Pneumatic Enabled Nano-Sieve for Sensitive Detection of Pathogens in Blood

Ke Du (The University of California, Riverside)

Sepsis poses a severe and potentially life-threatening risk, arising from various pathogens, including bacteria, viruses, fungi, and parasites. Beckman Coulter's study reveals that sepsis accounts for approximately 19.7% of global deaths annually. Early identification of sepsis is paramount for effective treatment and mortality reduction. However, its detection is challenging due to low pathogen concentrations in the blood and a critical 3-hour detection window as sepsis progresses rapidly.

In addressing this challenge, we introduce a miniaturized nano-sieve device featuring a pneumatically-regulated chamber for highly efficient pathogen purification from blood. Utilizing packed magnetic beads as a matrix and capitalizing on the deformability of the nano-sieve channel, we achieve a remarkable on-chip concentration factor of ~15-fold for methicillin-resistant *Staphylococcus aureus*. Integration of this device with recombinase polymerase amplification and clustered regularly interspaced short palindromic repeats (CRISPR)-Cas detection system yields an on-chip detection limit of approximately 100 cfu/mL.

To enhance versatility, we present an enhanced nano-sieve version by incorporating "micro-grooves" in the channel to create a low-flow rate zone, facilitating the detection of smaller pathogens like viruses. This innovative approach offers a rapid, precise, and centrifuge-free solution suitable for point-of-care diagnostics, with the potential to enhance patient outcomes, particularly in resource-limited medical conditions.