Fluorescence-Based Detection of Bacterial Porphyrins: Using the Odinwell Sensor

Background and Objective

The early identification of bacterial colonization in wounds is critical for preventing infection-related complications and optimizing treatment strategies. Certain bacterial species are capable of metabolizing 5-aminolevulinic acid (ALA) into porphyrins—intermediates in the heme biosynthesis pathway—which exhibit characteristic red fluorescence when excited by blue-violet light (approximately 405 nm). This biochemical property provides a potential diagnostic marker for bacterial presence, enabling non-invasive detection through bacterial autofluorescence [1,2].

The objective of the study was to evaluate the ability of the Odinwell sensor to detect porphyrin fluorescence produced by clinically relevant bacterial species following exposure to ALA, under conditions simulating wound environments.

Methodology

Three bacterial species commonly associated with wound infections—*Staphylococcus aureus, Pseudomonas aeruginosa, and Escherichia coli*—were cultured on ALA-supplemented substrates. Incubation was carried out at 34–37 °C for 2, 3.5, and 5 hours. A mixed-species sample was also included [3].

The experimental protocol was adapted from established porphyrin detection methods, including the porphyrin production test described by Lund and Blazevic [4] and the differentiation method developed by Kilian [5].

Fluorescence measurements were performed through wound dressing film using the prototype sensor. The system employed a 405 ± 5 nm excitation source, and emission spectra were recorded across the 300–900 nm range, with emphasis on the 600–700 nm interval where porphyrin-associated fluorescence is expected. Each sample was measured at the point of maximum signal intensity.

Results

- All three bacterial species produced detectable fluorescence within 2 hours of incubation, see Figure 1.
- Fluorescence intensity varied spatially, reflecting heterogeneity in bacterial distribution.
- *S. aureus* exhibited a distinct spectral profile compared to the Gram-negative species, suggesting potential for taxonomic discrimination, see Figure 2.
- The mixed-species sample also yielded measurable fluorescence, indicating the sensor's applicability in polymicrobial conditions.

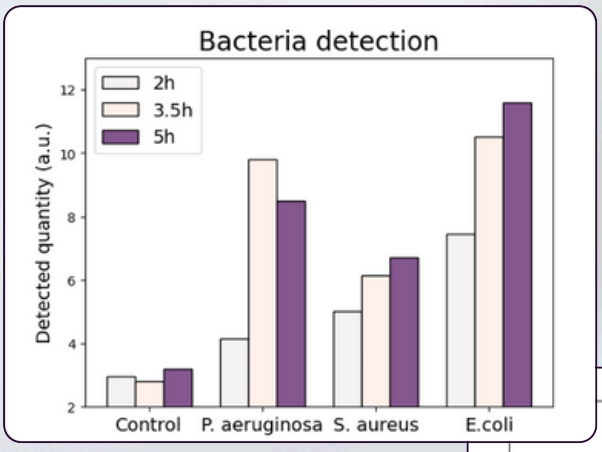

Figure 1

Displays the fluorescence levels of three wound-associated bacterial species, *P. aeruginosa, S. aureus, and E. coli,* alongside a control sample after 2, 3.5, and 5 hours of incubation.

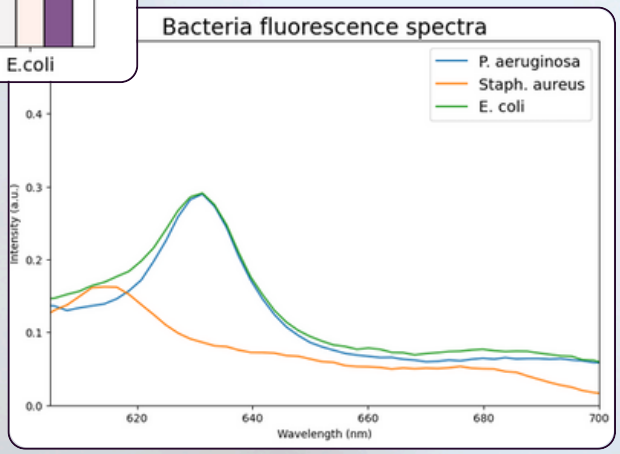

Figure 2

Illustrates the spectral profiles of three distinct bacterial species, highlighting clear differences in peak wavelengths between Gram-positive (*S.aureus*) and Gram-negative (*E.coli* & *P. aerginosa*) bacteria.

Conclusion

These findings provide preliminary validation of the sensor's capability to detect porphyrin fluorescence from wound-associated bacteria. The results support the potential of this technology for early, non-invasive detection of bacterial colonization in wounds. Furthermore, the observed spectral differences between bacterial species may offer opportunities for species-level discrimination in future clinical applications.

References

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