Combating Anti-Microbial Resistance by AI-Powered FILM

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Abstract

Multidrug-resistant (MDR) bacterial infections are among the most urgent and rapidly escalating global health threats of the 21st century. A major driver of this crisis is the empirical and often uncontrolled use of antibiotics, which is frequently unavoidable because traditional diagnostic methods are time-intensive, requiring approximately 48 hours to identify the infecting species and determine its antibiotic susceptibility. Notably, the first 24 hours are typically devoted solely to species-level identification, forcing clinicians to prescribe broad-spectrum antibiotics in the absence of definitive diagnostic information. This delay underscores the urgent need for a new approach that can rapidly deliver both bacterial identification and antibiotic susceptibility testing. Here, we present a platform that integrates Fluorescence-detected Infrared photothermaL Microscopy (FILM) with machine-learning-based spectral classification. AI-powered FILM enables single-cell identification of the five most common clinically relevant bacterial species with ~90% accuracy and determines susceptibility to two antibiotics with comparable accuracy. By combining photothermal imaging with data-driven classification, FILM reduces the time required for species identification and antibiotic susceptibility testing from approximately 48 hours using classical microbiology to less than one hour. This dramatic acceleration enables earlier, targeted antibiotic therapy, minimizing reliance on broad-spectrum antibiotics and helping to curb the spread of resistance. AI-powered FILM thus provides a rapid, accurate, and scalable diagnostic strategy with the potential to transform clinical decision-making and combat the global rise of MDR bacterial infections.