

THE HARTWELL FOUNDATION

2024 Nominee Individual Biomedical Research Award

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Deep Learning Model to Improve Critical Event Prediction in Hospitalized Children



Pediatric hospital teams must balance many competing tasks in a high-risk and hectic setting. They must quickly and accurately diagnose sepsis, titrate respiratory support, and identify patients requiring intensive care. Timely completion of these tasks is necessary to avoid worsening illness or death. To improve data-based decision making, single task predictive models are often developed to alert teams of impending critical events. However, these models suffer from high false positive rates and poor generalization outside of their training data. This may stem from challenges inherent in pursuit of child wellness. In children, the context of each observation is essential, and the same vital sign can be normal or abnormal based on age or medical condition. Furthermore, children often have a greater physiological reserve than adults, and therefore clues to impending serious illness may be more subtle. Thus, to improve critical event prediction in hospitalized children, it is essential to develop methods that can handle nuances specific to children. This information could be leveraged through alerts, by enabling early intervention, and revealing patterns of disease physiology to inform new treatment strategies. A class of deep learning models known as “transformers” and an approach called “pre-training” has revolutionized language modeling in recent years. Transformers are not specific to language, but at their core are an efficient model for complex sequences of data where context is critical. Pre-training refers to training the model on a broad data set using a general task, such as predicting the next data element given prior data, to create what is called a foundation model. Because the pre-training task may embody completing hundreds or thousands of simultaneous tasks, this model can serve as a “foundation” on which the model is optimized to perform specific tasks following fine tuning. This approach has not been leveraged in pediatric populations, and therefore has tremendous potential to improve care for hospitalized children. To improve critical event prediction in hospitalized children, I will develop a deep learning foundation model of the health trajectories of hospitalized children using a novel method to incorporate categorical and numeric data that will be fine-tuned for specific clinical prediction of sepsis, respiratory disease, ICU transfer, and patient discharge with interpretable explanations for model predictions. If successful, this predictive model will have direct translational benefit by enabling the development of alerts to ensure timely clinical intervention of hospitalized, critically ill children.