Clostridium Difficile (C. diff) – Steel and Solid Surface Efficacy Testing for Healthcare Furniture

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Introduction

The Centers for Disease Control and Prevention (CDC) has increased its estimate of the annual burden of Clostridium difficile (C. diff) infections in the United States, to 453,000 cases per year, with 29,300 associated deaths, based on a 2011 study. Antibiotic stewardship, while helpful, is not trending towards zero incidents. Since the transmission is possible from surfaces, this study performed in May of 2019, focuses on evaluating typical surfaces of furniture that would be found anywhere in a healthcare or senior living setting. Wood is porous by nature underneath a millimeter coating and was not evaluated because it is already becoming deemphasized in clinical areas. There has been a shift to steel framed furniture which has several millimeters, powder coated, top coat. Solid surface framed furniture was compared to steel framed furniture by eliminating the top coat to emulate the harsh healthcare environment and both were inoculated to compare how surfaces would perform in a lab environment with cleaning protocols including PDI Super Sani-Cloth germicidal wipes (EPA Reg. Rn. 9480-4). The solid surface sample demonstrated lower bacterial spore burden relative to steel with average percent reduction of 92.56%. The difference between control and test samples was very statistically significant ($p<0.005$).

Antimicrobial Efficacy Test Method Details

Test Organisms:
Clostridioides difficile (C. diff) ATCC BAA-1870

Test Samples:
Kwalu Chair and Steel Chair

Material Preparation:
Test sample locations on chairs were abraded (using razors on one side, and razors followed by steel wool on the other side) to emulate harsh healthcare environment. Following this abrasion, the chairs were cleaned by wiping down with a bleach solution twice a day for 13 total days.

For each experiment, chairs were wiped with Clorox Bleach Germicidal Wipes, then after 3 minutes rinsed with a 70% ethanol solution and allowed to dry.

Inoculum Preparation:
For each experiment, a stock solution of C. diff spores in phosphate buffered saline (PBS) (1x) with fetal calf serum (0.05%), at a spore concentration of approximately 1.84E+08 colony forming units per milliliter (CFU/mL), was incubated at room temperature for 24 hours to prepare spores for germination. This stock solution was diluted with PBS (1x) to achieve a concentration of approximately 1.50E+07 CFU/mL.

Inoculum Application:
Inoculum solution was applied in 0.010 mL aliquots spread across each 4cm x 4cm test area and allowed to dry.

Incubation:
After the inoculated test locations dried, compromised test samples were wiped with PDI Super Sani-Cloth (EPA Reg. No. 9480-4) germicidal wipes, then allowed to dry after 2 minutes dwell time (to simulate the healthcare cleaning protocol typically used for a patient space with an unknown C. diff contamination).

Recovery:
Bacteria was recovered from dried surfaces by pressing a RODAC plate (brain-heart infusion agar supplemented with yeast extract [2%] and taurocholate [0.1%]) gently onto each test sample. RODAC plates were incubated at 37°C for 48-72 hours. Resulting colonies were enumerated by hand-counting colonies present on RODAC plates.

Data Analysis:
For low-burden plates, all grid colonies were counted. For high-burden plates, average colony counts of representative grid squares from each test sample were used to calculate the total colony forming units per square centimeter (CFU/cm2) recovered from each test sample.

Average CFU/cm2 values were calculated from replicate data points. Welch's t-test was performed to analyze the statistical significance of the reductions by the Kwalu samples relative to the steel samples.

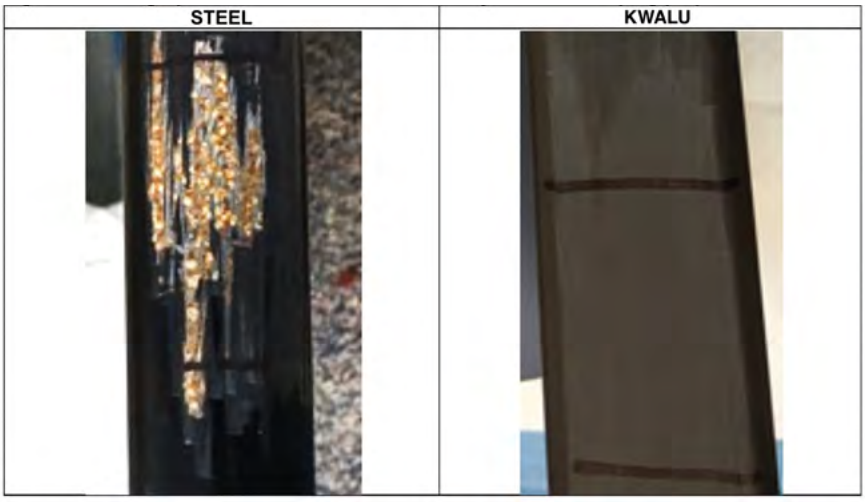

Figure 1: Photographs of chairs after razor and 8 days of bleach wiping preparation

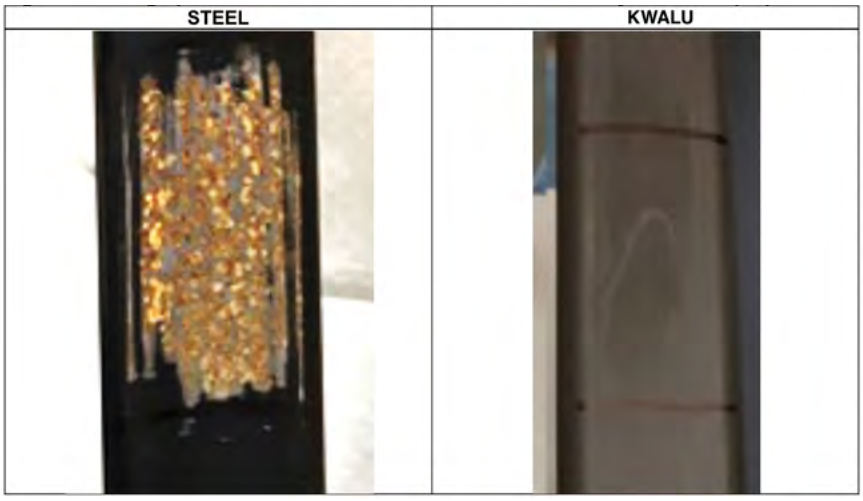

Figure 2: Photographs of chairs after razor and steel wool and 8 days of bleach preparation

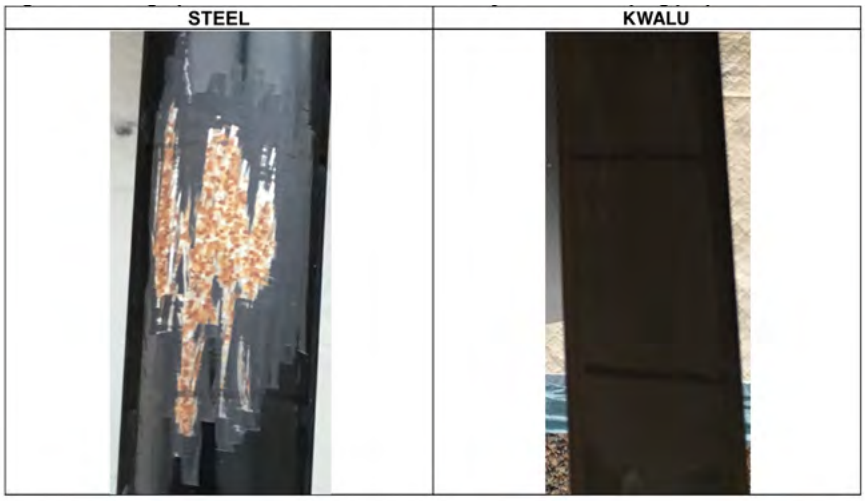

Figure 3: Photographs of chairs after razor and 13 days of bleach preparation

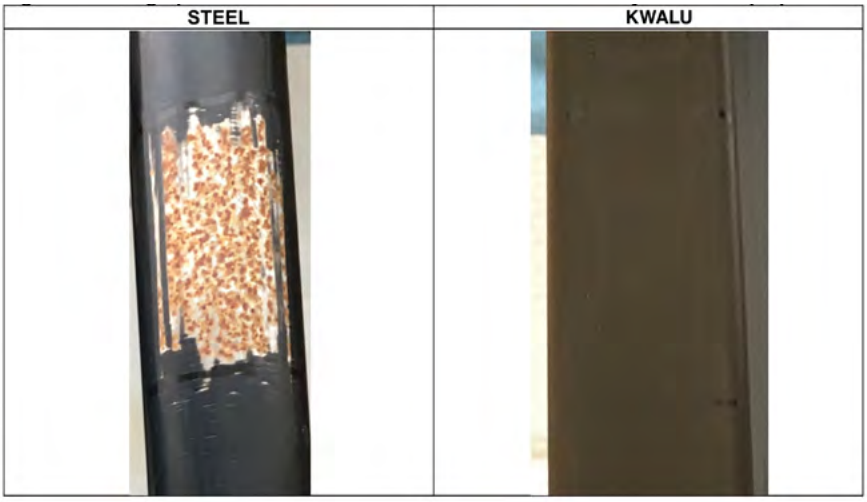

Figure 4: Photographs of chairs after razor and steel wool and 13 days of bleach preparation

Results

The control sample (steel chair) exhibited an average C. diff bacterial spore burden of 2.29E+03 CFU/cm2.

The test sample (Kwalu chair) exhibited an average C. diff bacterial spore burden of 1.70E+02 CFU/cm2. Thus, the Kwalu sample demonstrated lower bacterial spore burden relative to control with average percent reduction of 92.56%. The difference between control and test samples was very statistically significant ($p<0.005$).

While 92.56% was the quantifiable reduction between the Kwalu chair and the control steel chair, this is likely an understatement of the impact. As pictured (Figure 5), the bacterial burden on the control steel.

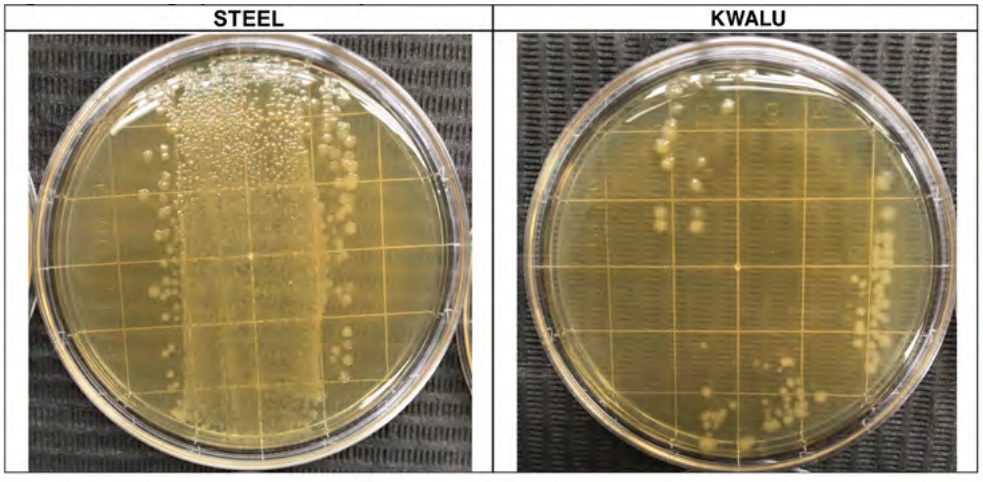

Figure 5: Photographs of RODAC plate results

	STEEL	KWALU
AVERAGE CFU/cm²	2285.85	170.10
p value (compared to Steel)	--	0.003
Percent Reduction (compared to Steel)	--	92.56%

Figure 6: Results Table

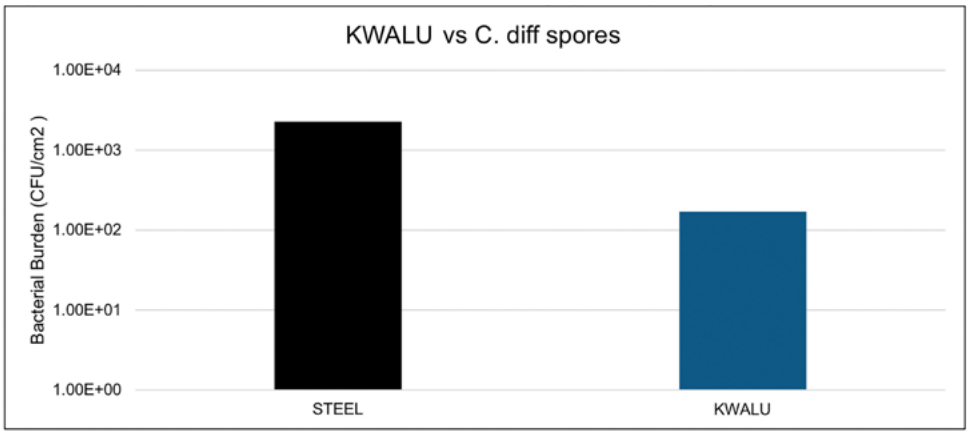

Figure 7: Graph, C. diff spore viable bacterial burden (log-scale y-axis)

Conclusion

Based on results, surfaces and harsh healthcare environment should be considered when designing rooms where Clostridium Difficile is a concern, like in a patient room. More testing needs to be done on uncompromised surfaces. In addition, even though the results, while statistically significant, at 92.56% reduction between the Kwalu chair and the control steel chair, it was understated because the labs testing method could not count all the additional spore colonies on the steel sample. Recommend exploring additional testing methods of recovering C. diff spores using sponge swabs or anaerobic swabs.

Disclosures:
Sylvia Nash was an employee of Kwalu.

Kwalu paid for the 3rd party testing conducted by:
ResInnova Laboratories – 8807 Colesville Rd, 3rd Floor Silver Spring, MD 20910.