Optimal Sound Frequencies for Targeted E. coli Biofilm Eradication on Indwelling Medical Devices

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Bacterial biofilms, which contribute 80% of microbial infections in humans, are difficult and expensive to treat due to their antibiotic resistance. This experiment investigated the potential of sound waves as a non-invasive, cost-effective, and safe solution for biofilm removal from indwelling medical devices. The impact of the frequency of sound waves on biofilm concentration was explored to test the hypothesis that higher frequencies exhibit greater efficacy in biofilm eradication. E. coli biofilm was exposed to sound waves at a frequency of 2,500 - 20,000 Hz for 30 minutes at each level. Biofilm formation and structure was analyzed qualitatively, and a Crystal Violet Assay was carried out. A spectrophotometer measured the absorbance at 600nm (with a dilution factor of 4), which correlated to the concentration of biofilm. All sound-exposed trials exhibited higher efficacy rates than the control (no sound). Of these, lower frequencies exhibited the highest efficacy, contradicting the hypothesis. Statistical Analysis (T-tests) rejected the null hypothesis. Additionally, lower frequencies resulted in fainter and more separated stains compared to higher frequencies and the control, reinforcing the quantitative data. This is likely due to acoustic resonance, which is dependent on a natural frequency that can be easily calculated, providing ideal frequencies for biofilm eradication on any medical device. The acoustic resonance of a well plate is 3916 Hz, supporting trends in the data. This study has shown that sound waves, particularly those aligned with a natural frequency, have the potential to be used as an alternative or supplementary method for removing biofilms from indwelling medical devices, greatly improving the lives of patients.