The Assessment of the Sporicidal Activity of Selected Environmental Surface Disinfectants Using Spores of *Clostridium difficile*

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ABSTRACT

Background/Objectives: The emergence of the NAPI strain of *Clostridium difficile (C. diff)*, an anaerobic spore-former, as a major nosocomial pathogen, points to the need for safe, effective and fast-acting environmental sporicides for infection control. Existing formulations which are effective in inactivating such spores in a short contact time of only a few minutes can be corrosive and unsafe for humans and the environment. The purpose of this study is to evaluate the sporicidal activity of selected formulations at varying drying times.

Methods: The quantitative carrier test (QCT), which is a standard (E2111) of ASTM International was used for sporicidal tests against spores of *C. diff* and its surrogates *B.subtilis* and *C.sporogenes* with contact times of 1, 5 and 10 minutes at 20±1°C. The tested products were a 4.5% AHP sporicidal gel, and domestic chlorine bleach at 500 PPM and 5000 PPM of free available chlorine (FAC).

Results: In sporicidal tests, 4.5% AHP and Bleach at 5000 PPM of FAC inactivated >6 log10 of viable spores of all three types at 10 min contact, but were unable to do so after 1 min. Bleach at 500 PPM of FAC did not show any significant sporicidal activity even after 10 min. In drying tests, 4.5% AHP remained wet for the entire 10 min contact time, while Bleach dried in about 4 min.

Conclusions: 4.5% Accelerated Hydrogen Peroxide (AHP) sporicidal gel (tested undiluted) and Bleach at 5000 PPM of FAC showed strong activity at 10 min against all three types of spores tested. The gel was able to keep the surfaces wet for the entire 10 min required sporicidal contact time as opposed to the chlorine Bleach which dried in about 4 min, therefore did not achieve the required contact time. The gel, designed especially for use on toilet bowls due to its superior vertical surface adhesion ensures a sufficient surface contact time is met and represents a safer alternative to strong bleach solutions, for both the user and the environment.

INTRODUCTION

Until the recent emergence of *C. diff*., bacterial spore-formers were not among the major targets for environmental decontamination in hospitals and other healthcare settings. It is now well accepted that the frequent and profuse diarrhea caused by *C. diff*. infections can lead to wide-spread environmental contamination as *C.diff* spores can not only survive for extended periods of time on surfaces but are also relatively resistant to many commonly used environmental surface disinfectants. Viable spores of *C. diff*. have been recovered from inanimate surfaces of hospital wards housing *C. diff*. cases. Direct or indirect contact (e.g. via hands) with spore-contaminated environmental surfaces are among the various means of *C. diff*. transmission. Toilets are among the environmental surfaces with highest level of *C.diff* contamination, and consequently require special care for decontamination.

While sodium hypochlorite solutions (chlorine bleach) containing no less than 5,000 parts per million (ppm) of free available chlorine (FAC) can inactivate spores rapidly, their general use is constrained due to (a) decreased microbicidal activity in the presence of organic matter, (b) release of pungent and potentially toxic chlorine gas, and (c) high corrosivity. Acidification of such solutions can further enhance their microbicidal action, but it can also increase off-gassing and corrosivity. Other disinfectants such as alcohols, quats, and phenolics are not effective against spores even at high concentrations and therefore, are not appropriate for *C.diff* decontamination. In this study, the sporicidal activity of domestic chlorine bleach was compared to that of a 4.5% accelerated hydrogen peroxide at different contact times.

MATERIALS AND METHODS

Test Solutions:

1) 4.5% AHP sporicidal gel is a viscose product based on 4.5% Accelerated Hydrogen Peroxide. 2) Domestic Bleach with free active chlorine concentration (FAC) of 5000 PPM and 500 PPM. Water with 400 PPM was used to dilution the concentrated bleach to desired dilutions.

Sporicidal Tests:

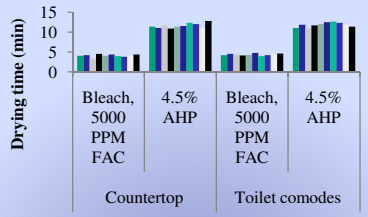
The test solutions were compared for their sporicidal activity using the quantitative carrier test method (ASTM 2111-00) against spores of *Bacillus subtilis* (ATCC 19659), *Clostridium sporogenes* (ATCC 7955), and *Clostridium difficile* (a clinical isolate)

Drying test:

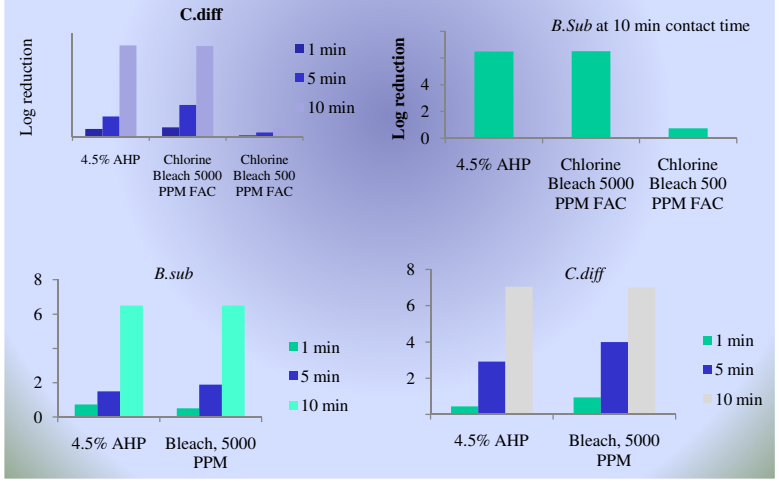
Paper towels (20 cm x 20 cm), saturated with the test solution, were applied to a vertical surface of toilet commodes and epoxy resin countertops and let air dry at room temperature (20±2°C). The time was measured for each product to dry approximately on 50% of the wetted surface. The test was repeated 10 times for each product for meaningful statistical analysis.

RESULTS

Drying Tests



Microbicidal tests:



DISCUSSIONS AND CONCLUDING REMARKS

When using sporicides it is imperative that the surface remain wet for the required contact time. When sporicides do not have the ability to remain wet on a surface for the required contact time, reapplication is necessary, otherwise even strong sporicides may be ineffective. 4.5% AHP sporicidal gel, a formulation especially designed for application on toilet bowls for longer dwell times, proved to be a good sporicide in a contact time of 10 min at room temperature. Its gel formulation allows it remain wet for the 10 min required contact time even on inclined surfaces, and its surfactant package prevents beading (hydrophobicity) on the surface, which provides better wetting or contact to the surface being disinfected. Its composition also makes it safer for use as compared to higher concentration of Bleach.