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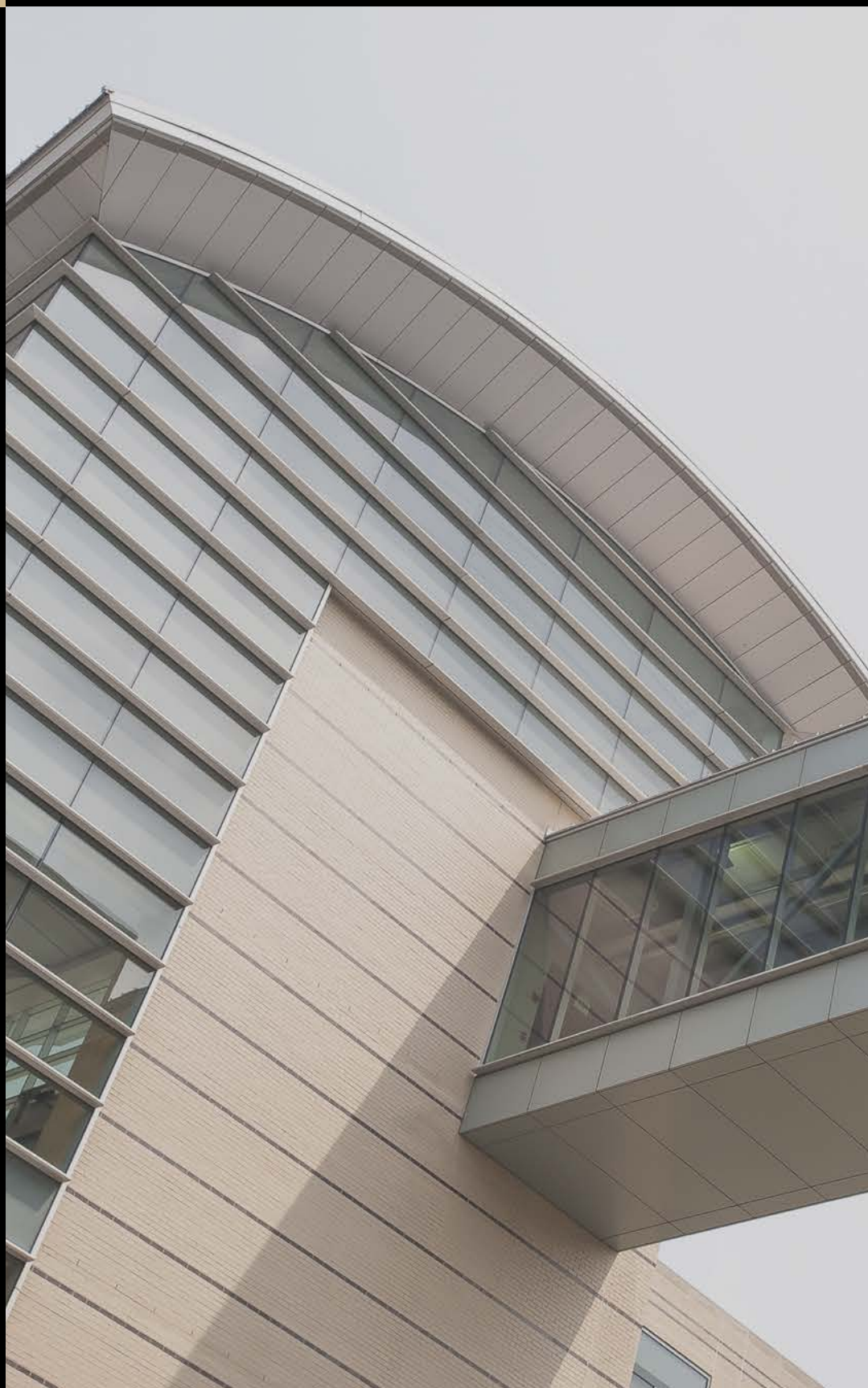

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No Room in the Hospital? An Analytical Tool Helps Doctors Decide Which Patients to Discharge

by Melvin Durai

The COVID-19 pandemic has put immense stress on hospitals around the country, many of them struggling to provide enough beds to accommodate the surge in patients. To create room for all these new patients, hospitals have been forced to discharge existing patients earlier than expected. But even in ordinary times, hospitals face difficult decisions regarding when to discharge patients. Sending them home early alleviates overcrowding and reduces costs, but it may put their health at risk, increasing the chances that they'll be back in hospital beds within a few weeks.

So how do hospitals manage this tradeoff between readmission risk and ward congestion? They follow an unstructured, reactive approach, according to Pengyi Shi, assistant professor of operations management in Krannert School of Management.

Source:
Pengyi Shi

Shi and her co-researchers found that at some hospitals, including a partner hospital in Indiana where they conducted research, a typical response to overcrowding is to send a message to all physicians asking them to discharge as many patients as possible.

"Without an analytical guided tool, the doctor may be discharging a suboptimal set of patients, and may overreact to this message by discharging too many patients unnecessarily," Shi said.

Collaborating with Jonathan E. Helm of Indiana University's Kelley School of Business, as well as Jivan Deglise-Hawkinson and Julian Pan of Singapore-based Lean Care Solutions, the data analytics contractor at the partner hospital, Shi developed a data-integrated decision support framework for managing the tradeoff between readmission risk and inpatient crowding.

It optimizes not only the number of patients to discharge each day, but also which patients specifically to discharge, based on personalized risk estimations as a function of length of stay.

"This framework can help support the discharge decision, particularly when the hospital is facing high demand, such as in the peak time of COVID," Shi said. "It can help balance many objectives in real time, which is difficult to be done by individual doctors."

The researchers describe the framework in a paper entitled "Timing it Right: Balancing Inpatient Congestion versus Readmission Risk at Discharge," accepted for publication on Dec. 30, 2019, in *Operations Research.*

In the paper, which has won several awards, including the 2018 Pierskalla Best Paper Award, INFORMS, the researchers discuss some of the complexities that their decision support framework needed to address.

"Uncertainty is one of the biggest challenges," Shi said. "That is, the amount of patients that will eventually show up at the hospital, and the type of new patients who will show up. Also, for existing patients in the hospital, they may have very diversified characteristics, such as the type of disease, how well they've recovered, whether they have support at home after being discharged – all these factors would affect their risk of being readmitted."

To create their discharge decision framework, the researchers built a large-scale Markov Decision Process (MDP) based on a patient flow model with re-entries. Unlike traditional service rate control models, it accounts for personalized patient risk trajectory and their history-dependent state.

The researchers tested their decision framework through a counterfactual study that used historical data from their partner hospital. They found that their tool would have potentially prevented more than 50 percent of actual readmissions by suggesting that the patients' length of stay be extended. Increasing the length of stay moderately can reduce the readmission risk significantly.

The "plug-and-play" design of the framework allows it to be easily adapted to a broad range of hospitals and hospital IT systems.

The researchers note that discharge decisions are complicated and involve a variety of factors. They emphasize that their tool is meant to provide analytical support for discharge decisions. Doctors can still use their own discretion in discharging patients and the tool would accommodate such deviations.

"The tool is providing a recommendation, not forcing doctors to use it," Shi said. "The doctors make the final call. Providing this flexibility is very important for implementation to work in healthcare. The tool can adjust to make subsequent recommendations after seeing the actual action doctors made."

Krannert School of Management

Writers:
Melvin Durai

Faculty:
Ben Dunford
Tongseok Lim
Ben McCartney
Hojun Seo
Pengyi Shi
Umit Ozmel Yavuz

Krannert School of Management Department Head Office:

Ananth Iyer, Department Head

Christa Jackson
Dean's Office Administrative Assistant

Krannert School of Management
Krannert Building
403 S. State Street
West Lafayette, IN 47907
(765) 494-6532

@PurdueKrannert

Krannert School of Management

Comments? krnmgmth@purdue.edu