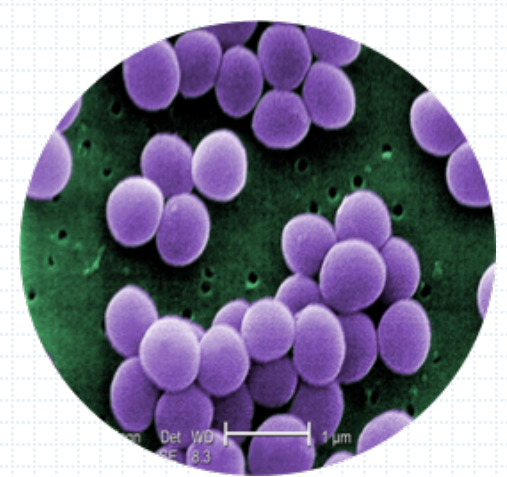


Antimicrobial activity of a silver doped fabric for the production of scrubs

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Abstract

Hospital acquired infections (HAIs) caused by bacteria such as *Staphylococcus aureus* and *Klebsiella pneumoniae* take an estimated 100,000 lives while costing approximately \$33 billion on extended length hospital stays annually in the United States. In addition, the frequency of HAIs have not decreased in the past 20 years (Condò et al. 2015). As a result, new methods for reducing the prevalence of such bacteria often responsible for HAIs are essential in the ultimate reduction of the frequency of HAIs. This research project hypothesized that hospital personnel carry bacteria on their scrubs that contribute to frequency of hospital acquired infections.



S. aureus



K. pneumoniae

As a result, an antimicrobial agent, silver, may be utilized as a means to be incorporated into hospital uniforms to reduce the frequency of HAIs. Previous research has shown that silver has antimicrobial capabilities due to its ability to disrupt vital cell physiologies such as cell wall synthesis and membrane transport (Castellano *et al.* 2007). Using a silver doped experimental fabric provided by the USD nursing school, analysis of results demonstrated that elimination of the gram-negative bacterium *K. pneumoniae* occurred at an earlier time on the experimental silver fabric compared to the control fabric.

Analysis of a two-way ANOVA indicated that while time had a significant effect on percent reduction of *S. aureus*, material has no significant effect on percent reduction of *S. aureus* (Figure 1). As a result, there is no difference in the antimicrobial ability of either fabric to eliminate *S. aureus* as both materials eliminated *S. aureus* by 24 hours. In contrast, however, while time also had a significant effect on percent reduction of *K. pneumoniae*, material additionally had a significant effect on percent reduction of *K. pneumoniae* (Figure 2). After conducting pair-wise comparisons, a significant difference in the percent reduction of *K. pneumoniae* at 12 hours demonstrates that the silver material was more efficient at eliminating *K. pneumoniae* than the control where elimination did not occur until 24 hours.

Results

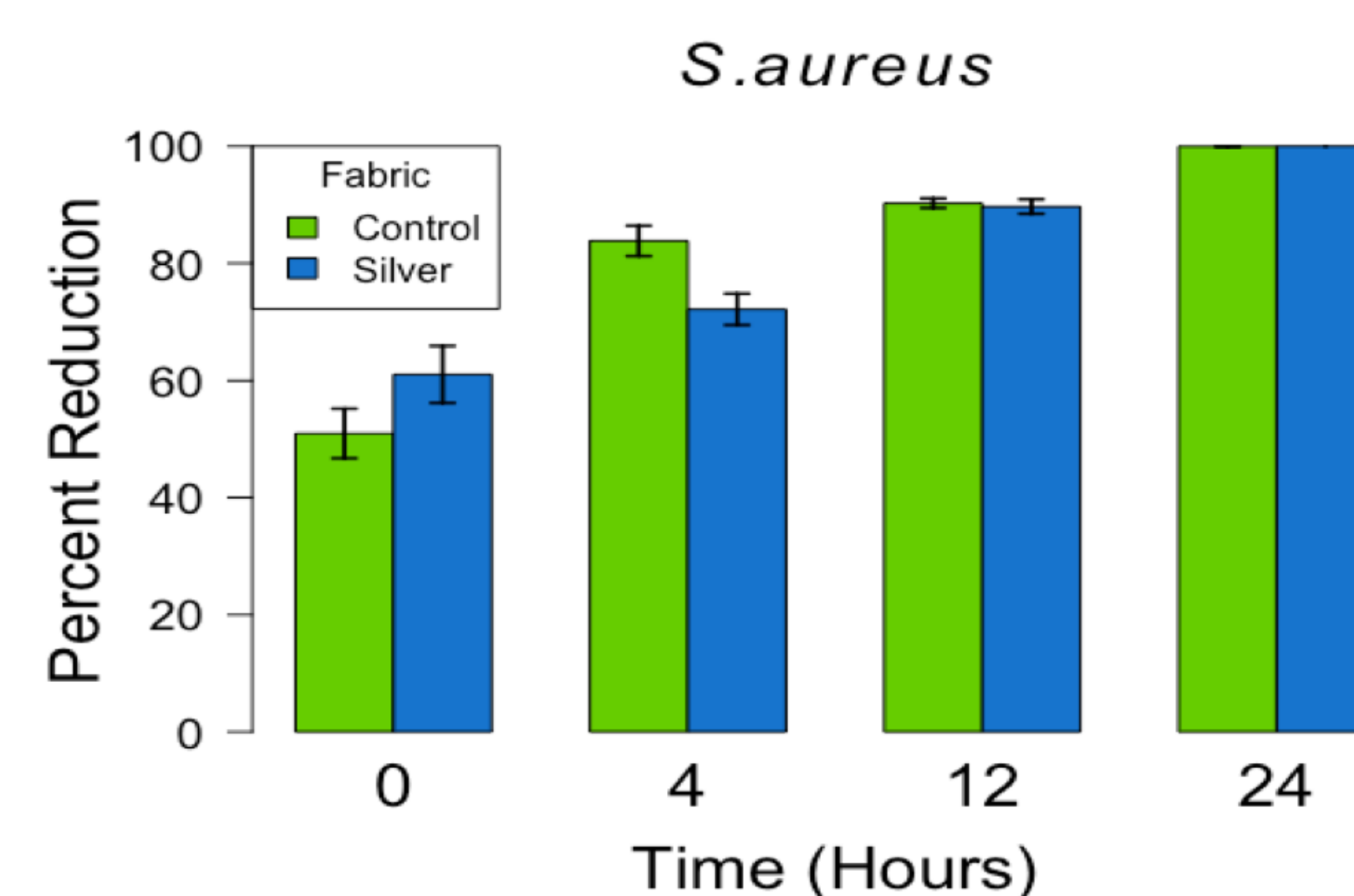


Figure 1. Analysis of a two-way ANOVA (d.f.=2, P-value_{Time} = 1.5e-10 *** P-value_{Fabric} = 0.78134, P-value_{Fabric*Time} = 0.00876 **).

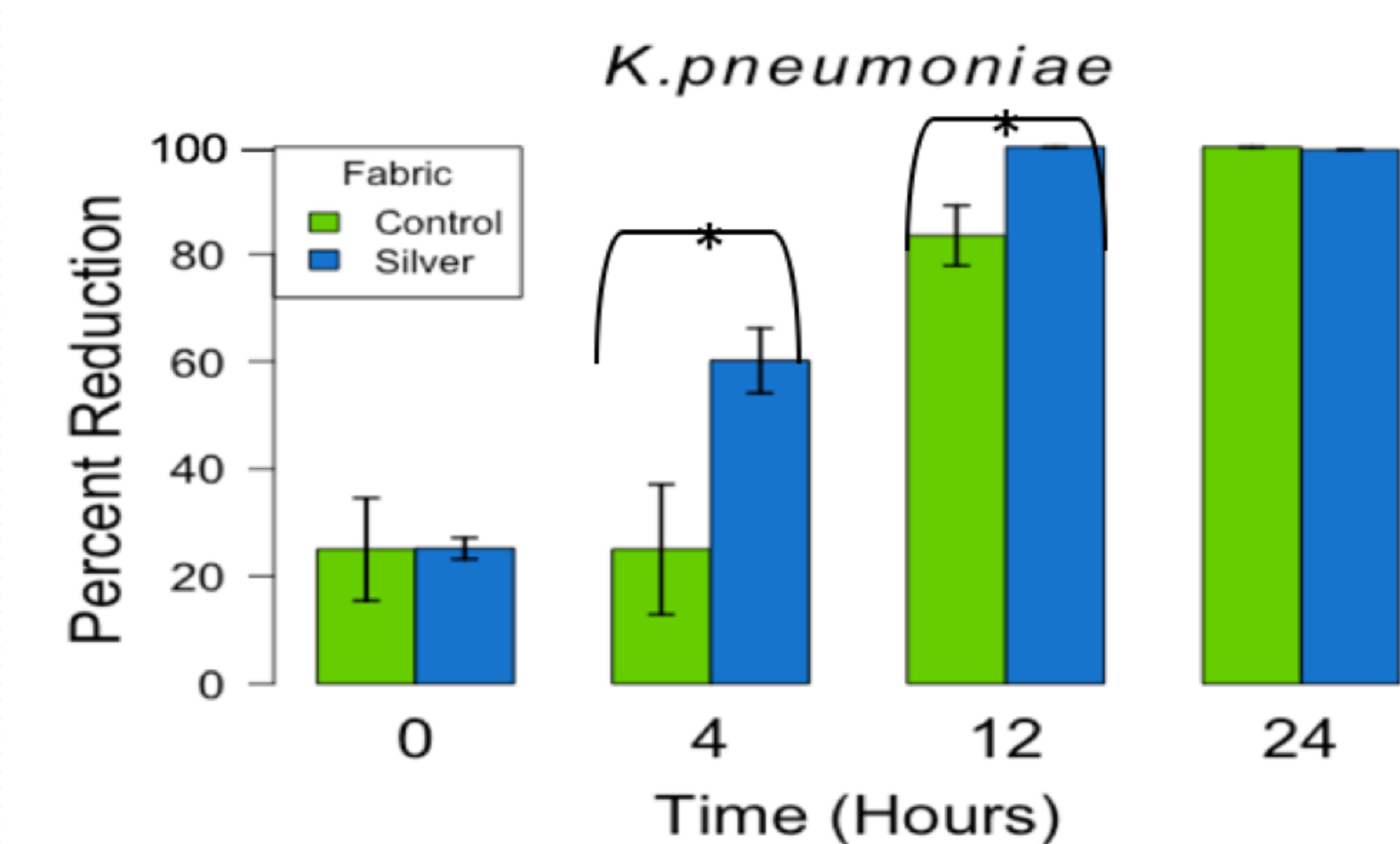
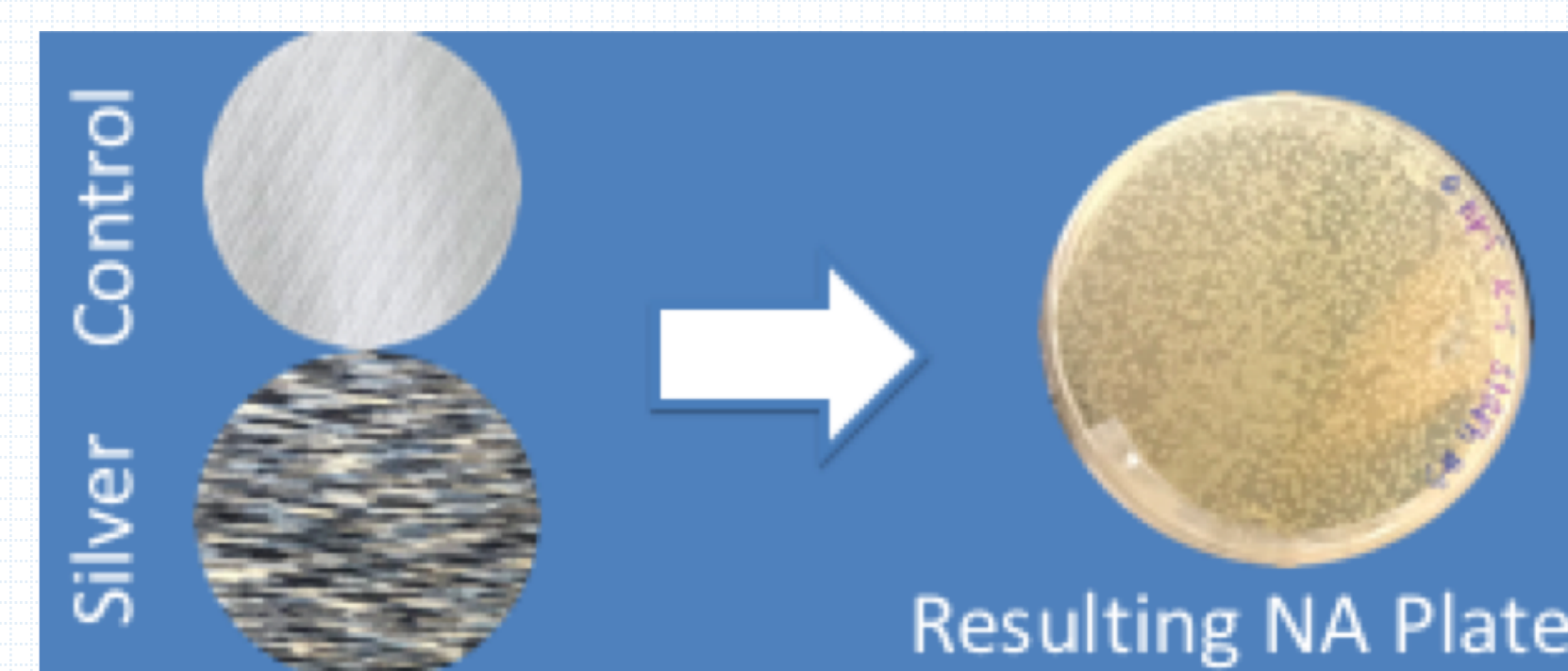


Figure 2. Analysis of a two-way ANOVA (d.f.=2, P-value_{Time} = 2.26e-09 *** P-value_{Fabric} = 0.0101 *, P-value_{Fabric*Time} = 0.0352 *). Error bars represent standard error. (*) represents p<0.05.

Methods

Cultures of *S. aureus* and *K. pneumoniae* were grown overnight at 37°C. 1mL of diluted cultures were then deposited onto a sterile control material and a experimental silver material and left in an empty petri dish. After 0,4,12, and 24 hours, materials were removed and vortexed in 5mL of sterile nutrient broth. 100µL of the resulting culture was then spread plated onto three replicates of nutrient agar plates, left to incubate for approximately 24 hours at 37°C, and then analyzed by the counting the number of colony forming units (CFUs) of the resulting agar plate. Percent reductions were then calculated by subtracting the number of CFUs counted by the calculated number of bacterial cells originally plated on the nutrient agar plate.



Conclusions and Future Directions

Results showed that while *S. aureus* was completely eliminated at 24 hours by both fabrics, the experimental silver fabric was able to eliminate *K. pneumoniae* by 12 hours compared to the 24 hours it took the control fabric(Figures 1&2). In conclusion, while the experimental silver fabric was able to reduce *K. pneumoniae* quicker than the control material, there was no difference in the efficacy at which either material eliminated *S. aureus*. Interestingly, this is a common finding among the literature and may be indicative of a general higher susceptibility of gram-negative bacteria to damage by silver than gram-positive bacteria (Dakal et al. 2016). Unfortunately, due to this undistributed result, this study is unlikely to go to clinical trials. However, continued research into methods that utilize antimicrobial agents, such as silver, will be essential to the reduction in the frequency of HAIs.

References

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