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Effectiveness of Hospital Disinfectants against Clostridium Spores

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Introduction:

Clostridium is a genus of anaerobic spore-forming bacteria notable for causing human infections. C. difficile has an especially high impact, affecting roughly 453,000 individuals in the U.S. in 2011 (1). C. tetani and C. perfringens infections occur much less frequently, although they remain clinically important. Disinfecting objects contaminated with Clostridium is challenging, as Clostridium spores are resistant to extreme temperature, desiccation, and most chemicals (2, 3). Clostridium is also frequently found within soil, making it a likely contaminant on almost any piece of medical equipment (3).

Currently, the U.S. EPA only requires sporicidal disinfectant efficacy tests against C. sporogenes, a non-pathogenic Clostridium species, for use approval (4). To make a specific C. difficile claim, additional testing with C. difficile is required (5). However, Clostridium species are very different, and spores from different species may have different sensitivities to disinfection. As a result, current EPA guidelines might be leaving patients at risk to infections from less commonly studied Clostridium species, especially C. tetani and C. perfringens. Post-operative cases of C. tetani and C. perfringens infection have been reported, although they are much less common than hospital outbreaks of C. difficile infection (6, 7). Additional research is needed to determine whether current disinfectants adequately inactivate spores from those species.

Methods:

First, spore suspensions were made for C. sporogenes, C. difficile, C. tetani, and C. perfringens. EPA protocol MB-28 was followed, which contains directions for making C. difficile spores, although this protocol was adapted slightly for other Clostridium species. Making the suspensions involved inoculating each bacterium onto 10 agar plates, incubating those plates in an anaerobic jar for 10 to 20 days, and harvesting the growth using a cell scraper. From there, each suspension was washed and heat-shocked. The C. perfringens and C. difficile suspensions were purified using a density gradient medium; this step was not possible with C. difficile or C. tetani.

Once the spores were made, they were used to perform contact disinfectant tests according to EPA protocol MB-31. This involved depositing each spore suspension onto several metal carriers and placing those carriers at the bottoms of glass tubes. From there, disinfectant or a control solution was added to the carrier, and after two minutes, 10 mL of neutralizer was added to the tubes, stopping the disinfectant action. The neutralized mixture was then diluted and spread onto agar plates. By counting the colonies on each plate and taking the dilution into account, the total number of surviving spores in the original mixture was determined. 5% peracetic acid was tested, which is a common ingredient in hospital sporicidal disinfectants.

Results:

Unfortunately, a series of shipping delays and some problems with equipment prevented definitive results from being obtained. However, the results collected indicate that C. perfringens is about as susceptible to...
peracetic acid disinfection as C. difficile, with both microbes demonstrating a 3-log reduction in the number of viable spores present after 2 minutes of exposure. C. tetani and C. sporogenes seemed to be more susceptible, however, with both microbes demonstrating a 5-log reduction or more.

Discussion:

These results suggest that peracetic-acid based disinfectants with a C. difficile claim can also effectively kill C. perfringens and C. tetani. Peracetic acid kills spores by decomposing into hydroxyl radicals and oxidizing spore components, and several other types of disinfectants including hydrogen peroxide act in a similar way, so those disinfectants are also probably safe to use.

However, these findings suggest that C. sporogenes may not be a good test organism for peracetic acid-based disinfectants, which is concerning. Thus, sporicidal peracetic acid-based disinfectants without a C. difficile claim may not kill C. difficile and C. perfringens effectively, leaving patients vulnerable.

Conclusion:

Peracetic acid-based disinfectants with a C. difficile claim should also kill C. perfringens and C. tetani effectively, making them safe to use in a clinical setting. Additional testing should be done to determine whether C. sporogenes is a suitable test organism for peracetic-acid based disinfectants, and regulations should be modified accordingly.

References:


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