Optimal Admission and Discharge Decision-Making in an Intensive Care Unit

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Challenge

An Intensive Care Unit (ICU) is a highly specialized and costly section of a hospital, and houses some of the most critically ill patients in the healthcare system. The dynamic ICU system has multiple attributes that strain the clinical and medical decision-making tackled constantly by physicians and nurses. In addition, capacity issues elsewhere in the hospital and healthcare network affect operations in the ICU. The administration of the ICU at St. Michael's Hospital therefore sought assistance to help maximize patient flow within the ICU.

Methodology

The daily operations of the ICU and the decision-making processes of physicians were observed in the actual ICU setting, to identify the areas of uncertainty and the decision epochs (i.e. sequence of time points when decision is required). From here, we modeled this uncertain, continuous decision-making problem using a Markov Decision Process where we classify patients based on their origin, severity and estimated length of stay. For inputs to the model, we collected data from the actual ICU and recorded preferences in the decision-making of physicians and nurses. We completed the model by developing its functionality to generate optimal policies to derive a decision based on the current snapshot of the ICU and the event that has occurred.

Results and Impact

The optimization model provides a decision-making framework for the ICU physicians, to make decisions more consistent amongst different physician teams and provide a basis for training in the ICU. The data-driven approach helps physicians with capacity planning by showing the impact of their admission and discharge decisions on future capacity and flow of patients in the ICU. The model also illustrates the impact that downstream capacity issues, such as insufficient floor beds, could have on ICU operations.

Partner Profile

St. Michael's Hospital (SMH) is a teaching and research hospital located in the downtown core of Toronto. Known for providing exceptional patient care, SMH is home to four specialized ICUs: Medical Surgical, Cardio Vascular, Trauma and Neurosurgery, and Coronary Care. Each ICU houses specific types of patients requiring specialized needs, care or equipment. Decision-making within each ICU is performed by a team of physicians, nurses, technicians and other healthcare professionals.

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