

10 YEAR ANNIVERSARY EDITION



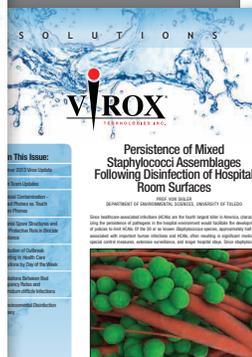
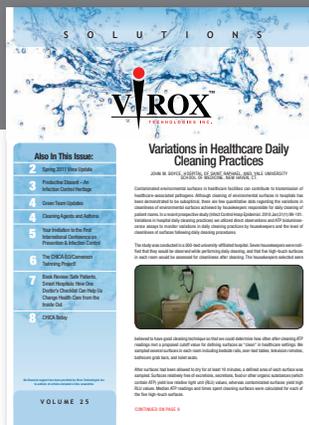
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This year represents the tenth anniversary of the Virox Solutions newsletter, and over the last decade we have been very fortunate to work with many world renowned experts. After an informal survey of readers and authors, we are pleased to present nine of the most frequently mentioned articles (in no particular order) ... and one new one about a global hero of infection prevention and control. There are many more important articles available to you in the back issues of the Solutions newsletter, all of which are available through www.virox.com, we invite you to take a moment and have a look.



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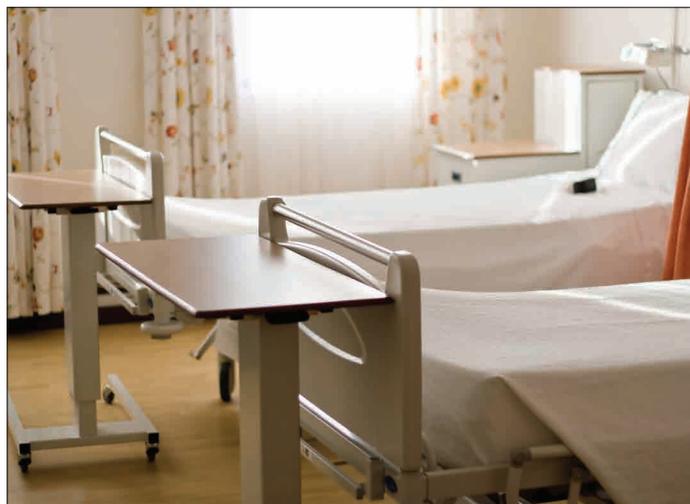
Hospital Cleaning in the 21st Century

DR. STEPHANIE J. DANCER, MEDICAL MICROBIOLOGY, HAIRMYRES HOSPITAL, UK

There is general consensus that environmental cleanliness is important for controlling infection, and there is increasing evidence to support basic cleaning in hospitals when considering hospital-acquired infections (HAIs). Finding the evidence to support cleaning as a significant factor in preventing infection has been seriously disadvantaged because there are no accepted risk-based standards to verify whether a hospital is truly clean and safe. Visual inspection of the hospital environment does not provide a reliable qualitative nor quantitative assessment of the infection risk for patients - microbes are invisible and they are not necessarily associated with visual dirt. Indeed, there has been a recent surge of articles supporting the importance of cleaning, including in the paper from which this article is derived (Euro J Clin Microbiol Infect Dis. 2011 Dec;30(12):1473-81).

Pathogens survive in the hospital environment

The microbes linked with HAI have two special properties. Not only do they cause disease, but they survive in the hospital environment for weeks. Examples include methicillin-resistant *Staphylococcus aureus* (MRSA), *Clostridium difficile*, Acinetobacter, and vancomycin-resistant enterococci (VRE). Viruses such as norovirus and influenza, and fungi such as *Candida albicans*, may also persist in hospitals for long periods of time. Gram-negative coliforms, e.g. *Escherichia coli* and *Klebsiella spp.*, are less robust but survive on dry, as well as wet surfaces,



although this tends to be for shorter periods of time. A hospital pathogen will persist in an appropriate environmental niche unless removed through some cleaning process. If abandoned, it may contaminate hands or be lifted by air currents and deposited onto a patient or surfaces beside the patient.

Location of pathogen reservoirs

Environmental screening can identify pathogens on a variety of hospital surfaces. Organisms attached to droplets, skin scales or dust particles may intermittently disperse through the atmosphere, ultimately settling on floors, but

any surface can host a range of microbes for varying lengths of time. Items or surfaces that are frequently touched present the largest risk of contamination by pathogens spread on hands. These sites then act as reservoirs for subsequent dispersal. Seeding pieces of cauliflower mosaic virus onto a telephone in a paediatric unit allowed researchers to track the movement and spread of the virus marker around the unit, from hand-touch site to hand-touch site, over the course of hours and days. Furthermore, a community-based study that placed virus marker onto a door handle in a students' flat revealed how direct hand-to-hand contact, as which occurs during hand-shaking, was able to spread viral pieces to a succession of people following initial contamination from the door handle. Past and recent studies have shown how pathogens can be retained on hands or gloves following contact with the hospital environment.

Cleaning reduces infection risk for patients

Insufficient cleaning, or the mistiming of a cleaning intervention, encourages the re-emergence of cases. This is further exacerbated by a higher throughput of more vulnerable patients, due to shorter lengths of stay. The persistence of viral and bacterial pathogens also exposes new patients to enhanced infection risk, as aptly demonstrated by studies examining the residual contamination of rooms previously occupied by infected patients. The clinical management of hospital-acquired infection involves extended length of stay as well as expensive, powerful drugs. Such avoidable costs are well worth considering when planning basic cleaning schedules.

Sites for targeted cleaning

Since contaminated near-patient hand-touch sites are thought to constitute the highest risk for patients, cleaning schedules should emphasize these sites. There is little scientific support for this at present and virtually no evidence to convey cleaning methods or frequency.

Some environmental sites are forgotten or ignored for various reasons. The underside of the overbed table, for example, is touched everyday by the patient and staff, but it is usually only the upper surface that receives a wipe down before and after mealtimes. An organism intent on accessing the gastrointestinal tract, e.g. *C. difficile*, would do well by contaminating this particular site. A recent audit on a surgical ward found high levels of organic soil on clinical items that did not appear to have anyone responsible for their cleaning. The use of ATP monitoring clearly showed the effect on domestic staff when they received educational guidance.

Cleaning staff

The trouble with motivating staff is that both short and longer term stimuli aimed at improving cleaning standards wear off over time. If cleaning fails, it is more likely to be a failure of personnel, rather than of product or procedure. Domestic personnel have a tiring and repetitive physical job to do. Maintaining high levels of compliance deserves appropriate recognition, but since it is difficult to measure, extra effort usually goes unrewarded. As with all professional activities, cleaning requires teaching and training, and never more so than in a hospital.

Cleaning methods and materials

Detergent-based cleaning might remove microbes, but will not necessarily kill them. There are numerous examples of contaminated cleaning cloths and equipment actually spreading microbes across surfaces rather than removing them. Numerous guidelines emphasize the importance of cleaning but offer little practical advice on how to achieve this, or how often sites should receive cleaning attention.

Despite the promising results from new decontamination methods and from antimicrobial surface coatings, traditional cleaning methods should not be relaxed or abandoned. No one single process will remove all relevant microbial soil from the hospital. There has already been concern raised over the efficacy of some methods such as microfibre, steam cleaning, ozone, and high-intensity light irradiation, and doubts remain over disinfectant activity in the field, since laboratory testing does not necessarily predict what actually happens on hospital surfaces.

SARS – Another Lesson in Humility

SYED A. SATTAR, PH.D., PROFESSOR OF MICROBIOLOGY, DIRECTOR CENTRE FOR RESEARCH ON ENVIRONMENTAL MICROBIOLOGY, UNIVERSITY OF OTTAWA, OTTAWA, ONTARIO, CANADA

What do West Nile, Ebola, Nipah, Hendra, the bird flu, and Norwalk have in common? These are all relatively new viruses - unknown to us until the last few years. And secondly, each one of these infinitesimal beasts has taught us that the human race can be readily humbled. The most recent addition to this list is the virus that causes SARS (Severe Acute Respiratory Syndrome). In just a few short months it has had more profound and humbling an impact on our lives than we have seen from an infectious agent in generations.

The ability of the virus to spread by the respiratory route, on close contact with infected individuals, is now well documented. Such viral distribution exposes caregivers to the greatest viral loads and the infection risk – the high proportion of cases in healthcare personnel is incontrovertible evidence of this. We should take comfort in that the virus does not appear to be transmitted by air in the same manner as influenza, mumps and measles. Had that been the case, we would have seen an even greater impact of SARS in a much shorter period.

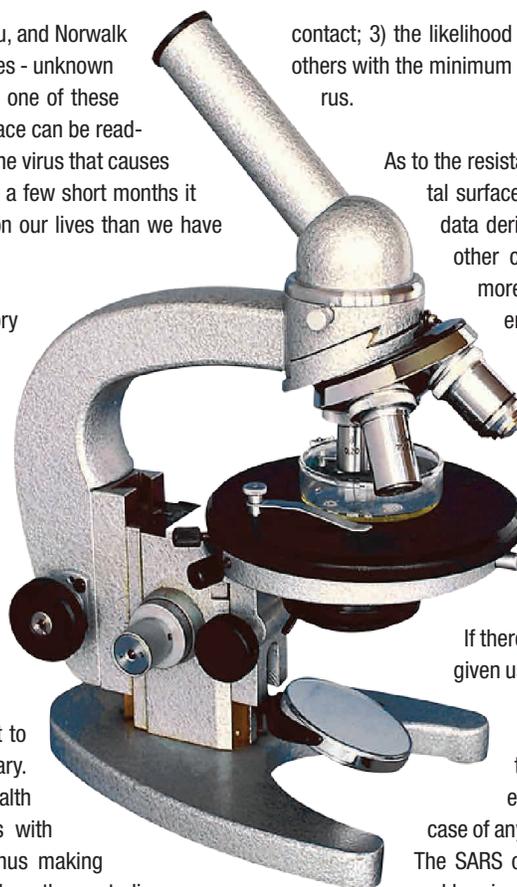
Our understanding of the ability of the SARS agent to survive in the environment is still very rudimentary. The summary reports published by the World Health Organization, for example, are based on studies with fundamental differences in test methodologies, thus making their data difficult to interpret. Statements based on these studies can also be quite misleading. For instance, the virus may survive on an environmental surface for perhaps 24 hours, but this does not necessarily translate into a health risk for those touching such a surface or object. A better way to measure the risk is to determine: 1) how much infectivity the virus has lost during that period; 2) the amount of virus that can be acquired upon hand

contact; 3) the likelihood of inoculating oneself or others with the minimum infectious dose of the virus.

Conclusion

Targeted and comprehensive cleaning regimens reduce the risk of acquiring a hospital pathogen. Comprehensive cleaning is also easier to implement than persuading busy staff to wash their hands or by reducing empirical antimicrobial use. A culture of hygiene pervading all healthcare facilities would influence and encourage the importance of cleaning and cleanliness for everyone. Global business and industry already play a central role in bringing novel methods onto the market; working together with doctors and scientists, government and cleaners themselves should continue to establish the importance of cleaning for everyone in the 21st century.

FROM SPRING
2003 ISSUE



As to the resistance/susceptibility of the SARS agent to environmental surface disinfectants and antiseptics, I am unaware of any data derived from tests on the SARS agent itself. Work with other coronaviruses indicates that while they are slightly more resistant to commonly used germicides than other enveloped viruses (this may be due to their closer association with membranes in host cells), they are substantially less resistant to germicides than non-enveloped viruses. However, until we have better evidence on the exact means of transmission of the SARS agent, disinfection and antiseptics with safe and environmentally friendly chemicals must remain an essential part of any prevention and control strategies.

If there is a silver lining to this dark cloud it is that SARS has given us a crash course in outbreak control the likes of which we have not seen in a long while. Local, national and international agencies have been forced to pool their expertise to counter this common enemy. This experience will be most helpful in our preparations in case of any deliberate or accidental release of infectious agents. The SARS outbreak has demonstrated yet again the unstinting and heroic dedication of our healthcare and public health professionals.

In spite of the oft-noted progress in our battle against infectious agents, many pathogens somehow continue to find our Achilles' heel, proving how vulnerable we truly are to these incredibly small life forms and the havoc they can wreak.



FROM VOLUME 24 - 2011

Healthcare Environment Decontamination

PROF. MARKUS DETTENKOFER, UNIVERSITY MEDICAL CENTER FREIBURG, GERMANY

It is universally accepted that healthcare-associated infections pose a substantial risk to patients, and that contamination of the inanimate healthcare environment with microbial pathogens can lead to contamination of healthcare workers' hands thus providing a vector to infect vulnerable patients. Evidence exists that many of these pathogens survive well, thrive even, in environmental reservoirs. The conditions and mechanisms of decontamination, however, are still debated. And it should be kept in mind that the still generally low compliance with hand hygiene is the more urgent problem in infection control.

The benefits and disadvantages of surface disinfection compared with cleaning using detergent only have been discussed in detail in several publications (e.g., Rutala WA, Weber DJ. *Am J Infect Control* 2005;33:434; Dettenkofer M, Spencer RC. *J Hosp Infect* 2007;65 Suppl 2:55, Dancer SJ. *J Hosp Infect* 2009;73:378). Many American researchers believe it is reasonable to use hospital disinfectants on noncritical patient care surfaces, patient equipment surfaces, and house-keeping surfaces in patient care areas. Conversely Europeans argue against routine surface disinfection and favor surface cleaning without the use of biocidal substances, particularly in light of the risk of workplace injury (e.g., contact dermatitis to the ubiquitous benzalkonium chloride) and the selection for resistance, which poses a risk to humans and the environment.

In a systematic review we assessed the evidence with respect to the effects of using a detergent alone or a detergent-disinfectant to decontaminate inanimate surfaces in the healthcare setting (Dettenkofer M et al. *Am J Infect Control* 2004;32:84). Our broad search of peer reviewed as well as informal data identified 236 articles meeting the inclusion criteria. Interestingly, none of these described a meta-analysis, systematic review, or randomized controlled trial, and only four described completed cohort studies with concurrent or historical controls meeting the criteria for final inclusion. None of the articles showed lower infection rates associated with routine disinfection of surfaces compared to cleaning with detergent only. Despite further studies on this issue published since then this chapter of hospital infection control is far from being closed.

Recent guidelines and recommendations reflect this lack of evidence and are mainly based on expert consensus. Robert Koch-Institute (Germany) issued its revised guideline on household cleaning and surface disinfection in 2004. That document recommends detergent-based cleaning for most surfaces and targeted surface disinfection for surfaces that frequently come into contact with hands and skin of patients or personnel. The lack of evidence in support of routine disinfection of surfaces is also reflected by the Centers for Disease Control and Prevention (USA) guideline on environmental infection control. Likewise, the Hospital Isolation Precaution Working Group (UK) stated that "Hot water and detergent are sufficient for most purposes".

The importance of cleaning with a detergent using up-to-date technologies must be highlighted. However, in circumstances of heavy organic soiling, such as blood or body fluid spills, rapid disinfection is inevitable and necessary in order to prevent fixation. In these circumstances, not all disinfectant products perform

equally. The efficacy of different methods of surface disinfection and cleaning to reduce microbial loads and prevent the dissemination of micro-organisms in a laboratory model (wet mop technique) has been studied (Exner M et al., *J Hosp Infect* 2004;56 Suppl 2:S70). This investigation found that when aldehydes and peroxides were used as the disinfectant agent, *S. aureus* was not smeared and spread to other surfaces. By contrast, smearing and spread to other test surfaces did take place when using water, surfactants, and even certain types of disinfectants (glycol derivatives, quaternary ammonium compounds and alkylamines).

New disinfectants, mainly peroxygen compounds, show good (and even sporicidal) properties and will probably replace more problematic substances such as chlorine-releasing agents. For preventing the transmission of prions, new methods and substances show promising activity. The transmissibility of viruses like norovirus shows the need for sound data on how different disinfectant classes perform with respect to inactivation. The same applies for biofilms or other forms of surface-adherent microbes, which pose a special challenge to decontamination.

Although resistance to biocides is generally not judged to be as critical as antibiotic resistance, scientific data generally discourage the widespread use of biocides, especially in low concentrations and in consumer products Carson RT et al. *J Antimicrob Chemother* 2008;62:1160). Increased use of biocides, particularly in many household products, is in conflict with the principle that antiseptics and disinfectants (incorporated into formulated products) should be used only when necessary and then only with a full appreciation of the factors influencing their activity. Even the widespread use of silver as a biocide – commonly in appliances such as refrigerators or toilet seats - is likely to support the development of resistance without proven beneficial effect. New technologies and products (like hydrogen peroxide vapour decontamination) must be evaluated with sound methods to demonstrate their properties and their restrictions.



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Patient Safety Climate: Variation in Perceptions by Infection Preventionists and Quality Directors

PROF. ELAINE LARSON, CENTER FOR HEALTH POLICY, COLUMBIA UNIVERSITY SCHOOL OF NURSING, NEW YORK, NY

A “culture of safety” has been defined as the shared values and patterns of behavior that determine the degree to which all organizational members direct their attention and action towards minimizing patient harm. Many healthcare institutions have adopted a “culture of safety” philosophy as an integral part of their delivery process or service.

Healthcare-associated infections (HAI) are a key patient safety issue. In the past 20 years, the overall incidence of HAI has increased by 36%, and the substantial human suffering and financial burden of these infections is staggering. Annually, in the United States, approximately 2 million patients develop an HAI, and nearly 90,000 of these patients are estimated to die. The Centers for Disease Control and Prevention has recently estimated the annual hospital costs of HAI in the United States to be between 25.0 to 31.5 billion dollars per year.

In a recent study (*Interdisciplinary Perspectives on Infectious Diseases Volume 2011, Article ID 357121*) we explored whether patient safety climate varied between two different but essential roles in the prevention of infection and across different hospitals: Infection Preventionists (aka Infection Control Professionals) and Quality Directors. The aims of this study were (1) to compare the perceptions of two aspects of patient safety climate between Infection Preventionists and Quality Directors in the same hospital, (2) to identify setting and role characteristics associated with differences in perceptions of patient safety climates, and (3) to identify setting characteristics that predict more positive perceptions of patient safety climates.

This study was an analysis of two cross-sectional surveys conducted simultaneously. There were 322 eligible hospitals; 149 hospitals (46.3%) responded to both surveys. Seventeen hospitals with insufficient data were excluded. Additionally, hospitals were removed from specific analyses if there were two or more missing responses and imputation was not possible.

We found that Infection Preventionists and Quality Directors in the same hospital varied in their perceptions across the two patient safety climate scales. However, our hypothesis that Infection Preventionists would perceive a lower climate of patient safety compared to Quality Directors was

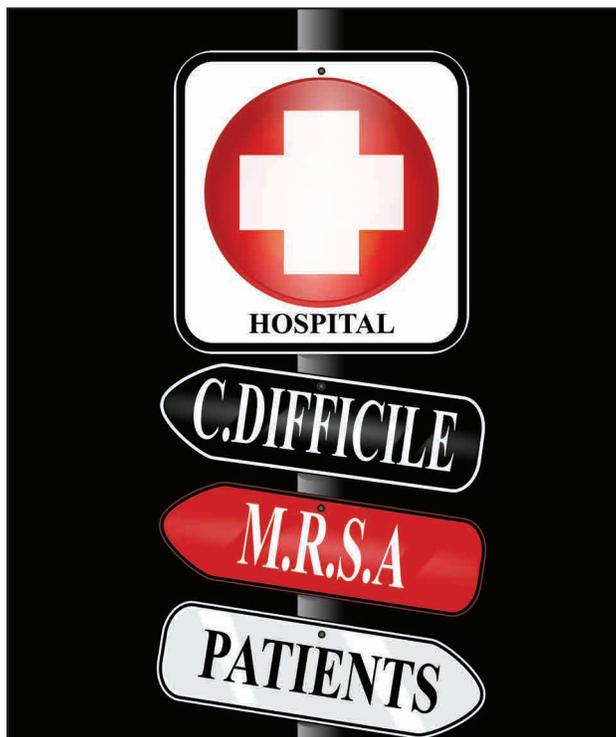
supported in only one of the microclimates. Generally, Infection Preventionists had more positive perceptions of Senior Management Engagement, and the Quality Directors had more positive perceptions of Leadership on Patient Safety.

In a study of personnel in 92 hospitals, Singer and colleagues found differences in perceptions of safety climate by both role (i.e., senior management, supervisor, and front line worker) and by discipline (i.e., physician, nurse, other clinician and nonclinician). Similar to our findings, these researchers found that senior managers perceived fewer problems with Senior Management Engagement than front line workers.

Another key finding of our study is that budget was an important predictor of more positive perceptions of patient safety climates. Having an independent budget for the infection prevention and control department may allow for more autonomy and development of infrastructure to promote patient safety. According to a policy brief by Pronovost et al., efforts are being made at Johns Hopkins Hospital to improve the safety culture by investing resources to monitor the rate-based measures of quality and safety. These authors noted that fulfilling a commitment to safe and high-quality care is not possible without significant investment in patient safety infrastructure. Based on a study by Fukuda et al., implementing hospital-wide safety practices requires considerable financial investment. Results from their study confirmed that hospitals with greater financial and organizational resources are more capable of promoting the activities required for patient safety and infection control.

Conclusions

Although there have been many efforts to curb the increase in HAI, it is clear that this preventable issue is slow to improve. Leaders play a pivotal role in hospital initiatives to improve quality. This study represents an advance over previous studies on the relationship between safety climate and personnel perceptions by examining those leaders who are essential to the prevention of HAIs in acute health care settings. Given the finding that there are differences in perceptions among essential leaders, this discord could be an inhibition toward achieving the goal of decreased HAIs. It is essential for those personnel in leadership to work collaboratively in order to not only enhance health care environments but also make it safer for patients.





FROM VOLUME 27 - 2012

10 YEAR ANNIV

Cleaning Agents and Asthma

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Although cleaners represent a significant proportion of the working population worldwide, they remain a relatively understudied occupational group. Cleaners undertake diverse tasks, ranging from domestic cleaning to cleaning in offices, hospitals, kitchens, public buildings, and industrial plants. It has been reported that 3% of the female workforce in Finland and 4% in the United States have a job in this field. And in my country, Spain, approximately 10% of women over 16 years old worked as cleaners in the year 2000. Exposure to substances in

The cleaning products used for common janitorial tasks are mixtures of many chemicals, which are usually classified in product categories according to their application. The main chemical components of cleaning products include detergents, disinfectants, alkaline agents (eg. sodium hydroxide, ammonia), acids, complexing agents (water softeners), solvents, corrosion inhibitors (eg. monoethanolamine), film formers and polishes (eg. acryl polymers, polyethylene), preservatives (eg. benzalkonium chloride, isothiazolinones, formaldehyde), and perfumes or scents.



the workplace is thought to cause more than 10% of all cases of adult-onset asthma, and cleaning has been described as a particular occupational risk due to an increased incidence of asthma and asthma-like symptoms among cleaning workers. In a recent article (Quirce S, Barranco P. Cleaning agents and asthma. *J Investig Allergol Clin Immunol.* 2010;20:542-50) we explored this risk.

In the USA, the states of California, Massachusetts, Michigan, and New Jersey conduct work-related asthma surveillance as part of the Sentinel Event Notification System for Occupational Risks (SENSOR). The Californian surveillance system showed that janitors and cleaners had the highest incidence of work-related asthma. Rosenman et al reviewed reports on work-related asthma associated with cleaning products and found that a cleaning product was 1 (or more) of the 3 suspected agents identified in 236 (12%) of the 1,915 confirmed cases. Of the products identified, bleach was the most frequent.

Cleaning Agents

A cleaning product is defined as any material used for cleaning or disinfecting surfaces in general work environments. These products have become an indispensable part of modern life, as they are used on daily basis in nearly all workplaces and homes. A wide array of cleaning agents has been developed to facilitate dust and dirt removal, and for disinfection and surface maintenance.

Detergents

Detergents, such as fatty acid salts (soap) and organic sulphates, reduce the surface tension of water. More aggressive and effective detergents are increasingly used and may cause irritation of the skin and mucous membranes. Only sparse data exist in relation to surfactants and allergic sensitization. It has been hypothesized that the strong surfactant properties of some ingredients of modern detergents may interfere with various intricate cellular interactions taking place along immunological pathways, including formation of type 2 helper T cytokines.

Disinfectants

The main chemical classes of disinfectants are alcohols (eg. ethanol, isopropanol), aldehydes (glutaraldehyde, orthophthalaldehyde), oxidizers (eg. sodium hypochlorite, H₂O₂), phenolics (phenol, thymol, o-phenylphenol), and quaternary ammonium compounds. Disinfectants have been identified as the most hazardous group of cleaning agents.

Bleach, whose active compound is sodium hypochlorite, and ammonia are among the most common chemicals used in cleaning products. Chlorine is a very toxic gas and exposure to levels as low as 1 ppm for a few minutes can irritate the eyes, nose, and throat. Chlorine also has a strong irritant effect on the airways.

Quaternary ammonium compounds, which are also known as quats, are widely used in cleaning products as antiseptics, disinfectants, detergents, and preservatives. Bernstein et al described a case of occupational asthma caused by prolonged workplace exposure to a cleaning solution containing benzalkonium chloride. Exposure to quats can occur either by inhalation of aerosolized liquid particles generated during application or by inhaling these liquid particles absorbed into the dust particles that are re-suspended in the air.

Perfumes and scents

Perfumes and scents are common components of many cleaning products. Pine scent containing terpenes can act as a sensitizer, as can limonene, eugenol, and other fragrances. Terpenes can cause secondary emissions due to reactions of the primary exposures with oxidizers present in indoor air. These reactions can

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Role of Hospital Surfaces in the Transmission of Emerging Healthcare-Associated Pathogens

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There is no dispute that healthcare-associated infections (HAI) remain a major cause of patient morbidity and mortality in healthcare facilities, including non-acute facilities. In the United States there are approximately 1.7 million HAI every year, resulting in close to 100,000 deaths. In particular, emerging organisms such as norovirus, *Clostridium difficile*, and *Acinetobacter* spp have caused a great deal of distress for patients, and the healthcare workers who have to battle these bugs. For many years the role of the contamination of surfaces in healthcare facilities was a debatable point. However, these three organisms in particular have shown that the healthcare environment has everything to do with healthy patients, and that it requires greater attention.

A recent article in the American Journal of Infection Control drove this point home quite nicely. David Weber, William Rutala, and colleagues looked specifically at norovirus, *C. difficile*, and *Acinetobacter* and the role that the hospital environment played as a vector of transmission. These three organisms were selected in particular for several reasons, not least of which because they are known to survive for long periods on environmental surfaces (hours to years), they each have a low infective dose (just a few virions in the case of norovirus), and they are the causative agent in a great number of outbreaks every year. The authors explore each organism in turn.

The understanding of norovirus transmission and pathophysiology has been limited by the lack of a culture system for growing the virus, and limited animal models. The sheer number of norovirus outbreaks is astounding. This pathogen is responsible for approximately 50% of all epidemic gastroenteritis, and more than 90% of all non-bacterial gastroenteritis. This virus is responsible for an estimated 267 million infections annually. Transmission is generally fecal-oral (although outbreaks from contaminated food and water are reported), most notably from coming into contact with contaminated surfaces and not subsequently performing adequate hand washing. Norovirus infection is associated with a short incubation period (10-51 hours), although the infected person remains a potential transmitter for several days beyond the point when clinical symptoms have resolved. It is a hardy organism, not substantially affected by alcohol hand rubs, and able to survive for long periods in in-use concentrations of quaternary ammonium disinfectants.

Clostridium difficile is widely known and loathed by infection control professionals. A spore-forming and toxin-producing bacillus, it is carried in the intestinal flora of approximately 3% of healthy adults, and 20-30% of hospitalized adults. Once in the environment it can exist as a vegetative cell or spore form. The vegetative cell survives for only 15 minutes on dry surfaces, although they may remain viable for up to 6 hours on moist surfaces. The spore form, on the other hand, is highly resistant to chemical disinfectants, alcohol hand rubs, heat treatment, and physical removal. It is transmitted by the fecal-oral route. Hands, surfaces, and equipment are easily contaminated, to the extent that as many as 75% of rooms with a symptomatic patient show heavy contamination on surfaces. In recent years an increased incidence of *C. difficile* infection has been



reported, along with an increase in related hospitalizations and deaths. The frequency of drug-resistant *Acinetobacter* spp has been increasing, and multiple outbreaks have been reported. Once these aerobic, gram-negative bacteria are established in an institution, outbreak strains often become endemic. The crude mortality rate ranges as high as 50%, and the attributable mortality can be as high as 43% for intensive care patients. *Acinetobacter* can survive in the healthcare environment for weeks, particularly in areas of high humidity, and up to an hour on fingertips. One study recovered *Acinetobacter* from 28.6% of the hands of healthcare workers tested. The organism is found to be generally susceptible to surface and hand disinfectants.

Hand hygiene is seen as the cornerstone of infection prevention and control, and yet the frequency of positive hand cultures is directly related to surface contamination. In one study with *Clostridium difficile*, hand contamination was 0% when environmental surface contamination was between 0% and 25%. When surface contamination was between 26% and 50%, hand contamination climbed to 8%, and when surface contamination was greater than 50%, more than 36% of hands tested showed contamination.

The authors of this AJIC article point out time and again that these 3 “emerging” organisms are becoming ubiquitous in healthcare environments and conclude that enhanced environmental cleaning/disinfection is recommended as part of a bundle approach to resolve or prevent outbreaks. Complete prevention of environmental contamination is not possible, considering that hospitals and long term care are populated by buggy humans. However, the appropriate deployment of properly educated environmental services workers, equipped with the chemical and mechanical tools that they need, using checklists and validation testing has had demonstrable improvements in the battle to prevent and control hospital-associated infection.



FROM WINTER 2006 ISSUE

Cleaning *C diff* – Whose Job Is It Anyway?

EXCERPTS FROM A TELECLASS LECTURE BY DR. MICHELLE ALFA, WINNIPEG, MANITOBA

Toilets and commodes are probably the most heavily soiled and contaminated surfaces in the room of a patient infected with *Clostridium difficile*. And there is potential for a disastrous outbreak if the proper cleaning isn't happening. Although it sounds like a rhetorical question – whose job is it? – what you think is happening, may not actually be happening.

The toilets in most healthcare facilities are the responsibility of the housekeeping staff to clean. In my own facility the protocol is that the toilets are cleaned once a day on the wards and throughout the hospital. If the patient is diagnosed with *Clostridium difficile* Associated Diarrhea (CDAD), that is bumped up to twice daily cleaning of their bathroom area, morning and afternoon. Our infection control protocol recognizes that the toilets need to be kept as clean as possible to reduce the risk for transmission.

To test the bathroom cleaning compliance of housekeeping staff in the rooms of CDAD patients we use a water-soluble UV marker to “inoculate” various surfaces of the toilet seat. The marks show up as fluorescent whirls under UV light, but are invisible under normal light. The fresh marks are considered 100% fluorescence, and even a simple wipe with a damp cloth can remove 50% of the mark. We allowed the housekeepers to clean the toilets as they normally would, unaware of the mark, and then viewed and evaluated the residual fluorescence. We discovered that the cleaning efficacy of toilets in CDAD isolation rooms aver-

aged 56.5%, whereas a regular non-isolation room averaged 72.9%. Rather than increased cleaning and decontamination, toilets in isolation rooms were cleaned less carefully. We can only speculate that the cleaners wanted to get in and out of the isolation room quickly and thereby rushed the decontamination procedure.

Commodes are notorious for moving between rooms. Of course it is important that once a patient is diagnosed with CDAD, if they need a commode, it is dedicated to their room and not shared between patients in multiple rooms. If the commode is handy to the patient, who will have frequent and sudden bouts of diarrhea, there won't be a temptation for a worker to rush into another room for a commode. The question again is: who is designated as responsible for cleaning the commodes? It was a surprise to us to find out that everybody thought everybody else was doing it, and in the end, nobody was doing it because it had not been designated as a responsibility.

If no-one is designated to clean the commodes, they may not be cleaned at all, or they may be cleaned very sporadically. You may think that in your policy you have toilet cleaning once or twice a day as a routine, but the commodes are one of those little cracks in the sidewalk. If nobody is actually aware that they are responsible for it, the cleaning of commodes will get lost in the busyness of modern healthcare.

FROM VOLUME 32 - 2013

The Battle for 'Clean' Surfaces

DR. STEPHANIE DANCER, DEPARTMENT OF MICROBIOLOGY, HAIRMYRES HOSPITAL, UK

When hospitals are threatened by increasing infection rates, it is unsurprising that administrators would seek a rapid solution. The rising popularity of automated no-touch systems, such as those that radiate UV light or disperse hydrogen peroxide, illustrates a predictable managerial reaction to outbreaks. In keeping with twenty-first century ethos, automated systems offer labour-saving decontamination, and we should be grateful for the technology. However, there is a concern that managers might choose push-button gadgets rather than reduce bed occupancy or employ more cleaners. I discussed this recently in the *Journal of Hospital Infection* (2013 Aug;84(4):339-40).

Automated systems radiating UV light or dispersing hydrogen peroxide eliminate a range of surface pathogens as would be expected following such exposure. In one published review, the hydrogen peroxide decontamination device resulted in patients being 64% less likely to acquire any multiply drug-resistant organism, and 80% less likely to acquire vancomycin-resistant enterococci (VRE). However, not mentioned in that review was that the risk of acquiring *Clostridium difficile*, Methicillin-resistant *Staphylococcus aureus* and multidrug-resistant Gram-negative bacilli was 'not significantly reduced'. The microbicidal effects of the hydrogen peroxide decontamination devices are impeded by surface properties and debris, e.g. linen, soft furnishings, and organic soil. The automated systems

cannot be used where rapid turnover of rooms is required, nor when rooms are occupied, and there are continuing risks of accidental exposure to people, plants, and animals.

Is current evidence on clinical benefit sufficiently plentiful and robust to allocate scarce healthcare resources for these systems? Is anyone promoting the benefits of basic cleaning with soap and water? Not only is physical removal of bioburden a vital component of the cleaning process, it is just as effective as many hospital disinfectants for controlling environmental microbes. This is partially, but not solely, explained by the fact that the microbicidal activity of many disinfectants is inversely proportional to the degree of organic soiling on a surface.

Hospital cleaners are still not valued for the work that they do and there are too few in most facilities. If hospitals want to use automated systems, then the caution offered in this opinion will not stop them. But before discarding mops and buckets, managers should remember that, smart as they are, these automated devices cannot yet remove a puddle of urine, nor can they retrieve the potato-crisp packet from under the bed. For those of us with a mind to Darwinism, the cumulative effect of repeated microbial obliteration does not bode well for the future.





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Healthcare Environment Decontamination

Conclusions

Targeted surface disinfection is indispensable in modern healthcare facilities. However, disinfectants may be hazardous to personnel and patients, as well as the environment, and require special safety precautions. Unrestricted use of biocides, especially in low concentrations, may lead to the development of resistance. Disinfection and cleaning are established components of hospital infection control, and special situations require special procedures, e.g. when treating infected or severely immunocompromised patients or patients colonized with multi-resistant pathogens. New technologies and biocidal substances with promising properties should be further evaluated. As emerging resistant pathogens will challenge healthcare facilities in the coming years even more than at present, there is a need for well-designed (multicenter) studies addressing the future role of disinfection in hospital infection control (Dettenkofer M et al. *J Hosp Infect* 2011;77:7).

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Cleaning Agents and Asthma

release secondary ultrafine particles that may be responsible for respiratory irritation symptoms.

The airborne concentrations of glycol ethers (regulated toxic air contaminants) and terpenoids (including d-limonene) were measured during and after the application of 5 different cleaning products and air fresheners in a 50-m³ room ventilated at 0.5 m³/h. The results indicated that some cleaning agents can yield high levels of VOC, including glycol ethers and terpenes, which can react with ozone to form a variety of secondary pollutants including formaldehyde and ultrafine particles.

Summary and Conclusions

Cleaning agents are used in large quantities throughout the world. Epidemiological studies have shown an association between cleaning work and asthma, but risk factors are uncertain. Exposure to cleaning products is a function of both product formulations and product application. Factors inherent to the environment where cleaning is done or the type of cleaning agents used may explain the differences observed between the different types of exposure. For instance, the use of cleaning products in spray form facilitates inhalation, and sprays may contribute to the burden of asthma in adults who do the cleaning in their homes. The ingredients of cleaning products should be systematically evaluated, and exposure in the workplace and at home should be assessed. A combination of product evaluation and exposure data is necessary to develop strategies for protecting exposed individuals from cleaning hazards.





Didier Pittet

Review - Clean Hands Save Lives

The story of a revolution in hospital hygiene and the man who led it

PROF. ANDREAS WIDMER, MD, MS, UNIVERSITY HOSPITAL, BASEL, SWITZERLAND

It's an unfortunate truism that we generally discover the significance of someone's life-contribution only while attending their funeral. A fascinating new book by Thierry Crouzet, weaves moving, motivating, and inspirational stories of the journey of a man still very much alive. "Clean Hands, Save Lives" explores the life and work that shepherded an earth-shifting change in the way that hospitals practice hand hygiene. It's the story of how one leader, Didier Pittet, was able to advance his dream of saving lives through clean hands worldwide.

"How about infectious diseases, does that tempt you?"

Professor Francis Waldvogel, didn't accept new doctors on his team at the University of Geneva Hospitals, just senior physicians. For this 26 year old, however, he would make an exception. Pittet had come to his notice as a 4th year medical student who competently, compassionately took charge of a patient interview, introducing the patient to the eminent Waldvogel and asking pertinent questions. At that time, medical students would not likely have been present at this interview with a very ill leukemia patient, let alone speak without explicit permission. Didier Pittet was not, and is not, any ordinary man.

"Instead of striving to kill microbes in wounds, wouldn't it be more reasonable not to put them there in the first place?"

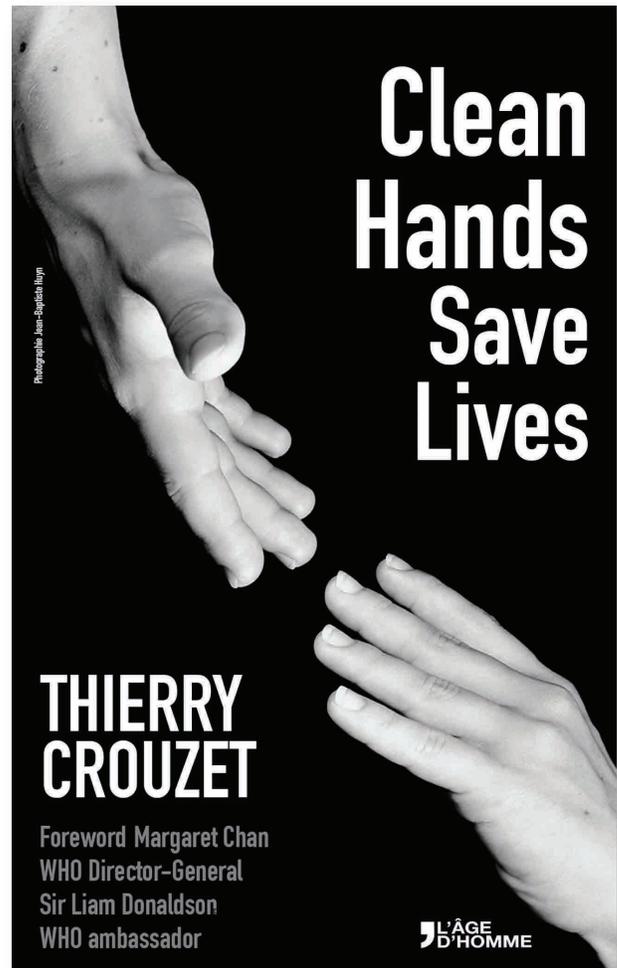
Author Crouzet has a wonderful talent for storytelling. He takes us on a ride from the child boy scout, captain of his soccer and hockey teams, to the organizer of all the parties in medical school, who "carries everyone along with him". We see the young doctor who observed nurses and other staff day and night to understand the flow of their work to thus better understand the processes involved in infection transmission. We meet pharmacist William Griffiths, who was an expert on alcohol-based solutions and who created the first alcohol hand disinfectant, key to the global Clean Hands movement to come. We follow Pittet as he carries people along with him first in his own hospital, seeing hand hygiene improve and nosocomial infections decrease, and eventually converting those lessons to success around the globe.

Never impose anything. Educate and incite.

Success, even in his own University of Geneva Hospital, was not immediate nor simple. The book candidly describes some of the roadblocks encountered by Pittet. In this respect we are also treated to a masterful encapsulation of the Semmelweis story, and the lessons taken from it into Pittet's own efforts. In 1847, Ignaz Semmelweis bullied and brow-beat clinicians into rinsing their hands with the most corrosive and foul smelling cleaner that could be raided from the janitor's closet. The resulting impact on deaths in his maternity clinic was impressive and would have likely been celebrated had it not been for Semmelweis's disagreeable manner. He was dismissed from the hospital whereupon the death rate returned to "normal". Pittet would never force or impose. He

offered the alcohol solution to everyone working in the hospital environment, explained the benefits, and released the results of hospital infection rates every six months. In the first three years of the program, consumption of alcohol handrub increased fivefold and nosocomial infection rates were halved. Similar to Semmelweis, Pittet developed gray hairs likely resulting from his endless battle to change human behavior.

The foreword for this book was penned by no less eminent personalities than Margaret Chan, Director-General of the World Health Organization, and Sir Liam Donaldson, WHO Patient Safety Envoy. They write that the book is about how a great leader can inspire, galvanize action, transform, and sustain the benefit. To them goes the last word. *"We are grateful for his exemplary leadership and for the bonds that he has helped us to forge ... Much can be learned from the story that is told so well and so inspirationally in this book."*





Microbicides in Healthcare: Usage, and Possible Problems

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Originally employed for food and water preservation, chemical microbicides have been used for centuries. There are accounts, as early as Lister's employment of carbolic acid in 1867, of their use for wound management. The advent of antiseptics and the use of chlorine water in the early 19th century issued in the era of microbicides in healthcare, and the 20th century witnessed a tremendous increase in the number of these agents. Microbicide (biocide) is now a term commonly used for a chemical compound showing antimicrobial activity and use as a disinfectant, antiseptic or preservative.

Microbicidal agents are used extensively in healthcare settings for different applications: disinfection of surfaces and water; "sterilization" of medical devices; skin antiseptics; and the preservation of various formulations. In addition, there are now numerous commercialized products containing low concentrations of microbicides, the (rapidly increasing) use of which is controversial. Indiscriminate use of disinfectants in the hospital environment is not a new problem as it was first raised in the 1960s, but it remains a current issue.

There is currently a debate as to whether all surfaces should be disinfected, or only "critical" and "non-critical" surfaces that may come in contact with sterile part of the body or vulnerable patients. There are a number of arguments either for the indiscriminate use of microbicides on surfaces or their prudent use and to date the status quo remain. However, other medical articles need thorough cleaning with detergents and chemical disinfection. Flexible endoscopes are of

particular interest, since they are now used for a wide range of diagnostic and therapeutic procedures, are often grossly contaminated, and require special sterilization regimens involving chemical disinfectants as these medical devices are often heat sensitive. There are some reports describing the washer-disinfectors as a source of instrument contamination when the concentration of the high-level disinfectant is too low, or when biofilms are present.

There needs to be a balance between efficacy (ie, destroying microorganisms) of a microbicide and toxicity. The increased usage of products containing low concentrations of commonly used microbicides, such as phenolics and cationic compounds such as quaternary ammonium compounds (QACs), has raised some concerns about their overall efficacy, but also about the possible emergence of microbial resistance. Indeed, there are now multiple laboratory reports about the emergence of bacterial resistance to microbicides, often as a result of exposure to a lower (sublethal) concentration. The possible development of bacterial resistance (not only to microbicides, but also to antibiotics), the benefit of microbicide usage, and their possible role in the emergence of multidrug-resistant bacteria, add further questions to the extensive use of microbicidal products. The benefits and disadvantages of microbicide usage in the healthcare environment need to be carefully considered.

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Alteration of activity

An understanding of the factors affecting antimicrobial activity is essential to ensure that a microbicide product/formulation is used properly. A microbicide's concentration is probably the most important factor to affect antimicrobial activity. Poor understanding of the effect of dilution on microbicide antimicrobial efficacy can lead to microbial survival on surfaces, but also in products, and thus to infection or spoilage. Bacterial survival in microbicide formulations, notably containing QACs, has been described since the 1950s' and has been linked to inappropriate usage. Bacteria resistant to all known preservatives have also been reported.

Exposure time is also essential. Decreasing exposure time is often associated with a decrease in activity. Other important factors relate to the conditions in which a product is employed, mainly the presence of organic materials (which will inactivate certain microbicides), or the concurrent use of a quenching agent (eg, combining a cationic agent with an anionic surfactant), or the combined use of a microfibre cloth with a cationic agent (eg, QAC). In addition, the effect of temperature on microbicide activity is important to understand in specific situations, for example, where microbicide efficacy relies upon a combination of chemical inactivation and elevated temperature (eg, certain sterilization process; automated washer-disinfector). Finally, pH might not be as important here, but should not be allowed to change drastically during use. Understanding these factors is essential and the appropriate training of end users, ie, nursing and housekeeping staff, is important to ensure that the efficacy of a biocidal product/formulation is maintained.

Bacterial resistance to microbicides

As mentioned earlier, some microorganisms are better at surviving a biocidal treatment than others, primarily through their intrinsic properties. "Impermeability barriers", encountered in spores but also in vegetative bacteria such as mycobacteria and to some extent in gram-negative bacteria, limits the amount of a microbicide that penetrates within the cell. The role of specific cell structure, such as lipopolysaccharides in gram-negative bacteria, have been demonstrated to be important in preventing the penetration (and subsequent activity) of certain microbicides in the microbial cell. The insusceptibility of gram-negative bacteria to biocidal agents can be decreased further by a change in overall hydrophobicity, outer membrane ultrastructure, protein content, and fatty acid composition.

Bacteria are also able to decrease the intracellular concentration of toxic compounds by using a range of efflux pumps. The involvement of multidrug efflux pumps in bacterial resistance to various compounds including QACs, phenolics, and intercalating agents has been widely reported, particularly in *Staphylococcus aureus*, and in gram-negative such as *Pseudomonas aeruginosa*, *Salmonella* spp. and *Escherichia coli*.

The acquisition of resistance is of notable concern since a previously sensitive microorganism can become insusceptible to a microbicide or a group of antimicrobials through, for example, the acquisition of multidrug resistant determinants. Acquired resistance can arise through several processes - mutations,

the amplification of an endogenous chromosomal gene, and the acquisition of genetic determinants. Phenotypic variations resulting from microbicide exposure also might lead to bacterial resistance and this is now well supported by documented laboratory evidence. Phenotypic variation and antimicrobial resistance also concern bacterial biofilms, which are increasingly associated with bacterial contamination and infection.

Emergence of bacterial resistance to microbicides and antibiotics

While there is ample evidence from laboratory studies of bacterial adaptation to microbicides, linkage to antibiotic resistance is not always clear-cut. Several laboratory investigations have explored a possible linkage between bacterial resistance to antibiotics and different microbicides such as chlorhexidine and QACs. Although similar mechanisms of resistance have been identified such as impermeability, the induction of multidrug efflux pumps, over expression of multi-gene components or operons, and the alteration of a target site, the evidence in situ is lacking overall. Nevertheless, there have been a number of cases linking microbicide usage and emerging antibiotic resistance. For example, the use of chlorhexidine scrub-based preoperative showers might be associated with the emergence of methicillin-resistant *S. aureus* (MRSA), and the heavy use of QACs has been blamed for the dissemination of qac genes and the spread of efflux pumps.

Other considerations

Microbicides are chemical agents that are usually toxic at relatively high concentration, not only for the end user, but also for the environment. The toxicity of some microbicides has been particularly well described. The use of glutaraldehyde has been associated with dermatitis and occupational asthma. Toxicity and irritation have also been reported with other microbicides such as chlorhexidine, povidone iodine, QACs, and other disinfectants and antiseptics. A recent study found that hospital staff using disinfectants might not appreciate the health risks associated with a product.

The future of microbicides in the healthcare environment

The increased usage of microbicide in formulations needs to be balanced between the clear benefit of controlling infection and the potential risk associated with usage, not only in terms of emerging microbial resistance, but also their toxicity and environmental pollution. For a microbicide formulation/policy to be effective, three essential components must include: knowledge of the chemical microbicide (ie, activity and limitation), training of end users, and verifiable compliance.

Conclusion

Microbicides are essential in preventing and controlling infections in the healthcare environment and the benefits from their prudent usage currently outweigh possible disadvantages. Disinfection of noncritical surfaces and items, and the usage of microbicide-containing products, need to be reviewed, although the incorporation of microbicides into medical devices to prevent bacterial infection is promising, if controlled and assessed appropriately.

(References for this article are available on request)



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