ARTICLE IN PRESS

Surgery ■■ (2017) ■■–■■

Contents lists available at ScienceDirect

Surgery

journal homepage: www.elsevier.com/locate/ymsy

Central Surgical Association

Cost variation and opportunities for cost reduction for laparoscopic cholecystectomy

Kevin L. Grimes [a,b,*], Charleen Scott [a], and Christopher R. McHenry [a,b]

[a] Department of Surgery, MetroHealth Medical Center, Cleveland, OH
[b] Case Western Reserve University School of Medicine, Cleveland, OH

ARTICLE INFO

Article history:
Accepted 11 October 2017

ABSTRACT

Background. We performed 163 laparoscopic cholecystectomies at our institution during the third quarter of 2016. Direct supply cost per case varied from $524 to $1,022 among 14 surgeons. The purpose of this study was to determine the reasons for cost variation between high- and low-cost surgeons and identify opportunities for cost reduction.
Methods. Average cost of supplies per case was examined for laparoscopic cholecystectomy during a 6-month period. Two groups were created, with the 4 highest-cost surgeons comprising group A and the 2 lowest-cost surgeons comprising group B. The cost for each item was identified, and utilization was compared between groups.
Results. The average supply cost per case in group A was significantly greater than group B ($930 vs. $518). The difference persisted in subgroup analyses of both inpatients and patients with high American Society of Anesthesiologists scores. Compared with group A, surgeons in group B used reusable instruments more often and tended to choose lower-cost disposables.
Conclusions. Significant variation in direct cost exists between surgeons performing laparoscopic cholecystectomy. Much of the cost difference can be accounted for by a relatively small number of high-cost instruments. We identified areas for cost savings by substituting lesser cost alternatives without compromising the quality of patient care.

Since its introduction in 1987, laparoscopic cholecystectomy (LC) has been adopted widely and is now one of the most commonly performed procedures in the United States. Despite its pervasiveness, both the technique and the instrumentation are known to be variable between hospitals and even between different surgeons at the same hospital. With the continuing decrease in reimbursement rates and increasing emphasis on "value," there is increasing pressure on hospitals and on surgeons to decrease the cost of procedures.

Studies of surgical subspecialties have found that the operating room (OR) costs constitute a substantial portion of the total cost of care for surgical patients and that instrumentation may account for one third of OR costs.[1,2] Despite this, a study of orthopedic surgeons found that their estimates for the cost of implants were accurate only one fifth of the time and that some of the estimates were off by as much as 25-fold.[3]

At our institution, LC is a high-volume procedure with 163 laparoscopic cholecystectomies performed during the third quarter (July 1–September 30) of 2016. The direct supply cost per case varied from $524 to $1,022 among 14 surgeons, with a median supply cost of $709 and an average cost (±standard deviation [SD]) of $737 ± 154. Because of this wide variation in cost per case and the large number of cases performed, LC was identified as a potential opportunity for cost reduction.

Previous studies have tended to focus on specialties with high-cost instrumentation or implants (and presumably a greater margin for improvement), such as neurosurgery or orthopedic surgery,[4] rather than on relatively low-cost but high-volume general surgical procedures. The purpose of this study was to analyze a single, high-volume procedure (LC), to obtain the costs for disposable instruments and supplies, to compare use between high- and low-cost surgeons, and to identify opportunities for cost reduction.

Materials and Methods

Commercially available cost tracking software (Crimson Continuum of Care, The Advisory Board Company, Washington, DC) was used to examine average cost (to the hospital, not charge to the patient) per case of disposable instruments and supplies for LCs

The authors have no conflicts of interest or financial ties to disclose.

Presented at the Central Surgical Association (CSA) Annual Meeting, Chicago, IL, July 30–August 1, 2017.

* Corresponding author. Kevin L. Grimes, MD, MetroHealth Medical Center, Department of Surgery, Room H920, Cleveland, OH 44109.
E-mail address: kevin.grimes@gmail.com (K.L. Grimes).

https://doi.org/10.1016/j.surg.2017.10.032
0039-6060/

Table 1
Surgeon demographic characteristics.

Surgeon	A	B	C	D	E	F
High or low cost	High	High	High	High	Low	Low
Specialty	Surg Onc	Bariatric	Trauma/ACS	Trauma/ACS	Endocrine	General
Years in practice	25	7	5	3	27	28
Cases per 6 months	5	5	3	5	26	21

ACS, acute care surgery; *Surg Onc,* surgical oncology.

performed by 14 surgeons at a tertiary care academic center during a recent 6-month period (June 1–November 30, 2016). The period chosen was the maximum for which cost data were available. Average supply costs for all 14 surgeons were examined; surgeons were divided into high cost (>$800/case), medium cost ($600–$800/case), and low cost (<$600/case) groups. The 4 surgeons in the high-cost group were group A, and the 2 surgeons in the low-cost group were group B. Individual supply costs, line-item costs for each specific item, and item utilization were compared between groups. The medium-cost surgeons were assumed to represent a blend of high-cost and low-cost instrument selection and were excluded.

A retrospective chart review was then performed to collect patient demographic data (including age, sex, body mass index, American Society of Anesthesiologists [ASA] classification, inpatient status), final pathologic diagnosis, performance of concurrent procedures (such as umbilical hernia repair), and complication rates. ASA classification was used as the indicator of patient severity of illness because of its correlation with perioperative morbidity and mortality.[5] Complications were analyzed according to the Clavien-Dindo classification.[6] Cases were excluded if laparoscopic cholecystectomy was not the primary procedure.

Continuous variables were compared using unpaired Student *t* test. Categorical variables were compared using Fisher exact test. Ordinal data were compared using the Mann-Whitney *U* test. Data are presented as a percentage, mean ± SD, or median (range).

Results

A total of 65 LCs were performed by the 4 high-cost surgeons (group A) and 2 low-cost surgeons (group B) during the study period. Surgeon demographic characteristics, including specialty, case volume during the study period, and time in practice, are listed in Table 1.

Cost and patient demographic data are presented in Table 2. The average supply cost for group A was greater than for group B ($914 vs $530; $P < .0001$). Group A operated on a greater proportion of patients with inpatient status (56% vs 15%, $P < .005$), higher ASA class (median 3 [range 2–4] vs median 2 [range 1–3], $P < .05$), and a greater percentage of patients with a preoperative diagnosis of acute cholecystitis (33% vs 4%, $P < .005$). There were no other significant differences in patient demographics, rate of performance of concurrent procedures, conversion rate, complication rate, or presence of acute cholecystitis on final pathologic report. In a subgroup analysis of only inpatient procedures, a total of 17 cases were analyzed (Table 3). The supply cost for group A remained greater ($912 vs $571, $P < .05$). The risk of major complications (grade III or IV) in groups A and B were 0% vs 14% ($P = .4$) and the rate of conversion to open LC was 0% vs 14% ($P = .04$).

In a second subgroup analysis of only ASA class III or IV patients, a total of 27 cases were analyzed (Table 4). Again, group A was more expensive ($944 vs $554, $P < .005$) but group A operated on a greater percentage of patients with a preoperative diagnosis of acute cholecystitis (33% vs 0%, $P < .05$). There were no other significant differences. In group A there is a trend toward an increased percentage of inpatients (50% vs 13%, $P = .09$), whereas in group B there were possibly an increased number of concurrent procedures such as umbilical hernia repair (33% vs 17%, $P = .4$) and an increased risk of major complications (grade III or IV, 13% vs 0%, $P = .5$).

Higher-cost disposable instruments were used with increased frequency in group A. These data are summarized in Table 5. In particular, group A was more likely than group B to use the 5-mm clip applier (100% vs 47%), a disposable rather than reusable Hasson cannula (100% vs 16%), a disposable suction/irrigator (53% vs 0%), a 5-mm optical trocar (24% vs 2%), a Carter-Thomason needle (Cooper Surgical, Trumbull, CT) for fascial closure (18% vs 0%), and Dermabond (Ethicon, Somerville, NJ) rather than Steri-Strips (3M, Maplewood, MN) (100% vs 19%). Although the Endoloop (Ethicon, Somerville, NJ) was used with equal frequency between groups (6% vs 5%), in cases where the Endoloop was used, group A used an average of 2 loops per case, whereas Group B used only 1 loop per case.

Differences in supply cost are summarized in Table 6. The difference in cost between high-cost disposable instruments and low-cost alternatives ranged from $16 to $276.

Discussion

The 4 highest-cost surgeons in our department spent an average of 72% more for disposable instruments and supplies for LC than

Table 2
High versus low cost.

	Group A (high cost)	Group B (low cost)	*P*
n	18	47	–
Cost	$914 ± $310	$530 ± 81	<.0001
Age (yr)	47.9 ± 16.5	47.6 ± 17.9	>.5
BMI	30.8 ± 6.3	31.9 ± 7.6	>.5
% Male	11%	26%	.32
ASA class			.0214
I	0%	2%	–
II	33%	66%	–
III	61%	32%	–
IV	6%	0%	–
Indication for OR			
Symptomatic cholelithiasis	33%	26%	>.5
Acute cholecystitis	33%	4%	.0043
Chronic cholecystitis	17%	62%	.0018
Choledocholithiasis	17%	4%	.13
Gallstone pancreatitis	0%	4%	>.5
Inpatient status	56%	15%	.0031
Concurrent procedure*	11%	21%	.49
Intraoperative cholangiogram	6%	2%	.48
Lysis of adhesions	6%	2%	.48
Conversion to open	0%	2%	>.5
Postoperative procedure†	0%	2%	>.5
Complications‡			
Grade I	0%	4%	>.5
Grade II	6%	0%	.28
Grade III	0%	4%	>.5
Grade IV	0%	0%	>.5
Grade V	0%	0%	>.5

* Additional concurrent procedure such as umbilical hernia repair.
† Additional postoperative procedure such as ERCP, which is also included as a grade III complication.
‡ According to Clavien-Dindo classification.
BMI, body mass index (kg/m^2); *ERCP,* endoscopic retrograde cholangiopancreatography.

Please cite this article in press as: Kevin L. Grimes, Charleen Scott, and Christopher R. McHenry, Cost variation and opportunities for cost reduction for laparoscopic cholecystectomy, Surgery (2017), doi: 10.1016/j.surg.2017.10.032