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First-case tardiness reduction in a tertiary academic medical center operating room: A lean six sigma perspective

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ABSTRACT

Purpose: Previous research has shown that lean six sigma(LSS) may be successful for addressing first-case tardiness (FCT), a delay of the first surgery of the day. However, evidence of its effectiveness in tertiary public academic hospitals in developing countries is still lacking. In this study, we aim to analyze the impact of a process improvement project in a large public tertiary academic hospital with the goal of reducing OR FCT.
Methods: We used the standard LSS framework (DMAIC methodology: define, measure, analyze, improve, control) to address the leading causes of delayed surgery First-case starts. We assessed the effect of our project by comparing FCT on the year prior and after our intervention in our study group of Operating Rooms (OR) and in a control group where we did not implement changes. Primary outcome measures were the proportion of late starts and the mean tardiness in minutes; secondary outcomes included OR raw utilization and cases running after regular hours.
Findings: We found a significant decrease in the proportion of late starts and in the mean tardiness after our intervention: late starts decreased from 62% to 31% and mean tardiness reduced from 56 min. to 34 min. We also found an increase in OR utilization rates from 70% to 73% and a decrease in the proportion of cases running late from 9% to 7%, but only the latter effect was statistically significant.
Practical implications: The interventions we have performed in our hospital require simple, low investment actions, which make them especially suitable for being replicated in other public hospitals in developing countries.

1. Introduction

Hospitals around the world are increasingly adopting innovative process improvement strategies that may help them reduce costs, while coping with an increasing demand. Several of these initiatives are using lean six sigma as the primary framework for rolling-out these care redesigning projects and inspiring a culture for continuous improvement throughout the hospital.[8,45]

Lean Six Sigma (LSS) is a business philosophy that aims to achieve products or services with virtually zero defects, by reducing process variability and eliminating every step in a process that does not add value to it.[3,25]

There is a plethora of research that documents successful LSS projects implemented in different areas of the hospital, from the emergency department (ED)[10,11,19] to the intensive care unit,[16] with the goal of reducing patients' length of stay,[28,40] ED revisit and left-without-being-seen rates,[41] door-to-balloon time in patients with ST-elevation myocardial infarction[12] or reduce patient transfer times from floor to critical-care beds.[35]

Operating Room (OR) Departments in particular, are one of the areas where the implementation of lean has been most intense and successful,[4,5,23,27] for several reasons: firstly, OR efficiency is crucial for a hospital's financial sustainability, since ORs account for more than 40% of the hospital's total revenue and an even higher share of its total costs[26]; secondly, ORs are a multiprofessional, stressful environment that often involve complex and highly variable processes that may have failures in several stages and for several factors. This is a scenario where lean and six sigma methods usually excel.

First-case tardiness (FCT) – a delay of the first surgery of the day – is one of these common inefficiencies[13,24,39,44,47] that has a high impact in patients' satisfaction, particularly for those who are fasting and continue to wait for their surgery.[21] Furthermore, some authors argue

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that when first cases start late, succeeding surgeries may run out of the regular OR day schedule[36] or even be delayed to the following day.[43] Ultimately, the (in)efficiency of an OR has a direct impact on waiting lists for elective surgery, which represent a major public issue in several health systems,[7,20], including Brazil.[18]

The degree of inefficiency is sizeable and may be addressed in several ways: under the Dutch OR Benchmarking initiative, van Veen-Berkx et al. reported a figure of more than 50,000 minutes lost annually per OR due to surgeries starting late and a reduction of almost 30,000 minutes annually (equivalent to $6000–26,000 savings, under their calculations) after several process improvement strategies were implemented.[37]. Similarly, in Germany, more than 70% of general surgery and trauma/orthopedic cases started late in 2011.[34]

LSS tools proved to be successful in reducing first-case delays in several for-profit hospitals in Europe and the US. However, to our knowledge, there are no studies that evaluated their effectiveness in a developing country and in the context of a Public Hospital Operating Room, where efficiency is usually lower[2,17] and process improvement methods are still incipient.[6,8]

In this study, we aim to estimate the impact of a process improvement project in a large public tertiary academic hospital with the goal of reducing OR first-case tardiness, in order to validate the effectiveness of this methodology in public hospitals within developing countries.

2. Methods

2.1. Setting

Hospital das Clinicas of the University of Sao Paulo (HCFMUSP) is the largest public hospital in Latin America. The hospital is a tertiary center with 8 Institutes, 2600-bed, and its main surgical suite has 33 ORs and a daily surgical production of more than 200 surgeries.

In July 2014, the Hospital's Clinical Director sponsored a project for improving the overall efficiency and patient safety in its main Surgical Centre (*"Centro Cirúrgico do Instituto Central"*). The hospital board assembled a multidisciplinary team with the aim of guiding these initiatives and improving regular management activities. The team held rapid process improvement meetings beginning in July, along with representatives of the multiple specialties that helped us roll out the most important improvement strategies.

In this study, we also included a control group, consisting of the elective surgeries performed in other decentralized ORs in our institute (8 ORs),[1] where we did not implement our process improvement changes. Including this control group will arguably net out any factors causing surgeries to start earlier by reasons which are unrelated with our intervention (e.g. any seasonal or organizational-related effect).

2.2. The intervention

2.2.1. Define

We started by determining the scope of our project: our intervention was limited to elective inpatient surgeries in our main OR, thus explicitly excluding emergency surgeries, elective outpatient surgeries or surgeries performed in other specialized institutes.

Using our OR staff's own experience and external benchmarking,[37,39,47] we defined the problem we were trying to improve: for each OR, "first-case tardiness" was defined as the difference in minutes between 7:00 AM (the scheduled starting time) and the actual time the first patient on each day entered the room. This actual patient OR entry time is registered by the OR nursing staff and should be validated by the surgeon and the anesthesiologist in charge after each surgery.

A maximum delay period of 30 minutes is acceptable according to similar studies,[37,39,47] which gives us a benchmark for our "upper specification limit" (or "service level agreement"). The lower limit is naturally no delay, and we considered the value of zero if the case entered the OR before 7:00 AM.

Fig. 1 is a value-stream map representing the patient flow, from the arrival in our pre-holding area until the patient enters the OR.

2.2.2. Measure

Data on first-case OR arrivals was collected from the Hospital's Operating System, including the proportion of on-time arrivals to the OR (ie. surgeries starting before 07:30 AM).

2.2.3. Analyze

Causes for first-case tardiness in our main OR had already been outlined in a previous process improvement project with the assistance of a consultancy company.

Furthermore, two members of the hospital's health management fellowship (PROAHSA) engaged in direct observation of the process over a period of 2 weeks to list the main reasons for delays in the OR.

We also adapted an open-source software to be used as a problem-reporting tool by front-line staff, giving us causes for delays in the OR (e.g. patient delay due to lack of surgical consent), as well as a channel for communicating with the areas involved (e.g. pharmacy, inpatient nursing staff, etc.).

The leading causes for delay discovered in our ORs were the lack of an ICU bed in the post-op, a change in the OR schedule (e.g. due to a patient lacking clinical conditions for surgery, or the need for an emergency patient to bypass an elective surgery), the room was not ready, team delays, a delay in the inpatient unit, and the lack of a pre-operative evaluation by the anaesthesiologist. In annex 1, we provide a fishbone diagram that was created for assessing the causes for our FCT.

2.2.4. Improve

We built an institution-wide comprehensive package of measures aiming to reduce FCT in a sustainable way:

- At the *inpatient units*, we introduced an operational checklist to streamline patients' admission into the OR including all of the required elements that were needed for a patient to be cleared for admission into the OR (e.g. patient identification, patient record, surgical and anesthesia consents, etc.)
- At the *OR reception area*, we adjusted the day shift starting time from 7:00 AM to 6:30AM and, to further increase the size of our front-line staff during this period without hiring more staff, we changed the morning duty roster, moving staff from the post-op recovery room – which is empty in early mornings - to the reception area.
- *At the ICU*, we developed a new method of scheduling for elective surgeries that needed a post-surgical ICU bed in order to control major surgery demand and reduce same-day cancellations. This consisted of a set of priorities for assignment of a morning ICU-bed (1st priorities were children or pregnant women, followed by a predefined rotation between several specialties, according to weekly demand). In this way, surgical teams could schedule their ICU cases anticipating the days when they would have higher probabilities of having an ICU bed. Furthermore, the OR and the ICU department leadership agreed on starting 30% of surgeries that requested a post-op ICU bed independently of the official bed release. This was the historical minimum daily percentage of ICU beds available in the morning for the elective OR.
- *In the OR*, we changed the rule that required that the anesthesiol-

[1] These are ORs that for historical reasons are not located in the main Surgical Centre. For instance, the Urology department has a dedicated Surgical Centre and the Ear, Nose and Throat Department has some ORs dedicated to plastic surgery. More importantly, these control ORs perform inpatient surgeries that have the same clinical complexity and go through the same administrative processes required in the Main Surgical Centre (e.g., patients are always admitted in the previous day and come to the OR from the inpatient unit), which makes them comparable in the context of our study.