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Major article

The effectiveness of a single-stage versus traditional three-staged protocol of hospital disinfection at eradicating vancomycin-resistant *Enterococci* from frequently touched surfaces

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Background: Environmental contamination is a reservoir for vancomycin-resistant enterococcus (VRE) in hospitals.
Methods: Environmental sampling of surfaces was undertaken anytime before disinfection and 1 hour after disinfection utilizing a sodium dichloroisocyanurate-based, 3-staged protocol (phase 1) or benzalkonium chloride-based, single-stage clean (phase 2). VRE colonization and infection rates are presented from 2010 to 2011, and audits of cleaning completeness were also analyzed.
Results: Environmental samples collected before disinfection were significantly more likely to be contaminated with VRE during phase 1 than phase 2: 25.2% versus 4.6%, respectively; odds ratio (OR), 7.01 ($P < .01$). Environmental samples collected after disinfection were also significantly more likely to yield VRE during phase 1 compared with phase 2: 11.2% versus 1.1%, respectively; OR, 11.73 ($P < .01$). Rates of VRE colonization were higher during 2010 than 2011. Cleaning audits showed similar results over both time periods.
Conclusion: During use of a chlorine-based, 3-staged protocol, significantly higher residual levels of VRE contamination were identified, compared with levels detected during use of a benzalkonium chloride-based product for disinfection. This reduction in VRE may be due to a new disinfection product, more attention to the thoroughness of cleaning, or other supplementary efforts in our institution.

Vancomycin-resistant enterococcus (VRE) has become an endemic problem in many hospitals in Australia and throughout the world.[1] Barwon Health is a 921-bed health care network in Geelong, Victoria, Australia. In early 2007, a prospective surveillance program was initiated to detect VRE-colonized patients through screening of inter-hospital transfers and routine screening of selected high-risk areas. From 2007 to 2010, 526 patients were newly identified with VRE. While 92% of these patients were colonized, VRE bloodstream infections tripled from 2007 to 2010.

The important role of environmental contamination as a reservoir for VRE has been previously reported.[2] VRE has been found on a variety of inanimate surfaces in the health care environment where they may survive for days to weeks.[3-5] Noskin et al found that *Enterococcus faecalis* survived 5 days, and *Enterococcus faecium* survived for 7 days on countertops, and both species survived for 60 minutes on telephone hand pieces.[3] Therefore, frequently-touched environmental surfaces are commonly contaminated in the rooms of patients colonized with VRE, and pathogens may be transferred from such surfaces to both health care workers and susceptible patients.[6] Previous studies have found environmental VRE contamination in the rooms of patients with VRE in 7% to 37% of samples obtained and 8% of cultures after "terminal cleaning."[7,8]

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Conflicts of interest: None to report.

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Thorough room cleaning, however, reduces the burden of VRE in the environment.[6]

High-risk areas (medical-surgical intensive care unit [ICU] and hematology/oncology ward [HOW]) at our institution screen patients via rectal swab. In these high-risk areas, colonized patients are placed in a single room in contact precautions or cohorted with other VRE-colonized individuals. Owing to an increase in VRE isolates, several interventions were introduced between 2007 and 2010, including measures to address the role of the physical environment in VRE acquisition. Interventions included hand hygiene promotion (2007), installation of toilet lids (February 2010), use of 2% chlorhexidine shower wash (October 2009 in ICU, August 2010 in HOW), enforcement of policies requiring staff to be bare below the elbow (May 2010), use of disposable gowns when close to patients (May-June 2010), and cleaning of toilets 3 times daily on HOW (June 2010).

The effectiveness of routine disinfection for eradicating VRE had not previously been assessed at Barwon Health. A proposed change in cleaning and disinfection methodology and products provided the impetus for an analysis of the effectiveness of both the traditional and new methods of disinfection for eradicating VRE from the physical environment of patients in 2010-2011.

METHODS

Disinfection methods: Phase 1

At Barwon Health, Victoria, Australia, the traditional disinfection methods for the physical environment of patients who were VRE colonized or infected was a daily 3-staged protocol using 1,000 ppm of a sodium dichloroisocyanurate-based product, Contain (ECOLAB PTY LTD, Sydney, New South Wales, Australia), an organic chloramine product,[9] requiring designated equipment and a multistep process. Designated cleaning equipment included bucket, mop, disposable cleaning cloths, measuring jug, sachet of disinfectant, container of neutral detergent, and 5-liter bowl.

Step-by-step instructions were provided for cleaning staff including the following: apply personal protective equipment (including a mask and safety glasses), clean all horizontal surfaces with the detergent solution in hot water, and apply disinfectant solution (1 × 8-g sachet of Contain dissolved in 5 liters of cold water) to each horizontal surface in patient's room and bathroom and leave on surfaces for 10 minutes. Rinse the disinfected surfaces in the patient's room and bathroom with warm water and dry all areas. Clean and disinfect all cleaning equipment and return to storage for next use.

New disinfection methods: Phase 2

In 2010 the new Australian Guidelines for the Prevention and Control of Infection in Healthcare simplified the recommended cleaning procedures.[10] For VRE, this guideline recommends a physical clean using a combined detergent and chemical disinfectant (2-in-1 clean plus disinfection). The product selected for trial use in patient rooms and bathrooms daily at Barwon Health was a benzalkonium chloride-based product, Viraclean (Whiteley Industries PTY LTD, Tomago, New South Wales, Australia). Viraclean is a glutaraldehyde-, chlorine-, and phenolic-free product whose major ingredient is benzalkonium chloride 0.426%. Viraclean has proven activity against hepatitis B virus[11] and has passed AOAC Association's hard surface carrier tests against both VRE and influenza A (unpublished data). From February to April 2011, disinfection methods were changed to a single-stage clean of all surfaces with Viraclean. The disinfection utilized either full strength Viraclean or disposable V-wipes. Hard floor surfaces were damp mopped with neutral detergent solution using normal cleaning equipment.

Step-by-step instructions provided for cleaning staff included the following: hand hygiene, using either cloth immersed in full strength Viraclean, or disposable V-wipes; undertake routine disinfection of all horizontal/contact surfaces in patient's room/cubicle and bathroom; wash floors with hot soapy water; clean and disinfect all cleaning equipment; return to storage for next use.

Environmental sampling

For 5 consecutive weekdays in December 2010 (phase 1), approximately 5 rooms of VRE-colonized patients were selected daily for environmental sampling. Some rooms were repeatedly sampled over consecutive days. Twelve predetermined environmental sites for sampling, representing frequently touched surfaces were selected from patient rooms and bathrooms (see below).

Samples were collected anytime before disinfection and 1 hour after disinfection. This disinfection was either routine daily disinfection of an occupied room or a full exit clean and disinfection on patient discharge using traditional 3-staged protocol methods.

Following institution of new 2-in-1 disinfection methods using Viraclean in 2011, the environmental sampling was repeated in July 2011 (phase 2) over 5 consecutive weekdays as above. During phase 2, additional samples were collected from bathroom sites 2 and 4 hours after disinfection. All samples in both phases were collected by the same researcher (C.T.).

Frequently touched surfaces

The frequently touched environmental sites in the patient room and bathroom included patient remote control, patient telephone receiver, patient locker drawer handles, patient over bed table, toilet door handle, toilet light switch, toilet seat, portable toilet seat handles, toilet wall hand rail, toilet flush, toilet floor, and bathroom taps. These sites were extrapolated from previous studies of environmental contamination.[12]

Environmental sample collection and microbiology

A single sample was collected from each of the frequently touched environmental sites, and, if 1 site was not available (for example, some bathrooms do not contain a portable toilet seat with handles), the researcher moved to the next sample. Sterile cotton swabs were moistened in sterile normal saline then swabbed over an approximately 50-cm^2 area of the surface to be tested. Swabs were then placed back in 1-mL aliquots of sterile saline and briefly agitated.[13] Swab tips were then broken off and sealed inside a labelled, screw-cap container and transported to the clinical microbiology laboratory. At the laboratory, the saline aliquots were flooded onto plates of Agar chromID VRE-selective medium (bioMérieux, Baulkham Hills, New South Wales, Australia).[14] Vancomycin-resistant *E faecium* was directly detected through the characteristic color of violet colonies after 48 hours incubation at 37°C.

VRE infection and colonization

Cases of VRE infection and colonization were collected as part of routine prospective laboratory-based surveillance performed by the Infection Prevention Service at our institution. Screening for VRE is undertaken routinely on admission and weekly in HOW and on admission and twice weekly in ICU at our institution. The number of incident cases of VRE was compared by quarters and total years over 2010 and 2011 when the 2 different disinfection methods were being used.