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## Use of a Daily Disinfectant Cleaner Instead of a Daily Cleaner Reduced Hospital-Acquired Infection Rates

DR. MICHELLE ALFA, ST. BONIFACE RESEARCH CENTRE WINNIPEG, MANITOBA



There are a number of studies documenting that disinfection of the high-touch areas reduces the load of antibiotic-resistant organisms (AROs) in the health care environment. Others have reported that room decontamination using various new technologies (eg, ultraviolet [UV] light, vapors of hydrogen peroxide, peracetic acid) could also eliminate or reduce the presence of viable bacteria and spores in patient rooms. To our knowledge, our study is the first to show that routine daily use of a disinfectant cleaner (instead of a cleaner only) for all patient care high-touch sites in isolation and non-isolation rooms could result in additional benefit beyond what could be achieved when the same disinfectant cleaner was used only in isolation rooms.

Our study was undertaken in a 538-bed acute care tertiary hospital in Canada, starting in November 2012 and continuing for 52 weeks. A second acute care tertiary hospital in the same city was used

# Virox Update

## Virox launches new brand in Canada

Virox will be launching a new brand in Canada and new AHP formulations designed specifically to address the needs of markets outside of acute care, long term care and healthcare clinics.

PREempt Disinfectant Cleaners and Instrument Reprocessing solutions will be supporting markets such as instrument and device reprocessing, research labs, clean rooms, spas and salons, and mold remediation and will also include new formulations, new packaging, specific label language and industry specific efficacy claims for these markets.

The Virox team will continue to assist in providing education on infection prevention and control in acute care, long term care and clinics, but we look forward to increasing our presence in these other industries. There is a need for additional infection prevention education and support. As we did in traditional Healthcare industries, we want to help dispel the myths and clear through the smoke and mirrors surrounding disinfection product selection.

## 2015 Virox Patron Scholarship Winners Announced!

2015 marks the 12th year of the IPAC-Canada Scholarship program. We recognize the importance of infection prevention, and Virox and Sealed Air Diversey Care have come together to realize the synergies we can support in the battle of infection prevention. We would like to congratulate the 2015 IPAC-Canada Scholarship winners. Thirteen Infection Prevention & Control Practitioners from across Canada were chosen by the IPAC-Canada Board of Directors. This year's winners are: Jeffrey Eruvvetaghware, Stefania Cloutier, Lin Tang, Melissa Zambrano, Greg Bruce, Cheryl Collins, Kelly Hebert, Zahir Hirji, Lynn Mercer, Lorna Morgan, Wendy Runge, Jane Van Toen and Marion Yetman.



2014 Virox Scholarship Winners



## Green Team Update

Virox continues to be committed to innovating, developing and improving peroxide based, environmentally sustainable cleaners and disinfectants so that our affiliates can reduce their environmental impact when consuming such necessary products. The focus on health and environmental sustainability is a legacy everyone at Virox has embraced. Our Adopt-A-Program for Coventry Road continues to be a participant favorite.

We are also looking at ways to continue to improve upon the "green" status of our building. In the coming months we will be expanding our production / warehousing area, and the team in charge of the construction project ensured that the renovation specifications will meet our Silver LEED certification. We will even be able to expand upon our LEED points with the addition of solar panels to the new roof!

## Join in the Conversation!

Virox strives to help answer some of the questions and concerns about the use of disinfectants through the Talk Clean To Me blog which is non-product specific and focuses on topics around the use of disinfectants for infection prevention and biosecurity and the Insights Blog which aims to translate general education in the proper use of AHP. If you're not already a follower we hope you sign up!



# Outbreak of Norovirus Illness in a College Summer Camp: Impact of Cleaning on Occurrence of Norovirus on Fomites

PROF. CHARLES GERBA, UNIVERSITY OF ARIZONA

Norovirus is the leading cause of nonbacterial gastroenteritis worldwide and an excellent example of the importance of cleanliness happened almost exactly 10 years ago. On July 20, 2005, the local health department communicable disease program coordinator received a call from the infection control practitioner at Flagstaff Medical Center, Arizona, about three emergency department patients with similar symptoms: vomiting, diarrhea, and dehydration. All three patients (two participants and a staff member) were also members of Camp A (wrestling camp) from an area summer camp. Further investigation by the communicable disease staff identified 40 other Camp A members with similar symptoms. On July 21, 2005, an outbreak investigation was initiated.

Norovirus was formerly known as the Norwalk-like virus or small round structured virus, and is a member of the *Norovirus* genus in the Caliciviridae family of viruses. They are non-enveloped, positive-sense, icosahedral, single-stranded RNA viruses. Human norovirus is genetically diverse and belongs to one of three genogroups (GI, II, or IV), each of which is further divided into more than 25 genetic clusters. Outbreaks of norovirus gastroenteritis occur most frequently in various settings such as schools, daycare centers, nursing homes, hospitals, and cruise ships

Noroviruses are transmitted via the fecal-oral route. The average incubation period for norovirus-induced gastroenteritis is 12–48 hours with symptoms that usually resolve in 12–72 hours. Illness is characterized by acute onset projectile vomiting, watery non-bloody diarrhea with abdominal cramps, low grade fever, headache, and malaise. The very low infectious dose of norovirus may be one reason why it is the most common cause of diarrheal illness; norovirus may also remain viable on surfaces for more than a month. Our study investigated a summer camp-associated outbreak of norovirus illness to identify the source of infection and the causes of disease spread and to recommend strategies for prevention of future outbreaks in such settings.

A retrospective cohort study of all persons attending the summer camp from July 18, 2005, to July 31, 2005, inclusive, was conducted. The residence halls that housed norovirus cases from Camp A, a multipurpose athletic facility, and the student union were cleaned on July 30. The cleaning crew did not have specific cleaning instructions and used their common cleaning solutions composed of soap and water. After the cleaning, 51 fomites in residence halls and Camp A facilities were swabbed for norovirus again on August 1. The surfaces included toilet handles and seats, bathroom sink faucet handles, bathroom doorknobs, walls, mattresses, urinal handles, chairs, drinking fountains, and floors.

After review of the results, the environmental health program manager (EHPM) for the local health department instructed facilities management personnel to again clean and disinfect contaminated fomites. The EHPM advised the summer camp facilities staff to clean and disinfect surfaces in bathrooms, bedrooms, and common areas using a liquid virucidal disinfectant agent. The surfaces were cleaned with detergent (soap and water) prior to disinfection. The final fomite sample collection (10 samples) took place on August 15 after cleaning of fomites as per instructions of the EHPM. Only the surfaces that tested positive for norovirus from the fomite sampling on August 1 were resampled.

Of the fomites samples collected on July 21 and 22, norovirus was detected on only 17% of the samples. More extensive sampling took place on August 1 after cleaning with rags, soap, and water, of which 11 (22%) were positive for norovirus. Forty-five percent (45%) of the fomite samples of August 1 from toilet seats and toilet handles in the wing of the residence hall that housed ill individuals from Camp A were positive for norovirus. Surfaces that were supposed to be cleaned and disinfected still tested positive for norovirus. The second cleaning and disinfection occurred on August 14 before resampling of the same fomite locations on which norovirus was detected on August 15. After this round of cleaning and disinfecting, the percentage of dorm rooms testing positive was reduced to less than 35%.

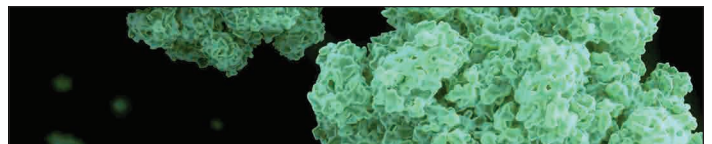
This outbreak of noroviruses in a summer camp was associated with attack rates varying from 3% to 30% that may have resulted from poor disinfection procedures or cross contamination from the use of the same cleaning/disinfecting tools (e.g., clothes, rags, mops, etc.) during the outbreak.

In our study, after the second round, we found the following steps were effective to reduce the number of surfaces on which norovirus was detected.

1. All surfaces that had previously tested positive for norovirus should be washed with a detergent solution prior to disinfection (to improve the effectiveness of the disinfectant).
2. A solution of 5,000 mg/L free chlorine or a liquid disinfectant effective against non-enveloped viruses were used.
3. The chlorine solution should be kept at 5,000 mg/L by frequently making fresh solutions. A study by Barker and co-authors (2004) found that 28% of surfaces cleaned and sanitized using 5,000 mg/L free chlorine were still positive for norovirus.

The Centers of Disease Control and Prevention have previously reported that norovirus may be spread via fomites. The virus may also be aerosolized during vomiting and when diarrhea stools are flushed in a toilet. This virus has a very low infective dose and may remain viable on surfaces for more than one month. This virus is also resistant to free chlorine concentrations of 1,000 parts per million in laboratory studies using feces.

This outbreak of norovirus illness in a summer camp underscores the importance of understanding the spread of the virus via fomites, especially in areas where people tend to congregate. The closed environment of summer camp, combined with inadequate cleaning procedures, spurred the spread of this outbreak. When outbreaks occur in institutional settings, such as a college summer camp, it is important to reinforce the advice about proper hygiene in order to curtail the spread of the outbreak to other settings such as households.



# Transmission and Persistence of Livestock-Associated Methicillin-Resistant *Staphylococcus Aureus* Among Veterinarians and Their Household Members

NICOLE KENNY, VIROX TECHNOLOGIES INC



In recent years MRSA has increasingly been isolated from livestock. In the Netherlands, livestock-associated MRSA (LA-MRSA) has become quite prominent, reportedly making up approximately 40% of all MRSA strains isolated from humans for molecular typing as part of the Dutch national MRSA surveillance. In a recent study (*Applied and Environmental Microbiology*, 2015 Jan;81(1)), Dr. Thijs Bosch and colleagues at the National Institute for Public Health and the Environment, in The Netherlands, investigated the potential of genetic mapping to identify possible transmission of LA-MRSA between humans. It's a fascinating paper.

Transmission of LA-MRSA has been described in multiple reports, suggesting that human-to-human transmission of LA-MRSA is less likely to occur than that of other MRSA lineages. However, the study authors made use of a new high-resolution typing technique for LA-MRSA - whole genome mapping. Using this method, epidemiologically unrelated LA-MRSA isolates that were previously indistinguishable can now be differentiated. Furthermore, the method is able to identify transmission events between livestock veterinarians and their household, showing its potential as a typing tool for LA-MRSA.

Comparison of whole genome maps (WGMs) of LA-MRSA revealed that transmission had likely occurred within 14 of the 16 veterinarian households (similarities per household ranged from 98.5% to 100%). In these 14 households, only a single LA-MRSA strain per household appeared to be involved in transmission, and the WGMs of these LA-MRSA strains differed considerably between households. In addition, in one of the two remaining households, there was no likely transmission between the veterinarian and his household member; the similar-

ity between the maps was 92.7%, and, following the definition, these isolates are therefore regarded as different strains.

Besides transmission, persistent carriage or reacquisition of the same LA-MRSA strain among household members was found in eight different households. Indistinguishable WGMs were found for LA-MRSA isolates obtained from household members at different sampling moments. In six of the households, this occurred in a single contact of each household, and in the two remaining households, persistence of LA-MRSA was observed in two household members. The period of apparent persistence of LA-MRSA in household members in this study ranged from 4 to 8 months.

In this study, the authors showed that there was frequent transmission of LA-MRSA between veterinarians and their household members. In addition, their data showed that both veterinarians and their household members carried LA-MRSA strains for prolonged periods of time, with carriage lasting up to 14 months. This provides arguments that LA-MRSA is a successful human colonizer.

The results of this study show that LA-MRSA is genetically diverse and that this genetic variation can be used to characterize LA-MRSA strains. Also, the study authors showed that carriage of LA-MRSA in veterinarians and their household members can be persistent, lasting up to 14 months. Furthermore, this study demonstrates that transmission of LA-MRSA between veterinarians and their household members occurs, posing a potential risk for spread in the community of this highly resistant pathogen.

# Effect of Cleaning and Disinfection of Toys on Infectious Diseases and Microorganisms in Daycare Nurseries

DR. TOBIAS IBFELT, COPENHAGEN UNIVERSITY HOSPITAL (RIGSHOSPITALET), DENMARK

The rising number of children in daycare nurseries increases opportunities for the transmission of infectious diseases. Pathogens may be transmitted directly from child to child via sneezing, coughing and touching, or indirectly via the environment. Toys are among the fomites with the highest pathogen load, but their role in disease transmission is unknown.



Children, especially children aged three years and under, have a high frequency of infectious disease episodes. Children in daycare nurseries have more infections than children cared for elsewhere, mainly because of direct transmission between children, contact or respiratory droplet transmission, and inadequate hand hygiene. Although indirect transmission of infection via the nursery environment has not been studied extensively, it is likely to play a role. Previous research on bacteria in the nursery environment has shown positive cultures in 10-60% of samples, depending on location, but almost all bacteria isolated were of low pathogenicity.

The aim of our recent study was to determine whether regular systematic cleaning and disinfection of toys would decrease the prevalence of bacteria and respiratory viruses in the nursery environment, and reduce sickness absence in Danish nurseries.

Quantitative polymerase chain reaction (PCR) to determine the diversity of bacteria in the nurseries has shown that the most common bacteria in the nursery environment are coagulase-negative staphylo-

cocci (CoNS), *Bacillus* spp. and *Pseudomonas*-like bacteria, all of which rarely cause disease in healthy children. Less is known about viruses in the nursery environment in spite of the frequency of viral respiratory infections caused by rhinovirus, bocavirus, adenovirus and respiratory syncytial virus (RSV). This study found that toys were not washed or disinfected systematically. The Danish Health Board recommends monthly cleaning, but it is not known whether regular cleaning of toys in nurseries can affect the pathogen load and reduce infection.

## IPAC Canada 2015 Conference



The Professional & Technical Services (PTS) team is a Virox consulting resource for Infection Control Professionals, Public Health Inspectors and Nurses, Environmental Services Personnel and our Distributor Sales Reps. We are huge fans of all manner of infection prevention and control education, and one of our favorite events each year is the IPAC Canada conference.

In 2015 the conference will be held in the spectacularly beautiful west coast setting of Victoria, British Columbia.

Conference planners have arranged for a keynote lecture by the amazing Michael Grinder, who will speak on "The Power of Influence" and also give a half-day workshop on presentation skills. If you've never experienced a Michael Grinder presentation, you won't want to miss this. Also Prof. Shaheen Mehtar will come from Cape Town, South Africa to give three presentations, including a plenary session on infection prevention and control resources in Africa in the age of Ebola.

Dr. Gary Garber, Dr. Bonnie Henry, and a couple of extremely funny physicians called "The Wisequacks" (Doctors Without Boredom!) will also give important sessions.

### Plan to come .....

For a copy of the Preliminary Program, refer to the IPAC Canada web site – [www.ipac-canada.org](http://www.ipac-canada.org)





# Diversity of Bacterial Communities of Fitness Center Surfaces in a U.S. Metropolitan Area

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As we aspire to stay fit and healthy, many of us regularly visit fitness centers or “gyms”. Data from the International Health, Racquet & Sportsclub Association indicates a surge in the number of people visiting fitness centers in recent years. However, there is a lack of knowledge about the diversity of microbial communities at fitness centers. The overall microbial load and diversity of the environment are often implicated as a critical indicator of hygiene and cleanliness, and several previous studies focusing on environmental hygiene and sanitation (e.g., in food production or health care settings) had found a direct relationship between microbial load in the surrounding environment and the risk of pathogen transmission. Therefore, an understanding of overall bacterial population and diversity in gymnasiums and athletic facilities would obviously shed light on the risk of the pathogen propagation from these facilities.

In our recent study (December 2014, International Journal of Environmental Research and Public Health), we explored the overall bacterial ecology of selected fitness centers in Memphis, Tennessee, utilizing culture-independent pyrosequencing of the 16S rRNA genes. Our goal was to assess and comprehensively understand the microbial diversity associated with fitness center surfaces; and to determine if different surfaces of fitness centers (e.g., exercise instruments, floor mats, handrails, etc.) serve as potential reservoirs for different bacterial communities.

Most of the studies reported to date from gymnasiums, playgrounds, athletic facilities, or venues where individuals come in contact with others are focused on the transmission of staphylococci, in particular on methicillin-resistant *Staphylococcus aureus* (MRSA). Also important to note is that most of these studies relied on culture-based techniques. A large number of microorganisms are difficult to culture, thus, the overall microbial diversity associated with fitness center environments remains largely unknown. By enabling identification of both “cultivable” and “non-cultivable” microbial populations, the culture-independent pyrosequencing method provides a vivid realization of the relationship among humans, microbes, and the environment.

Pathogenic microorganisms can survive on inanimate surfaces for prolonged periods of time as reported in several previous studies. These pathogens can readily be transferred from surfaces to the human body through the touch of hands or other body parts. Carpets, yoga mats, clothing, equipment handles, etc. may serve as excellent living places for bacteria. Fitness centers offer a unique setting to explore microbial diversity, a function of 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 center surfaces.

Surface swab samples were collected from four membership-based fitness centers around the Memphis metropolitan area in Tennessee. Samples were

collected by trained volunteers from the skin-contact surfaces on exercise equipment (nautilus machine, treadmill, stationary bike, power strider, elliptical machine, and leg press), dumbbell, toilet handles, and handrails on stairs of the fitness centers during October 2013. The samples were obtained from certain places that had not been sanitized before sample collection. While swabbing on equipment surfaces with different shapes, appropriate care was taken to cover approximately the same surface area. After swabbing, the swab sticks were immediately placed back into the tube containing sterile diluent solution and the samples were transported in a refrigerated container to the laboratory within four hours for analysis.

Taxonomical composition revealed that the bacterial families with the highest relative abundances across all the samples were Bacillaceae, Staphylococcaceae, Enterobacteriaceae, Aerococcaceae, and Microbacteriaceae. In general, the most common bacterial genus observed in this study was found to be *Staphylococcus*. We identified the presence of several *Staphylococcus* spp. in all surface swab samples. Among them, *S. saprophyticus* is the most predominant bacterial species, followed by *S. epidermidis*, and *S. aureus*.

Pathogenic *S. saprophyticus*, commonly present in the human urogenital and gastrointestinal tract, in food products such as cheese, meat, and vegetables, and in the environment, has been associated with urinary tract infections. The transmission of *S. aureus* has been reported from the public places such as gymnasiums, playgrounds, beaches, schools, daycare centers, and athletic facilities. Moreover, MRSA was also identified in indoor environments such as kitchen and bathroom surfaces. The presence of *S. aureus* in this study is an obvious public health concern. Future study is needed to evaluate the prevalence of antibiotic resistance of *S. aureus* isolates obtained in our study.

Some pathogenic or potentially pathogenic bacteria such as *Salmonella enterica*, *Klebsiella pneumoniae*, *Enterococcus faecalis*, *Bacillus cereus*, *Pantoea agglomerans* were detected in swab samples. The presence of food-borne pathogenic bacteria *Salmonella enterica*, associated with cattle and poultry, have been observed on stair rails, and in the composite samples from weeks 1 and 2. The probable reasons of the presence of *Salmonella enterica* in our study may be attributed to gym users who are either exposed to or come in contact with livestock or work in a veterinary clinic or having prior exposures to the infection source. Another pathogenic bacteria, *Klebsiella pneumoniae*, associated with urinary tract infections and bacteremic liver abscess, have been identified in our study. The presence of these bacteria may also be a public health concern.

Although the bacteria communities identified in this study can be transferred by surface touch, it is difficult to estimate the risk of acquiring the disease through surface touch as there are no reports of any associated diseases. Such reporting is rare, unless associated with a large epidemic outbreak.

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In our study, twelve nurseries from the municipality of Copenhagen were recruited in Autumn 2012. The intervention took place from January to March 2013. A commercial cleaning company collected toys and linen every two weeks from nurseries in the intervention group for cleaning in their industrial cleaning facility. Toys that were not suitable for washing machines were either immersed in a disinfectant or cleaned manually with a microfibre cloth using the same disinfectant. The toys were subsequently rinsed with water, air dried and returned to the nurseries. Cleaning of toys was staggered to ensure that the children had some toys to play with while others were being cleaned.

Absence data and disease patterns were recorded for each child on a daily basis from December 2012 to March 2013. The number of absent children and the reason for absence (as reported by the parents) was recorded by the staff within the following categories: respiratory infections, gastrointestinal infections, other illnesses, or day off.

Very few potentially pathogenic bacteria were found in the samples. Out of 240 samples, there were 15 potential pathogens (6%) in the pre-intervention samples (six in the control group and nine in the intervention group) and 11 (5%) potential pathogens in the post-intervention samples (eight in the control group and three in the intervention group). These were bacteria of low pathogenicity such as *Enterobacter* spp., *E. coli* and nonhaemolytic streptococci. The highest prevalence was found on pillows and sofas, followed by changing mats and various toys.

A mean of three different respiratory viruses was found at each sampling point. The most prevalent virus was coronavirus (97% positive samples), followed by bocavirus (96%), adenovirus (73%) and rhinovirus (46%). The intervention reduced the presence of adenovirus, rhinovirus and RSV approximately two- to five-fold compared with the control group. On the other hand, metapneumovirus was found significantly less often in the control group than in the intervention group. The intervention had no effect on the detection of other viruses. The fomites with the highest presence of respiratory virus were pillows and sofas, followed by toys and playroom tables.

The proportion of healthy children in the control group decreased from 84% to 76% in the post-intervention period, whereas it was unchanged in the intervention group. However, the difference between the groups was not significant. No significant differences in any of the disease categories were found between the groups.

The main endpoint in this study was the number of days of absence due to sickness. This study did not find a decrease in total sickness absence or in sickness absence due to respiratory infection.

To our knowledge, this was the first study to measure the isolated effect of cleaning toys on infectious diseases in nurseries. This study showed that respiratory virus DNA and RNA are widespread in the nursery environment. Fortnightly cleaning and disinfection of toys reduced the frequency of detection of some respiratory viruses, but not the bacterial load, and did not reduce the number of days of absence due to respiratory infection or sickness as a whole. As this is the first study of its kind, further studies are needed to confirm or refute the findings. Studies over a longer period of time may be necessary to control for seasonal fluctuation in infection rate and virus types.

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Overall, our study represents the microbiome of selected fitness centers from metropolitan Memphis area (representing approximately 1.2 million populations), which can be deemed as a representative model of a large metropolitan setting. As revealed by our study, a high degree of microbial diversity originating from inanimate surfaces of fitness centers may be alarmingly 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 of proper hygienic practices in fitness centers and gyms for minimizing the spread of disease-causing organisms.

## How Rapidly Does Environmental ATP Deteriorate?



Ensuring cleaning compliance of housekeeping staff is critical to ensure adequate application of surface disinfectants. Adenosine triphosphate (ATP) testing has been recommended as a way to monitor cleaning compliance; however, little is known about the stability of ATP on environmental surfaces.

In a recent article in the *Journal of Hospital Infection* (2015, 59-65), Dr. Michelle Alfa and colleagues analyzed the stability of ATP from various sources to determine if it is stable for sufficient time to be an effective means of assessing environmental cleaning and disinfection.

The authors conclude that ATP residuals from organic material and micro-organisms (dead or alive) are stable when dried onto surfaces. In the absence of cleaning and disinfection, the relative light unit signal will not deteriorate rapidly, making ATP a good marker to monitor cleaning. They also note that in the absence of wiping, disinfecting agents such as Accel Intervention and 5000ppm bleach inactivated ATP, whereas agents such as quaternary ammonium did not. This has implications because cleaning and disinfection may have been performed properly, and the surface may be free of viable organisms but may still show residual ATP, indicating a “non-clean” surface.

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as a comparator hospital that used a non-disinfectant cleaner throughout all patient care areas and only used a disinfectant cleaner for *C. difficile* isolation rooms. The intervention hospital has an older patient population with longer hospital stays compared with the non-intervention hospital.

This was a prospective study. At the intervention site, HAI rates for VRE, MRSA, and *C. difficile* on all wards with admitted patients were tabulated each week. The definition of hospital-acquired VRE, MRSA, and *C. difficile* prior to and during the intervention period followed the Manitoba health guidelines. The UV-visible marker system has been in use at the intervention site for the last 7 years. This monitoring process continued during the intervention period to confirm if surfaces had been wiped with the disinfectant cleaner. However, the frequency of monitoring was increased to ensure the HAI rates each week could be stratified. Two patient care rooms on each of the 15 study wards were assessed each week (ie, 30 rooms/week), whereas historically, approximately 15 patient care rooms were monitored throughout the hospital per week. Monitoring was done by marking approximately 15 of 35 potential high-touch sites in the bedroom and bathroom. The rooms on each ward were selected randomly each week, and the 15 high touch sites selected varied from week to week. As per the hospital's existing monitoring benchmark, cleaning was considered acceptable provided that a minimum of 80% of the UV-visible marks were partially or completely removed. At the control hospital site (non-intervention site), the hospital-wide HAI data were also tabulated prospectively, but this site did not use a cleaning monitoring protocol.

The housekeeping staff at the intervention site were trained in the use of the containerized, disposable, disinfectant cleaner wipe (DCW) system prior to the commencement of the study. For each patient zone, 2 wipes were used for the bed, bedside table, chair, and leading edge of the privacy curtain. The common zone used 1 wipe for the room door knob, computer keyboard and mouse, and other items in the common area; 3 wipes were used in the bathroom (includes the door knob). If a commode was present, a dedicated wipe was used whether in the patient or bathroom zone. This disposable wipe cleaning protocol was applied to isolation and non-isolation rooms and discharge rooms. All discharges also included more wipes for the mattress, bed frame, and inside of drawers and the removal of any patient supplies and the replacement of privacy curtains in isolation discharge rooms. The number of wipes used for patient-shared items depended on the size of the item.

Housekeeping personnel at the intervention hospital received same day feedback on cleaning compliance (CC) based on UV-visible marker monitoring and were asked to re-clean sites that were not adequately cleaned (this feedback process had been in place for >7 years prior to the start of the DCW study). The control hospital continued to use a cleaner with cotton rags (CCR) system and did not use a cleaning monitoring program.

Comparing the intervention period to the previous years (matched for the same months), the overall reduction of VRE rates was significant regardless of the CC rate and resulted in an avoidance of 115 cases of VRE. This likely reflects the

significant role of environmental contamination in transmission of VRE within health care settings during high incidence periods and the value of using a disinfectant cleaner (instead of a cleaner only) to reduce the overall microbial level (even if the CC does not reach at least 80% every week). For *C. difficile*, there were 2 cases avoided; for MRSA, there were 12 cases avoided regardless of CC levels during the intervention period. The number of cases avoided was increased when CC was >80%. It will be of interest to assess the incidence rates over upcoming years to determine how low the HAI rates can go when environmental cleaning and disinfection continue to be at an optimal level.

This improvement in HAI rates when DCWs were used hospital-wide supports the role of environmental reservoirs in HAI transmission before the patient is known to have MRSA, VRE, or *C. difficile* (ie, prior to being placed on isolation precautions).

A limitation of this study was that no environmental cultures were performed. This was because in our previous study, DCWs were compared with CCR and the former was shown to significantly reduce the load of *C. difficile* spores in the toilets of patients on isolation precautions for this infection. In this previous study, only if CC for the DCWs and the CCR was ≥80% was the data included in the analysis (ie, same approach as used in the current study). As such, it was thought to be unnecessary to do cultures in the present study. Another limitation of this study is that a containerized wipe system was used in place of the cotton rags used historically, making it difficult to dissect out the role of a better application by wipes versus better microbial killing by the disinfectant chemistry in the reduction of ARO HAIs. However, our previous study, where the same application system (cotton rags) was used for both products, supports the improved microbial killing of the disinfectant cleaner compared with the cleaner only. A third limitation of this study was that it is not possible to control for all potential confounders. There were no changes to hand hygiene, antibiotic stewardship and prescribing practices, fecal containment, or cleaning protocols over the course of the study period for the intervention and non-intervention hospitals. Furthermore, our data for the non-intervention hospital show that the HAI rates during the study period do not change compared with the previous 3-year rates. Although we could not control for all confounders, there were no identifiable major region-wide changes that could have accounted for the HAI rate changes documented in the intervention hospital over the study period.

In conclusion, our study found that when DCWs were applied on a daily basis to patient care high-touch environmental surfaces with a minimum of 80% compliance, the rates of HAIs caused by *C. difficile*, MRSA, and VRE were significantly reduced. This study indicated that to achieve HAI reduction there were 3 key components. These included the following: a clearly defined housekeeping protocol with education (including an assessment of the adequacy of housekeeper performance), routine housekeeping CC monitoring with staff feedback and a minimum of 80% compliance expected, and use of an effective disinfectant cleaner. It is clear from our data that HAIs caused by AROs were not completely eliminated by the use of a disinfectant cleaner instead of a cleaner but the combination of the 3 key components did ensure that the ARO HAI rates are near to or below the Canadian National Infection Surveillance Program benchmarks.



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