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A SIMULATION-BASED DECISION SUPPORT SYSTEM TO PROGRAM SURGERY BLOCKS IN A PRIVATE HOSPITAL

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EXTENDED ABSTRACT

This document presents a project required by a private hospital in Santiago, Chile, which included the development of a simulation model that replicates the flow of patients within the hospital. The main objective of this project was to develop a tool to evaluate different strategies to optimize the use of beds and operating rooms at the hospital.

The study considered all types of patients who are hospitalized, whether surgical or medical, scheduled or spontaneous. The flow of patients is considered from the admission to the hospital and until the patient is discharged. During the stay, the patient may spend a number of nights in different units (Medical-Surgical, Intensive Care, among others). Furthermore, some patients may require surgery, which implies a flow to operating rooms, including preparation, pre-anesthesia and recovery.

The hospital has 350 beds, distributed in 11 different units, and 13 operating rooms, one of which is reserved for unscheduled surgery (coming from the ER) and one for coronary surgery.

70% of the occupancy of the hospital is explained by spontaneous arrivals: emergency procedures, unscheduled surgeries, cancer treatments, among others. The remaining 30% is generated by the stay of patients undergoing scheduled surgeries.

These surgeries are scheduled using what is called a surgical block, that is, each operating room is assigned a medical specialty, for a period of time. Then, doctors schedule their surgeries depending on their specialty at these times. More than 90% of scheduled surgeries are made between Monday and Friday, generating a significant seasonal effect. While on weekends the hospital shows a significantly lower occupancy, in the middle of the week the occupancy can reach levels above 90%, which translates into longer waits for beds and a general deterioration of service quality.

The sequence of beds and the stay of a patient that undergoes surgery depends on the surgery performed (and therefore the surgical group), the age of the patient, the severity of the condition, among other reasons. There are more than 650 different surgeries, each one with different possible sequences of beds, and different patient characteristics. To reduce the thousands of probability distributions required and to focus on the objectives of the project, the unit of analysis considered is the medical specialty for the surgical patients. For each medical specialty, there is a probability distribution for the sequence of beds and the length of stay in the hospital. This allows to analyze the impact of modifying the surgical blocks in occupancy and waiting times of patients by unit, by day, by hour.

Data from the first half of 2014 were considered to compute all probability distributions employed in the model. To validate the simulation model, the March-April-May 2014 quarter was considered. The model was able to estimate occupancy and waiting times, with a global accuracy of 6%.

Different schedules were evaluated. First, a greedy heuristic was used to schedule the surgical blocks, permuting them between different days of the week. This method achieved a reduction of 10% in the average patient's wait for a bed, and distributed the patients more evenly during the week, reducing the usual half-week occupation peaks by 3%.

Other schedules were evaluated, adding surgical blocks on the weekend, and subtracting them from the week. First, the surgical blocks in one of the operating rooms were switched to Saturday, between Monday and Friday. A similar experiment was then performed, but moving the surgeries equivalent of two operating rooms per day, adding surgeries on Saturday and Sunday respectively. These scenarios reduced waiting times by 16% and 10% respectively, and reduced peak average congestion by 3% and 4% respectively.

Bed occupancy is the bottleneck in the hospital. Reducing peak occupancy (like it was done in the previous experiments) allows more surgeries to be scheduled, and more patients to be hospitalized, increasing the hospital real capacity. Three scenarios were evaluated. In the best one, based on the greedy schedule previously presented and combined with an increase in the utilization of Saturday's surgery blocks, a 10% increase in the number of schedules surgeries and a 4% in the number of weekly bed-days was obtained, without increasing the peak occupation of the clinic compared to the base case.

In addition to evaluating different schedules of operating rooms, the model allows evaluating other key parameters of the operation of the hospital. One is the probability distribution of the patient's time of discharge and transfers between beds, in which the hospital has no clear policies today. Another parameter in the model is the bed allocation policy, which determines how the queues are set up within the hospital. By analyzing these policies, patient's and unit's waiting time goals can be set and monitored. Furthermore, the model also allows assessing referral policies, and determine under what conditions of occupancy the hospital should start referring patients with non-severe conditions.

Finally, the model also allows to change the arrival rate of patients and the scheduled utilization of the operating rooms, allowing to use the model as a tool to plan the growth of the hospital.

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