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MIDAS: rapid, multiplexed molecular profiling for integrated host–pathogen analysis

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Addressing the need for integrated molecular analysis in complex infectious conditions requires technologies that rapidly quantify both pathogens and host responses. This is particularly relevant in sepsis research, where existing tools typically measure either microbial or host biomarkers. Here, we present MIDAS (Multiplexed Intelligent Diffraction Analysis System), a proof-of-concept platform that integrates shape-encoded hydrogel particles with lens-free diffraction imaging and deep learning–based analysis to enable simultaneous quantification of bacterial RNA and inflammatory proteins in a single system optimized for potential point-of-care use. The assay completes multiplexed measurements in under 4 h, significantly faster than standard culture workflows (~20–40 h). Beyond spiked studies, MIDAS is evaluated using specimens from a clinically relevant porcine sepsis model, showing high concordance with culture, qPCR and ELISA. Although further clinical validation is required, this flexible platform may support the development of accessible host–pathogen profiling tools with broad applications in healthcare, agriculture, food safety, and beyond.

Sepsis—life-threatening organ dysfunction caused by infection[1]—affects more than 1.7 million Americans and kills ~270,000 annually, at a cost of USD$24 billion per year[2,3]. It is the leading cause of death among hospitalized patients[4,5], and survivors of sepsis often face profound long-term health consequences (e.g., neurocognitive impairment)[6–8]. Prognosis for septic patients deteriorates hourly in the absence of appropriate treatment[9,10]; therefore, earlier identification of sepsis and focused treatment are keys to improve patient outcomes. Unfortunately, current diagnostic methods often fail to provide timely and produce actionable results in busy clinical settings. Clinicians currently rely on nonspecific clinical criteria (e.g., heart rate, blood pressure, respiration rate) to identify potentially septic patients, leading to high false positive rates[11,12]. Without rapid and specific diagnostic tests, patients with suspected sepsis are frequently subjected to unnecessary and excessive antibiotic administration, propelling the development of antibiotic resistance.

Sepsis pathophysiology is driven by complex interactions between the causal pathogen and the host response, making both

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