Evaluation of biofilm removal in hospitals environment using different cleaning solutions with and without DNase.

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Background

Healthcare professionals are increasingly aware of the risk for patient's safety of microbial biofilms present in hospital environments such as medical devices, water treatment systems, surfaces, etc (Muhammad et al., 2020).

In several industrial sectors (food, pharmaceutics, cosmetics, etc) cleaning solutions containing a mix of efficient enzymes, including DNase, have been shown to achieve efficient removal of different types of biofilms (Coughlan et al., 2016). This study aims to evaluate several commercial cleaning solutions with or without DNase to eradicate the main biofilms implicated in hospital environments.

Materials and methods

The model used to assess biofilm removal was described by Iglesias and al. (2019) and adapted to include other bacterial strains encountered in healthcare environments. Briefly, strains were grown for 24h (Staphylococcus aureus, ATCC33591), or 48h (Pseudomonas aeruginosa, ATCC27853, and Escherichia coli, ATCC25922) at 37°C in 96-well microplates. Six cleaning solutions, one of which including DNase, were then applied to selected wells according to the plate template. Crystal violet staining was finally applied to measure biomass reduction. Inside the same plate, every enzymatic solutions were tested six times and each plate was tested four times. The results obtained were processed graphically with Box Plots and statistically with nonparametric tests (Kruskal Wallis and Wilcoxon tests).

Results and discussions

For S. aureus, the results show that only the enzymatic cleaning solution containing DNase allows an efficient biofilm removal with a reduction of 61.2% compared to the control (p-value < 0.0001).

For P. aeruginosa, the results indicate that the solution containing DNase has the best removal efficiency with a reduction of 65.5% (p-value = 0.010). Biofilm reduction was also measured for two other cleaning solutions, but these results were not reproducible on all plates.

For E. coli, the results revealed once again that the product with DNase showed significant removal values with 43.2% of reduction (p-value = 0.005).

Figure 1, 2 and 3 illustrates a summary of the results obtained respectively for S. aureus, P. aeruginosa and E. coli, for each solution tested, including the biomass measurements after the treatments and the statistical test results compared to the control.

Figure 1: *S. aureus* Box plot including Min, P10, P25, P50, P75, P90, Max

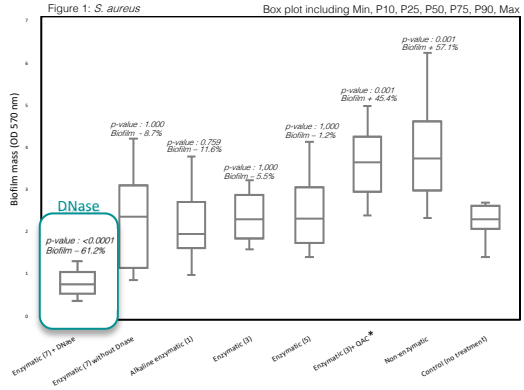


Figure 2: *P. aeruginosa* Box plot including Min, P10, P25, P50, P75, P90, Max

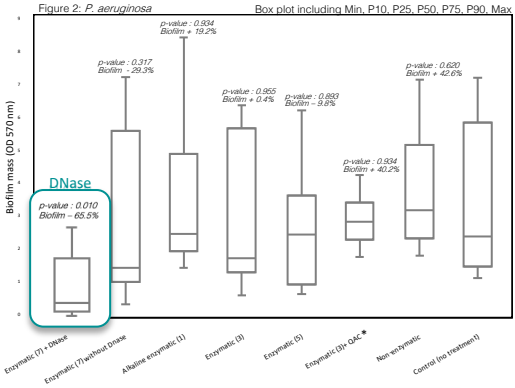
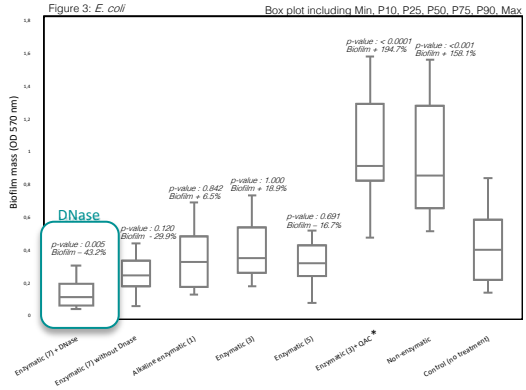


Figure 3: *E. coli* Box plot including Min, P10, P25, P50, P75, P90, Max



* Quaternary Ammonium Compound

Conclusions

This study aimed to assess several commercial cleaning solutions for the removal of biofilms encountered in hospital environments. The enzymatic cocktail containing DNase shows a systematic efficiency whatever biofilms type. Other cleaning solutions do not or only partially remove biofilms and moreover, some of them, might increase the biofilms.

Figures 1,2, and 3: Box plot of absorbance values (570nm) obtained with crystal violet staining assay respectively for S. aureus, P.aeruginosa and E. coli biofilms treated with different cleaning solutions

Bibliography: Coughlan, L. M. Frontiers in Microbiology, 7, 1641 // Iglesias, Y. D. Antimicrobial Agents and Chemotherapy, 63(7) // Muhammad, M. H. Frontiers in Microbiology, 11, 928