THE HARTWELL FOUNDATION

2020 Individual Biomedical Research Award

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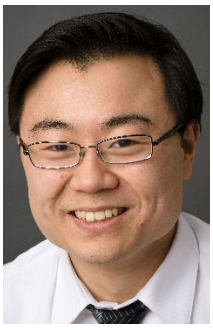

Predicting Sepsis with a Machine Learning Algorithm Enabled by Continuous Monitoring of Cardiovascular Health

Sepsis is the whole-body inflammatory immune response to a life-threatening bloodstream infection (septicemia). It occurs most frequently in newborns and infants and is a leading cause of pediatric death. The early signs of sepsis depend somewhat on age and variously include high fever, fatigue, rapid heart rate, difficulty breathing, mental confusion, severe pain and discomfort, and an increase in white blood cell count. Elapsed time to intervention is critical, because if the subtle symptoms go unrecognized or treatment is delayed in time for adequate resuscitation, blood circulation to the brain, heart, and kidney will decrease, resulting in blood clots and a dramatic drop in blood pressure that leads to cardiovascular collapse (septic shock) and a fatal outcome. With more than 72,000 children and teens in the United States hospitalized annually with sepsis, mortality is high, ranging from 5-25%. Early detection and appropriate intervention can decrease mortality and improve patient outcomes. Unfortunately, existing beneficial computer-based surveillance algorithms are reliant on intensive clinical observation and the limitations of source data recorded in electronic health records. This is because surveillance strategies designed to recognize the early warning signs of sepsis depend on medical device monitoring systems that are hindered by proprietary machine platforms, which limit access to measurement parameters and raw data essential for independent development of a real-time signal processing. To address these issues, Steve proposes to develop a generalized algorithm for sepsis that leverages the unique capabilities of an ICU-grade medical device platform that he co-invented to enable non-invasive, continuous monitoring of vital signs in children. Deploying wireless data transmission to a computer system that supports real-time signal processing with negligible time delays, the technology will also provide novel quantitative information on hemodynamic and cardiovascular health states, including advanced measurements like continuous blood pressure and pulse wave velocity, temperature differentials, heart vibrations, and even vocalizations. Configured with machine learning software, the system will be trained to identify patterns in raw data input (phenotype) that will warn of impending deterioration from pediatric sepsis. The algorithm will be based on prospectively collected clinical data in parallel with input using refined electronic health records from critically ill children. Once the device is trained, artificial intelligence software will interpret patient data that hasn't been seen before and considering the balance of sensitivity, specificity and accuracy, make timely predictions about pediatric sepsis while dynamically updating and refining the algorithm. If Steve's approach to leverage a powerful physiological data monitoring and sentinel system can be translated clinically to broad deployment in U.S. hospitals, early detection of sepsis will improve clinical outcomes and prolong the lives of affected children.