the effect of current cleaning practices in reducing the risk to the observed levels and the potential for further reduction were unknown.

Inadequate cleaning triggers a domino effect: The microbial load (usually expressed in colony-forming units) on a surface or object can accumulate fairly quickly [study on high-touch objects here]. Inadequate cleaning [factors for rushed cleaning here] can leave microorganisms behind where they continue to flourish. Over the course of the day, new contaminants are added to these surfaces and objects and the level of bioburden increases because organic soil provides a food source for the bacteria. The cycle is repeated unless it is broken by proper cleaning and disinfection with a hospital-grade cleaning product approved by the Environmental Protection Agency (EPA).

There are two key ways to improve environmental cleanliness:

1. Effectively remove contaminants on surfaces and objects
2. Implement monitoring program that provides actionable results

Let's take a closer look at both strategies.

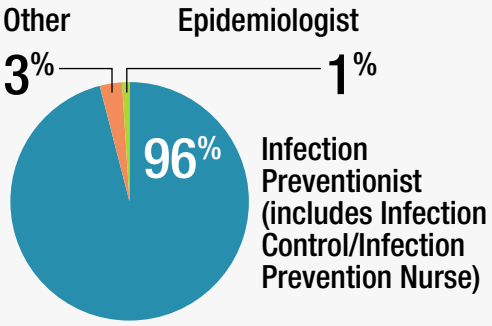
Carling and Huang (2013) underscore the importance of hospitals developing and implementing programs to optimize the thoroughness of high-touch surface cleaning. Healthcare institutions are advised to first implement a program consisting of optimization of current policies and procedures related to environmental disinfection cleaning. Such institutional policies should include the use of an EPA-registered hospital-approved disinfectant in patient care areas in conjunction with a process for adequate training and regular retraining of all staff who have cleaning and disinfection responsibilities. These policies should also address ownership for cleaning and disinfection of mobile and orphan patient care equipment or a process by which ownership is determined and followed.

Alice Guh, MD, MPH, of the Division of Healthcare Quality Promotion at the CDC's National Center for Emerging and Zoonotic Infectious Diseases says that the importance of environmental cleaning cannot be overstated. "For certain pathogens I think the environment plays a very critical role in preventing the spread

ENVIRONMENTAL HYGIENE MONITORING SURVEY

Infection Control Today surveyed infection preventionists and healthcare epidemiologists for their demographic information as well as inquired about their experiences related to environmental cleaning and monitoring. Here are the results:

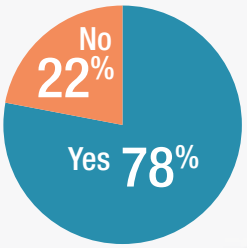
1 Please indicate your job function/role.



2 Which of the following describes the type of organization in which you work?

Hospital	81%
Ambulatory Care or Ambulatory Surgery Center	9%
Nursing Home or Long-Term Care	5%
Other	6%

3 Do you currently sit on a product evaluation committee or attend meetings to provide your input on new environmental cleaning and monitoring products/services?



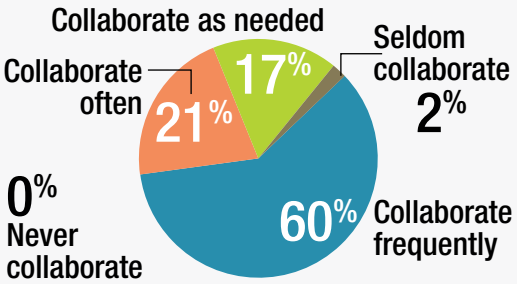
of healthcare-associated pathogens, especially for organisms like C. difficile that can survive in the environment for a long time. There have been studies that have shown transmission of pathogens from a contaminated environment to patients who occupied a room after a patient was known to be colonized with the same pathogen. Appropriate cleaning and disinfection of patient rooms can minimize the risk to subsequent occupants. I think the one thing we can emphasize in terms of environmental cleaning is the importance of focusing on high-touch surfaces. I think oftentimes the misconception is to focus cleaning on the walls and floors because these areas may not look clean, but it's the bedrails, the overbed table, the remote control, the call button — high-touch surfaces that are in the patient's immediate area that are more likely to be contaminated. So to help focus the cleaning efforts on those high-touch surfaces is really critical."

Efficacy of daily and terminal cleaning can be impacted by the demand for faster turn-around times of patient rooms. "I understand and sympathize with environmental services personnel who may not have a lot of time to clean rooms because of the quick turn-over between patients, but I still strongly recommend that there is effort and attention paid to doing thorough environmental cleaning and disinfection between patient stays, with a focus on terminal cleaning," she says. "What the CDC does not have are specific recommendations for evaluating daily cleaning, which is one area we still need to have a better understanding of, but we do have recommendations for facilities to objectively monitor terminal cleaning of patient rooms for the purpose of improving adherence to environmental cleaning. Hospitals should make an effort to implement these recommendations because it will make a bigger difference down the road even if we don't have all of the answers now. I believe implementing what we currently know will eventually lead us overall to better infection prevention." Guh continues, "There is the continued need for research on developing parameters to assess actual cleanliness of surfaces. There have even been questions about how to evaluate the cleaning of other type of surfaces that are not listed in the checklist

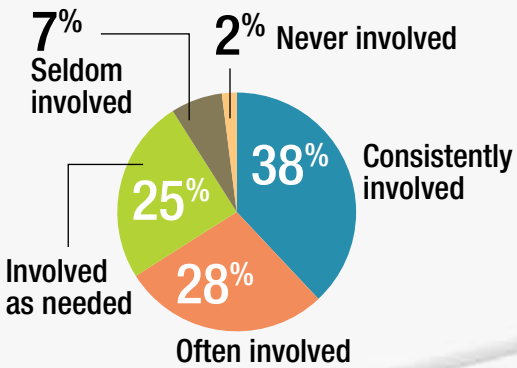
4 In your prevention practices, which of these functions are the highest priority? Please select the top two highest priority practices.

Tracking infection incidence	45%
Environmental cleaning	40%
Ensuring all personnel wear gloves	7%
Other	6%
Monitoring patient room surfaces	1%
Supplying face masks	0%

5 How would you describe the level of collaboration between Infection Prevention and Environmental Services at your institution?



6 To what extent are you involved in providing input or influencing environmental cleaning protocols?



in the toolkit; for example in the toolkit we focused on hard surfaces but questions come up about privacy curtains and fabrics, and there are a lot of unanswered questions that will require more research. But until then I think everyone should continue to do what we know can work and to improve compliance with the basic practices."

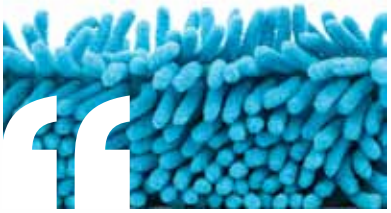
The scope of this report does not include finer details on environmental cleaning. These can be found in the CDC's Guidelines for Environmental Infection Control in Health-Care Facilities. Key take-home messages of this guidelines include:

- There are a number of factors that influence the choice of disinfection procedure for environmental surfaces: 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.
- Cleaning is the necessary first step of any sterilization or disinfection process. Cleaning is a form of decontamination that renders the environmental surface safe to handle or use by removing organic matter and visible soils, all of which interfere with microbial inactivation. The physical action of scrubbing with detergents and surfactants and rinsing with water removes large numbers of microorganisms from surfaces. If the surface is not cleaned before the terminal reprocessing procedures are started, the success of the disinfection process is compromised.
- The number and types of microorganisms present on environmental surfaces are influenced by the following factors: a) 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]. Strategies for cleaning and disinfecting surfaces in patient-care areas take into account 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).
- Clean and disinfect "high-touch" surfaces on a more frequent schedule than housekeeping surfaces seldom touched by patients and healthcare workers. Examples of "high-touch" surfaces: bed rails, overbed tables, surfaces in and around patient toilets, and nurse call buttons.

For more information about recommended environmental cleaning practices in healthcare settings, consult the Association for the Healthcare Environment's Practice Guidance for Healthcare Environmental Cleaning, Second Edition.

It has been said that process, along with the right products, can go a long way toward helping to achieve environmental cleanliness in hospitals. There are numerous sources of information in the marketplace about a wide range of products designed to assist environmental services personnel in their cleaning and disinfection efforts. Infection preventionists can work with environmental services directors and managers to determine what products

and tools are available, compared to the existing products and tools currently being used by ES personnel. They can then compare how these products and tools measure up to current industry recommended best practices and guidelines, as well as what is being demonstrated in the medical literature. For the purposes of this report, we will briefly look at one specific tool that can help improve the effectiveness of cleaning, and that is microfiber. Microfiber is a blend of densely constructed polyester and nylon fibers that are positively charged to attract dust and dirt, which are negatively charged. This charge is only broken when the microfiber is laundered and the soil is released. Unlike traditional loop mops and cleaning tools that simply move and push dirt around, microfiber actually grabs the dirt and removes it from the surface, so the cleaning power of ES personnel is maximized and there is a reduction in the amount of bioburden left behind.



Unlike traditional loop mops and cleaning tools that simply move and push dirt around, microfiber actually grabs the dirt and removes it from the surface, so the cleaning power of ES personnel is maximized and there is a reduction in the amount of bioburden left behind.

Microfiber cleaning materials are a blend of microscopic polyester and polyamide fibers which are split in such a way as to create microscopic "hooks" which act as claws that scrape up and hold dust, dirt, and grime. They are 1/16 the thickness of a human hair and can hold six times their weight in water.

Microfiber products are available for a variety of cleaning tasks, including bendable microfiber dusters that capture dirt in hard-to-reach places. Lint-free microfiber towels can be used to clean high-touch surfaces, while microfiber mop heads remove debris, soil and bacteria from the floor. The advantages of microfiber include the reduction and elimination of cross-contamination while reduces ES personnel's fatigue and exposure to disinfectants. Microfiber is advocated by the Joint Commission and the EPA and many experts emphasize that microfiber programs improve productivity and efficiency, thus saving the environmental services department valuable time while providing cost-effective return on investment.

In a 2002 paper, Using Microfiber Mops in Hospitals. Environmental Best Practices for Health Care Facilities, the Environmental Protection Agency (EPA) noted the movement from traditional mops to microfiber products: "Using conventional loop mops for wet mopping of patient care areas has long been the standard in floor cleaning for janitorial operations in hospitals. However, the healthcare industry has taken a recent interest in evaluating hard floor maintenance techniques in terms of employee, patient, and environmental health. Many floor cleaners used in hospitals contain harsh chemicals such as quaternary ammonium chlorides and butoxyethanol, which can be harmful to human health and the environment. To reduce the risk of cross-contamination for patients, conventional mopping techniques require janitors to change the cleaning solution after mopping every two or three room, meaning that cleaning solutions (including both chemicals and several gallons of water) are constantly being disposed of and replenished. Some facilities have begun using a new mopping technique involving microfiber materials to clean floors ... the positively charged microfibers attract dust (which has a negative charge), and the tiny fibers are able to penetrate the microscopic surface pores of most flooring materials. These characteristics make microfiber an effective

mopping material." Microfiber mops are less work-intensive than conventional mops, they help eliminate cross-contamination during janitorial tasks, and drastically reduce chemical and water use while cleaning more effectively. Microfiber wipers and towels also can help prevent cross-contamination and present a more environmentally friendly approach to cleaning..

Let's take a brief look at some of the findings in the literature. Rutala and Gergen, et al. (2007) investigated the effectiveness of microfiber mops to reduce microbial levels on floors by comparing the efficacy of microfiber mops with that of conventional, cotton string mops in three test conditions (cotton mop and standard wringer bucket, microfiber mop and standard wringer bucket, microfiber system). Twenty-four rooms were evaluated for each test condition. RODAC plates containing D/E neutralizing agar were used to assess "pre-cleaning" and "post-cleaning" microbial levels. The microfiber system demonstrated superior microbial removal compared with cotton string mops when used with a detergent cleaner (95% vs 68%, respectively). The use of a disinfectant did not improve the microbial elimination demonstrated by the microfiber system (95% vs 95%, respectively). However, use of disinfectant did significantly improve microbial removal when a cotton string mop was used (95% vs 68%, respectively).

Microfiber mops are less work-intensive than conventional mops, they help eliminate cross-contamination during janitorial tasks, and drastically reduce chemical and water use while cleaning more effectively.

Wren, et al. (2008) compared the ability of microfiber -woven cloths with conventional cloths moistened with water only, for their ability to remove several types of organisms relevant to hospital-acquired infections from a variety of surfaces in hospitals. They showed that microfiber cloths consistently outperformed conventional cloths in their decontamination ability, across all surfaces, and irrespective of whether the bacteria were coated on to the surfaces with phosphate-buffered saline (PBS) or PBS containing horse serum to simulate real-life soiling. The ability of the cloths to remove bacteria from surfaces was assessed by contact plating and colony formation, and by swabbing and measurement of ATP bioluminescence. The results suggest potential for use of microfiber in healthcare environments. Further studies are required, however, to define accurately how these cloths, which are designed to be used without detergent or biocides, might be capable of safe and effective deployment and recycling in the healthcare environment.

Diab-Elschahawi, et al. (2010) investigated the decontamination capacity of four different types of cleaning cloths (microfiber cleaning cloth, cotton cloth, sponge cloth, and disposable paper towels) commonly used in hospital in their ability to reduce microbial loads from a surface used dry or wet in new condition. All of the cloths except disposable paper towels were also compared after 10 and 20 times of reprocessing, respectively, at 90 degrees C for 5 minutes in a washing machine. Staphylococcus aureus (ATCC 6538) and Escherichia coli (ATCC 8739) were used as test organisms. Test organisms were then added to a test soil resulting in a controlled concentration of 5 x 10(7) colony-forming units per milliliter in the final test suspension. Standardized tiles measuring 5 x 5 cm were used as test surface. Microfiber cloths showed the best results when being used in new condition. However, after multiple reprocessing, cotton cloth showed the best overall efficacy.

Smith, et al. (2011) investigated the ability of 10 different microfiber cloths to remove microbial contamination from three surfaces commonly found in hospital settings (stainless steel, furniture laminate and ceramic tile), under controlled laboratory conditions. Tests were conducted using organisms known to cause healthcare-associated infections, i.e. methicillin-resistant Staphylococcus aureus (MRSA), Clostridium difficile (in spore form) and Escherichia coli. For all the cloths tested, there was significant statistical evidence to suggest a difference in cleaning performance between them on first and single use ($P<0.001$). However, the overall performance of the nine re-useable cloths did not differ in practice with differences in $\log_{10}$ reductions of <1. The performance of all cloths decreased with repeated use on a succession of contaminated surfaces. After repeated washing, re-usable cloth performance improved at 75 washes, and reduced after 150 washes, although, in most instances, performance after 150 washes was better than at first wash. For all cloths, price was not an indication of performance. Based on these laboratory findings, the researchers concluded that use of the microfiber cloths is an effective way to reduce the levels of MRSA, E. coli and C. difficile (in spore form) on a range of surfaces found in the clinical environment and could therefore be of benefit to hospitals.

> Microfiber cloths consistently outperformed conventional cloths in their decontamination ability, across all surfaces, and irrespective of whether the bacteria were coated on to the surfaces with phosphate-buffered saline (PBS) or PBS containing horse serum to simulate real-life soiling.

Monitoring and Evaluating Cleaning Efforts

The second key step to improving environmental cleanliness is implementing a monitoring program that provides actionable results. Steps to improve cleaning and disinfection efforts cannot be made until facilities have an understanding of how well or how poorly their cleaning is being performed.

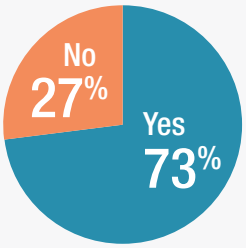
In 2010, the Centers for Disease Control and Prevention (CDC) issued a toolkit, Options for Evaluating Environmental Cleaning, designed to provide guidance to acute-care hospitals for developing programs to optimize the thoroughness of high-touch surface cleaning as part of terminal room cleaning at the time of discharge or transfer of patients. (Guh and Carling, et al. 2010)

Alice Guh, MD, MPH, of the Division of Healthcare Quality Promotion at the CDC's National Center for Emerging and Zoonotic Infectious Diseases, explains the impetus of this toolkit: "At the time, our division was working closely with health departments that were engaged in Clostridium difficile infection prevention collaboratives, which consisted of a number of acute-care healthcare facilities that were working collaboratively to identify effective ways to implement evidence-based prevention strategies against Clostridium difficile," she says. "Part of the prevention strategies for Clostridium difficile infection (CDI) is to improve environmental cleaning because the C. difficile spores can linger in the environment, and so these facilities wanted to increase adherence to environmental cleaning. So we decided to create this toolkit that would assist healthcare facilities

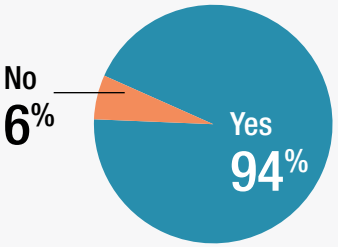
in developing programs at the facility level where they could work closely with environmental services to form a good collaboration between infection control and environmental services to do just that — objectively monitor environmental cleaning with the goal of improving adherence to it."

Guh and Carling (2010) encourage hospitals to develop programs to optimize the thoroughness of high-touch surface cleaning as part of terminal room cleaning at the time of discharge or transfer of patients. The program should be based on the institution's level of dedicated resources to implement objective monitoring programs. The program should be an infection preventionist/hospital epidemiologist infection prevention and control (IPC)-based program internally coordinated and maintained through environmental services (EVS) management level participation. The program should be based on a joint (IC/EVS) definition of institutional expectations consistent with CDC standards and a terminal room cleaning checklist. The responsibilities of ES staff and other hospital personnel

7 Do you currently monitor environmental cleaning in patient rooms?



8 Does this include monitoring high touch surfaces?



9 What type of monitoring do you do, and how often?

	Daily	Weekly	Monthly	Quarterly	As Needed	Never
Direct observation	27%	28%	15%	5%	19%	4%
Swab cultures	0%	4%	6%	5%	31%	54%
Fluorescent gel	2%	12%	12%	6%	16%	53%
ATP systems	4%	12%	12%	7%	7%	58%
Agar slide cultures	2%	0%	1%	3%	18%	77%
Other	3%	0%	4%	2%	7%	84%

"Other" methods cited included evaluation of discharge rooms; full-facility audit quarterly, monthly audit with discharge cleaning

for cleaning high-touch surfaces (e.g., equipment in ICU rooms) should be clearly defined. Structured education of the EVS staff should be undertaken to define, carry out and monitor programmatic and institutional expectations. Monitoring measures will be undertaken by the IPC/ES team and may include competency evaluation of EVS staff by EVS management, IPC staff or both. Regular ongoing structured monitoring of the program will be performed and documented. Interventions to optimize the thoroughness of terminal room cleaning and disinfection will be a standing agenda item for the Infection Control Committee (ICC) or Quality Committee as appropriate for the facility. In a more advanced program, Guh and Carling (2010) advocate for an objective assessment of terminal room thoroughness of surface disinfection cleaning done using one or more of the methods recommended by the CDC to document the pre-intervention thoroughness of disinfection cleaning. They also advise scheduled ongoing monitoring of the cleaning at least three times a year. The results should be used in ongoing educational activity and feedback to EVS staff following each cycle of evaluation. Results of the objective monitoring program and interventions to optimize the thoroughness of terminal room cleaning and disinfection should be a standing agenda item for the ICC.

> Steps to improve cleaning and disinfection efforts cannot be made until facilities have an understanding of how well or how poorly their cleaning is being performed.

Carling and Huang (2013) point to the aforementioned 2010 CDC guidance and encourage hospitals that have obtained a high compliance rate with surface cleaning move to a program involving a system for objective ongoing monitoring of cleaning practice in order to use such data in structured educational interventions within the institution. Such a system involves monitoring the effectiveness of environmental cleaning. To understand the current state of cleaning evaluation, it is essential to review the roots of environmental sampling. As Carling and Bartley (2010) explain "The use of environmental cultures has greatly enhanced our understanding of the epidemiology of C difficile transmission as well as MRSA and VRE. Such cultures have also been useful in evaluating the role of environmental contamination in outbreak settings involving C difficile, Acinetobacter, VRE, MRSA, and glycopeptide insensitive S aureus. Although potentially useful, logistical challenges involved in the collection of a large enough number of cultures to permit proper epidemiologic analysis, the cost of data collection and specimen analysis (typically including pulse-field gel electroforesis or other strain identification process) as well as the intrinsic challenge of drawing epidemiologically sound conclusions from possibly erratic fluctuations in environmental contamination as a result of unknown confounding variables represent important challenges related to problem-oriented environmental monitoring. Given these issues, the possible short- and long-term benefits of such information make it prudent to weigh carefully the overall value of collecting such data."

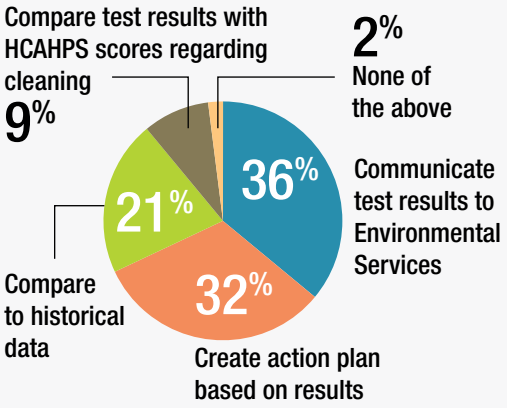
Carling and Bartley (2010) add that The ongoing evaluation and monitoring of cleaning interventions to reduce the risk of transmission of environmental pathogens through defined procedures have been elements of infection prevention and control practice in acute-care

hospitals for many years: "Until recently, such evaluation has exclusively relied on visual assessment of the cleanliness of surfaces. Currently, 89 percent of a large sample of U.S. acute-care hospitals confirmed that they perform visual assessments of cleanliness during regular environment of care rounds as the primary means for evaluating cleaning practice in their hospitals... Traditionally, such rounds are performed on a regular basis and involve the infection preventionist as well as an administrative representative from patient care services. Together, these individuals visit several patient care areas to monitor compliance with a range of safety practices and to assess visual cleanliness. The identified deficiencies, as they pertain to potential pathogen transmission issues, are reviewed and remedial activities approved by the infection control committee. Such assessment of environmental cleaning relies on the observation of visible soilage of surfaces by potentially infectious material or dust and dirt. Such findings are assumed to represent practice failures by the individual or individuals directly responsible for ensuring the microbial safety of the surface in question."

Carling and Bartley (2010) emphasize that while conventional monitoring may identify sporadic gross lapses in cleaning practice, this practice has a number of limitations, such as:

- An inability to objectively assess actual environmental cleaning practice
- The reliance on episodic negative findings as a basis for remedial individual and programmatic interventions
- Placement of undue emphasis on the cleanliness of floors and walls, which have limited roles in pathogen transmission because of the ease with which gross contamination or dirt can be visually documented on these surfaces
- With the exception of gross contamination by potentially infected material, a low sensitivity for defining what represents a microbiologically "dirty" surface
- Poor correlation with microbial contamination, namely, what appears to be clean may harbor substantial levels of microbial contamination
- Poor programmatic specificity, such as what may appear to represent a lapse in environmental cleaning may not be
- Intrinsically subjective with a high potential for observer bias
- The direct involvement of ES management and patient

10 Which of the following do you do with the test results? Select all that apply.



11 What are the biggest hindrances to monitoring? Select all that apply.

Time	36%
Budget	24%
Lack of equipment or supplies	13%
Administration support	10%
Environmental services support	9%
None of the above, no hindrance	5%
Not a priority for my organization	5%

care leadership in a monitoring system with low sensitivity and specificity, which may lead to inconsistent and potentially misdirected responses to what appear to be lapses in environmental cleaning

- An inability to evaluate other than daily environmental cleaning practice
- Limited ability to support the Joint Commission (TJC) standard EC.04.01.03.EP2, which states that the institution must be able to demonstrate that it "uses the results of data analysis to identify opportunities to resolve environmental safety issues"
- Limited ability to demonstrate compliance with the Centers for Medicare Services (CMS) Conditions for Participation (CoP), section 482.42.
- The need to utilize substantial leadership level personnel resources
- A limited ability to evaluate more than a small sample of patient care areas on a frequent basis
- An inability to define and respond to institutional or inter-institutional standards of environmental cleaning through benchmarking

As a response to these challenges, what is known as "enhanced" environmental cleaning monitoring has been developed, and according to Carling and Bartley (2010), encompasses the following elements:

- Uses an objective monitoring tool to evaluate the process of environmental cleaning
- Is performance rather than deficiency oriented
- Is based on the development of an independently functioning structured monitoring program incorporating specific environmental cleaning policy-based expectations and goals
- Relies on the repetitive monitoring of actual environmental cleaning by trained, unbiased individuals on an ongoing basis
- Is incorporated independently into the institution's ongoing quality improvement process through the infection control committee

The advantages of an enhanced program include:

- Allows for the direct evaluation of the process of hygienic cleaning
- Incorporates a built-in standardization and uniformity of evaluation
- Incorporates ES staff education based on specific objectively evaluable expectations
- Facilitates the development of a program that has a high potential for identifying specific as well as systemic institutional programmatic issues that limit or adversely impact environmental cleaning
- Allows for short cycle monitoring of ES staff performance with direct feedback to improve environmental cleaning and documents the sustainability of improvements, once they have been achieved
- Has the potential for using positive performance achievement to reinforce good performance and the value of such performance in the context of the institution's objectively defined patient safety goals
- Has the ability to objectively identify and document individual environmental cleaning oversights and the need for remedial action
- Represents a system easily adaptable to established process improvement modalities

such as the Plan-Do-Act (PDA) cycle, Positive Deviance, Six Sigma, and others

- Facilitates compliance with TJC standards and CMS CoP mandates
- Provides objective performance information for internal and inter-institutional benchmarking
- Allows for use of the same monitoring systems for one-on-one and small group, hands-on, education
- Facilitates the use of the same process improvement system over a range of practices and venues within the hospital

Carling and Bartley (2010) list five systems that may be potentially useful for enhanced programmatic monitoring:

1. Covert practice observation
2. Swab cultures
3. Agar slide cultures
4. Fluorescent gel
5. ATP bioluminescence

Guh and Carling (2010) review these methods that can be employed to evaluate environmental cleaning:

- Direct Practice Observation: Covert monitoring of disinfection cleaning can provide an objective assessment of individual ES staff performance and compliance with cleaning protocols. While conceptually feasible, logistical issues related to maintaining such a program outside a research setting may limit adaptation of this form of Level II monitoring. Furthermore, the complexity of monitoring cleaning practice in individual patient rooms without the evaluator being recognized as such might represent a difficult confounding issue.
- Swab Cultures: While several outbreak intervention studies have associated decreased environmental contamination by target organisms as a result of modified cleaning practice leading to decreased acquisition of targeted pathogens, none of the reports specifically note if serial environmental culture results were actually used to provide practice feedback to the ES staff.

Monitoring Program to Check the Efficacy of Environmental Cleaning Efforts

Guh and Carling (2010) outline two levels of a monitoring program to check the efficacy of environmental cleaning efforts:

Level I Program

The program will be an infection preventionist/hospital epidemiologist infection prevention and control (IPC) based program internally coordinated and maintained through environmental services (ES) management level participation. The goal should be seen as a joint (IPC/ES), team effort during planning implementation and ongoing follow-up phases.

Each program will be hospital-specific and based on a joint (IC/ES) definition of institutional expectations consistent with the CDC standards and checklist. The responsibilities of ES staff and other hospital personnel for cleaning high touch surfaces (e.g., equipment in ICU rooms) will be clearly defined.

Structured education of the ES staff to define programmatic and institutional expectations will be carried out and the proportion of ES staff who participate will be monitored.

Development of measures for monitoring along with methods and identified staff for carrying out monitoring will be undertaken by the IPC/ES team. Monitoring measures may include competency evaluation of ES staff by ES management, IPC staff or, preferably, both. Teams are also encouraged to utilize patient satisfaction survey results in developing measures. Regular ongoing structured monitoring of the program will be performed and documented.

Interventions to optimize the thoroughness of terminal room cleaning and disinfection will be a standing agenda item for the Infection Control

Although swab cultures are easy to use, the cost of processing, including isolate identification, the delay in analyzing results, the need to determine pre-cleaning levels of contamination for each object evaluated in order to accurately assess cleaning practice, and the limited feasibility of monitoring multiple surfaces in multiple patient rooms as part of an ongoing Level II monitoring program represent issues which could limit the broad application of this system.

- Agar Slide Cultures: Agar-coated glass slides with finger holds were developed to simplify quantitative cultures of liquids. The slides have been adopted for use in environmental surface monitoring in healthcare settings. These studies have used agar-coated slide systems to evaluate cleaning practice by quantifying aerobic colony counts (ACCs) per cm. While studies have measured aggregate ACCs before and after cleaning, no studies to date have evaluated the actual thoroughness of cleaning of the same objects to determine if objects with relatively high ACCs were either poorly cleaned or actually overlooked by the ES staff. Although some difficulties have been encountered in utilizing the agar slide cultures on other than large, flat surfaces, they potentially provide an easy method for quantifying viable microbial surface contamination. There is a need, similar to that noted above for swab cultures, to determine pre-cleaning levels of contamination for each object evaluated in order to accurately assess cleaning practice.
- Fluorescent Markers: Fluorescent gel, powder, and lotion have all been developed for the purpose of marking high touch objects prior to room cleaning. While the powder and lotion have been used as part of educational interventions, their overt visibility (lotions and powder), ease with which they can be disturbed (powder), and difficulty with easy removal (lotion if allowed to air dry) may limit their use in a monitoring system and there is little or no published experience in their use for this purpose. In contrast, the fluorescent gel dries transparent on surfaces, resists abrasion, and

Committee (ICC) or Quality Committee as appropriate for the facility.

Consideration of the feasibility of moving to the Level II program will be discussed by the ICC and documented in the committee minutes.

Results should be reported to the ICC and facility leadership.

Level II Program

The program will be an infection preventionist/hospital epidemiologist infection prevention and control (IPC) based program internally coordinated and maintained through environmental services (ES) management level participation. The goal should be seen as a joint (IPC/ES), team effort during planning implementation and ongoing follow-up phases.

Each program will be hospital-specific and based on a joint (IC/ES) definition of institutional expectations consistent with the CDC standards and the checklist. The responsibilities of ES staff and other hospital personnel for cleaning high touch surfaces (e.g., equipment in ICU rooms) will be clearly defined.

Either covertly or in conjunction with ES staff, an objective assessment of the terminal room thoroughness of surface disinfection cleaning will be done using one or more of standard monitoring methods to document the pre-intervention thoroughness of disinfection cleaning (generally referred to as the "TDC Score" calculated as # of objects cleaned / total # of objects evaluated X 100). Such results will be maintained by the institution and used internally to optimize programmatic and educational interventions.

Structured education of the ES staff to define programmatic and institutional expectations will be carried out and the proportion of ES staff who participate will be monitored. It would be expected that the results of the pre-intervention

there are several studies demonstrating the accuracy of the system in objectively evaluating cleaning practice and quantifying the impact of educational interventions on such cleaning. Because these fluorescent markers are all designed to indicate physical removal of an applied substance, surfaces that are effectively disinfected but less effectively cleaned may be more likely flagged as failing to meet a quality standard using one of these markers than one of the culture techniques.

- ATP Bioluminesence: The measurement of organic ATP on surfaces using a luciferase assay and luminometer has been used to evaluate cleanliness of food preparation surfaces for more than 30 years. A specialized swab is used to sample a standardized surface area which is then analyzed using a portable handheld luminometer. The total amount of ATP, both microbial and non-microbial, is quantified and expressed as relative light units. Although readout scales vary more than 10-fold and sensitivity varies between commercially available systems, very low readings are typically associated with low aerobic colony counts (ACCs). Very high readings may represent either a viable bioburden, organic debris including dead bacteria or a combination of both. An independent study in 2007 by the U.K. National Health Service evaluating the potential role of the ATP tool in assessing cleaning practice concluded that the tool could potentially be used effectively for ES education. Although it is likely that part of the lack of correlation between ATP readings and ACCs noted in the preceding studies relates to the fact that ATP systems measure organic debris as well as viable bacterial counts, several studies have noted additional environmental factors which may increase or decrease ATP readings. Because a large proportion of surface contamination with ATP is non-microbial in origin, surfaces that are effectively disinfected but less effectively cleaned may be more likely flagged as failing to meet a quality standard using the ATP tool than one of the culture

objective evaluation of disinfection cleaning be incorporated into the ES educational activity in a non-punitive manner.

Scheduled ongoing monitoring of the TDC cleaning using one or more of the objective monitoring approaches discussed in Appendix B will be performed at least three times a year. The monitoring will use a projected sample size based on the previous level of TDC in order to detect a 10 percent to 20 percent change in performance. The results should be recorded in an excel spreadsheet to calculate aggregate TDC scores.

The results of the objective monitoring program and the objectively developed TDC scores will be used in ongoing educational activity and feedback to the ES staff following each cycle of evaluation. It is recommended that such results be shared more widely within and beyond the institution as useful and appropriate.

Results of the objective monitoring program and interventions to optimize the thoroughness of terminal room cleaning and disinfection will be a standing agenda item for the Infection Control Committee (ICC).

Results should be reported to the ICC and facility leadership and could be reported to the state health department through the state prevention collaborative coordinator by various mechanisms (e.g., NHSN template), depending on infrastructure. ICT

Source: Options for Evaluating Environmental Cleaning, CDC

12 Indicate your level of agreement with the following statements:

Microfiber is proven to be more effective at removing dirt/soil than cotton.

Strongly Agree	Agree	Somewhat Agree	Disagree	Strongly Disagree
45%	36%	17%	1%	1%

Using EPA approved hospital disinfectant kills what's living on the surface, but improper removal of what remains can act as a food source for new contaminants.

Strongly Agree	Agree	Somewhat Agree	Disagree	Strongly Disagree
35%	41%	16%	7%	1%

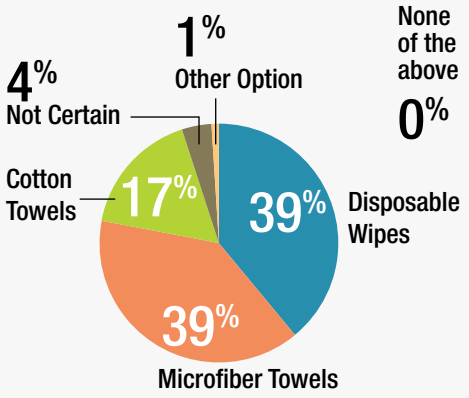
Surfaces in patient rooms remain contaminated even after terminal cleaning.

Strongly Agree	Agree	Somewhat Agree	Disagree	Strongly Disagree
13%	30%	33%	21%	2%

techniques. Additionally, high concentrations of bleach may potentially quench the ATP bioluminescence reaction and result in a signal reduction, but further research is needed to better understand the impact of bleach-based disinfectants on the use of the ATP system. If a bleach-based disinfectant is used, it is important that the surface is dry before using the ATP tool. Similar to the culture methods described above, it is unclear whether "threshold values" for a clean hospital surface can be established using existing methods, suggesting use of the ATP tool is likely to require pre-cleaning levels of contamination for each object evaluated in order to accurately assess cleaning practice. Despite these limitations, the ATP system has been used to broadly document significant improvement in daily cleaning as well as provide quantitative measurement to indicate the level of cleanliness of high-touch surfaces.

Let's take a closer look at the use of ATP in healthcare settings. Adenosine triphosphate (ATP) is an enzyme that is present in all living cells, and an ATP monitoring system can detect the amount of organic matter that remains after cleaning an environmental surface,

13 What type of tool is used for routine cleaning of high-touch surfaces? Select all that apply.



a medical device or a surgical instrument. Hospitals are using ATP-based sanitation monitoring systems to detect and measure ATP on surfaces as a method of ensuring the effectiveness of their facilities' sanitation efforts. The amount of ATP detected, and where this ATP was detected, indicates areas and items in the healthcare setting that may need to be re-cleaned, and the possible need for improvement in a healthcare facility's cleaning protocols. Manufacturers of ATP systems suggest a testing protocol that includes identifying a number of high-touch surfaces and objects such as bed rails, bedside tables, tray tables, IV poles, patient call buttons, TV remote controls, door handles, etc. Working together, infection preventionists and environmental services supervisors determine which patient rooms will be sampled and confirm that the cleaning has been completed by environmental services personnel. The targeted surfaces are swabbed and the results displayed in the luminometer are documented. It is advisable that these results are entered into and maintained in an Excel spreadsheet. A graph can be constructed to indicate pass/fail surfaces, for easy reference.

Carling and Bartley (2010) acknowledge that the measurement of organic ATP on surfaces using a luciferase assay and luminometer has been used to evaluate cleanliness of food preparation surfaces for more than 30 years: "A specialized swab is used to sample a standardized surface area, which is then analyzed using a portable handheld luminometer. The amount of ATP, both microbial and non-microbial, is quantified and expressed as relative light units (RLU). Although readout scales vary more than 10-fold and sensitivity varies between commercially available systems, very low readings are typically associated with low ACCs on food preparation surfaces. Very high RLU readings may represent either the viable bioburden, organic debris including dead bacteria, or a combination of both. Indeed, a recent study has found that debris accounts for approximately 66 percent of ATP on surfaces. The clinical relevance of this issue was clarified in a study of ambient contamination of surfaces potentially touched following handwashing based on proposed cleanliness standards. A mean ATP RLU reading of 3707 was

Performance of ATP Systems

Practitioners who use ATP should be aware that variations in performance of different ATP systems can influence the processes to determine validity and verification for each system. As Sciortino and Giles (2012) note, "Although ATP technology is nonspecific, the caveat that a reduction of ATP relative light units (RLU) correlates with a reduction of infectious microorganisms may be an acceptable outcome. Some investigators have discussed benchmarking and the establishment of ranges for acceptability. We realize that ATP luminometer systems vary in capacity to measure bioload and that ATP benchmarking may require some instrument-specific standardization. To make valid decisions regarding the results of ATP luminometry testing, instrument verification and validation are necessary.

In their study, Sciortino and Giles (2012) sought to validate, compare and address specifics of instrument functionality for three commercially available ATP luminometers, as well as to determine the ability of instruments to measure long-term stability of ATP dried on surfaces. Dilutions of three species of microorganisms and a blood sample were dried onto a surface and tested. The performance characteristics of instruments were compared side-by-side for their ability to recover microorganism-derived ATP from surfaces. Timed studies showed that surface biologic-ATP remained detectable for 10 days. Instrument clinical sensitivity, precision, detection range, limit of detection, and linearity were determined. Swab recovery of microorganisms from surfaces varied by instrument and organism; regarding swabbing efficiency, there was great variability in the recovery of microorganisms using the three different ATP luminometery systems. All three systems detected microorganisms in the presence of disinfectants.

Of importance, Sciortino and Giles (2012) addressed the questions, "what percent of ATP

found on the 618 surfaces tested, with 89 percent failing to meet the ,500 RLU level in a proposed standard. In contrast, only 27 percent (168/618) of the same surfaces had ACCs above the proposed ACC cleanliness standard of 2.5 (colony-forming units)/cm2. In 2007, a study was undertaken by the National Health Service to evaluate the potential role the ATP tool in evaluating EC in hospitals. While noting limitations in the ATP system, the authors concluded that the tool could potentially be used effectively for education of ES staff, although an evaluation of such use was not part of the study design. Although it is likely that part of the lack of correlation between ATP readings and ACCs noted in the preceding studies relates to the fact that ATP systems measure organic debris as well as viable bacterial counts, several studies have noted additional environmental factors that may increase or decrease ATP readings, including residual detergent and disinfectants that may either increase of decrease RLU readings, plasticisers found in microfiber cloths, ammonium compounds found in laundry chemistries, and surfaces in poor condition."

While ATP is a valuable tool, Carling and Bartley (2010) caution that "Additional logistical limitations of the ATP tool include the need to develop baseline values, to evaluate a surface within a few minutes of cleaning, and the inability to use the system when a bleach-based disinfectant is being used for cleaning. Boyce et al. used pre-intervention ACCs along with ATP results in education of the ES. Subsequently, individual housekeepers were asked to clean a room that they were told would be monitored by the ATP system following cleaning. As a result of these interventions, the authors documented significant improvement in the daily cleaning of four near-patient surfaces as measured by the ATP system."

Carling and Huang (2013) note that, "With evidence that visual inspection is insufficient to ensure adequate removal of important healthcare-associated pathogens, alternative methods have succeeded in improving the evaluation and quality of cleaning and disinfection. Specifically, more comprehensive risk-based audit checklists and ultraviolet (UV) light or bioluminenscence-based adenosine triphosphate (ATP) assays have been evaluated as routine monitor- is actually recovered from surfaces coated with microorganisms and do differences occur between ATP systems?" The variation in the percent efficiency of ATP recovery was organism- and system-dependent. The researchers say that swab design may explain the higher recovery efficiency with one system over the others because it was wet and had more contact surface area. The researchers emphasize that swab design should be an important consideration because hospital surfaces have a wide variation in composition, design, moisture and biofilm burden.

Sciortino and Giles (2012) indicate that "The greatest challenge for the use of ATP technology to monitor hospital surfaces has been interpretation of results. In these studies when all surface RLUs from single rooms were combined, system 1 and system 3 achieved a statistical difference between pre-cleaning versus post-cleaning samples, but system 2 did not. Brown et al. recently argued that, because of interfering substances, ATP monitoring of patient room hygiene is not an effective tool. Our studies show that, even in the presence of detergents and disinfectants, two systems gave discriminate data, whereas system 3 was minimally successful. These findings may account for the argument presented by Brown et al. regarding earlier studies that

The researchers emphasize that swab design should be an important consideration because hospital surfaces have a wide variation in composition, design, moisture and biofilm burden.

ing systems. Evidence is greatest for the use of invisible UV markers whereby pre-cleaning placement on high-touch surfaces by EVS workers or infection prevention monitors allows assessment of the EVS workers' success at removal during cleaning. Use of these markers has the advantage of being readily understandable by EVS workers, including the ability for direct and immediate feedback. In addition, it has been associated with the reduction in important HAI pathogens on surfaces, and although further research is needed in this regard, its use has been associated with reduced transmission of HAI pathogens. Bioluminenscence-based ATP assays have also been evaluated for detection of residual organic material on post-cleaning surfaces. They also have the advantage of direct and immediate feedback. However, more evidence is needed to associate ATP levels with the presence of microbial pathogens and the reduction of transmission."

Carling and Huang (2013) explain that "Improved monitoring systems beyond visual inspection should be considered a necessity to ensure adequate quality of cleaning and disinfection. These systems should be jointly selected and supported by infection prevention and EVS leadership. Since culturing of surfaces is expensive and generally limited to research settings, adoption of intensive checklists and/or objective monitoring systems is already warranted because of the inadequacies of visual monitoring and the need to demonstrate under the Joint Commission standard EC.04.01.03.EP2 that 'results of data analysis [are used to] identify [and correct] opportunities to resolve environmental safety issues.' It is important that observers be unable to differentiate pre-cleaned from post-cleaned surfaces."

In this study the researchers demonstrated that ATP systems differ in respect to linearity, LOD and clinical sensitivity. They say that it validates that all three ATP systems reached a LOD, clinical sensitivity, and linear range needed for hospital surface monitoring. As Sciortino and Giles (2012) summarize, "Two instruments failed verification, meaning that both systems require modifications to the manufacturers' protocols to improve data acquisition and analysis. This study is intended to aid users as a Rosetta Stone in the selection of an instrument that meets their intended purpose. Each user should verify and validate their system in-house, prior to setting interpretive criteria. ATP system monitoring may uncover the need for new disinfectant designs that remove hospital surface biofilms, rendering used hospital equipment to its native state whereby a zero reading by ATP monitoring can be achieved." Sciortino and Giles (2012) emphasize that careful consideration of the technologic application and instrument performance are important criteria for the selection of an ATP monitoring system. ICT

Reference: Sciortino CV and R. Giles RA. Validation and comparison of three adenosine triphosphate luminometers for monitoring hospital surface sanitization: A Rosetta Stone for adenosine triphosphate testing. Am J Infect Control. 40 (2012) e233-9.

> With evidence that visual inspection is insufficient to ensure adequate removal of important healthcare-associated pathogens, alternative methods have succeeded in improving the evaluation and quality of cleaning and disinfection.

jective monitoring be a joint partnership between EVS and infection prevention, which is supported by the Centers for Medicare and Medicaid Services standard. For example, it may be beneficial to have the monitoring program principally conducted by EVS supervisors where feedback is directly linked to an authority structure for praise and correction. However, like many self-observation processes, inherent bias exists and additional safeguards are necessary for internal and external validity. Thus, periodic external validation by infection prevention and retraining of the monitoring process may be critically important for ensuring adequate feedback and high compliance. This may be particularly important with the high turnover that often occurs in EVS programs."

Conclusion

As we have seen, robust environmental cleaning and use of an enhanced system to monitor the effectiveness of cleaning efforts can make great strides toward controlling and prevent healthcare-acquired infections. However, further research is warranted to define concepts of cleanliness to better inform the use of ATP as a means of evaluating cleaning efficacy. Currently, there are no standard methods for how to obtain and to process specimens for aerobic colony counts to provide data on contamination by important pathogens. Additionally, there are no accepted criteria for defining a surface as "clean" by using aerobic colony counts (Sehulster et al, 2003; Dancer, 2004).

> There may be hospitals that are more advanced in their attention to environmental cleaning, while others haven't really done anything to address the improvement of their environmental cleaning yet.

As Guh and Carling (2010) observe, "At present, the objective monitoring of the cleaning process of certain high-touch surfaces (e.g., the curtain that separates patient beds) beyond those outlined in the (CDC's) checklist is not well defined. Additionally, there is no standard method for measuring actual cleanliness of surfaces or the achievement of certain cleaning parameters (e.g., adequate contact time of disinfectant) or for defining the level of microbial contamination that correlates with good or poor environmental hygienic practices. As our understanding of these issues evolve and a standardization of assessment in these respective areas can be developed and practically implemented, hospitals that have obtained a high compliance rate with surface cleaning as outlined in the Level II program are encouraged to advance their efforts in optimizing environmental hygienic practices."

Since dedicated resources to implement objective monitoring programs may need to be developed, hospitals can initially implement a basic or Level I program, as outlined by Guh and Carling (2010). Some hospitals should consider implementing the advanced or Level II program from the start, particularly those with increased rates of infection caused by healthcare-acquired pathogens (e.g., high Clostridium difficile infection rate). All hospitals that have successfully achieved a Level I program should advance to Level II."

The CDC's Alice Guh acknowledges the wide variability in implementation of environmental cleaning and monitoring programs at healthcare institutions across the U.S. and says hospitals should take stock of where their current efforts stand. "When we were discussing develop-

At a minimum, every hospital should at least be at Level I, with the expectation that they would advance to Level II."

ment of this toolkit I don't think we went into it thinking it would be a two-tiered approach; we were thinking it would be great to have institutions objectively monitor the thoroughness of cleaning but in our discussion we recognized that not every hospital is at the same level," she says. " There may be hospitals that are more advanced in their attention to environmental cleaning, while others haven't really done anything to address the improvement of their environmental cleaning yet. At a minimum, every hospital should at least be at Level I, with the expectation that they would advance to Level II."

The next step after achieving Level II is still unwritten, Guh says. "There are some indications as to what to do next but I think that is a grey area for us still. There are studies underway to discuss the type of cleaning and disinfection methods that can be applied to terminal cleaning and may be even to daily cleaning that might change even how we approach cleaning. I don't know how things might evolve, but it will take some time as we better understand the role of environmental cleaning. We do rely heavily on humans to perform the majority of the cleaning, and we need more research on how new technologies can change how we approach cleaning and disinfection."

Until that day comes, it is critical for infection preventionists and environmental services managers to take action on the data that a monitoring program produces. "It is very important for the data to be actionable," Guh says. "We try to emphasize as much as possible that this must be a joint, collaborative effort between the infection control committee and the environmental services management. From the very beginning, they must work together to determine the institution's expectations, what will come from this effort and how this data can be shared with the environmental services staff in a non-punitive way in order to drive prevention efforts. Ultimately it's going to be up to the individual institution how they want to carry out their monitoring and evaluation program but they must be thinking ahead to the ultimate objective for the program, and that is to be able to effect change, to be able to encourage people to want to improve their efforts to protect patients and eliminate infections." ICT

References:

Bhalla A, Pultz NJ, Gries DM, Ray AJ, Eckstein EC, Aron DC, Donskey CJ. Acquisition of nosocomial pathogens on hands after contact with environmental surfaces near hospitalized patients. Infect Control Hosp Epidemiol. 2004 Feb;25(2):164-7.

Carling PC and Bartley JM. Evaluating hygienic cleaning in healthcare settings: What you do not know can harm your patients. AJIC: Am J Infect Control. Vol. 38, No. 5, Pages S41-S50, June 2010.

Carling PC and Huang SS. Commentary: Improving Healthcare Environmental Cleaning and Disinfection: Current and Evolving Issues. Infect Control Hosp Epidem. Vol. 34, No. 5. May 2013.

Carling PC, Briggs JL, Perkins J, Highlander D: Improved Cleaning of Patient Rooms Using a New Targeted Method.. Clin Infect Dis 2006;42:385.

Diab-Elschahawi M, Assadian O, Blacky A, Stadler M, Pernicka E, Berger J, Resch H, Koller W. Evaluation of the decontamination efficacy of new and reprocessed microfiber cleaning cloth compared with other commonly used cleaning cloths in the hospital. Am J Infect Control. 2010 May;38(4):289-92.

Environmental Protection Agency (EPA). Using Microfiber Mops in Hospitals. Environmental Best Practices for Health Care Facilities. November 2002.

Guh A and Carling P. Options for Evaluating Environmental Cleaning. Centers for Disease Control and Prevention. December 2010. Accessible at: http://www.cdc.gov/hai/toolkits/evaluating-environmental-cleaning.html/. Appendices available at: appendices: http://www.cdc.gov/HAI/toolkits/Appendices-Evaluating-Environ-Cleaning.html

Kramer A, Schwebke I and Kampf G. How long do nosocomial pathogens persist on inanimate surfaces? A systematic review. BMC Infectious Diseases 2006 6:130 doi:10.1186/1471-2334-6-130.

Rutala WA, Gergen MF, Weber DJ. Microbiologic evaluation of microfiber mops for surface disinfection. Am J Infect Control. 2007 Nov;35(9):569-73.

Sehulster LM, Chinn RYW, Arduino MJ, Carpenter J, Donlan R, Ashford D, Besser R, Fields B, McNeil MM, Whitney C, Wong S, Juranek D, Cleveland J. Guidelines for environmental infection control in health-care facilities. Recommendations from CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). Chicago; American Society for Healthcare Engineering/American Hospital Association; 2004.

Smith DL, Gillanders S, Holah JT, Gush C. Assessing the efficacy of different microfibre cloths at removing surface micro-organisms associated with healthcare-associated infections. J Hosp Infect. 2011 Jul;78(3):182-6.

Weber DJ and Rutala WA. Understanding and Preventing Transmission of Healthcare-Associated Pathogens Due to the Contaminated Hospital Environment. Infect Control Hosp Epidem. Vol. 34, No. 5. May 2013.

Wren MW, Rollins MS, Jeanes A, Hall TJ, Coën PG, Gant VA. Removing bacteria from hospital surfaces: a laboratory comparison of ultramicrofibre and standard cloths. J Hosp Infect. 2008 Nov;70(3):265-71