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Improving the value of care for appendectomy through an individual surgeon-specific approach

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ABSTRACT

Purpose: Standardized care via a unified surgeon preference card for pediatric appendectomy can result in significant cost reduction. The purpose of this study was to evaluate the impact of cost and outcome feedback to surgeons on value of care in an environment reluctant to adopt a standardized surgeon preference card.
Methods: Prospective observational study comparing operating room (OR) supply costs and patient outcomes for appendectomy in children with 6-month observation periods both before and after intervention. The intervention was real-time feedback of OR supply cost data to individual surgeons via automated dashboards and monthly reports.
Results: Two hundred sixteen children underwent laparoscopic appendectomy for non-perforated appendicitis (110 pre-intervention and 106 post-intervention). Median supply cost significantly decreased after intervention: $884 (IQR $705–$1025) to $388 (IQR $182–$776), $p < 0.001$. No significant change was detected in median OR duration (47 min [IQR 36–63] to 50 min [IQR 38–64], $p = 0.520$) or adverse events (1 [0.9%] to 6 [4.7%], $p = 0.062$). OR supply costs for individual surgeons significantly decreased during the intervention period for 6 of 8 surgeons (87.5%).
Conclusion: Approaching value measurement with a surgeon-specific (rather than group-wide) approach can reduce OR supply costs while maintaining excellent clinical outcomes.
Level of Evidence: Level II.

Value-based surgical care (*outcomes per dollars spent*) emphasizes both quality and efficiency in the care of surgical patients. Rising costs, regulatory requirements, and consumer demand are encouraging hospitals and providers to evaluate the value of care provided by measuring costs, tracking outcomes, and providing these data to the public [1–4]. Meanwhile, surgeon preference for differing supplies in the operating room (OR) has been shown to contribute to significant variability in the costs of operations without apparent differences in outcomes [5–7].

While the importance of measuring costs is widely accepted, relatively few studies have examined the effect of surgeon decision-making on healthcare expenditures [8]. Most surgeons desire to limit costs, yet few have knowledge of hospital costs for each procedure they perform or how their costs compare to that of their colleagues [8,9]. Recent work suggests that surgeons may choose a lower-cost surgical supply in the OR when presented with costs of potential alternatives [10–12]. The limitation of these studies is that the majority evaluated surgeon behavior after providing aggregated data on a periodic basis [11,12], while few have measured changes in practice patterns when surgeons were presented real-time, patient-level cost data [10].

Acquisition of patient-level cost data by surgeons is difficult in most healthcare systems as costs are either not available or aggregated over time or departmentally, rather than provided at the patient-level [1,8,13,14]. We have previously shown that institution of a clinical practice guideline (CPG) for perforated appendicitis resulted in a decrease in variability of care, improvement in clinical outcomes, and decrease in overall cost of care [14,15]. This CPG did not incorporate any intraoperative changes, such as standardization of OR equipment or incentives for OR cost reduction. Variability in surgical technique and OR supplies for laparoscopic procedures is common [16–19]. Prior publications have reported that standardization of intraoperative device utilization with a unified surgeon preference card resulted in significant cost reduction for pediatric appendectomy [19,20]. As supplies consist of the greatest

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proportion of consumable costs in the process of care for pediatric appendectomy [21], they are an important target for potential value improvement. Mandating use of specific OR supplies is not feasible in many surgical practices. The purpose of this study was to evaluate the impact of cost and outcome data feedback to individual surgeons on value of care in an environment reluctant to adopt a standardized surgeon preference card for appendectomy.

1. Methods

We performed a prospective observational study comparing OR supply costs and patient outcomes for children undergoing appendectomy before and after an intervention to provide surgeons with patient-level, real-time cost data.

1.1. Subjects and setting

The study population consisted of all children treated for non-perforated appendicitis by laparoscopic appendectomy at the Monroe Carell, Jr. Children's Hospital at Vanderbilt, a 271-bed, freestanding, tertiary referral center affiliated with Vanderbilt University Medical Center in Nashville, TN during a 6-month period before intervention (January 1, 2016 to June 30, 2016) compared to a 6-month period following intervention (October 1, 2016 to March 31, 2017). All children 18 years of age or younger who underwent laparoscopic appendectomy during these time periods were prospectively identified and tracked within Tableau software, a database management software that provides interactive data visualization and analytics [22]. To decrease bias in our two patient cohorts, children were excluded if the laparoscopic case was converted to open or if perforated appendicitis was identified. Electronic medical records were reviewed manually by three reviewers (JRR, NHC, CG) with a fourth reviewer (MLB) involved to address discrepancies. Perforated appendicitis was determined by review of the operative note and defined as fecalith extrusion or a visible hole in the appendix. Children with gangrenous appendicitis were included as non-perforated appendicitis. The institutional review board approved the study with waiver of informed consent.

1.2. Intervention

The intervention was real-time feedback of OR supply cost data to individual surgeons via automated dashboards and monthly reports. An automated Tableau dashboard was created, which utilized data extracted from a "point of use (POU)" cost accounting system and database. The POU system was a standard part of the OR charting performed by the OR circulating nurses and accounted for all supplies used during each operation. Variables displayed in the Tableau dashboard (within 48 h after the operation) included the specific surgeon, procedure duration, hospital length of stay (LOS), and full supply cost data for each operation (Fig. 1a). Within Tableau, graphs were created to visualize overall costs for the entire group (Fig. 1b) and each surgeon's average OR supply costs over time.

Each surgeon's baseline OR supply use (during the 6-month period before intervention) was compiled to inform opportunities for cost reduction. These cost-reducing opportunities were reviewed in person with each surgeon individually. During intervention, surgeons were shown the Tableau dashboard data at irregular intervals depending on their individual interest level. Monthly reports were also generated from Tableau to show each surgeon's current average OR supply costs compared to his or her baseline, as well as to the overall group. These reports were emailed, printed, and hand-delivered to all surgeons monthly. Laminated pocket cards were also distributed to all surgeons and OR personnel (circulating nurses and scrub technicians) that listed commonly used supplies with their hospital costs and reviewed the preferred "high value" appendectomy (i.e., non-sheathed cannula, hook cautery for mesoappendix, endoloops for appendiceal base, and selective use of the specimen retrieval bag).

1.3. Assessment of operative characteristics and clinical outcomes

The main clinical outcomes of interest included adverse events, OR procedure duration (skin incision to skin closure), total OR time, and LOS. Adverse events within 30 days of appendectomy were predefined as superficial or organ-space surgical site infection (SSI), return to OR, postoperative interventional radiology drainage, and readmission. LOS was measured as time from admission order to discharge order. Outcomes were compared using Fisher exact test or Wilcoxon rank sum test as appropriate. Analyses were conducted in R version 3.3.3 [23].

1.4. Analysis of cost data

Finance departmental personnel obtained financial data for the episode of care for each patient from the hospital's internal cost accounting system. This system, Allscripts Enterprise Performance Systems Inc. (EPSi), provides patient-level hospital costs integrated into a single database and was used in all patients. The data were stored in an Oracle based Enterprise Data Warehouse and extracted using SQL Developer.

All cost data were collected and analyzed at the patient-level. Costs that were extracted included variable and fixed direct and indirect hospital costs (also known as technical costs). Professional costs were not included. Cost comparisons were performed using Wilcoxon rank sum test.

2. Results

2.1. Demographic characteristics

During the study, 216 children underwent laparoscopic appendectomy for non-perforated appendicitis. Of these, 110 were in the 6-month pre-intervention period and 106 were post-intervention. Average age was 11.0 (IQR 8.7–13.6) years. The majority were male (128 children, 59.3%), Caucasian (169 children, 78.2%), and admitted as inpatients (187, 86.6%). Interval appendectomies performed for a resolved perforation were included with 4 patients in the pre-intervention cohort and 1 patient post-intervention. No significant difference was observed between patient demographics before and after the intervention (Table 1).

2.2. Clinical outcomes of children undergoing laparoscopic appendectomy

Before the intervention, one child had an adverse event compared to 6 children after the intervention, although this change was not statistically significant ($p = 0.062$). The most frequent adverse events were superficial SSIs with 5 in the post-intervention cohort and none before intervention. The remaining adverse event was a post-operative small bowel obstruction requiring reoperation. No significant change was detected in median OR procedure duration before (47 [IQR 36–63] minutes) compared to after the intervention (50 [IQR 38–64] minutes, $p = 0.520$) or total OR duration (83 [IQR 70–102] before versus 86 [IQR 72–103] after, $p = 0.418$). LOS before the intervention was slightly shorter than length of stay after (1.1 [IQR 0.8–1.5] days versus 1.2 [IQR 0.9–1.6] days, $p = 0.023$).

2.3. Cost outcomes of children undergoing laparoscopic appendectomy

OR supply costs for laparoscopic appendectomy represented 20.9% of total hospital costs before the intervention (Table 2). There was a significant reduction in OR supply costs following the intervention ($884 [IQR $705–$1025] pre-intervention to $388 [IQR $182–$776]