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Case Report

An evaluation of buffered peracetic acid as an alternative to chlorine and hydrogen peroxide based disinfectants

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Abstract This short report documents an in-use evaluation of three disinfectant solutions that was conducted within the operating theatre of a South Australian hospital to address a high occurrence of *Clostridium difficile* Infection (CDI). The disinfectants were all registered by the Therapeutic Goods Administration (TGA) and included a buffered peracetic acid, a chlorine-based disinfectant used at 1000 ppm, and a hydrogen peroxide-based disinfectant. The use of the chlorine and hydrogen peroxide disinfectants both caused a number of adverse staff reactions and increased safe-work related incident reporting. The peracetic acid-based product met all criteria for use, including staff acceptance, cleaning expectation, cost and efficacy requirements.

Highlights

- The operating theatre was struggling to select a suitable disinfectant for terminal cleaning that provided staff satisfaction.
- Chlorine and hydrogen peroxide based products had been found unsuitable due to adverse staff reaction and remnants of surface residues.
- The buffered peracetic acid based product was found to have the broadest acceptance by staff and met the requirements for terminal cleaning.

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Introduction

Healthcare associated infections (HAI) are a known risk within the healthcare environment affecting up to 165,000 Australians each year [1]. The pathogens that cause these infections are often multi-drug resistant organisms (MRO). Many of these MROs survive in biofilms on common and frequently touched dry surfaces within healthcare facilities, and can remain viable for transmission for up to several years [2,3]. Effective management of the cleanliness of environmental surfaces is a critical component of infection control strategies used to mitigate the risk of pathogen transmission via fomites and other surfaces within healthcare settings [4,5].

The South Australia "Cleaning Standards for Healthcare Facilities" (SA Standard), outlines cleaning procedures with standard operating procedures in place for environmental cleaning based upon risk assessment criteria [6]. High risk areas, such as operating theatres, are those that pose a high risk of transmission of infection due to contamination and vulnerable patient exposures. Additional cleaning and disinfection is required whenever a patient is either confirmed or suspected of infection or colonisation with "a multi-resistant organism, infectious respiratory pathogen, infectious gastroenteritis or *Clostridium difficile*" (transmission-based precautions) [6].

The SA Standard requires that disinfectants selected for use within healthcare settings must be either "a TGA approved hospital-grade disinfectant, preferably with label claims against specific organisms or a chlorine-based product such as sodium hypochlorite" [6]. Label claims against specific organisms are required to match scientific data provided to the Therapeutic Goods Administration (TGA) prior to registration.

The mortality risk for *C. difficile* infections (CDI) is estimated at 7.3% of CDI patients admitted into Australian healthcare facilities [7]. The significance of *C. difficile* and other pathogen contamination of floor surfaces and the ability of transference through floor contact has been previously reported [8]. In one study, CDI patient rooms demonstrated increased presence of other MRO whilst *C. difficile* environmental recovery rates were constant throughout the hospital [8]. Transmission to hands after contact with high touch objects present on contaminated floors was also demonstrated.

The use of disinfectants that are preferable to cleaning staff has been associated with better hygiene outcomes, particularly where strong chlorine-based disinfectants are the alternative [9]. Therefore, it is important to select an appropriate cleaning and disinfectant products, both to reduce the risk of pathogen transmission and to minimise any additional risks to staff and patients.

Case study

Due to the high incidence of *C. difficile* Infection (CDI) in the operating theatre of a South Australian hospital, the cleaning protocol was escalated to meet the requirements of transmission-based precautions. This resulted in the need to consider and select an appropriate disinfectant for regular/daily cleaning and disinfection. All disinfectant products selected were confirmed as acceptable under the applicable policy requirement from the SA Standard. All disinfectants were prepared as per manufacturer's instructions and used at recommended dilutions with monitoring on correct exposure times.

The core considerations for this hospital were minimised safety/health risk to staff members, pathogen transmission risk reduction, cleaning workload reduction, and also a decrease in cost whilst meeting the requirements of the SA Standard.

In 2011, a chlorine based disinfectant (Actichlor™ Plus, Ecolab, Macquarie Park, NSW. ARTG 174320) was implemented as the principle surface disinfectant, with a use concentration of 1,000 ppm in compliance with the state based guidelines [6]. The use of Actichlor™ Plus was discontinued following reports of five staff members having adverse respiratory reactions to the product. An assessment by an occupational hygienist indicated that the reported reactions were product related to the strong chlorine odour. Several staff were immediately reassigned whilst several required worker's compensation leave prior to redeployment. Safe work measures were implemented limiting the use of chlorine disinfectants or use of an alternative disinfectant whilst on duty.

A replacement product was selected that was not chlorine based. The hydrogen peroxide disinfectant (Oxivir® TB, Diversey, Lane Cove, NSW Australia. ARTG 165058), was selected for trial from March 2016. However, due to a specific lack of evidence on the efficacy of the product against *C. difficile* spores, additional staff vigilance was required regarding awareness of CDI patients or colonisation [10]. The use of the chlorinated disinfectant was reinstated for terminal cleaning following procedures performed on *C. difficile* colonised patients.

There were safe work concerns with the hydrogen peroxide based disinfectant, including an increase of slip incidents and near miss slip incidents reported. This was due to a build-up of product residue on floor surfaces which was sticky when kept dry, but which became quite slippery when wet. The correction of the residue issue resulted in the increase of cleaning staff workload, as an additional detergent (cleaning) step was introduced to manually remove this build up on a weekly basis.

From April 2017, a buffered peracetic acid (PAA) based cleaner/disinfectant was trialled for use (Surfex®, Whiteley Corporation, Tomago NSW Australia. ARTG 257360). This product also contains a surfactant providing a dual cleaning and disinfection effect. Given the enhanced surveillance following the earlier and unsuccessful trials, both the Country Health South Australia Local Health Network (CHSA LHN) Product Standardisation Committee and the local hospital Work Health Safety (WHS) committee were consulted prior to trial commencement.

Following a full year trial, it was accepted that the buffered PAA based product was suitable for transmission precautions in accordance with the established criteria including the SA Standard, efficacy requirements, staff acceptance, cost, and workload reduction. Staff noted a visible improvement of cleanliness which were supported by internal audits, with no lingering floor residue reported. Despite a vinegar like odour, there were no respiratory issues reported by staff, including those originally affected

Table 1 Staff survey responses to Surfex® following 5 months of implementation.

	Excellent	Very Good	Good	Average	Below Average
Product Appearance	1	13	2	3	0
Product Fragrance	10	6	0	1	2
Clarity of directions for use	15	1	3	0	0
Product use training provided by manufacturer	13	3	3	0	0
Overall staff satisfaction	11	3	4	0	1
WHS Benefits	14	3	1	1	0
TOTAL	64	29	13	5	3

Table 2 Cost analysis of trialled disinfectant products — Actichlor™ Plus, Oxivir® TB and Surfex® at time of study.

	Actichlor™ Plus	Oxivir® TB	Surfex®
Active ingredient	Chlorine	Hydrogen peroxide	Peracetic acid
Cost per unit	16 cents/tab	$8.81	$3.80
Units per day	1 tablet/ litre	12	7
Direct Cost per day	$3.20	$105.72	$26.60

by chlorine. Staff feedback demonstrated a positive response toward Surfex®, particularly in relation to fragrance, directions for use, and overall response (Table 1). The costs of the three solutions is outlined in Table 2 and supports the use of the PAA based product.

Conclusions

The selection of an appropriate disinfectant with demonstrated effectiveness against MRO and biofilm is critical for infection prevention, as surface contamination with pathogenic microorganisms has been reported previously [3,8,11]. Whilst the eradication of pathogenic organisms is of great importance, the management of occupational risk from the use of such products is equally important to address. Adverse reactions due to exposure to cleaning products as observed within this facility have been previously reported. Previous reports include respiratory stress such as work related/aggravated asthma and dermal effects such as contact dermatitis [12,13]. Therefore, the selection of a high-level disinfectant must not only be based on kill claims and effectiveness, but also take staff satisfaction and risk into account.

The performance of the buffered PAA product against dry surface biofilms also informed the selection of the product for use in healthcare facilities [14]. Further studies are underway to continue monitoring of safe work practises and staff issues for products cleaning protocols that used for terminal cleaning and disinfection with colonised or infected patients.

The implementation of infection control strategies aims to not only reduce the occurrence of HAI, but also to minimise work, safety and health risks, and to mitigate financial pressure on healthcare systems. A balance between effective surface disinfection, cost effectiveness, and minimised operational risk is of the highest importance to patients, visitors, and staff.

Authorship statement

I hereby certify that the authors listed on this manuscript have contributed to the paper as per the guidelines. No authors have been excluded who should otherwise have been listed on the manuscript. Sharon Otterspoor was responsible for experimental design and data collection at the facility of her employment. Dr Jessica Farrell was responsible for data assessment and manuscript preparation for submission.

Conflicts of interest

Dr Jessica Farrell is employed by Whiteley Corporation in combination with the University of Sydney regarding a collaborative research grant not related to this manuscript.

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Provenance and peer review

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Ethical considerations

Ethics approval was not sought as this study does not include human subjects. However, approval for the use of Surfex was obtained from both the Country Health South Australia Local Health Network (CHSA LHN) Product Standardisation Committee and the local hospital Work Health Safety (WHS) committee prior to commencement.

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