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Solving the negative impact of congestion in the postanesthesia care unit: a cost of opportunity analysis

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ABSTRACT

Background: Congestion in the postanesthesia care unit (PACU) leads to the formation of waiting queues for patients being transferred after surgery, negatively affecting hospital resources. As patients recover in the operating room, incoming surgeries are delayed. The purpose of this study was to establish the impact of this phenomenon in multiple settings.
Methods: An operational mathematical study based on the queuing theory was performed. Average queue length, average queue waiting time, and daily queue waiting time were evaluated. Calculations were based on the mean patient daily flow, PACU length of stay, occupation, and current number of beds. Data was prospectively collected during a period of 2 months, and the entry and exit time was recorded for each patient taken to the PACU. Data was imputed in a computational model made with MS Excel. To account for data uncertainty, deterministic and probabilistic sensitivity analyses for all dependent variables were performed.
Results: With a mean patient daily flow of 40.3 and an average PACU length of stay of 4 hours, average total lost surgical opportunity time was estimated at 2.36 hours (95% CI: 0.36-4.74 hours). Cost of opportunity was calculated at $1592 per lost hour. Sensitivity analysis showed that an increase of two beds is required to solve the queue formation.
Conclusions: When congestion has a negative impact on cost of opportunity in the surgical setting, queuing analysis grants definitive actions to solve the problem, improving quality of service and resource utilization.

Introduction

Patient flow is one of the keystones of hospital function. It is determined by overall patient admission and discharge rates, staff availability, patient transporters, and service complexity.[1,2] As a determinant of hospital revenues and service quality, inefficient flow is one of the most important issues to correct.

The setting for this study is the Hospital Universitario San Ignacio, a third level university hospital located in Bogota Colombia. Hospital Universitario San Ignacio serves as teaching facility for students, both in medical school and

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residency programs for the Pontificia Universidad Javeriana. This institution is considered to have a high patient flow by Colombian standards. Many services, including the emergency room, radiology unit, and postanesthesia recovery unit are often fully occupied and congested. The problem lies within a greater service demand over actual capacity, which creates a bottleneck in patient flow. An inevitable phenomenon, which presents itself in this situation, is queues or waiting line formation. To compensate for congestion, patient recovery occurs in the operating room (OR) directly after surgery. This causes delay in other aspects of the surgical process, including OR preparation and OR occupancy time, thus creating congestion in the entire surgical unit. In the case of OR congestion, delayed surgery represents a serious problem. In cases such as trauma or emergency surgery, patients often have to be referred to other institutions. In other cases, such as scheduled surgery, many procedures can be canceled or reprogrammed, thus perpetuating the problem. This translates to lower number of patients treated, an increase workload for nursing staff,[3] a decrease in staff morale,[4] fewer opportunities for surgical residents to perform procedures, and ultimately, a potential loss in revenues for the institution.

Many strategies intended to correct this problem have been proposed. Implementing efficient nurse schedules with overlapping shifts, adjusting staffing each day, and guaranteeing a steady flow of patients with an efficient surgical schedule can lead to considerable improvement in PACU efficiency.[5] If these measures are implemented and the congestion problem persists, adding capacity becomes a necessity.

As with most processes, optimization is very important in creating efficient systems that reduce bottlenecks, while consuming the least amount of resources. Thus, the ideal number of additional beds should be determined based on informed and planned strategies, preferred over the trial and error approach, saving both time and money in the process. Queuing theory is one of the many strategies that are used in optimization analysis. This theory helps to understand the behavior of queuing systems and their underlying processes. Considered to be simple, applicable to complex systems, and capable of predicting future results,[2] queuing theory is ideal in helping health care professionals in resource allocation and optimization decision-making.

It was hypothesized that queuing theory can correctly estimate waiting time in the PACU setting. As a result, the objectives of this study were to validate queuing theory for the analysis of PACU capacity and waiting times.

As secondary objectives, the determination of the impact of delays in terms of economic losses due to OR underuse and the proposal of an optimized solution for the congestion problem were pursued.

Methods

Ethical considerations

Taking into account that the functional and capacity data of units were analyzed, no personal information or clinical history contents were recorded. According to local regulations concerning ethical aspects of research in health, including research in health provision services, this type of study (i.e., analyzing data without the modification of biological, physiological, or psychological variables) is considered a "risk-free" study.[6] Approval of the institutional research and ethics board was granted.

System overview

Patient recovery after surgery occurs in a unit comprising 15 beds. Patient flow comes from 11 ORs and can follow two discharge pathways. The first is admission to the PACU, representing approximately 90% of patients. The second is recovery in other departments, such as the ICU or hospitalization rooms, without the need of recovery in the PACU. The latter case is reserved for special cases, such as critically ill patients or multidrug-resistant infected patients. In cases such as cardiovascular surgery, ICU availability is required before the surgical procedure. If no rooms are immediately available, recovery occurs in the PACU, with priority discharge to the other departments. This phenomenon is relatively rare (<1% of patients) and was excluded from the analysis, due to low impact on the global problem.

The admission rate to the PACU, also referred as arrival rate (λ), is defined as the number of patients entering the unit per hour, whereas discharge rate or service rate (μ), is the number of patients being discharged per hour.[7] The system is represented in Figure 1.

Data collection

We collected data on the total number of patients that came out of surgery. Weekends were excluded, due to low surgical volume. Patients that continue their stay on weekends do not represent a congestion problem. For convenience issues, all patients were included initially, but patients going directly to the ICU or to hospitalization rooms were sequentially excluded. Data for this model was prospectively collected in the Department of Anesthesiology, during a period of 2 months, from June 1 to August 1, 2014.

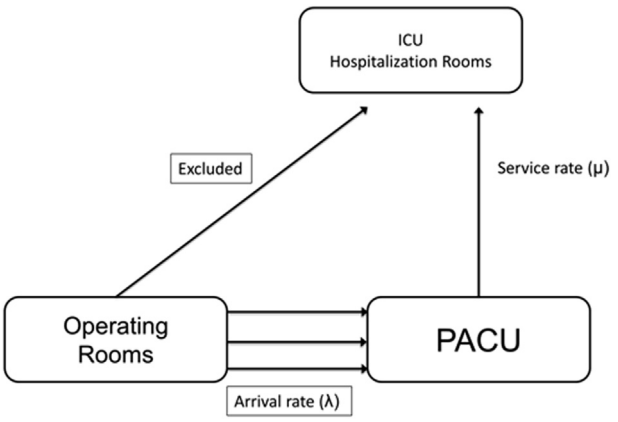

Fig. 1 – Graphical representation of patient flow in the postsurgical setting. Arrows represent possible patient pathways.