Effects of Disinfectant Wipes on Sensitive Healthcare Surfaces

D. Del Re[1], C. Ikeno[1], K. Smid[2] and D. Swift[1]
[1]Biolennia Laboratories, Toronto, ON; [2]BDL, Stevensville, ON

ABSTRACT

Background/Objectives: Studies have shown that environmental surfaces serve as a route for transmission of pathogens; however, proper disinfection protocols are lacking to address sensitive surfaces and equipment that can be permanently damaged by common disinfectants in use in healthcare environments. In this study, we tested commercially available disinfectant wipes on various surfaces, including point-of-care touch screens, bedding material and keyboards to examine antimicrobial efficacy as well as any damaging effects. **Methods:** Samples were taken from point-of-care touch screens, keyboards and computer mice at 4 Long Term Care facilities across the Greater Toronto Area. Samples were plated on tryptone soy and Sabouraud dextrose agars to isolate bacteria and fungi, respectively. Surfaces were sampled before and after use of a disinfectant wipe.
Pieces of mattress coverlet material and touch screens were wiped approximately every hour for two months with various disinfectant wipes and examined for any changes in appearance or damage. Swabs were taken before and after the first wipe and at the end of the study to determine antimicrobial efficacy. **Results:** All of the surfaces sampled at the LTC facilities showed marked contamination with bacterial and fungal organisms prior to disinfection. After wiping with Product T, the samples were cleared of contamination. Touch screens and mattress coverlet material showed no damaging effects after repeated wiping with Products S and T; however, discoloration and damage were observed with Products C, A/V, and Cl. Some surfaces were found to be contaminated with select organisms, including *S. aureus and E. coli*. Variable results were observed for antimicrobial effectiveness with some wipes showing complete removal of organisms and others showing some to no reduction in colonies. **Conclusions:** This study further illustrates that common environmental surfaces can be contaminated with potentially harmful bacterial and fungal pathogens, thereby stressing the importance of disinfection of these surfaces for reducing disease transmission. The sensitive nature of some clinical surfaces presents a challenge to disinfection due to damaging effects of some products already in use; however, we have demonstrated that there are products available that can effectively disinfect sensitive surfaces without causing harmful and costly damage.

INTRODUCTION

Healthcare-associated infections (HAIs) are a major cause of patient mortality. While the major source of these nosocomial pathogens is believed to be the patient's endogenous flora, it is estimated that 20-40% of HAIs are attributed to cross infection via healthcare personnel whose hands can become contaminated by touching environmental surfaces[1]. Numerous studies have shown that a variety of surfaces, including keyboards[2], privacy curtains[3], and bed rails[4], can become contaminated with bacteria and fungi, suggesting such high-touch environmental surfaces could act as reservoirs for infectious pathogens. Studies by Neely and Maley[5] and Neely and Orloff[6] tested the ability of bacterial and fungal pathogens to survive on common hospital fabrics and plastics, including privacy curtains, towels, and lab coats. Both studies demonstrated that organisms were able to survive for days to weeks on the various surfaces, providing evidence for the potential for hospital fabrics and surfaces to act as vectors for pathogen transmission in healthcare settings.

Advancements in technology have resulted in the increased use of point-of-care computer-based systems, including keyboards and/or touch screens, within patient rooms and throughout healthcare facilities. While studies have shown that keyboards can become readily contaminated with microorganisms[2,7], no studies have examined the contamination of touch screens. In this study, we sampled various surfaces, including keyboards, touch screens and computer mice at Long Term Care facilities to determine whether these high-touch surfaces pose the potential for acting as reservoirs for bacterial and fungal organisms.

Despite such evidence that a variety of healthcare surfaces are readily contaminated with bacteria and fungi, proper protocols are lacking to address the need for disinfection of such high-touch healthcare surfaces, especially with regards to sensitive electronic equipment. The sensitive nature of these electronic surfaces presents a challenge to disinfection due to the potential for costly damaging effects by some disinfectant products already in use in healthcare facilities. In this study, we tested commercially available disinfectant wipe products on mattress coverlet and point-of-care touch screens to examine any damaging effects these products may cause to these surfaces.

This represents the first study that has examined the effects of disinfectant wipe products on various surfaces, and that has demonstrated that touch screens have the potential to serve as reservoirs for microorganisms in the healthcare setting. We have shown that products are available that can effectively disinfect sensitive surfaces without causing harmful and costly damage.

OBJECTIVES

The main objective of this study was to test different disinfectant wipes on sensitive surfaces and examine any effects on the surface appearance and quality.

METHODS

Disinfectant Wipe Products Tested
The disinfectant wipes used in this study are outlined in Table 1 below.

Table 1: Disinfectant Wipe Products

Product	Active Ingredients
Product S	70.5% Ethanol, 0.2% Chlorhexidine gluconate
Product T	19.9% Ethanol, 0.1% Chlorhexidine gluconate
Product C*	0.28% diisobutylphenoxyethoxyethyl dimethyl benzyl ammonium chloride (Quat), 17.2% isopropanol
Product A/V	0.5% Hydrogen peroxide
Product Cl	0.55% Sodium hypochlorite

*Product C also contains 1-5% Ethylene glycol monobutyl ether (Butyl Cellosolve) as a non-active ingredient

Swabbing at Long Term Care Facilities
Samples were taken from point-of-care touch screens, keyboards, computer mice, and phones at 4 Long Term Care facilities across the Greater Toronto Area. Surfaces were swabbed twice using swabs dipped in phosphate buffered saline (PBS). The first sample was plated on tryptone soy agar (TSA) while the second was plated on Sabouraud dextrose agar (SDA) to isolate bacteria and fungi, respectively. Surfaces were sampled before and after use of Product T. Surfaces were wiped with a single wipe, going over the surface three times to ensure coverage. A contact time of three minutes was allowed to elapse before taking the second set of swab samples. TSA plates were incubated at 30-35°C for 24-48hr, while SDA plates were incubated at 20-25°C for 5-7 days. Images of the sample plates "Before" and "After" use of the disinfectant wipe were captured.

Testing Disinfectant Wipes on Touch Screen and Mattress Coverlet
A point-of-care touch screen was divided into four sections, while a mattress coverlet was cut into five 4-inch x 4-inch pieces and fixed onto a cardboard surface for testing of different disinfectant wipes. The surfaces were wiped 3-5 times daily for 50 days with the test disinfectant wipe and observed for any changes in colour and/or appearance.
Each screen and mattress section was swabbed before and after the initial wipe with a sterile swab dipped in PBS. The swab was plated in 12ml of tryptone soy broth (TSB) and vortexed to mix. For each TSA and SDA plate, 5ml of the sample solution was filtered through a 0.22um membrane filter and plated. TSA and SDA plates were incubated as above. The remaining 2ml of sample was incubated at 30-35°C for 24-48hr for use in specific organism testing (*Pseudomonas aeruginosa, Staphylococcus aureus, E. coli* and *Salmonella*). Following incubation, 100ul of the enriched samples were plated onto each of mPAC, mannitol salt agar (MSA), MacConkey agar (Mac) and xylose lysine deoxycholate (XLD) agar plates. The samples were spread over the surface of the plates with a sterile glass hockey stick and allowed to dry. Once dry, plates were inverted and incubated at 30-35°C for 24-72hr. Plates were then examined for presence or absence of the specific organisms. Swab samples were also taken at Day 25 and Day 50 to determine if antimicrobial activity was sustained throughout the course of the project.

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RESULTS

Swabbing at Long Term Care Facilities
All sampled surfaces, including touch screens, keyboards, computer mice and phones, showed varying levels of contamination with both bacteria and fungi. Surfaces that were used more often showed higher levels of contamination. Most of the touch screens, keyboards and phones that were sampled also showed evidence of *S. aureus*.

After using Product T, all surfaces showed an absence of contamination. Figures 1 and 2 show examples of the plates isolated from surfaces before and after wiping with Product T.

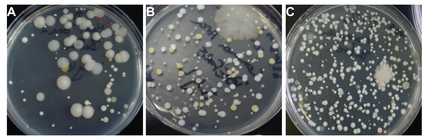

Figure 1: Samples of bacterial plates isolated from Long Term Care touch screens and a computer mouse. (A) Sample from a touch screen located in a hallway. (B) Sample from a touch screen located in a common area for residents. (C) Sample from a computer mouse. All samples taken after wiping with Product T showed no growth of colonies.

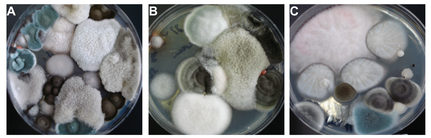

Figure 2: Samples of fungal plates isolated from Long Term Care touch screens and keyboards. (A) Sample from a computer keyboard. (B) Sample from a touch screen located on a mobile cart. (C) Sample from a computer keyboard. All samples taken after wiping with Product T showed no growth of colonies.

Effect of Disinfectant Wipes on Touch Screen
The touch screen was wiped a total of 133 times over the course of the study for all products except the bleach wipe, which was used 127 times due to the product having fewer wipes per canister compared to the other test products. The screen surface was swabbed before and after the first wipe, after 71 wipes, and again at the end of the study to determine antimicrobial efficacy over the course of the project. At the start of the study, all four screen sections showed heavy bacterial and fungal contamination (Figure 3). In addition, as outlined in Table 2, most of the surfaces also showed evidence of *P. aeruginosa, S. aureus, E. coli* and *Salmonella*. Samples taken partway through and at the end of the study showed an absence of bacteria and fungi, including the specific organisms listed above.

Table 2: Isolation of specific organisms from touch screen at start of study

Product	*P. aeruginosa*	*S. aureus*	*E. coli*	*Salmonella*
Product T	+	+	+	+
Product C	+	G*	+	+
Product A/V	+	+	+	+
Product Cl	+	G*	+	+

+ indicates presence of the organism; G* indicates growth of colonies not characteristic of *S. aureus*, but likely represents colonies of *S. epidermidis*.

After just 3-4 wipes, slight spotting of the screen was observed with Product C, while Products A/V and Cl showed light filming and streaking, respectively. After 16 wipes, the spotting with Product C was more pronounced, while Product A/V left a more visible film on the screen surface and Product Cl left substantial white film and residue on the screen. Product T did not leave any film or residue on the screen surface. After 21 wipes Product Cl began to create a buildup of a white, crusty residue along the corners of the screen. The appearance of each screen section as described above remained similar over the course of the study. By the end of the study, only Product T showed an absence of spotting, film or residue on the screen. Figure 4 shows images of the screen over the course of the project.

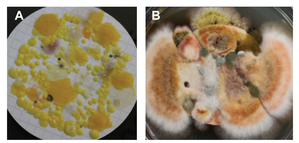

Figure 3: Cultured samples from touch screen. (A) Bacteria isolated from the touch screen. (B) Fungi isolated from touch screen. Samples were taken at the start of the study before use of the first disinfectant wipe. All samples taken after the first wipe were clear of both bacteria and fungi.

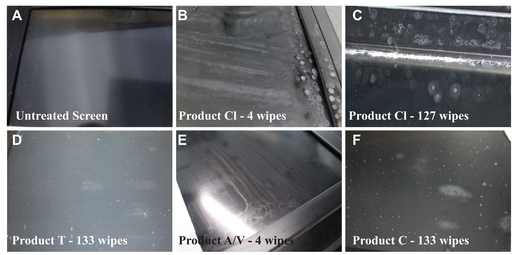

Figure 4: Appearance of touch screen after use of disinfectant wipes. (A) Untreated touch screen at the start of the study. (B) Screen after using 4 wipes of Product Cl, showing heavy residue and filming. (C) Screen after using 127 wipes of Product Cl showing buildup of white residue in corners of the screen. Heavy filming and residue on the entire screen surface was also present and similar in appearance to (B). (D) Screen after using 133 wipes of Product T, showing no film or resudue on the surface. (E) Screen after using 4 wipes of Product A/V, showing appearance of a film on the surface of the screen. (F) Screen after use of 133 wipes of Product C, showing spotting on the screen surface.

Effect of Disinfectant Wipes on Mattress Coverlet
Pieces of a mattress coverlet were also wiped a total of 133 times with all test products, except for the bleach wipe (127 wipes). Swab samples taken before the first wipe showed contamination with both bacteria and fungi, although not as much as the screen samples, as well as evidence of *P. aeruginosa*, *S. aureus*, *E. coli* and *Salmonella* (Table 3). Samples taken after 71 wipes and at the end of the study showed an absence of any bacterial and fungal growth.

Table 3: Isolation of specific organisms from touch screen at start of study

Product	*P. aeruginosa*	*S. aureus*	*E. coli*	*Salmonella*
Product T	+	G*	+	+
Product C	+	+	+	-
Product A/V	+	+	+	-
Product Cl	+	G*	-	-
Product S	+	G*	-	-

- indicates absence of the organism; + indicates presence of the organism; G* indicates growth of colonies not characteristic of *S. aureus*, but likely represents colonies of *S. epidermidis*.

Products S and T did not cause any discoloration or other damage to the mattress coverlet material. The fabric retained its sheen and was still soft and supple by the end of the study.
After 92 wipes, the material treated with Product C was beginning to show slight discoloration and dullness. By the end of the study, the material had lost its sheen and had a rougher texture compared to the other products, except for Product Cl. Some of the edges of the fabric were also white, indicative of fraying of the material. Mattress coverlet material treated with Product A/V had a similar colour and sheen compared to the untreated sample by the end of the study; however, the material felt slightly rougher compared to the samples treated with Products S and T. Some edges of the fabric were also white and fraying, although not as much as the Product C treated sample.

After 21 wipes, the mattress coverlet piece treated with Product Cl began to appear lighter in colour compared to the other pieces. By the end of the study, the fabric was significantly lighter compared to the other products and the untreated material. In addition, the bleach-treated fabric felt rougher, had lost its sheen, and was more absorbent to liquids compared to all other products and the untreated control. Figure 5 presents images of the mattress coverlet material at the end of the study period.

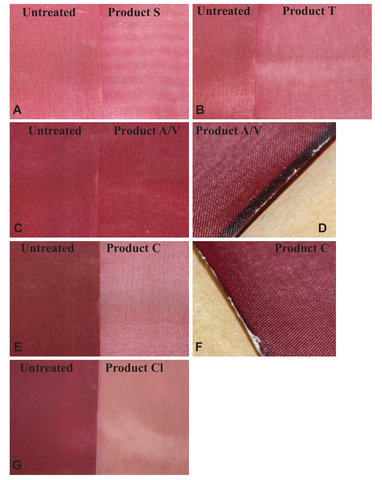

Figure 5: Mattress coverlet material treated with disinfectant wipes. (A) Material treated with 133 wipes of Product S, showing similar colour to untreated fabric. (B) Material treated with 133 wipes of Product T, showing similar colour to untreated fabric. (C) Material treated with 133 wipes of Product A/V, showing similar colouring to untreated and some fraying edges (D). (E) Material treated with 133 wipes of Product C, showing discoloration of material compared to untreated control and fraying edges (F). (G) Material treated with 127 wipes of Product Cl, showing significant discoloration compared to untreated fabric.

CONCLUSIONS

High-touch surfaces can serve as reservoirs for bacteria and fungi that can cause infections.

Disinfectant wipes are effective at removing bacterial and fungal pathogens from high-touch surfaces.

Wipes containing ethanol and chlorhexidine did not damage or leave a film on any of the test surfaces, suggesting they can be used on a variety of surfaces and materials.

The bleach wipes significantly damaged the mattress coverlet material and left the most residue on the touch screen compared to the other products, while the quat-based and accelerated hydrogen peroxide wipes produced some damage to the mattress coverlet material and produced filming and spotting on the touch screen.

Caution must be taken when selecting a disinfectant for use on high-touch surfaces, so as to minimize damaging effects on sensitive and costly equipment.