

The Hong Kong University of Science and Technology
Dept of Information Systems, Business Statistics
and Operations Management
Frontiers in Operations Management Workshop



**Emergency Department Modeling and Staffing:
Time-Varying Physician Productivity**

by

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Date : **2 December 2021 (Thursday)**
Time : **3:00 - 3:30 PM**
Venue : **Room G012, LSK Business Building, HKUST**



Abstract: Motivated by an intriguing observation on the time-varying physician productivity (measured by the number of new patients seen per hour, or PPH), we study a continuous-time optimal control problem to understand the transient behavior of individual physicians within their shifts in emergency departments (EDs). By applying Pontryagin's maximum principle, we characterize the optimal policy and provide insights into physician capacity, productivity, and throughput. We conclude that the transient behavior is intrinsic, mainly induced by shift-based scheduling. We leverage the insights from the time-varying PPH to model the complex ED system as a time-varying multi-server queue with shift-hour-dependent service rates. Validated using data from two Canadian EDs, the simulation results show that our model can accurately capture the time-of-day-dependent patient waiting times with a simple parameter estimation procedure, which is among the first in the literature. In contrast, the simulated waiting times under constant PPH rates deviate significantly from the data. Hence, it is important to explicitly consider time-varying service rates to obtain accurate and valuable models for ED operations. The essence of our model is dimension reduction by state aggregation. As a result, it also allows transient analysis through the uniformization of a continuous-time Markov chain, which can be integrated with off-the-shelf algorithms for physician staffing. Our case study using data from a Canadian ED shows that the new staffing schedule generated from our method can significantly improve the current schedule in practice.

Bio: Dr Zhankun Sun received his bachelor's degree in Industrial Engineering from Tsinghua University and PhD in Statistics and Operations Research from the University of North Carolina at Chapel Hill. He is currently an Assistant Professor at the City University of Hong Kong. His research interests include stochastic modeling and optimal control, especially with their applications in healthcare operations and smart-city operations. He is a recipient of the George E. Nicholson Award from UNC Chapel Hill and Best Service Science Student Paper Award from INFORMS.

All interested are welcome!
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