ORIGINAL ARTICLE

Use of Simulation Software in Optimizing PACU Operations and Promoting Evidence-Based Practice Guidelines

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Purpose: *As health care service costs continue to rise, hospitals are looking for innovative solutions to reduce financial burden while maintaining, and even advancing, quality of care. The objective of this study was to reduce costly delays in perioperative operations.*
Design: *Quality improvement project using lean methodology.*
Methods: *Discrete event simulation was used to evaluate multiple scenarios for improving the flow of patients through the Ambulatory Surgery Center's recovery unit. Bottlenecks were identified to safely minimize service delays and enhance the patient's experience.*
Findings: *Applying the Theory of Constraints, postanesthesia care unit recovery time was identified as the system constraint. An average 5- to 8-minute reduction in recovery time would reduce OR delays by more than 20%. Improvement efforts were focused on application of evidence-based practice.*
Conclusions: *Simulation established a safe and cost-effective environment for exploring tests of change and optimizing the physical design and operations of an expansion hospital site.*

Keywords: *simulation, process improvement, postanesthesia care unit, pediatrics.*

IN THE SETTING of a stand-alone, pediatric hospital where both inpatient and outpatient surgical procedures are performed using shared resources, a question of how best to increase capacity was posed. More than 14,000 surgical procedures are performed annually in this hybrid-model, hospital-based ambulatory surgery center. Of these, 86% are outpatient procedures. Senior leadership was challenged with an overarching strategic goal to increase the operating room (OR) efficiency throughout the perioperative services in response to increasing demands. The key measure for baseline efficiency is OR turnaround time, defined as the time the patient is wheeled out of the OR until the next patient is wheeled into that room. The complexity of this problem lies in that 14 specialties (not including anesthesia only or radiology procedures) performing an average 54-cases per day were funneling all patients from 15 ORs to 16 postanesthesia care unit (PACU) beds.

To better understand the problem, the hospital's process improvement department process improvement engineers were enlisted to provide assistance. Using classic engineering training, the process improvement team set out to better understand the current system's performance and identify performance-limiting factors. Lean

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Six Sigma improvement science methods were used throughout the project. To initially define the problem, the engineering team entered the work area and followed the patient's journey from arrival to disposition (discharge home or to the inpatient destination). Through this exercise, the value stream was defined. Value stream mapping is a lean-management method for making transparent the flow of materials and information.[1] By creating a detailed process map, the team was able to visualize and better understand the multiple steps of the patient's journey through the system.

The team reviewed OR delay reports from the electronic medical record to determine key focus areas. The most common documented delay reason was that a Phase I recovery bed was not available. The surgical center layout includes 22 dual-use bed spaces for preoperative and Phase II recovery, 15 ORs, and 16 Phase I recovery beds in the PACU. An initial area of concern was the limitations of the recovery configuration because of available PACU spaces. The recommended ratio of PACU spaces to ORs for a hospital that serves both inpatient and outpatient populations is 1.5 to 2 PACU spaces per OR to safely care for patients and minimize OR delays.[2] An overview of the recovery process is as the surgical day begins, patients begin to fill the PACU. Once the PACU beds are full, patients must remain in the OR until a recovery space is available. These delays are very costly and disruptive to a busy surgery schedule.

In the surgery center, throughput is defined as the number of patients who can be moved through the system in a period of time. Issues arise when the throughput of a downstream activity is less than that of its predecessor. In this case, the OR throughput exceeded the rate at which patients recovered in PACU, creating a capacity deficit. This behavior is outlined in Eliyahu Goldratt's Theory of Constraints (TOC).[3]

Design

TOC is a management philosophy that is focused on improving the weakest ring(s) in a chain to improve the performance of systems. TOC is the understanding that every system has a bottleneck or constraint that governs the output of that system.[3] Based on these principles, improvement efforts would need to be focused on improving the performance of the PACU to reduce this bottleneck effect on the whole system.

To test the theories of what changes could make the greatest impact on reducing or minimizing OR delays, measurements needed to be made. Data were collected through observation and in an electronic record system (OR Manager).

Time measures were recorded for each step of the patient's experience. Key timestamps, including procedure start and end times, emergence time, and admission-to-floor time were used to construct a discrete-event simulation model of the ambulatory surgery patient flow.

Data were analyzed to better understand the impact that each process step within Phase I recovery has on the system performance. Through observations made in the PACU, variations in both anesthesia and nursing practices were identified. A point of great variation was in the expected time of sleep or nonstimulation after arrival to Phase I recovery PACU. The anesthesiologists believed that the patient would be stimulated within 5 to 10 minutes postarrival. Nursing possessed a common understanding that the patients were not to be stimulated for a minimum of 30 minutes postextubation to prevent postanesthesia agitation. This fed into increased recovery time greater than actual procedure length, a bottleneck. Patients finishing OR procedures were unable to move to PACU as the given spaces were occupied by previous patients.

At this point, the problem had undergone definition, measurement, and analysis. Staff were given the opportunity to provide test of change ideas for improvement initiatives. This provided optimal efforts in getting key stakeholders invested in solutions. Anecdotally, staff were certain that hiring more personnel in the PACU area would create a more efficient working environment. The process improvement team needed a way to show potential gains without going through multiple tests of change and increasing the risk of staff dissatisfaction.