The American Journal of Surgery xxx (2018) 1–8

Contents lists available at ScienceDirect

The American Journal of Surgery

journal homepage: www.americanjournalofsurgery.com

Lean methods to improve operating room elective first case on-time starts in a large, urban, safety net medical center

Charles Coffey Jr. [a, b], Edward S. Cho [c], Eric Wei [a, d], Allison Luu [a, b], Maria Ho [a, d], Rodolfo Amaya [a, e], Marie Pecson [a], Florence V. Dalton [a], Deborah Kahaku [a], Brad Spellberg [a, d], Stephen F. Sener [a, f, *]

[a] Los Angeles County + University of Southern California (LAC+USC) Medical Center, Los Angeles, CA, USA
[b] Department of Medicine, Keck School of Medicine of University of Southern California, Los Angeles, CA, USA
[c] Keck School of Medicine of University of Southern California, Los Angeles, CA, USA
[d] Department of Emergency Medicine, Keck School of Medicine of University of Southern California, Los Angeles, CA, USA
[e] Department of Anesthesiology, Keck School of Medicine of University of Southern California, Los Angeles, CA, USA
[f] Department of Surgery, Keck School of Medicine of University of Southern California, Los Angeles, CA, USA

ARTICLE INFO

Article history:
Received 10 February 2018
Received in revised form
29 April 2018
Accepted 4 May 2018

Keywords:
Operating room
Lean
Efficiency
Start time

ABSTRACT

Background: Delays in first cases contribute to multiple operating room (OR) inefficiencies and decreases in OR productivity.
Methods: Lean process improvement methods were used to redesign the existing workflow for elective first cases of the day in a large, urban, public hospital. First case start times were prospectively recorded from May 2, 2016 through December 29, 2017.
Results: Data from 415 operating days were examined, 86 days prior to, 35 days during, and 294 days after implementation of interventions in the pre-operative holding area. During this time, of 23,891 operations performed, 14,981 were elective procedures, 5963 (39.8%) of which were first cases of the day. The mean rate of elective first case on-time starts per week went from 23.5% before and during to 73.0% after implementation of lean interventions ($p < 0.0000001$).
Conclusions: Implementation of lean interventions in the pre-operative holding area was associated with significantly improved rates of elective first case on-time starts.

Introduction

Given the importance of operating room (OR) productivity in both efforts to improve access for patients and the financial solvency of a hospital, many studies have been conducted to improve OR efficiency by increasing the number of on-time starts for first cases, decreasing turnaround times between procedures, and reducing idle non-operative time. Although a number of these studies utilized a systems-based approach, relatively few have used lean principles to frame, develop, and implement solutions to improve OR efficiency.[1–9] From these studies, numerous factors have been identified which contribute to OR inefficiencies, such as challenges with communications between members of a multidisciplinary group, variability in the proportion of emergency and urgent versus elective operations, case cancellations, and more. These inefficiencies are known to impact overall revenue for hospitals, since short-term labor costs remain fixed in the face of decreasing OR productivity.[10–13]

Lean is a set of process improvement tools first developed by Ohno and colleagues at Toyota after World War II.[14] When applied to healthcare, its main goal is to reduce waste and keep only what adds value to the patient. While a rising number of healthcare delivery studies have described using lean for process improvement, a relatively smaller proportion have reported the outcomes from lean implementation.[15] Furthermore, more recent literature has described the utilization of lean principles in conjunction with six sigma to improve processes in the OR setting.[15–23] In particular, two studies at major academic medical centers have used the lean approach and reported improved on-time starts for the first case.[17,21] A third study, conducted at a Veterans Affair (VA) medical

* Corresponding author. LAC + USC Medical Center, 1100 North State Street, Clinic Tower, 6A231A, Los Angeles, CA, 90033, USA.
E-mail address: stephen.sener@med.usc.edu (S.F. Sener).

https://doi.org/10.1016/j.amjsurg.2018.05.002
0002-9610/

center, reported positive results using lean methods to reduce waiting times for outpatient surgical procedures.[24] These studies do not necessarily address the ability to improve on-time starts in settings with a high proportion of non-elective cases (e.g., due to traumas), and particularly in settings with limited resources, such as at over-crowded safety net hospitals.

Los Angeles County + University of Southern California (LAC + USC) Medical Center is a large, urban, public hospital with 25 ORs and annual surgical total volume of approximately 14,000 procedures. It has one of the busiest Emergency Departments and trauma centers in the USA, managing >38% of all trauma in the most populous County in the USA.

The first case on-time start rate was defined as the percentage of patients having elective procedures and leaving the pre-operative holding area at or before the listed start time. Prior to the initiation of improvement efforts, only 23.5% of first cases at LAC + USC Medical Center per week started on time. The high frequency of delayed first-cases appeared to contribute to cancellations of cases scheduled later in the day, long surgical queues, consistently high hospital censuses, and low morale amongst residents, fellows, attending physicians, nurses, and other OR staff members. Patient satisfaction was negatively impacted due to long wait times and last-minute cancellations.

In 2015, LAC + USC Medical Center hospital and OR leadership created a Perioperative Lean Team to compartmentalize and stage efforts to improve OR productivity, initially concentrating on first-time starts rather than other components thought to be more complicated at the outset. This study reports the outcomes from implementing lean problem solving and process redesign to improve elective first case on-time starts at LAC + USC.

Methods

Lean process improvement methods

Lean thinking and identification of goals

Hospital leadership including the Chief Medical Officer, Chief Nursing Officer, Chief Operating Officer, Chief Quality Officer, and Perioperative Director, embraced the lean improvement philosophy of creating a safe environment that empowered those who did the work to improve the work. This was achieved through the creation of a multidisciplinary Perioperative Lean Team consisting of pre-operative nurses, OR circulating nurses, nurse anesthetists, advanced practice providers, resident physicians, and attending physicians. The team was launched in December 2015 with hospital and perioperative leadership providing clear roles for the executive sponsors, performance improvement advisors, and lean team members. Recognizing that the baseline for elective first cases starting on time was 23.5%, a goal was set to achieve 80% on-time starts for elective first cases by June 2017. The team went to the *gemba*, Japanese word for "where the work is done," did numerous observations and walk-throughs of the operating room and peri-operative areas through the patients' eyes to evaluate how the existing processes promoted the current state. Lean problem solving methods were then used, including value stream mapping, spaghetti diagrams, value and waste identification, root cause analysis using the 5 Why's, and future state design, to redesign the existing workflow for first cases of the day.

The process improvement maps, identifying outpatient pre-operative holding area processes before and after implementation of lean interventions, are shown in Fig. 1A and B. Waste and root causes were categorized and workgroups were created, which included Directions and Instructions for Patients, Patient Registration and Scheduling, Multi-disciplinary Team Communications, Nerve Blocks, Problems with Consents, Last-minute Schedule and Equipment Changes, and Team Communications in the perioperative holding area. These areas for improvement were addressed with three key goals in mind, to improve patient experience, decrease waste, and improve communication.

Improving the patient arrival process, the development of the pre-operative team huddle and the development of the "huddle board"

Through its work, the Perioperative lean team created and implemented an improvement bundle consisting of three key components: improving the patient arrival process; improving the operative team communication; and a multi-disciplinary team debriefing that reviewed and improved performance on a daily basis. Due to the critical nature of our surgical queues, kaizen event principles were applied, and the interventions were contemporaneously implemented in a bundled format.

The front line staff created standard work and daily management systems for these separate processes in parallel during the intervention period from September 1 through October 21, 2016. Workgroups and the lean interventions implemented by them during the intervention period are shown in Table 1.

Prior to the Perioperative lean team, all patients undergoing operations that day arrived at the same time (4:30 a.m.), regardless of the scheduled time of their procedures. These patients fought over a limited number of parking spots, and once they arrived to the pre-operative holding area, they had to navigate four separate but redundant queues to complete the check-in process. The patient arrival process was dramatically modified by the Directions and Instructions Workgroup, so that patients arrived in a staggered fashion, in concordance with their procedure start time. In addition, a simplified and clear map of the hospital, specific parking spots for patients, and new hospital signage were created. Greeters met the patients at the hospital entrance and escorted them to the OR check-in desk. The Registration and Scheduling Workgroup piloted multiple *Plan-Do-Check-Act* cycles on the check-in process to incorporate staggered arrivals, expedited registration, and direct-to-bed upon completion of check-in. Redundant queues were eliminated, thus creating a more efficient and pleasant patient experience.

To improve communication and ensure a shared understanding of the surgical care plan, expectations were defined for the huddle to occur at the patient's bedside 10 min prior to the scheduled time of the first case for each OR. Visual cues were also implemented in the form of "huddle ready" signs posted at the end of patient beds, to indicate that patients had been seen by all members of the operating team and were ready for their pre-operative huddle. All members of the operating team participated in the huddle, including surgical and Anesthesiology staff and circulating nurse. Prior to this pre-operative huddle, the operative team would meet for the first time in the OR during the surgical time-out, resulting in numerous last minute changes to the planned procedures, and thus, delayed first case starts.

To track the improved processes, a daily management system board ("huddle board") was placed in the holding area to provide daily monitoring, evaluation, and feedback for all the first case starts. The "huddle board" was designed so that nursing staff could easily document, track, and display the timeliness of first case starts, performance per surgical service, and reasons for delays, and so that all members of the surgical care team could see their performances on a daily basis. Also implemented was a daily team debriefing at 10 a.m. to discuss the results displayed on the huddle board. The debriefing was multi-disciplinary, including surgeons, anesthesiologist, and nurses from both the OR and pre-operative areas. The debriefing consisted of an evaluation of the day's performance, as well as a discussion of the reasons for first case delays. Most importantly, the team used root cause analysis techniques to

Please cite this article in press as: Coffey Jr. C, et al., Lean methods to improve operating room elective first case on-time starts in a large, urban, safety net medical center, The American Journal of Surgery (2018), https://doi.org/10.1016/j.amjsurg.2018.05.002