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Educational Article

Reduction and standardization of surgical instruments in pediatric inguinal hernia repair

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Summary

Aim
To standardize and reduce surgical instrumentation by >25% within a 9-month period for pediatric inguinal hernia repair (PIHR), using "improvement science" methodology.

Methods
We prospectively evaluated instruments used for PIHR in 56 consecutive cases by individual surgeons across two separate subspecialties, pediatric surgery (S) and pediatric urology (U), to measure actual number of instruments used compared with existing practice based on preference cards. Based on this evaluation, a single preference card was developed using only instruments that had been used in >50% of all cases. A subsequent series of 52 cases was analyzed to assess whether the new tray contained the ideal instrumentation. Cycle time (CT), to sterilize and package the instruments, and weights of the trays were measured before and after the intervention. A survey of operating room (OR) nurses and U and S surgeons was conducted before and after the introduction of the standardized tray to assess the impact and perception of standardization.

Results
Prior to creating the standardized tray, a U PIHR tray contained 96 instruments with a weight of 13.5 lbs, while the S set contained 51, weighing 11.2 lbs. The final standardized set comprised 28 instruments and weighed 7.8 lbs. Of 52 PIHRs performed after standardization, in three (6%) instances additional instruments were requested. CT was reduced from 11 to 8 min (U and S respectively) to <5 min for the single tray. Nurses and surgeons reported that quality, safety, and efficiency were improved, and that efforts should continue to standardize instrumentation for other common surgeries.

Conclusions
Standardization of surgical equipment can be employed across disciplines with the potential to reduce costs and positively impact quality, safety, and efficiencies.

Introduction

Curtailing escalating healthcare costs continues to be a challenge globally. Efforts to maintain and improve quality while hopefully reducing costs, in an environment of ever-increasing scientific and technological advances, are laudable, but also challenging.

Lean methodologies and other techniques of improvement science have been used successfully in industry to reduce waste, and have been adopted in health care to reduce waste, and thus reduce costs while enhancing safety and quality. The operating room (OR) and central supply (CS) are areas associated with high costs within a hospital. Despite such costs, improvement science has not been broadly implemented in these environments [1,2]. Specifically for the OR, Kenney has adapted the Lean principle of 5S, sort, simplify, sweep, standardize, and self-discipline, to safely reduce and standardize sterile instruments to the minimum number necessary to perform a given surgery [3]. Farrokhi further demonstrated, that by applying such methodology the number of instruments used in minimally invasive spine surgery can be reduced by 70%, with set-up time reduced by 37%, yielding significant cost benefit [4]. In an audit of 38 spine cases performed by two surgical specialty groups, neurosurgeons and orthopedic surgeons, only 58% of instruments were used at least once. By removing the unused instruments, the tray weight was decreased by 17.5 lbs and costs were reduced [5].

Avansino et al. addressed standardization in a common pediatric surgical procedure, laparoscopic appendectomy. They concluded that

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standardization of equipment increases value by reducing costs without negatively impacting quality [6]. Pediatric inguinal hernia repair (PIHR) is one of the most commonly performed operations in childhood and may be performed by both pediatric surgeons (S) and pediatric urologists (U). We hypothesized that a significant number of instruments for PIHR were never used by surgeons in either specialty, yet would be counted by the nursing staff in the OR, and require routine processing and packaging in CS. Our aim therefore, was to develop a single tray for all surgeons performing PIHR and assess the impact on the surgeons, nursing staff, and in CS.

Methods

This was a prospective, single-center, observation and implementation study that was carried out between October 2014 and June 2015 at the Hospital for Sick Children in Toronto after approval by the institutional Quality Improvement Committee. The aim of the study was to reduce instrumentation by at least 25% and develop a single, standardized instrument tray for PIHR that was satisfactory for both S and U over that period of time. Relevant tray set-up included trays for any male patient >3 months corrected gestational age undergoing open elective inguinal hernia repair, thus excluding emergency and newborn hernia repairs, and cases in which laparoscopic herniotomies were performed.

The design of the study employed the primary tool of Lean, observation [7]. A comparison of two clinical phases, pre and post-standardization each with several components was then carried out.

Phase I

A PowerPoint presentation was given to all major stakeholders, all surgeons and OR nurses, to appraise them of the project design and to address potential concerns. A non-validated survey then was administered to U and S surgeons to assess their attitudes toward standardized surgery and its impact on efficiency, quality, and safety. In addition, other questions related to potential costs and standard practice were included in the surgical arm. Four independent observers were trained to observe all PIHRs performed using the routine U and S instrument preferences, with a minimum of two cases/surgeon and >50 cases total being evaluated. The purpose of observation was to count the actual number of instruments used in each operation from induction through closure. Instrument use was defined as those instruments that were held by the surgeon at least once, even if not actually used on the patient. The study team met weekly to discuss collected data, and to assure that ongoing, frequent informal interaction with all stakeholders took place to update them of findings and invite their input. After compiling representative data for this phase, formal PowerPoint presentations were given to the U and S surgeons, CS and nursing service leaders, to engage them in any decisions made before a standardized tray was developed. After these discussions, a standardized tray was constructed with only instruments used in >50% of the cases during Phase I observation.

Phase II

After the new tray was unveiled, plans were to have the "old" routine tray available in all cases as back-up, but to open only the new, standardized tray for each PIHR. Using the same criteria as Phase I, the observers then compiled data on the instruments used in each operation. As with Phase I, ongoing weekly team meetings occurred. Surgeons and OR nurses were invited to submit requests to the project lead and/or the director of CS, to request additional peel pack instruments for their cases, if they felt the standardized set did not meet their needs. A survey similar to the pre-standardization survey with additional questions added related to perception of the standardized tray was administered to nurses and surgeons 6 weeks after implementation of the new tray.

Cycle time (CT) is a key measure used in Lean initiatives that helps to develop standard work and promote consistency [7]. In the CS area, the CT to rinse, sterilize and repack each tray was measured using a calibrated stopwatch on 10 pre-standardization routine U preference hernia sets, 10 pre-standardization routine S hernia sets, and 10 standardized new hernia sets. The same CS worker was used for all 30 cycles to minimize variability. In addition, the weights of each of the three trays were measured.

Results

All fourteen staff surgeons, eight S and six U participated in the study. In Phase I, the pre-standardization period, 56 consecutive open PIHRs over a 6-week period were observed: 44 performed by S and 12 performed by U. The routine preference cards for PIHR performed by U contained 96 instruments, and for S, 51 instruments. Between nine and 23 instruments were used by all surgeons. For U, only 16 instruments were used in >50% of cases, 11 used in <50% of cases, with 69 (68%) never used. For S cases, again 16 different instruments were used in >50% of cases, with 18 used <50% of the time, and 17 (33%) never used (Fig. 1A and B). The new, standardized tray comprised instruments used only >50% of the time in Phase I, 28 instruments with a reduction of 3.4-fold for U and almost a 2-fold reduction for S (Fig. 2).

In Phase II, four old, routine preference (non-standardized) instrument trays were opened in 52 cases observed (8%) over 5 weeks. One of these sets was opened in error so that only three (6%) represented a balancing measure of importance, where an instrument deemed necessary for that surgeon or that operation, would not have been available on the new tray. As the old routine set was available in these cases, although not to be opened unless an instrument was requested that was not on the standardized tray, no circulating nurses had to leave the OR to search for surgical equipment. Five of 14 total U and S (34%) sent emails requesting that three different instruments that were essential to them but were not included in the new standardized tray, be available in peel packs for their cases in addition to the new tray.

In the CS area, processing of a single, standardized tray, measured by CT calculation, was reduced to 5 min from 11 min for the old U hernia set and 8 for the S tray. In addition, the weight of the standardized tray was 8 lbs

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