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Regional cost analysis for laparoscopic cholecystectomy

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Abstract

Background Laparoscopic cholecystectomy is the most common procedure performed by general surgeons in the United States, with approximately 600,000 procedures performed annually. As the cost of care rises, there is increasing emphasis on utilization and quality. Our objective was to evaluate the cost of laparoscopic cholecystectomy in our health system and to compare the operative times and outcomes at high- and low-cost centers.

Methods We evaluated all laparoscopic cholecystectomies performed in our system over a 1-year period. The operating room supply costs and procedure durations were obtained for each of the hospitals. The American College of Surgeons National Surgical Quality Improvement Program outcomes and demographics were compared to the costs for each hospital.

Results During the study period, 7601 laparoscopic cholecystectomies were performed at 20 hospitals (170–759/hospital) by 227 surgeons. The average cost per case ranged from $296 at the lowest cost center to $658 at the highest cost center. The average operative time varied between sites from 46 to 95 min. There was no association between cost and operative time or case volume. There was a slight trend toward increased cost with higher number of emergency procedures, but this was not well correlated ($R^2 = 0.03$). The patient demographics and comorbidities were similar between sites. There were no significant differences in postoperative complications between high- and low-cost centers. The items with the greatest increase in cost were disposable trocars, disposable hook cautery, disposable endoscissors, and disposable clip appliers. We estimate that a savings of over $300/case is possible by using reusable instruments, which would result in an annual savings of $1.3 million for our health system, and $285 million nationwide.

Conclusion Performing laparoscopic cholecystectomy with reusable instruments can significantly decrease costs and does not increase operative time or postoperative complications.

Keywords Laparoscopic cholecystectomy · Cost · Utilization · Instrument

Healthcare expenditures in the US have increased every year since 1961, and totaled $3.3 trillion in 2016 [1]. Laparoscopic cholecystectomy is the most common general surgery procedure performed in the United States. Over 900,000 are performed annually [2], leading to $5 billion in healthcare expenditures [3]. Operating room (OR) costs comprise a large portion of healthcare expenditures, and instrumentation is a significant portion therein [4–6]. The development of new technologies has resulted in an abundance of high-cost disposable instrumentation. The increasing use of these items is in part responsible for rising healthcare costs.

With changes in reimbursement and consolidation of care, surgeons must have increased awareness of procedure costs. Surgeons have a unique opportunity to influence the purchasing of equipment and to lower operative costs without compromising patient care. As a large regional health system, we have the ability to assess OR costs on a large scale. The purpose of this investigation was to quantify the cost of disposable instruments for laparoscopic cholecystectomy and evaluate the effect, if any, on surgical efficiency and outcomes.

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Materials and methods

All data collected for this investigation were de-identified or pooled. We received a Not Human Subjects Research Determination by the Institutional Review Board of our health system. Cost data were retrospectively obtained for all laparoscopic cholecystectomies performed in our health system from May 1, 2016 to April 30, 2017. We excluded cases that included another procedure (cholangiography, hernia repair, etc.), cases performed robotically, and those that were converted to open. Disposable instruments used are recorded by the circulating nurse in the operative record. The cost of disposable instruments was obtained from the epic clarity database. The usage and cost were compiled into Tableau, data analysis software. Epic clarity places each item into a category. Total category usage was compared at each hospital to evaluate high- and low-cost trends. The items found to have the greatest contribution to cost were identified and compared to lower cost alternatives used at low-cost centers. Additionally, the three highest cost hospitals were compared to the three lowest cost hospitals in the rate of high-cost instrument use.

Procedure durations and case classification (elective vs. emergent) were obtained from operating room records. Many hospitals in the region have occasional rotating residents; however, only four were identified as having residents scrubbed for every case. The American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database was used to identify patient demographics, preoperative comorbidities, and outcomes. There are 22 hospitals in our health system. Operative data were available for those 22 hospitals; however, only 20 hospitals had NSQIP data. The additional two hospitals were very low-volume centers (< 100 cases annually) and were excluded from our analysis.

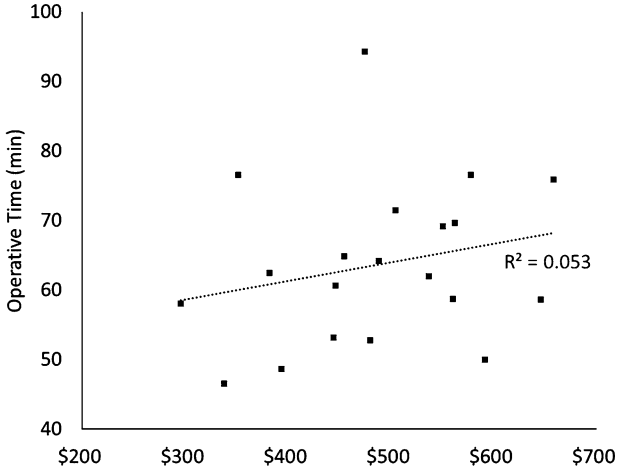

Fig. 1 Cost compared to operative time

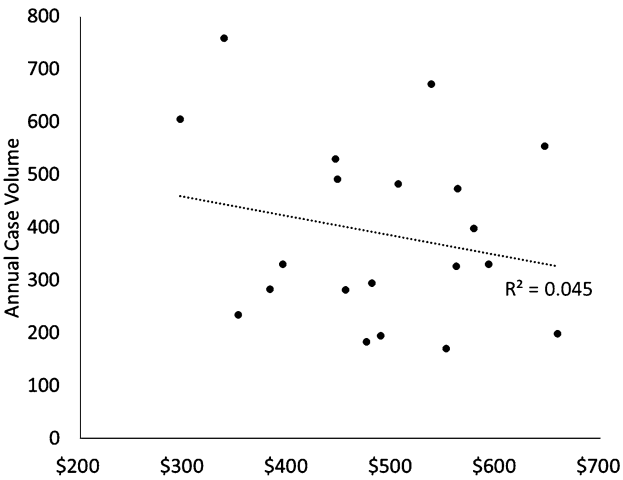

Fig. 2 Cost compared to case volume

Results

During the study period, 7601 laparoscopic cholecystectomies were performed at 20 hospitals in the region (range 170–759/hospital) by 227 surgeons. The average cost per case ranged from $296 to $659, with most centers falling between $400 and $600/case. The average operative time varied between sites from 46 to 94 min. There was a slight trend toward higher cost and increased operative time (Fig. 1), and increased cost with lower case volume (Fig. 2), although the trend was not well correlated for either comparison ($R^2 < 0.05$). Four of the 20 hospitals had surgical trainees in every case. These sites had an average operative time 14 min longer than sites with no trainees (74.8 vs. 60.8 min, $p = 0.03$); however, there was no difference in the average cost between sites with trainees and those without ($484 vs. $488, $p = 0.93$). Approximately 30% of cases in the region were performed on an urgent or emergent basis (range 7–64%). There again was a slight trend toward higher cost with more emergent procedures (Fig. 3), but with poor correlation ($R^2 = 0.03$). The highest cost center did have the highest rate of emergency procedures; however, the lowest cost center had the third highest rate at 45%.

To look at specific item costs, hospitals were assigned a letter with the lowest cost center designated A and the highest cost center designated T. Average case cost in each item category was compared identifying hospitals with a usage cost greater than 25% above average (Fig. 4). We were then able to identify nine items which had the greatest contribution to increased cost: trocars, clip applier, suction irrigator,

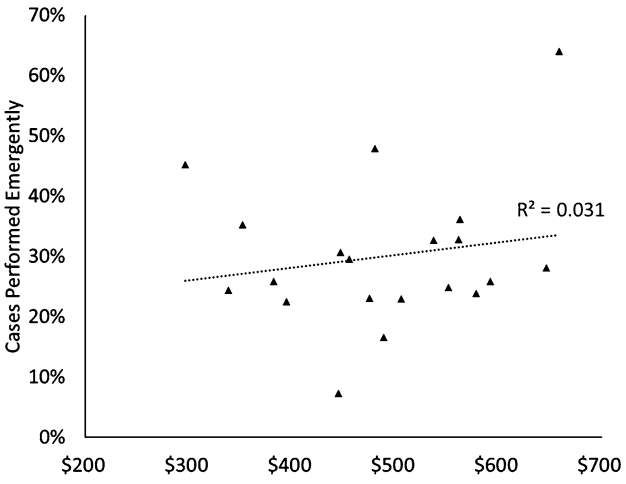

Fig. 3 Cost compared to emergency surgery rate

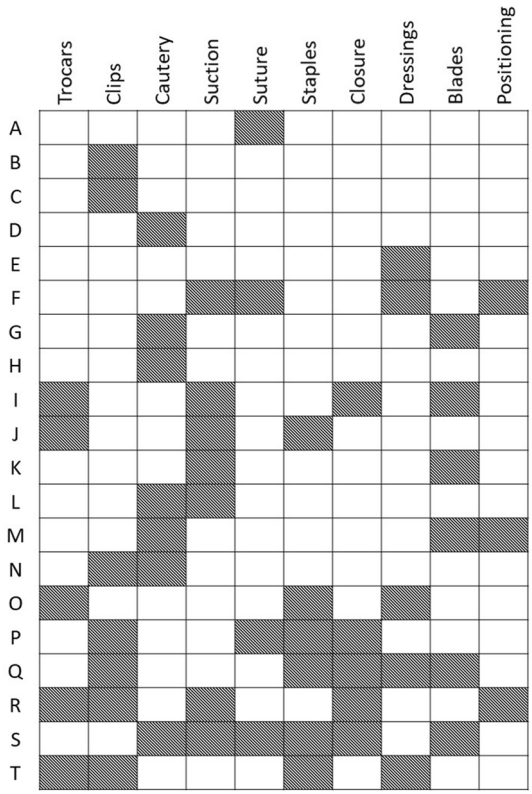

Fig. 4 Disposable instrument costs greater than 25% above average

endoscissors, hook cautery, laparoscopic peanut, PDS endoloop (off contract item), hover mat, and Carter–Thomason. Looking at the three highest cost centers and the three lowest cost centers, we evaluated the proportion of cases where these instruments were used (Fig. 5). Not every high-cost case used every item, and some low-cost centers had a high usage of both disposable trocars and disposable clip appliers. Nonetheless, there was a discernable trend toward increased usage at high-cost centers. Lastly, by looking at the lowest cost centers in each item category, we identified low-cost alternatives for each of the high-cost items (Table 1).

We obtained patient demographics and comorbidities for each hospital in the region (Figs. 6, 7), and found no significant difference between low-cost and high-cost centers. Postoperative outcomes from NSQIP were compiled for each hospital (Fig. 8). Average hospital stay ranged from 0.5 to 2.5 days. Readmission rate was low (2.2–5.4%) and reoperations were rare (0–1.5%). None of these outcomes showed a trend with cost. Overall, postoperative complications were low (< 2%). The six most common complications were identified and compared between hospitals (Fig. 9). There did not appear to be any correlation between cost and any complication.

Discussion

Advances in surgical technology have provided a wide variety of high-cost disposable instruments. We show herein that disposable instruments are not essential to the completion of a safe and time-efficient laparoscopic cholecystectomy. We estimate that limiting the use of high-cost disposable instruments can result a savings of $200–300/case. We recognize that the majority of operative costs come in the form of personnel and operating room overhead [4, 7]. However, these factors are not within the control of individual surgeons. Additionally, while it may seem to be a meager savings, $300 for every laparoscopic cholecystectomy can save $1.3 million annually in our health system, and $285 million nationwide.

Our work corroborates previous studies showing that reusable instruments do not change patient outcomes [8–10], even when cost is reduced by individual surgeons [8]. We also show that laparoscopic cholecystectomy can be completed with low-cost reusable instruments without sacrificing operative time. The cost of operating room time has been estimated anywhere from $8–20/min [7, 11]. A randomized trial performed in 1995 showed that reusable instruments increased operative time [12]. However, we found no evidence of that in our study. In fact, the lowest cost center had a below average operative time (58 min) and had residents scrubbed in every case. This suggests that while there may be a learning curve with new instrumentation, there should not be a long-term effect on operative time.

Admittedly, an institutional change toward the use of reusable instruments is no small undertaking. It requires the upfront purchase of instruments, training on the maintenance and management of new instruments, and possibly a change in the workflow of sterile processing. The biggest limitation,

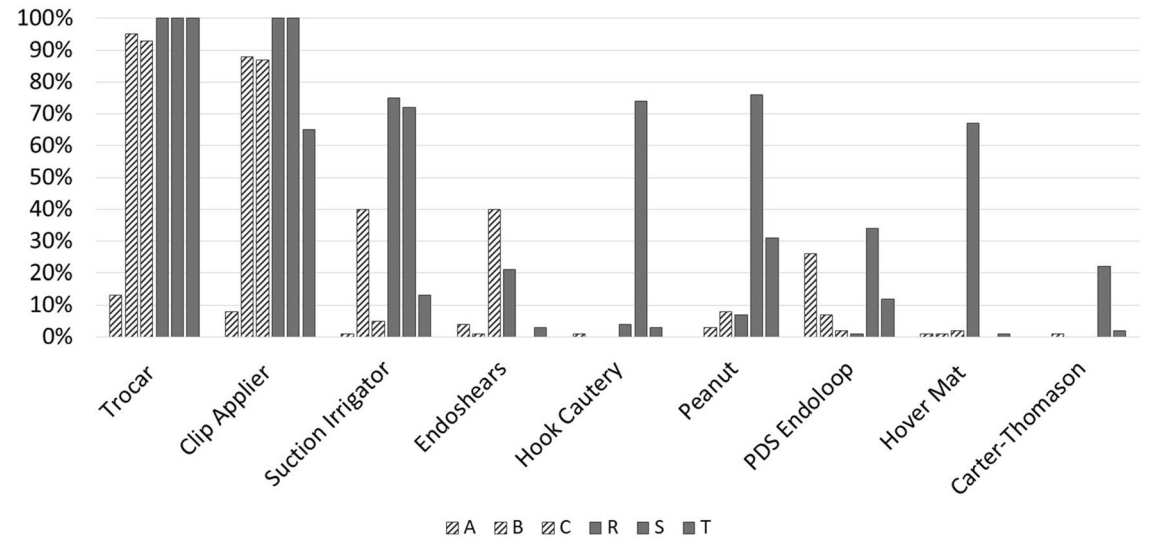

Fig. 5 Usage of high-cost disposable instruments

Table 1 High-cost disposable items and low-cost alternatives

High-cost disposable items		Low-cost alternative	
Trocar	$15–60	Reusable trocar	*
Clip applier	$80–180	Rack of 5 clips	$6–8*
Suction Irrigator	$40	Suction tubing	$5*
Endoshears	$40	Reusable endoscissors	*
Hook	$40	Reusable hook	*
Peanut	$22		
PDS endoloop	$130	Polysorb endoloop	$8
Hover Mat	$60–80		
Carter–Thomason	$120	Reusable suture passer endo-close	$21*

*Costs attributed to purchase and maintenance were not calculated

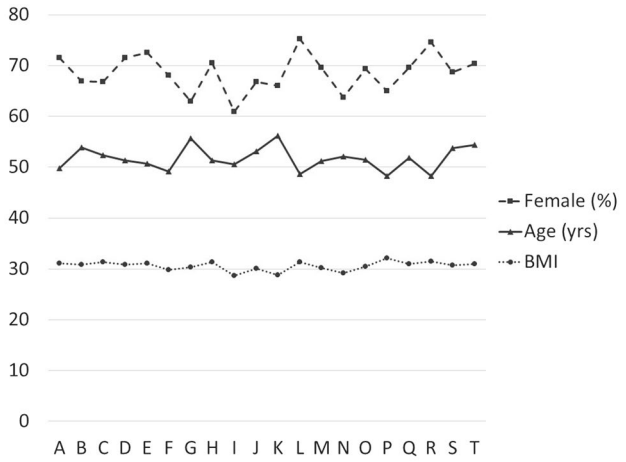

Fig. 6 Patient demographics by hospital

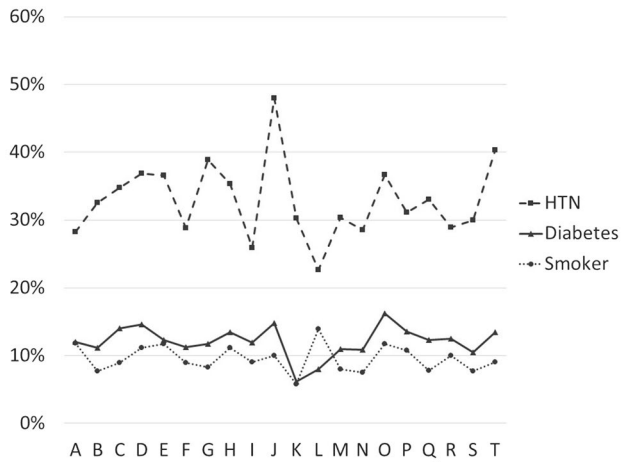

Fig. 7 Patient comorbidities by hospital

however, is buy-in from general surgeons to change the instrumentation for their most common procedure. We admit that some high-cost items may have a benefit over cheaper alternatives. However, the ubiquitous use of high-cost, disposable instruments is most likely the byproduct of hospital trend and surgeon habit. Multiple studies have shown that surgeon awareness of costs is enough to promote a change in usage and decrease in cost [13–16]. The rate of change reported has only been 5–20%; however, this may be due to the ready availability of reusable alternatives.

We recognize that there is a non-zero cost of purchasing and maintaining reusable instruments. Some studies have attempted to quantify the cost of sterile processing with estimates of $23–29/case or $3/instrument [17–19]. However, most surgeons are already using some reusable instruments

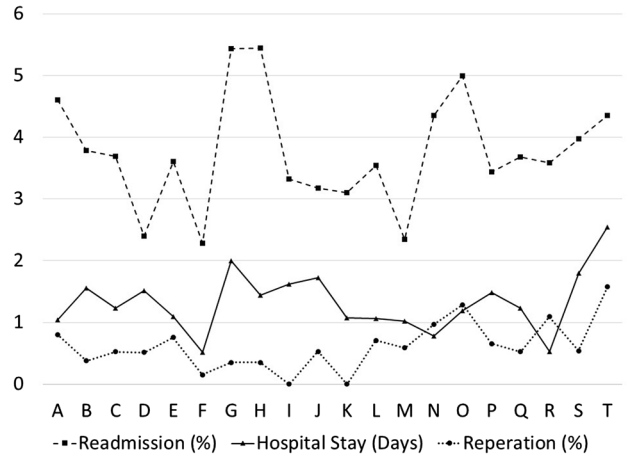

Fig. 8 Postoperative outcomes

for cholecystectomy which require sterile processing (laparoscopic graspers, Maryland, clamps, needle drivers, etc.). The added cost of extra instruments has yet to be quantified. These estimates also do not account for the fact that many reusable instruments can be used in other types of cases, decreasing the upfront cost by increasing utility. Other investigations looked at it differently and compared the overall cost of the case. These studies found an increased cost of 7–20× with disposable compared to reusable instruments [19–21], which would be even larger than the difference between our highest and lowest case cost (presuming $0 for reusable instruments).

This investigation is limited by the retrospective nature and potential database inaccuracies. If all instruments were not entered by the circulating nurse, the overall case cost could be underestimated. Additionally, given the low complication rate after laparoscopic cholecystectomy, there could be a difference in outcomes that we are insufficiently powered to detect. Nonetheless, our work is the largest individual study evaluating the cost of disposable instruments for laparoscopic cholecystectomy. The health system covers a large geographic area and includes 227 general surgeons. For these reasons, we think our results are relevant to every hospital in the nation.

Kaiser Permanente is an integrated health system which provides both health insurance and patient care to its members. It is a unique model where the health plan and providers collaborate rather than compete. As such, it allows the opportunity to devote resources to cost evaluation. Some concern may arise about the objectivity of an integrated health system in addressing issues of cost. However, the wide variety of instrumentation we found speaks to the

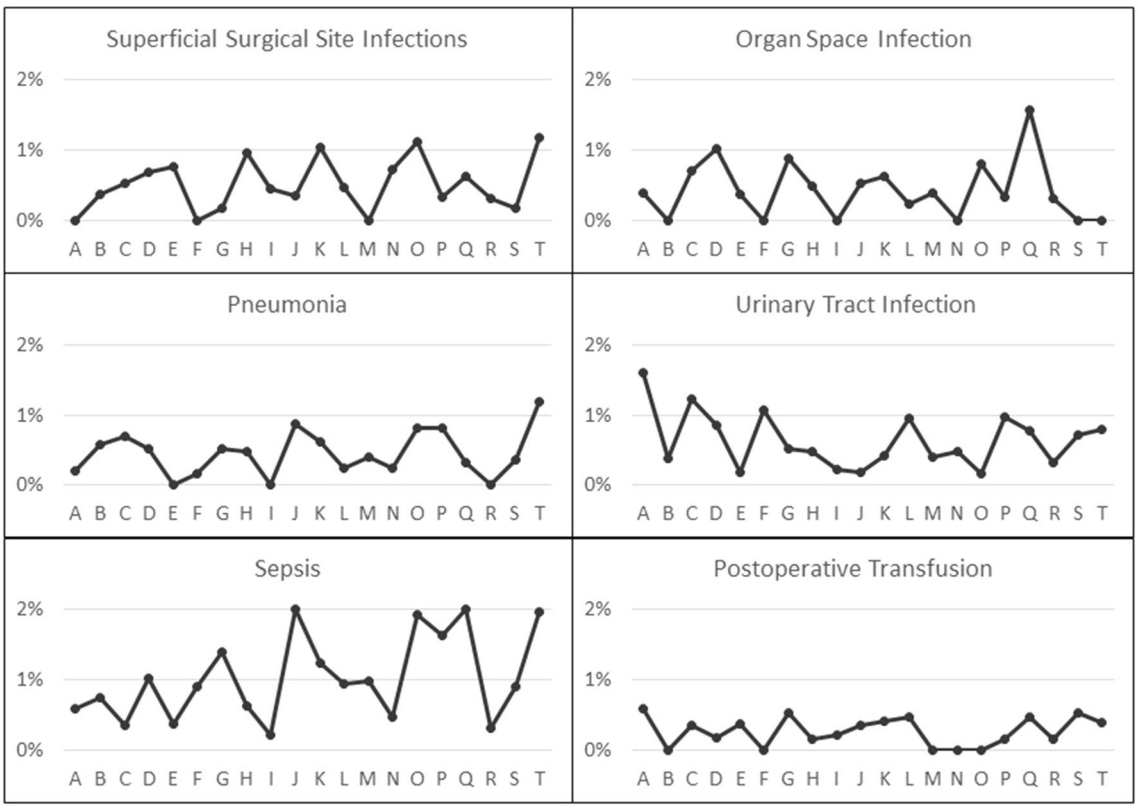

Fig. 9 Complications

degree of surgeon autonomy in selecting instruments. Additionally, our per-case expenditures were similar to studies conducted at non-integrated institutions [9, 10].

Decreasing the operating room cost of frequent procedures such as the laparoscopic cholecystectomy is essential to reducing the ever-rising cost of healthcare in the US. Surgeons have an obligation to know the cost of the instruments they use and advocate for the availability and use of lower cost alternatives. The next steps in our system will be to educate surgeons on their instrumentation costs and encourage a transition to using the least expensive options. We encourage all surgeons to initiate this process in their institutions.

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Compliance with ethical standards

Disclosure Drs. Pontarelli, Grinberg, Isaacs, Morris, Ajayi, and Yenumula have no conflicts of interest or financial ties to disclose.

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