Patient-centered Resuscitation: Optimizing Response to Acute Physiological Deterioration in Hospitalized Patients

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Unexpected acute and persistent physiological deterioration (APD) of the hospitalized patients is a critical problem in United States. Unrecognized or unanticipated APD may result in preventable respiratory instability, cardiac arrest and death. Early Warning Scores (EWS) have been implemented in hospitals for clinical assessment of deterioration and the activation of a Rapid Response Team (RRT) to provide acute medical care on the general floor. However, the current clinical implementation of EWS relies on fixed scores for the RRT activation without considering patient characteristics. With the goal of individualizing the acute medical care interventions, we use electronic medical records (EMR) to identify twelve statistically significant subpopulations using prior adverse event experience, risk for frailty at admission, and admission type (i.e., medical or surgical). We develop infinite horizon semi-Markov decision process (SMDP) models to optimize the acute medical care metrics time to stabilization and failure to rescue while capturing the care provider team resource intensity as a function of patient type and EWS. The optimal policies result in two categories of RRT activation rules. We provide theoretical insights into the optimal policy structure and the implications for clinical practice. In addition, our findings identify the time-based resource requirements as a function of the patient subpopulation and EWS observation.

Julie Simmons Ivy is an Associate Professor in the Edward P. Fitts Department of Industrial and Systems Engineering and Fitts Faculty Fellow in Health Systems Engineering. She previously spent several years on the faculty of the Stephen M. Ross School of Business at the University of Michigan. She received her B.S. and Ph.D. in Industrial and Operations Engineering at the University of Michigan. She also received her M.S. in Industrial and Systems Engineering at Georgia Tech. She is an active member of Institute of Operations Research and Management Science (INFORMS), Dr. Ivy served as the 2007 Chair (President) of the INFORMS Health Applications Society (HAS) and is currently the President for the INFORMS Minority Issues Forum. Her research interests are mathematical modeling of stochastic dynamic systems with emphasis on statistics and decision analysis as applied to health care and public health. The focus of her research is decision making under conditions of uncertainty with the objective of improving the decision quality. Dr. Ivy's research program seeks to develop novel concepts of maintenance and monitoring policies and associated scientific theories, and apply to medical decision making. Dr. Ivy has extensive background in stochastic modeling, in particular the application of partially observable Markov decision processes (POMDPs) and Markov decision processes (MDPs). Dr. Ivy's medical decision making research relates to studying the cost-effectiveness of mammography screening, dynamic breast cancer screening policy development, false positive prediction as a function of breast cancer screening policy, the impact of comorbidity on breast cancer patient outcomes, modeling birth delivery choice as a function of long term consequences such as pelvic floor dysfunction, and public health preparedness. Her research has been funded by the NSF and the Centers for Disease Control.

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