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One hospital, one appendectomy: The cost effectiveness of a standardized doctor's preference card ☆

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ABSTRACT

Purpose: Appendicitis in children provides a unique opportunity to explore changes that reduce variation, reduce cost, and improve value. In this study we sought to evaluate the effectiveness of standardization of surgical technique and intraoperative disposable device utilization for laparoscopic appendectomy among all surgeons at a tertiary children's hospital.
Methods: All 6 surgeons at our tertiary children's hospital agreed to standardize to a single technique of performing a laparoscopic appendectomy. We collected data on all pediatric patients who had a laparoscopic appendectomy following implementation of the uniform doctor's preference card (DPC) (March 1, 2013 to February 28, 2014) and compared them to a historical control group.
Results: Implementation of the uniform DPC decreased the device cost per appendectomy from $844.11 to $305.32. Operative times (skin incision to skin closure) were 34.8 minutes prior to the uniform DPC and 37.0 minutes using the uniform DPC. There were no significant differences in postappendectomy outcomes.
Conclusion: We have demonstrated that implementation of a uniform DPC and technical standardization for laparoscopic appendectomy can significantly reduce cost. Furthermore, this can occur without dramatically increasing operative times, length of stay, or postoperative complications.

Variation in laparoscopic appendectomy technique, as with many surgical procedures, is common and is based on individual surgeon training and preference. Despite differences in surgical technique among surgeons, outcomes are relatively similar. Given the high clinical volume combined with the low frequency of complications, appendicitis represents a unique opportunity to increase value by implementing cost-saving measures, reducing variability and minimizing resource utilization. In this study we sought to evaluate the effectiveness of standardization of surgical technique and intraoperative disposable device utilization for laparoscopic appendectomy among 6 surgeons at a tertiary children's hospital.

1. Methods

After obtaining institutional review board (IRB) (IRB no. 00064063) approval we performed a retrospective query of a prospectively maintained database at our tertiary care children's hospital. We standardized the doctor's preference card (DPC) for laparoscopic appendectomy on March 1, 2013.

1.1. Prior to uniform DPC

Prior to the implementation of the uniform DPC, 6 board certified pediatric surgeons at our children's hospital performed laparoscopic appendectomies using various techniques. Instruments varied from surgeon to surgeon but often included dilating sheathed ports, linear stapler(s), a pistol-grip heat source and a specimen retrieval bag.

1.2. Uniform DPC

We created and implemented the uniform DPC for laparoscopic appendectomy by consensus opinion among the 6 surgeons and based the selection of devices in our uniform DPC on cost, availability and utility. We identified several effective and inexpensive devices available in our healthcare system but not previously utilized at our institution. Changes regarding the instruments and technique included low-cost dilating ribbed ports, use of a reusable hook cautery to divide the mesoappendix and pre-tied surgical loops to control the base of the appendix and cecum. The uniform DPC excluded linear staplers, pistol-grip heat sources and specimen retrieval bags. These were only used if the

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operating surgeon determined during the procedure that the device was necessary.

1.3. Definition of ruptured vs. nonruptured appendicitis

We strictly defined ruptured appendicitis as a visible hole in the appendix or a fecalith in the abdomen [1]. Patients with gangrenous appendicitis were included in this analysis as nonruptured appendicitis in both analysis groups. The nonruptured status was based upon intraoperative identification and did not change during the postoperative hospital course. Pathologic results did not affect how patients were categorized or treated postoperatively. If the appendix was ruptured intraoperatively owing to surgical manipulation, that patient was categorized as "ruptured".

1.4. Activity-based accounting

Costs were derived from the hospital's cost-accounting program, the Standard Cost Master, which is a transaction-based microcosting system. This system identifies and aggregates the variable- and fixed-cost components of patient activities, hospital services, and products according to the date of service [2,3]. Total hospital costs are shown. Hospital costs incurred in years 2011–2014 were standardized to 2014 US dollars by applying a yearly consumer price index for hospital services [4]. Cost reported in this analysis includes the hospital cost of the initial evaluation, procedure, and hospital stay.

1.5. Statistics

Univariate analyses comparing before to after uniform DPC procedures and outcomes were performed. For categorical variables, differences in proportions between the 2 time periods were tested with the chi square test or Fisher's Exact test as appropriate. Continuous variable differences were tested using ANOVA or the equivalent nonparametric procedure. These analyses were performed using SAS version 9.4 (2013; SAS Institute Inc., Cary, NC).

Costs were converted to 2014 US dollars using the Consumer Price Index. Differences in the costs across the two study periods were tested using a multivariable generalized linear model (GLM) with a log link function. While the gamma distribution is typically used in GLM regressions for healthcare cost outcomes, the GLM family test (modified Park test) indicated that the most appropriate distribution for these data was the Poisson. Results were returned to the original cost scale using the margins command in Stata. These analyses were performed using Stata version 13 (2013; StataCorp LP, College Station, TX).

Significance was defined as P value $\leq .05$. Descriptive statistics were calculated as mean with 95% confidence interval or N (%).

2. Results

From March 1, 2013 to February 28, 2014 362 consecutive laparoscopic appendectomies were performed using the uniform DPC. In the historical control group there were 346 consecutive laparoscopic appendectomies performed prior to the implementation of the uniform DPC from March 1, 2012 to February 28, 2013. Comparisons of patients with ruptured and nonruptured appendicitis in whom the appendectomies were performed using the uniform DPC vs. the historical control group reveal no differences in gender, age, or WBC count on admission (Table 1).

2.1. Effect of the uniform DPC on the cost of the procedure

Implementation of the uniform DPC decreased the device cost per appendectomy from $829.73 to $279.76 for patients with nonruptured appendicitis and from $874.08 to $361.51 for patients with ruptured appendicitis. The cost savings directly attributable to the implementation of the uniform DPC during the one year time period of this study was $195,041.98. Operative times (skin incision to skin closure) were 31.2 minutes prior to the uniform DPC and 34.0 minutes using the uniform DPC for patients with nonruptured appendicitis and 41.7 minutes versus 43.4 minutes for patients with ruptured appendicitis. Total time in the operating room was 55.6 minutes prior to the uniform DPC and 58.3 minutes using the uniform DPC for patients with nonruptured appendicitis and 66.6 minutes versus 68.8 minutes for patients with ruptured appendicitis (Table 1).

Table 1
Demographic, cost, and duration information.

	Prior to uniform DPC, N = 346	With uniform DPC, N = 362	P value
	Mean (95% CI)	Mean (95% CI)	
All patients with appendicitis			
Age in years	9.4 (9.0–9.8)	10.0 (9.6–10.4)	0.047
Gender (M:F)	188:158 (54.3% Male)	196:166 (54.1% Male)	0.959
Admission WBC	13.8 (13.2–14.5)	13.7 (13.1–14.4)	0.758
Appendectomy device cost	$844.11 (838.65–849.56)	$305.32 (302.05–308.60)	<0.001
Skin to skin OR time (min)	34.8 (33.3–36.3)	37.0 (35.6–38.4)	0.006
Roll-in roll-out OR time (min)	59.3 (57.6–61.1)	61.7 (60.0–63.3)	0.016
Length of stay (hours)	50.9 (44.1–57.7)	46.7 (41.1–52.3)	0.394
Patients with nonruptured appendicitis			
	N = 229	N = 247	
Age in years	10.0 (9.6–10.5)	10.5 (10.1–10.9)	0.047
Gender (M:F)	123:106 (53.7% Male)	139:108 (56.3% Male)	0.574
Admission WBC	13.4 (12.6–14.2)	14.2 (13.3–15.0)	0.139
Appendectomy device cost	$829.73 (823.63–835.84)	$279.76 (276.22–283.29)	<0.001
Skin to skin OR time (min)	31.2 (30.2–33.4)	34.0 (32.3–35.3)	0.006
Roll-in roll-out OR time (min)	55.6 (53.7–57.5)	58.3 (56.6–60.0)	0.016
Length of stay (hours)	22.5 (20.3–24.6)	24.9 (20.9–28.9)	0.394
Patients with ruptured appendicitis			
	N = 117	N = 115	
Age in years	8.2 (7.5–8.9)	8.9 (8.2–9.6)	0.047
Gender (M:F)	65:52 (55.6% Male)	57:58 (49.6% Male)	0.361
Admission WBC	14.4 (13.3–15.5)	13.0 (11.9–14.0)	0.055
Appendectomy device cost	$874.08 (867.69–880.48)	$361.51 (357.41–365.61)	<0.001
Skin to skin OR time (min)	41.7 (38.9–44.4)	43.4 (40.6–46.3)	0.006
Roll-in roll-out OR time (min)	66.6 (63.4–69.9)	68.8 (65.3–72.4)	0.016
Length of stay (hours)	106.6 (91.2–121.7)	93.6 (82.2–104.9)	0.394

2.2. Effect of the uniform DPC on the overall cost of the treatment of appendicitis

Hospital length of stay increased from 22.5 hours prior to the uniform DPC to 24.9 hours using the uniform DPC in patients with nonruptured appendicitis and decreased from 106.6 hours prior to the uniform DPC to 93.6 hours using the uniform DPC in patients with ruptured appendicitis (Table 1).

2.3. Effect of the uniform DPC on outcomes

There were no significant differences in postappendectomy outcomes including inpatient readmission, observation readmission, postdischarge emergency department reevaluation, abdominal abscess, reoperation, postoperative interventional radiology drainage, subcutaneous abscess,