

Point of Care Spectroscopy - Multimodal Biophotonics Probe for Objective Assessment of Burn Injury Severity in the Surgical Burn Unit

Aalap Herur-Raman MD MS, Virginia Commonwealth University, Richmond, VA, USA; **Prabhu Senthil-Kumar MD**, Virginia Commonwealth University, Richmond, VA, USA; **Jaishankar Raman MBBS, MMed, FRACS, PhD, FCSANZ**, University of Melbourne, Melbourne, VIC, Australia

Abstract

Accurate and objective assessment of burn wound depth remains a persistent clinical challenge that directly influences surgical decision-making, wound management, patient outcomes, and length of stay. Traditional visual and tactile evaluation suffers from substantial inter-observer variability and limited sensitivity for partial thickness burns, often delaying optimal intervention. To address this, we propose the development and clinical validation of a novel bedside multimodal probe that integrates infrared spectroscopy, Raman spectroscopy, and confocal microscopy among other biophotonic techniques for real-time analysis of skin in patients with acute burns.

Infrared spectroscopy and near-infrared (NIR) spectroscopy have demonstrated the ability to detect physiologic changes in tissue oxygenation, water content, and hemoglobin distribution that correlate with burn injury depth more reliably than visual assessment alone. Raman spectroscopy provides a molecular fingerprint of biochemical alterations following thermal injury, including collagen denaturation and protein conformational changes, and has shown promise in differentiating burn depth and severity especially when combined with complementary optical modalities like Optical Coherence Tomography (OCT). Confocal microscopy delivers cellular-level morphological information, allowing submicron visualization of epidermal and dermal architecture that parallels histologic evaluation.

Prior research in multimodal imaging for burn evaluation has underscored the value of combining structural and biochemical diagnostics. Reviews of these tools in burn assessment further highlight that single-modality approaches provide valuable but incomplete diagnostic information when used in isolation.

The proposed integrated probe will co-register high-resolution morphological, biochemical, and spectroscopic data at the point of care, enabling clinicians to objectively quantify burn severity and predict healing potential within

minutes at the bedside. Such an approach could refine surgical triage and re-excision timing, inform decisions regarding optimal wound care agents, and improve overall clinical outcomes in the burn unit.