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(G*) Non-invasive optical monitoring of peripheral and cerebral vasomotion in early sepsis

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Introduction: Sepsis is a life-threatening host response to an infection that disproportionately affects vulnerable and low-resource populations. Since early intervention increases survival rate, there is a global need for accessible technology to aid with early sepsis identification. Peripheral microvascular dysfunction (MVD) is an early indicator of sepsis that manifests as impaired vasomotion in the skeletal muscle–that is, low-frequency oscillations in microvascular tone independent of cardiac and respiratory events. Previous studies have used oscillations in hemoglobin content (*HbT*), oxygenation (*StO2*), and perfusion (*rBF*) as sensitive markers for vasomotion. These physiological parameters can be monitored non-invasively with near-infrared spectroscopy (NIRS) and diffuse correlation spectroscopy (DCS). The objective of this study was to use a hybrid NIRS/DCS system to continuously monitor peripheral and cerebral vasomotion in a rat model of early sepsis.

Methods: 14 Sprague-Dawley rats were used for this study. Control animals (n=4) received an intraperitoneal (IP) injection of saline, while the experimental group (n=10) received an IP injection of fecal slurry to induce sepsis. Optical probes were secured on the scalp and hind limb of animals for simultaneous NIRS and DCS measurements. Peripheral and cerebral *HbT*, *StO2*, and *rBF* were quantified from NIRS/DCS measurements using algorithms developed in MATLAB. Continuous wavelet transform was used to dynamically isolate low-frequency isolations from the three parameters. Two-way ANOVAs were used to investigate power of vasomotion in all three hemodynamic parameters for differences across condition (control, septic) and time (period 1 = 0.5 - 2 h, period 2 = 2 - 4 h, period 3 = 4 - 6 h).

Results: Power of peripheral vasomotion was significantly higher in septic animals as reflected in all three parameters during periods 2 and 3. Power of cerebral vasomotion was significantly higher in septic animals only in the *HbT* signal.

Conclusions: Optical spectroscopy can be used as a non-invasive tool to detect peripheral MVD. Importantly, our results suggest that while the brain is partly protected, the skeletal muscle is a consistent early diagnostic target for sepsis. Limitations include the use of homogenous animal model. Future work will seek to validate these techniques in ICU patients.

Keyword-1

Sepsis

Keyword-2

Microvascular Dysfunction

Keyword-3

Optical Spectroscopy

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