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## Cleaning and Disinfecting Environmental Surfaces in Healthcare: Toward an Integrated Framework for Infection and Occupational Illness Prevention

EXCERPTED WITH PERMISSION:  
THE CLEANING AND DISINFECTING HEALTHCARE WORKING GROUP



Cleaning and disinfecting are important parts of a comprehensive infection prevention strategy. While demand for more effective cleaning and disinfecting is growing, there is also increasing evidence that exposure to cleaning and disinfecting can result in acute and chronic health effects, particularly respiratory illness. Thus far, there has been limited collaboration between the disciplines of infection prevention and occupational health to coordinate and optimize efforts to provide effective cleaning and disinfecting practices for HAI prevention while protecting the respiratory health of health care workers, patients, volunteers, visitors, and other building occupants. This lack of coordination has led to gaps in knowledge and practice guidance.

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# Virox Update

## 2016 IPAC-Canada Cleaning, Disinfection and Sterilization Symposium

Virox is excited to continue our sponsorship with the IPAC-Canada bi-annual Cleaning, Disinfection and Sterilization Symposium at the Niagara 2016 IPAC-Canada National conference. In line with our mandate to provide educational opportunities to the Infection Control Community, the 2016 symposium will focus on implementation science, which will include a workshop designed to help put theory into practice and equip infection control professionals across Canada with the knowledge and tools they need to prevail in the battle against germs.

## Infection Control Week

Welcome to National Infection Control Week! As many of you know, the purpose of Infection Control Week is to highlight infection control efforts and educate staff in hospitals, long-term care facilities and the community about the importance of infection prevention. Virox enthusiastically participates in Infection Control Week and enjoys getting the whole company involved. With daily events planned, we look forward to educating our staff on the importance of hand hygiene and the prevalence of germ transmission throughout our office. We hope you will follow us on Twitter and Facebook. "Clean Freak", Nicole Kenny will be posting daily "Talk Clean to Me" blogs all on the topic of C.L.E.A.N.



## PREempt<sup>®</sup> Disinfectants and Cleaners for Surfaces and Devices

We are pleased to announce the imminent launch of PREempt<sup>™</sup>, a new brand of our Accelerated Hydrogen Peroxide<sup>®</sup> (AHP<sup>®</sup>) disinfectants and cleaners for surfaces and devices. PREempt<sup>™</sup> brand products are labelled to be compliant with relevant pathogens and use instructions for markets such as clean rooms, laboratories, spas and sterile processing, as well as other markets that have unique requirements.

PREempt<sup>™</sup> products are designed with our five key decision making criteria in mind: Cleaning Efficacy, Germicidal Efficacy, Personal Health & Safety, Environmental Sustainability, and Compatibility.



## PTS Speaking Engagements

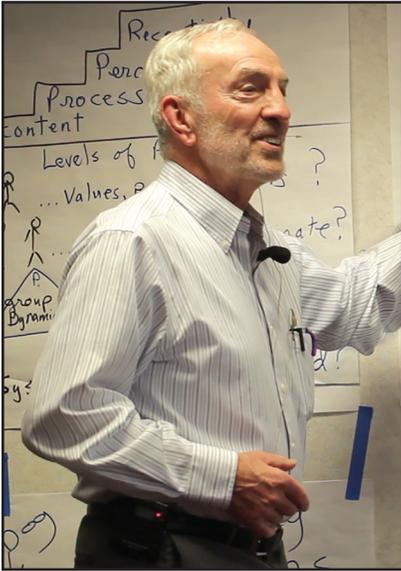
This year, the Professional and Technical Services (PTS) team has been busy speaking at infection prevention, public health and environmental services conferences and meetings across North America. As experts in chemical disinfection, we aim to provide unbiased education to the infection control community on a variety of topics relating to this industry. Some of the topics we have covered include the understanding of desired traits of disinfectants to ensure their proper use and how science has validated that the cornerstone to infection prevention programs is dependent on cleaning and disinfection of environmental surfaces and shared patient care equipment. In addition, we have discussed how facilities can improve their sustainability programs by using certified green cleaners and disinfectants.

“ *Cleanliness becomes more important when godliness is unlikely.* ”

P.J. O'Rourke

# Dimensions of Non-verbal Communication

MICHAEL GRINDER, MICHAEL GRINDER & ASSOCIATES



*The following is an excerpt of an article by Michael Grinder. Mr. Grinder spoke at the IPAC Canada conference, to universally rave reviews, and we wanted to bring a taste of his remarkable insights on communication to our larger readership.*

Noticing a non-verbal behavior without an interpretation about that behavior is useless and yet interpretation without evidence is dangerous. How one accurately interprets non-verbals can be found in the different levels or dimensions of non-verbals.

## 1st Dimension: About others

Each behavior is assigned a given interpretation; for example, forearms folded across chest means that the person is closed off. This interpretation-without-evidence approach is flawed on at least two levels: cultural and individual.

### Cultural

Different cultures have opposite non-verbals for head movement that indicates agreement or “yes.” To the Western world, head movement of up and down is “yes.” In other cultures “yes” is indicated with a head movement from side to side. It makes sense to say that one has to be “calibrated” to the culture before any interpretation can be accurately offered. The exception is facial expressions.

Charles Darwin asked Christian missionaries in developing countries if they could assist him to identify which facial expressions are universal. A century later Margaret Mead proposed that each culture had their own unique set of expressions. Paul Ekman settled the argument with his research: there are six homo-sapien expressions: fear, surprise, happiness, anger, disgust, and sadness. I remember them as mnemonic “F SHADS”.

### Individual

Each human is uniquely complex. Our sophomoric tendency to think we know someone’s inner sanctuary of values and motivations is fraught with landmines. One of the many landmines is context. How someone acts at a funeral is not indicative of how that same person might behave at a wedding.

The “Circles of Humanness” can be a useful starting model. There are many layers to a human being. Initially, we notice their appearance. Very quickly we become aware of their behaviors. Over time, we encounter their mental style. If we live or work with them we eventually experience their values. It is as if we are moving towards the person’s core.

The layers could be described as “Circles of Humanness.” Moving toward the

core, each circle supersedes the importance of the outer circle. Our impressions and hallucinations of the person as a human being that are based on appearance are replaced with the more sophisticated layer of behaviors

## 2nd Dimension: About yourself

While the first dimension has all the allure of pop psychology, the second dimension is much safer. The goal is to understand my own non-verbals. What are my baseline behaviors in certain contexts: How much eye contact do I have? What are my voice patterns? What are my default gestures, body posture, and proximity to people?

## 3rd Dimension: Interaction with others in the moment

This dimension’s goal is to know which non-verbal behaviors have what effect on others. This is where Non-Verbal Intelligence shines. Non-Verbal Intelligence is the ability to:

**-Recognize-  
-Label-  
-Predict-  
-Respond-**

to patterns of non-verbal communication. When humans are shocked by an event they breathe high/shallow and lack oxygen to the brain – they are reduced to primate level – knee-jerk reactive behaviors are activated. The advantage of having high non-verbal IQ is that we can see what is likely to happen before it occurs – this allows us to be proactive.

## 4th Dimension: Interaction with others over time

Perhaps the most sophisticated level of non-verbals is not just being able to predict in the moment (3rd dimension) what is likely to happen but also to understand over time what is likely to happen. Extrapolation is a useful term for this ability.

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# Microbiological Comparison of Hand-Drying Methods: The Potential for Contamination of the Environment, User, and Bystander

NICOLE KENNY, VIROX TECHNOLOGIES INC.



When we dry our hands in a public washroom we have a potential impact on the contamination of the environment. It's not something to which one would normally give much consideration, but an outstanding article by Prof. Mark Wilcox and his group at the University of Leeds in the UK is making me pay much more attention.

There is much emphasis on the correct method for hand washing, but less attention on the options for drying hands. Evidence suggests that efficiency of hand drying is important in the prevention of the transfer of microorganisms from person to person or to the environment. However, the authors of this study point out that the risk of aerosolizing microorganisms during hand-drying by various methods remain unclear. They designed an intricate test to evaluate the impact of three hand-drying methods. They also investigated the extent of possible contamination of people drying their hands, as well as the possibility of contamination of a bystander.

Over a 6-week period, the researchers conducted a series of tests. For each test, gloved hands were first coated by immersion in a suspension of lactobacilli (to simulate poorly washed hands) and then dried in a standardized manner using one of each of the three drying methods - a warm air dryer, a jet air dryer, or paper towels. Sixty air-sampling tests were taken during the study (20 for each drying method), along with 60 tests for controls. Half of the tests for each drying method were in close proximity to the hands being dried and half were 1 metre away. The air-sampling controls were taken before every hand-drying test to provide baseline measurements. Also, settle plates were placed on the floor directly under, and 1 metre away from the hand-drying devices.

Secondly, the researchers designed a separate set of experiments to provide a visualization of the extent of potential contamination occurring during each drying process within the environment. The tests were carried out as before, but instead of a lactobacilli hand dip, gloved hands were coated in a solution of black water-based paint, with the user wearing a white disposable Tyvek suit.

A bystander, also wearing a disposable suit, stood 1 metre diagonally adjacent to the dryer user in order to replicate the scenario of someone waiting to dry his/her hands. Each drying method was tested 10 times. The study authors determined the extent of possible contamination by enumerating the distribution of black paint splatters around each drying unit, and the distance traveled by measuring the distance of the paint spots away from the drying unit/area. The extent of potential contamination on the user and bystander was measured by counting the numbers of paint spots on the Tyvek suits.

## Results

For each drying method, study authors report that the air bacterial counts in tests performed in close proximity to hands drying were 4.5-fold higher for the jet air dryer compared with the warm air dryer, and 27-fold higher compared with use of paper towels. Airborne counts were also significantly different during use of towel drying vs warm air dryer. A similar pattern was seen in mean bacterial counts recovered from air collected 1metre away from hand drying - jet air dryer (89.5cfu), warm air dryer (18.7cfu), and paper towels. Moreover, the 20-26% of the lactobacilli test organism remained airborne for at least 15 minutes following the warm air dryer and jet dryer testing.

For the bacterial settle plates on the floor, the highest counts were found immediately under the warm air dryer, compared with the jet air dryer and the paper towel drying. Counts on settle plates 1metre away from the warm air dryer were also higher than those for the jet air dryer and the paper towels. There was a significant difference between the counts on settle plates for the paper towels when compared to the warm air dryer and jet air dryer. All settle plates for the control experiments were negative.

The test that they found most interesting, and the one that has most application to environmental cleaning and disinfection, was the visual test with black paint on the hands of the testers. For the jet dryer, paint spots were found up to 140cm laterally along each the wall on each side of the dryer unit as well as below it, 30cm above it, and 85 cm out from the wall along the floor. As air is emitted from the jet air dryer at speeds of up to 400mph, it is not surprising that bacteria were found on walls and other surfaces a good distance away from the device. For the warm air dryer, the maximum distance traveled by paint spots was 30-40cm on each side, 130cm downwards, and 40cm out from the wall on the floor. For the hand towel drying process, a few paint spots were seen on the towel dispenser and on the wall below it, and some on the floor presumably due to dripping while rubbing hands.

As far as the Tyvek suits are concerned, no paint spots could be found on the suits worn while drying with paper towels, but for both the jet air and warm air dryers, spots were found primarily in the upper body area, with the numbers of spots from the jet air dryer being significantly higher. Overall, contamination as represented by paint spots was significantly higher for the jet air dryer compared with the warm air dryer. The number of paint spots detectable on the bystander was generally low, but spots were found nonetheless, for both air dryers.

The study authors recognize its limitations, most notably the high innocula on the gloved hands, and relatively long dry times. If hands are actually less contaminated, and/or held for a shorter period of time under the forced air dryers, presumably contamination of surfaces and people would be reduced.

For those charged with the cleaning of public washrooms where forced air dryers are in use, it should therefore be noted that any surface within a metre or so of the drying device could be contaminated with gastrointestinal microbes. It would be appropriate to use a disinfectant and special care when cleaning these areas, particularly if they are likely to be touched AFTER hand washing, such as door handles.

The reference for the Wilcox article is *J Hosp Infect.* 2014 Dec;88(4):199-206.

## Your Own Unique Cloud

The readers of this newsletter will be familiar with the pervasiveness of bacteria as an essential part of humanity, our bodies consisting of more bacterial cells than anything else. A paper published by Prof. James Meadow and colleagues (*PeerJ. 2015 Sep 22;3:e1258*) gives evidence that we are also emitting bacteria in what the authors describe as our own microbial "cloud", at a rate of 1 million biological particles per hour. This has been somewhat described in previous literature, but further to this, they were able to determine that the composition of that cloud is sufficiently differentiated as to allow the identification of individual occupants of a room.

Dr. Meadow sat volunteers in a special scrubbed and disinfected room, ventilated with filtered air, and containing only a plastic swivel chair and sterile laptop computer. Each volunteer (six men and four women) would spend 4 hours alone in the room, which was carefully disinfected between each test. The authors collected bacteria both from air leaving the chamber (which it did



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# Diversity of Bacterial Communities of Fitness Centre Surfaces

OLIVIA LATTIMORE, VIROX TECHNOLOGIES INC.

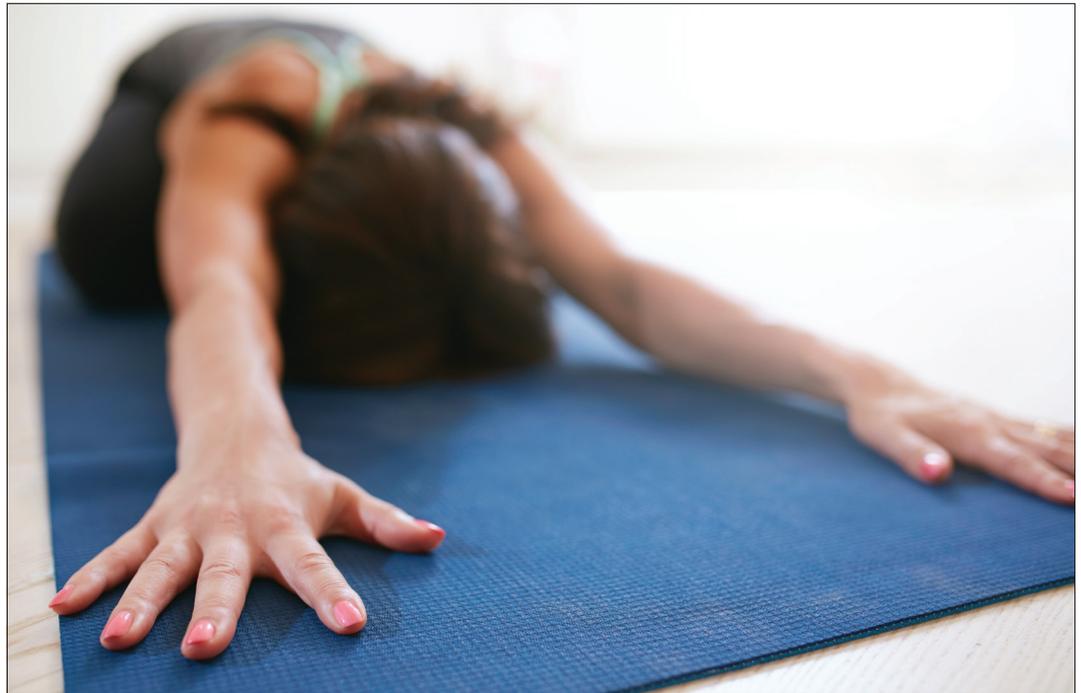
Compared to other indoor environments, it is interesting to note that fitness centres offer a unique setting to explore microbial diversity. This can be attributed to the physical activities with high frequency of surface touch by individuals with different personal hygienic practices. Such factors are likely to have strong influences on the types of bacteria observed on fitness centre surfaces. However, there is a lack of information on the microbial ecology of fitness centres in terms of the potential danger to the environment and public health.

In a recent study (*Int J Environ Res Public Health*. 2014 Dec 3;11(12):12544-61), the authors explored the overall bacterial ecology of selected fitness centres in a metropolitan area utilizing culture-independent pyrosequencing of the 16S rRNA genes. Their goal was

to assess and comprehensively understand the microbial diversity associated with fitness centre surfaces; and to determine if different surfaces of fitness centres (e.g., exercise equipment, floor mats, handrails, etc.) serve as potential reservoirs for different bacterial communities.

Most of the bacteria found in this study belong to environments such as soil, dust, air and water and human flora. The prevalence of human flora and environmental bacteria on the swab samples is not surprising as most gym equipment surfaces frequently come into contact with human skin. In addition, many other human-associated bacteria, including several lineages associated with the gut, mouth, and urine, (e.g., *Klebsiella pneumoniae*, *Enterobacter faecalis*, *Staphylococcus saprophyticus*, *Staphylococcus aureus*, *Staphylococcus epidermidis*, etc.) were observed on the surfaces of toilet handles, which is also not surprising.

The presence for food-borne pathogenic bacteria *Salmonella enterica*, associated with cattle and poultry, had been observed on stair rails. The probable reasons of the presence of *Salmonella enterica* in this study may have been attributed to gym users who were either exposed to or came in contact with livestock or who work in a veterinary clinic, or having prior exposures to the infection source. *Klebsiella pneumoniae* was also identified in their study, which may also be a public health concern. In addition, the air-borne bacterium *Aerococcus viridans*, was identified in high abundance on leg press equipment.



Several potentially pathogenic bacteria that were identified on nautilus machines, stationary bikes, dumb bells, leg press, and treadmills, cannot survive in high relative humidity (RH) which is common in fitness facilities. The authors of the study speculate a probable reason of the presence of these RH sensitive bacteria may be due to the transport from a different place to fitness centres by several routes of entry, and may reflect both climatic and personal hygiene influences.

Although the bacterial communities that were identified in this study can be transferred by surface touch, it is difficult to estimate the risk of acquiring the disease through this route. The study's authors found no reports of any associated diseases, but note that attribution of disease transmission to exercise equipment is rare, unless associated with a large epidemic outbreak. Nevertheless, the study provides a comprehensive assessment on the diversity in bacterial communities in the fitness centre along with the knowledge of the potential presence of pathogenic organisms. As revealed by this study, a high degree of microbial diversity originating from inanimate surfaces of fitness centres may be implicated to poor personnel hygiene of facility users as well as to the inadequate cleanliness of the facilities. To conclude, it is critical to underscore the need for proper cleaning, disinfection, and hygienic practices in fitness centers and gyms to minimize the spread of disease-causing organisms.

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The Cleaning and Disinfecting in Healthcare (CDHC) Working Group of the National Institute for Occupational Safety and Health (NIOSH) National Occupational Research Agenda (NORA) was established to develop a multidisciplinary review of the issues and identify future research and practice needs. The CDHC Working Group comprised a wide range of stakeholders in the public and private sectors. Their work was published in the American Journal of Infection Control (Am J Infect Control. 2015 May 1;43(5):424-34), from which this overview is derived. The document focuses on cleaning and disinfecting practices used on noncritical patient care items and noncritical environmental surfaces, which involve using cleaning products and low-level and intermediate-level disinfectants, and the occupational hazards associated with these processes.



### Gaps in knowledge, research, and practice

Knowledge gaps were identified and grouped in the 2 following broad areas:

- There is a need to better understand the effectiveness of cleaning and disinfecting products and procedures to reduce the incidence of infectious diseases and colonization in health care workers and patients.
- There is a need to better understand the adverse impact of cleaning and disinfecting products and procedures on the health of health care workers and patients, especially the impact on respiratory health.

### Effectiveness of cleaning and disinfecting products and procedures

Currently, there is a narrow focus on assessing the efficacy of products used for cleaning and disinfecting, with limited assessment of infection prevention effectiveness in actual health care settings. There is a need for further research to assess the contribution of surface contamination to the risk of infectious diseases among health care workers and patients. In particular, there is a need to:

- Evaluate the extent to which contact with surfaces that are contaminated with infectious agents

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## Your Own Unique Cloud

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via a hole in the floor), and from a ring of Petri dishes that surrounded the seated volunteer. These dishes caught debris heavy enough to settle. Both types of samples then had their DNA content analyzed to determine the type and strain of bacteria that they contained.

Samples varied from one person to another, both by sheer amount given off and by the relative proportions of what each cloud contained. *Staphylococcus epidermidis* and *Streptococcus oralis*, bacteria that occupy the skin and mouth respectively were common shedders.

Bacterial clouds from the occupants were statistically distinct, allowing the identification of some individual occupants. The study results confirm that an occupied space is microbially distinct from an unoccupied one, and demonstrate for the first time that individuals release their own personalized microbial cloud. In theory, there is then the possibility that a criminal could be identified by the microbial “footprint” left at the scene of a crime (would-be bad guys may soon need to pack disinfectant wipes). It has yet to be established if the contents of our bacterial clouds remain stable or change over time.

In a related study, “Microbiota of the indoor environment” (*Microbiome*. 2015 Oct 13;3(1):49), Dr. Meadow and his colleagues compiled a meta-analysis focused on studies of bacteria and archaea from the indoor environment. From the perspective of understanding mechanistic processes in the built environment, this meta-analysis confirms that broad factors, such as geography and building type, effect the structure of indoor microbes. These publications suggest that similar studies with common sampling techniques may be appropriate to explore the relative importance of subtle indoor environmental factors on the indoor microbiome.

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contribute to HAIs in patients and to occupationally acquired infections in health care workers.

- Evaluate the potential of environmental surfaces to transmit infections to health care workers and patients in health care settings other than hospitals (eg, nursing homes, ambulatory care settings, home health care).

### Product selection and use

There is a need for guidance that specifies which types of chemicals and products to use on different types of equipment and surface materials. Manufacturers' recommendations regarding which product to use on specific equipment often focus on brand names of proprietary products rather than classes of chemicals that can be effective and safe. There is a need for guidance on the effectiveness and safety of newer chemical disinfectants and alternative disinfecting technologies.

There is a need for research on the impact of biofilms (a group of microorganisms which adhere to each other on a surface) or surface soil to interfere with the efficacy of disinfectants applied to environmental surfaces. New research on this topic also needs to be translated for improved practice guidance.

### Adverse impact of cleaning and disinfecting products and practices

As infection prevention needs for disinfectant products increase, there is a concurrent need to integrate worker and patient health and safety into their development and application. Health and safety concerns should address both the protection of respiratory health and reduction of infection.

### Basic knowledge

Research is needed to better assess the hazards of environmental surface cleaning and disinfecting and the effectiveness of potential safer alternatives. Specifically, research is needed on the following:

- Toxicologic risk assessment
- Cleaning and disinfecting product risk assessment methods are needed to evaluate the potential for respiratory and dermatologic illness.
- Hazard assessment of products, application methods, and work practices
- As part of the effort to assess infection prevention effectiveness in actual health care settings, there is also the need for occupational health assessments of cleaning and disinfecting work practices in those worksites. Any evaluation of cleaning and disinfecting should include assessment of application methods and work practices and scrutiny of the products being used.
- Exposure assessment
- Chemical cleaning and disinfecting products are typically complex mixtures of ingredients having a variety of physical and chemical properties that require multiple monitoring measurement methods. Multiple measurement methods are resource and time intensive, therefore making it infeasible for occupational and environmental health practitioners to routinely quantify potential exposures. There is a need to research and develop practical exposure measurement methods that can be used in health care settings to monitor cleaning and disinfecting exposures related to respiratory and dermal health effects.

- Hazard assessment of residual cleaning and disinfecting products on environmental surfaces
- Methods are needed to assess the extent to which cleaning and disinfecting product ingredients can deposit and remain on environmental surfaces and whether they pose a health risk to those who contact the surfaces.
- Illness surveillance systems
- The cases of work-related asthma identified in sentinel and population-based surveillance conducted by health departments are frequently not recognized in health care worksite illness and injury recording systems. Research is needed to document the extent of under-reporting, determine the barriers to reporting, and to develop strategies to improve identification and reporting of work-related illness at the worksite.

### Floor cleaning and disinfection

Evidence is needed regarding whether floors should be disinfected at all and, if so, in which areas of the health care setting (eg, patients' rooms, waiting areas). Reducing chemical and particle exposures from floor cleaning could significantly improve indoor environmental exposures for workers, patients, and other building occupants because floors are cleaned frequently and have a high surface area, therefore requiring application of substantial amounts of cleaning and disinfecting products throughout health care facilities.

### Frequency of cleaning

Further evaluation is needed to determine the frequency with which cleaning and disinfecting should be performed with the objective to reduce chemical exposure while not reducing effectiveness of infection prevention. Practice guidance is needed regarding how to implement a model of health care improvement using the plan-do-study-act approach to assess the level of cleaning and disinfecting needed for different health care facility areas, environmental surfaces, and noncritical devices; practice guidance is also needed to review different cleaning methods and products, evaluate their efficacy, and evaluate the health and safety outcomes.

### Continuous improvement and evaluation

Practice guidance is needed to effectively engage all levels of staff in a health care organization (eg, workers, supervisors, administration) in the selection and safe use of cleaning and disinfecting products, including regular training and evaluation of the training. Additionally, a variety of stakeholders from all types of health care organizations should be engaged to design, implement, and evaluate training for the selection and use of cleaning and disinfecting products. These stakeholders should include infection prevention, employee health, and occupational safety personnel, purchasing managers, group purchasing organizations, and environmental services workers and managers.

### Conclusions

There is a need for a more integrated approach to infection and occupational illness prevention. Professional organizations in infection prevention and occupational health are well positioned to take leadership in this effort by establishing joint committees and engaging with funders to set priorities and a time table to move the research and improved practice guidance forward.



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