Using nsPEFs to sensitize MRSA to vancomycin treatment

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ABSTRACT

Staphylococcus aureus is a biofilm-forming pathogen. *S. aureus* treatment is marked by the development of antibiotic resistance. The public health impact has increased since the emergence of methicillin-resistant *S. aureus* (MRSA), which has started to show intermediate resistance to vancomycin in MRSA. Nano-second pulse electric fields (nsPEFs) are low-energy and high-power electric pulses, which have been suggested to sensitize pathogens to antibiotics by creating transient pores in the cell membrane. Our combinatorial treatment includes nsPEF pre-treatment and vancomycin post-treatment of MRSA cells. Our results show that MRSA log phase cells had the highest susceptibility to vancomycin. Surprisingly, MRSA biofilm cells were more susceptible to vancomycin when compared to MRSA stationary planktonic cells. These results demonstrate that nsPEFs could remove the pathogen's protective barrier that is caused by biofilms. They also have the potential of increasing the efficacy of current antibiotic treatments against other pathogens that are developing resistance to antibiotics.

INTRODUCTION

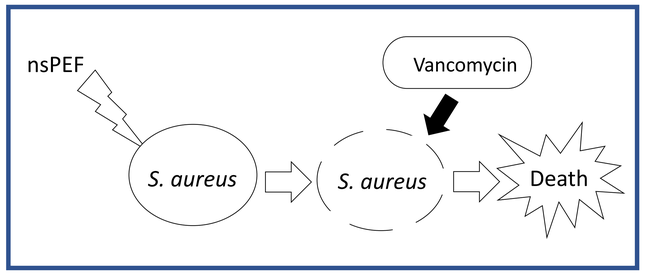

Figure 1. Schematic representation of the effect of nsPEF and vancomycin combinatorial treatment.

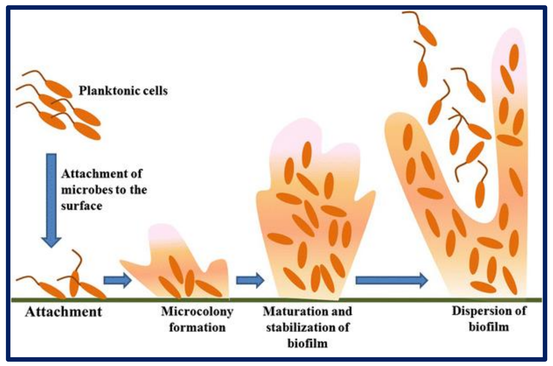

Figure 2. Schematic representation of biofilm formation

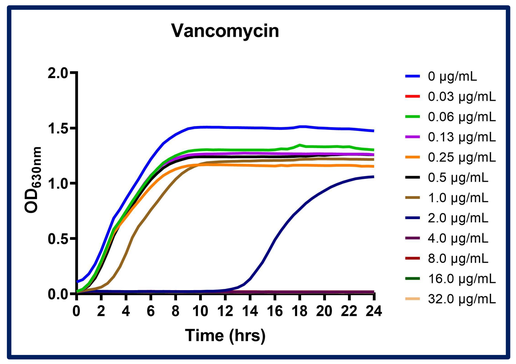

Figure 3. Effect of different concentrations of vancomycin on MRSA growth.

RESULTS

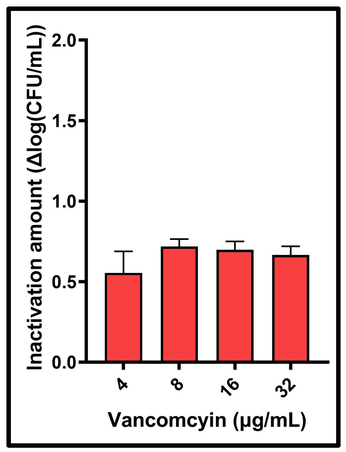

Figure 4. Effect of vancomycin on MRSA log phase cell viability.

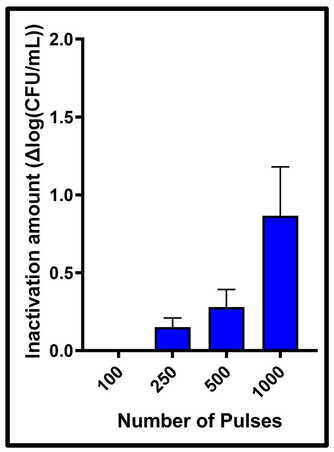

Figure 5. Effect of 300ns pulsed electric fields on MRSA log phase cell viability.

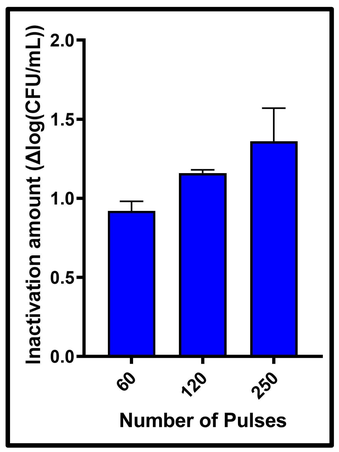

Figure 6. Effect of 600ns pulsed electric fields on MRSA log phase cell viability.

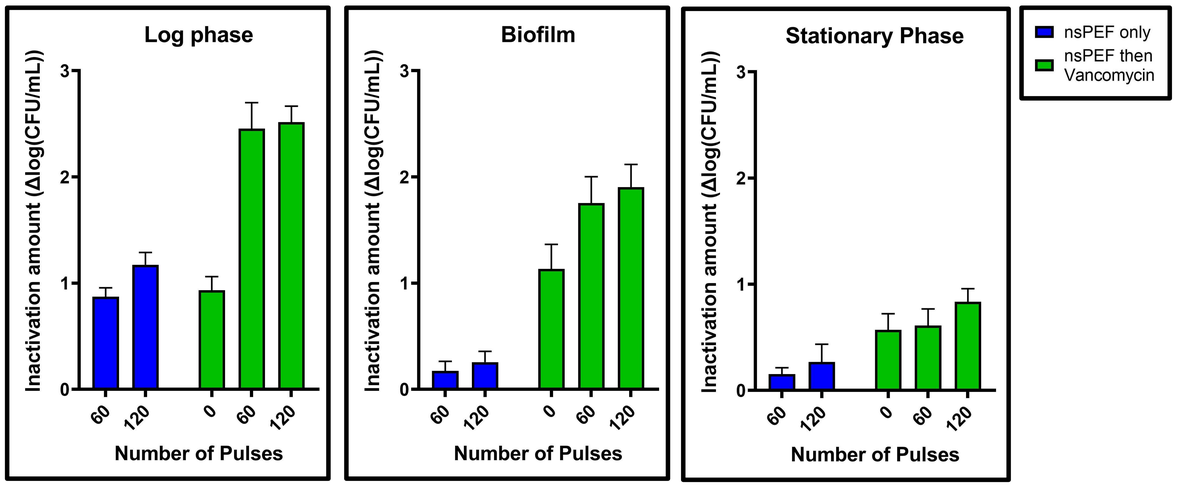

Figure 6. Effect of 600ns PEFs treatment only (black bars) or 600ns PEFs treatment followed by 40hr treatment with 1 µg/mL vancomycin treatment (gray bars) on MRSA cell viability.

CONCLUSIONS

- MRSA log phase cells have the highest susceptibility to vancomycin after nsPEF treatment.
- Surprisingly, MRSA biofilm cells were shown to be more susceptible to vancomycin, after nsPEF treatment, compared to MRSA stationary planktonic cells.

SIGNIFICANCE

- nsPEF treatment could remove the pathogen's protective barrier, caused by biofilms.
- This would have a major impact on increasing the efficacy of current antibiotic treatments against other pathogens.
- This treatment could also decrease the rate of multi-drug resistance.

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