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Major Article

Impact of antimicrobial wipes compared with hypochlorite solution on environmental surface contamination in a health care setting: A double-crossover study

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Objective: Antimicrobial wipes are increasingly used in health care settings. This study evaluates, in a clinical setting, the efficacy of sporicidal wipes versus a cloth soaked in a 1,000 ppm chlorine solution.

Intervention: A double-crossover study was performed on 2 different surgical and cardiovascular wards in a 1,000-bed teaching hospital over 29 weeks. The intervention period that consisted of surface decontamination with the preimpregnated wipe or cloth soaked in chlorine followed a 5-week baseline assessment of microbial bioburden on surfaces. Environmental samples from 11 surfaces were analyzed weekly for their microbial content.

Results: A total of 1,566 environmental samples and 1,591 ATP swabs were analyzed during the trial. Overall, there were significant differences in the recovery of total aerobic bacteria ($P < .001$), total anaerobic bacteria ($P < .001$), and ATP measurement ($P < .001$) between wards and between the different parts of the crossover study. Generally, the use of wipes produced the largest reduction in the total aerobic and anaerobic counts when compared with the baseline data or the use of 1,000 ppm chlorine. Collectively, the introduction of training plus daily wipe disinfection significantly reduced multidrug-resistant organisms recovered from surfaces. Reversion to using 1,000 ppm chlorine resulted in the number of sites positive for multidrug-resistant organisms rising again.

Conclusions: This double-crossover study is the first controlled field trial comparison of using preimpregnated wipes versus cotton cloth dipped into a bucket of hypochlorite to decrease surface microbial bioburden. The results demonstrate the superiority of the preimpregnated wipes in significantly decreasing microbial bioburden from high-touch surfaces.

Multidrug-resistant organisms (MDROs) are commonly associated with health care-associated infections. MDROs have a significant influence on patient morbidity and mortality and represent a substantial financial burden.[1-3] Hospital surfaces can be persistent reservoirs for health care-associated infections.[4-8] Patients admitted to a room previously occupied by a patient with MDROs have an increased risk of acquiring these pathogens.[9-12] The use of a wipe or cloth in association with liquid/spray/vaporized disinfectants is becoming a common method to apply disinfectants to hospital surfaces.[13] Preimpregnated wipes are increasingly being used for hospital cleaning or disinfection because of their ease of use and activity claims.[13] Whilst the majority of studies investigating preimpregnated wipes have focused on in vitro studies,[14-19] there is a limited number of studies that have assessed the efficacy of wipes for surface cleaning or disinfection in a clinical setting.[20-23] To date, no study has evaluated the comparative effectiveness of preimpregnated wipes against a disinfectant solution.

Our primary objective was to evaluate whether daily use of a peracetic acid/hydrogen peroxide preimpregnated wipe in place of the existing standard practice (detergent cleaning with cloth soaked in a bucket containing 1,000 ppm chlorine) led to a significant reduction in surface microbial contaminants.

METHODS

Setting

This study was conducted on 2 identical surgical and cardiovascular wards in a 1,000-bed teaching hospital over a 29-week period

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between August 2013 and April 2014. Following a 5-week baseline period (using a combination of detergent cleaning with cloth soaked in a 1,000 ppm chlorine (baseline), a 24-week double-crossover study was conducted (phases 1 and 2) (Fig 1) to assess the efficacy of the standard practice of chlorine disinfection with a cloth versus the introduction of a peracetic acid/hydrogen peroxide wipe.

Cleaning and disinfection protocol

For the purpose of this study, 1,000 ppm chlorine solution in a bucket was used in combination with cotton cloths following a detergent cleaning step for all the surfaces sampled. The disinfectant wipe was a dry preimpregnated (sporicidal) wipe that generates peracetic acid/hydrogen peroxide when activated with water. The number of wipes required per surface was determined depending on the surface area according to the manufacturer's instructions. Procurement of wipes was calculated on expected use per ward per week. To ensure the correct product was used during the intervention period, all detergent and chlorine-containing agents were removed from the specified ward.

Training

Training (approved by the infection prevention and control [IPC] team) was delivered to nurses, health care assistants, and environmental services cleaning staff, including supervisors. Training was conducted over a 2-week period in groups of 1-5 staff members, for 30-45 minutes before both intervention periods (Fig 1).

Environment sampling

Surface samples were collected weekly from 11 sites (bed control, bed rails, tray table, call button, patient chair, drug locker, commode top, bathroom door handle, flush handle, toilet grab rail, and toilet seat) between 6 AM and 7 AM, before cleaning. Locations included ward, isolation rooms, 4-bed bays, single and shared bathrooms, and sluice room.

A 10×10 cm^2 sterile template (Thermo Fisher Scientific, Waltham, MA) was placed on surfaces where possible. Surfaces were wiped with a premoistened (neutralizing buffer) cellulose sponge (Sponge-Stick; 3M Company, Maplewood, MN) under aseptic conditions. Sponge-Sticks were applied firmly 3 times horizontally and 3 times vertically on each side of the sponge so that the designated area was sampled. For the call button, the entire surface (front, back, and sides) was sampled; for the toilet flush handle, the flush handle itself and area immediately surrounding the flush handle was sampled.

Sponge heads were placed in individually sealed bags and transported within 3 hours of sampling. Handles were aseptically removed, and sponges processed following the method of Dubberke et al[24] with the following modifications: Excess liquid was aseptically squeezed into a stomacher bag, which was placed in a Stomacher 400 (Seward, West Sussex, UK) and homogenized for 15 minutes at room temperature. The volume of homogenized liquid was measured to the nearest decimal point with a 10 mL stripette and placed into a 50 mL centrifuge tube.

Total aerobic and anaerobic counts

A 100-µL sample was plated onto brain heart infusion agar (Oxoid Ltd, Cheshire, UK), incubated at 37°C for 72 hours for aerobic colony counts. For anaerobic colony counts, prereduced brain heart infusion agar (Oxoid Ltd) was inoculated and incubated in an anaerobic workstation (MG500; Don Whitley Scientific, West Yorkshire, UK) for 72 hours. All the results were expressed as total aerobic/anaerobic count (in colony forming units per centimeters^2) of sampled surface.

Indicator microorganisms

The presence of methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococci (VRE), extended-spectrum beta-lactamases (ESBLs), carbapenem-resistant Enterobacteriaceae (CRE) and *C difficile* on environment surfaces was monitored by inoculating 10 µL of each sample onto the appropriate selective culture media, including Brilliance MRSA 2 Agar, Brilliance VRE Agar, Brilliance ESBL Agar, and Brilliance CRE Agar (Oxoid Ltd).

For *C difficile,* a 2-stage process was undertaken: direct inoculation onto prereduced cefoxitin cycloserine fastidious anaerobe agar (LabM, Heywood, UK) supplemented with 5 mg/mL lysozyme (Sigma-Aldrich, St Louis, MO), 1% (w/v) sodium taurocholate (Sigma-Aldrich), and 1% (v/v) defibrinated sheep blood (VH Bio Ltd, Gateshead, UK) and postenrichment inoculation—following anaerobic incubation of samples for 72 hours, tubes were centrifuged at 5,000 g for 5 minutes at 4°C, resuspended in 80% (v/v) absolute ethanol, and held for 1 hour at room temperature. Following ethanol shock, samples were centrifuged, resuspended in 2 mL sterile deionized water, and heat shocked for 20 minutes at 60°C. Samples were allowed to cool to room temperature and 10 µL plated onto cefoxitin cycloserine fastidious anaerobe agar supplemented with

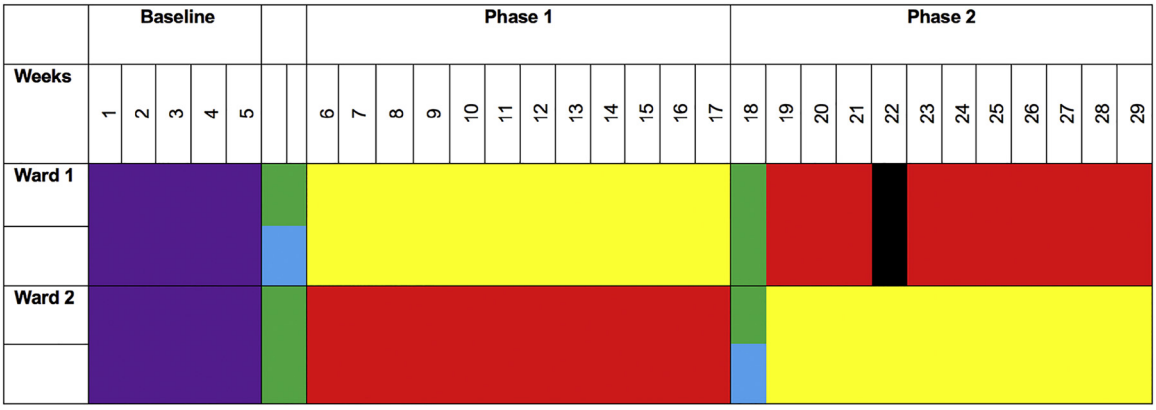

Fig 1. Schematic of double crossover field study. Purple shading indicates baseline date: Use of standard cleaning regimen. Red shading indicates use of detergent and chlorine 1,000 pm. Yellow shading indicates use of preimpregnated sporicidal wipes. Green shading indicates general training on disinfectant use, wiping, and infection prevention. Blue shading indicates specific training on the use of preformulated wipes. Black shading indicates wards closure.