

Time is money: quantifying savings in outpatient appendectomy

Elise Taylor Bernard, Daniel L Davenport, Courtney M Collins, Bethany A Benton, Andrew C Bernard

Department of Surgery, Acute Care Surgery, College of Medicine, University of Kentucky, Lexington, Kentucky, USA

Correspondence to

Elise Taylor Bernard, Department of Surgery, Acute Care Surgery, College of Medicine, University of Kentucky, Lexington, KY 40506, USA; 16bernarde@gmail.com

Presented at the 2018 Academic Surgical Congress, Jacksonville, Florida, January 30, 2018. Formatted for *Trauma Surgery & Acute Care Open*.

Received 6 August 2018
Revised 30 November 2018
Accepted 5 December 2018

ABSTRACT

Background Laparoscopic appendectomy can be performed on a fast-track, short-stay, or outpatient basis with high success rates, low morbidity, low readmission rates, and shorter length of hospital stay. Cost savings from outpatient appendectomy have not been well described. We hypothesize that outpatient laparoscopic appendectomy is associated with cost savings.

Methods We performed an original retrospective cohort analysis of patients undergoing laparoscopic appendectomy between June 2013 and April 2017 at our academic medical center before and after implementation of an outpatient protocol which began on January 1, 2016. We assessed appendicitis grade, length of stay (LOS), cost, net revenue, and profit margin.

Results After protocol implementation, the percentage of patients discharged from the postanesthesia care unit (PACU) increased from 3.7% to 29.7% (χ^2 $p < 0.001$). The proportion of inpatient admissions and admissions to observation decreased by 5.7% and 20.3%, respectively. On average, PACU-to-home patients had a total hospital cost of \$4734 compared with \$5781 in patients admitted to observation, for an estimated savings of \$1047 per patient ($p < 0.001$). Comparing the time periods, the mean LOS decreased for all groups ($p < 0.001$). Appendicitis grade was higher in those who required inpatient admission, but could not distinguish which patients required an observation bed.

Discussion Outpatient appendectomy saves approximately \$1000 per patient. Adoption of an outpatient appendectomy pathway is likely to be gradual, but will result in incremental improvement in resource utilization immediately. Grade does not predict which patients should be observed. Considering established safety, our data support widespread implementation of this protocol.

Level of evidence III.

INTRODUCTION

Laparoscopic appendectomy is the most common treatment of appendicitis. Recent evidence suggests laparoscopic appendectomies can be performed on a fast-track, short-stay, or even outpatient basis.¹ This approach was described a decade ago and has been used in adults and children.² This outpatient appendectomy protocol provides high success rates, low morbidity, low readmission rates, and shorter length of hospital stay.³

Financial benefits of outpatient protocol have not been established as definitively as clinical outcomes.⁴ In one study, a fast-track protocol for laparoscopic appendectomy reduced hospital costs;

however, the average length of stay for fast-track patients was still longer than 1 day, so this study did not fully represent the true effect of outpatient appendectomy.⁴ In a similar study in children with appendicitis treated on a fast-track protocol, the average savings was approximately \$350 compared with children who stayed overnight.⁵ In another study, total hospital charges were reduced by around \$900 in patients successfully managed on a fast-track protocol designed for appendicitis, but costs were not reported. In a study from Canada showing true outpatient appendectomy where patients were discharged from the postanesthesia care unit (PACU), cost savings were \$323.46 per patient.⁶ Cost savings in adult patients undergoing outpatient appendectomy have not been well reported in the USA.

Length of stay is an important determinant of hospital costs, and therefore an important potential financial opportunity.⁷ For example, in patients with acute cholecystitis, costs increase incrementally for each additional hospital day.⁸ We hypothesize that an outpatient appendectomy protocol where patients go home from the PACU will result in cost savings.

PATIENTS AND METHODS

After institutional review board approval, we performed a retrospective cohort analysis (level III evidence) of data from the University of Kentucky healthcare discharge database, Hospital Finance, and medical records of patients admitted for the time period of June 1, 2013 to April 30, 2017. We included subjects 15 years or older with the admission diagnosis of "appendicitis." Elective appendectomies, open cases, non-resective operations, and those involving intestinal resection more than the appendix were excluded.

Individual medical records were analyzed to determine whether patients went home from the PACU or were admitted to an observation or inpatient bed. For patients not discharged directly from the PACU, the indication for observation or inpatient admission was determined. Patients were categorized as inpatient admission, observation admission, or PACU-to-home. Patients were divided into two time periods, before and after the outpatient appendectomy protocol was implemented on January 1, 2016. Outpatient protocol was not restricted by age. Patients were admitted to the emergency department (ED) observation area and taken to the operating room on an emergency basis. The criteria for identifying patients eligible

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To cite: Bernard ET, Davenport DL, Collins CM, et al. *Trauma Surg Acute Care Open* 2018;**3**:e000222.



for outpatient appendectomy include laparoscopic procedure, could tolerate liquids in PACU without vomiting, did not require prolonged intravenous antibiotics, and had adequate pain control. The process for the outpatient appendectomy protocol was defined by a discharge order for the patient to leave directly from the PACU without any diet order, no planned observation bed, and no plan for interval examination by the team. PACU discharge was based on standard PACU criteria for other outpatient general surgery (eg, cholecystectomy, inguinal hernia repair). Faculty and residents were encouraged to use this protocol based on their clinical judgment. One concern about the use of outpatient appendectomy is short-term readmission rates. Short-term readmission was defined as within 3 days of discharge, which was based on the mean length of stay for inpatients, found to be slightly above 3 days.

Outpatient, observation bed, and inpatient admission decision were analyzed by time of case completion to determine the effect of night-time on discharge decision. We also analyzed post-PACU disposition by appendicitis grade using the American Association for the Surgery of Trauma (AAST) grading scale, American Society of Anesthesiologists (ASA) class, and age.

Net revenue, direct and indirect costs, profit margin (revenue – total costs), and specific resource costs (operating room, ED, diagnostics, and pharmacy) were obtained from the hospital cost accounting system. Revenue was analyzed according to payer grouping. Each cost center was examined separately. Changes in proportions between periods were calculated using χ^2 tests. Differences in financial parameters were calculated using t-tests or analyses of variance. Significance was set at $p < 0.05$ for all comparisons. Statistical tests were performed using SPSS V.24.

RESULTS

There were 453 patients who underwent emergency laparoscopic appendectomy on the acute care surgery service at our academic medical center during the study period, 295 before protocol implementation and 158 after. The median patient age was 31 years (IQR 21–45 years) and 44.6% were female.

One hundred and eighty-six (41.1%) were admitted to an inpatient bed, 209 (46.1%) to an observation bed, and 58 (12.8%) were discharged home from the PACU. The percentage of PACU-to-home discharges increased from 3.7% during the pre-implementation period to 29.7% in the postimplementation period, whereas inpatient admissions decreased from 48.1% to 27.8% (table 1, χ^2 $p < 0.001$). The proportion of patients assigned to an observation bed also decreased with an absolute reduction of 5.7% and a relative reduction of 11.8%.

Of the 58 patients discharged from the PACU during the study period, three patients returned to the ED, two of whom fell within the 3-day threshold to be classified as a readmission. One patient presented to the ED the day after discharge with complaints of difficulty voiding and blurry vision. This patient

Table 2 Financial performance by PACU discharge destination

PACU discharge destination	Home	Observation	Inpatient
Patients, n	58	209	186
Net revenue	7175*	7074*	10 997†
Total hospital costs	4734*	5781†	9066‡
OR services/supplies	2701*	2942†	3355‡
ED services/supplies	304*	303*	333†
Imaging and lab	245*	220*	527†
Pharmacy	326*	374*	602†
Profit margin	2462*	1325†	1931*

* , †, and ‡ identify groups within financial parameters that were statistically different based on post-hoc non-parametric tests, $p < 0.05$.
ED, emergency department; OR, operating room; PACU, postanesthesia care unit.

was discharged from the ED with no abnormality found. A second patient, a 60-year-old woman, presented 2 days after discharge with a chronic obstructive pulmonary disease exacerbation and a type II non-ST-elevation myocardial infarction. She was discharged 2 days later. One patient returned to the ED on day 10 with constipation, and again on day 29 concerned with wound healing. At the clinic follow-up appointment this patient was well. This patient was not classified as a readmission, as they simply chose the ED for follow-up care. Two of these three patients who returned to the ED after discharge were not English-speaking.

PACU-to-home patients had a mean total hospital cost of \$4734 compared with \$5781 for those placed into an observation bed, for an estimated savings of \$1047 (95% CI \$718 to \$1377) per patient discharged from the PACU under the protocol ($p < 0.05$, table 2). The total cost for inpatients was dramatically higher than patients discharged from the PACU and those admitted for observation ($p < 0.05$). When analyzed by cost center, operating room services and supplies were \$241 higher in patients admitted to observation and \$654 higher in those admitted to an inpatient bed ($p < 0.05$). Inpatients had significantly higher pharmacy, imaging and lab, and ED service and supply costs than patients discharged from the PACU or admitted for observation ($p < 0.05$).

Revenue was not significantly different for patients discharged home compared with patients admitted for observation; however, as a result of decreased costs, patients discharged home had a higher profit margin than patients admitted for observation ($p < 0.05$, table 2). Revenue was higher for inpatients than either patients discharged home or admitted for observation ($p < 0.05$, table 2). Significantly increased costs for inpatients paralleled increased net revenue resulting in a profit margin comparable with patients discharged home and significantly greater than patients admitted for observation. There were less managed care

Table 1 Number and percent of patients by PACU discharge destination preimplementation and postimplementation of protocol

Period	Preimplementation		Postimplementation		Total for both periods	
	n	%	n	%	n	%
PACU discharge destination						
Home	11	3.7	47	29.7*	58	12.8
Observation	142	48.1	67	42.4	209	46.1
Inpatient	142	48.1	44	27.8*	186	41.1
Total for all destinations	295	100.0	158	100.0	453	100.0

* $P < 0.001$ vs. preimplementation.
PACU, postanesthesia care unit.

Table 3 PACU discharge destination by payer group

	Home	Observation	Inpatient
Managed care	34 (58%)	129 (62%)	70 (38%)
Medicaid	15 (26%)	49 (23%)	52 (28%)
Medicare	1 (2%)	6 (3%)	40 (21%)
Self-pay/charity/other	8 (14%)	25 (12%)	24 (13%)
	58	209	186

Medicare was disproportionately represented in the inpatient group, whereas managed care was under-represented.
PACU, postanesthesia care unit.

and more Medicare in the inpatient group compared with the other two groups ($p < 0.001$, table 3).

After implementation of the protocol, the total average time from operation completion to discharge home decreased by 7.5 hours for those discharged from the PACU and those placed in an observation bed (table 4, $p < 0.001$). In addition, the average time from operation to discharge decreased for each group individually, with a 2.5-hour decrease for patients discharged from the PACU and a 4.2-hour decrease for patients admitted to observation.

Patients whose appendectomy procedure ended between 21:00 and 05:00 were more likely to go to an observation bed ($p = 0.036$) or an inpatient bed ($p = 0.014$) than to be sent home from the PACU (table 5). AAST operative grade was predictive of who would require an inpatient bed ($p < 0.001$), but could not distinguish patients who would require an observation bed from those discharged from the PACU ($p = 0.171$). Similarly, AAST clinical grade predicted who would be admitted to an inpatient bed ($p < 0.001$), but did not identify those who would require an observation bed rather than being discharged home from the PACU ($p = 0.345$). Age and ASA classification were both higher in inpatients, but did not differ between observation and outpatient cases.

DISCUSSION

Outpatient appendectomy has now been clearly established as safe and effective, with complication rates, readmission rates, and satisfaction equivocal to those patients kept in observation.⁹ We were successful in implementing an outpatient appendectomy protocol that increased the percentage of patients discharged from the PACU. Implementation of an outpatient appendectomy protocol was not successful in facilitating discharge home of all eligible patients. By comparing the preimplementation and postimplementation periods, we are able to show gradual adoption of this protocol. The most important difference between the two time periods is a significant increase in patients who were sent home from the PACU. One reason that this protocol is expected to yield a slow adoption rate is that individual surgeons varied in the rate

Table 4 Hours to discharge decreased in both patients discharged to home and admitted to observation after implementation of the protocol

Mean hours to discharge	Period	
PACU destination	Preimplementation	Postimplementation
Home	4.6	2.1
Observation	16.6	12.4
Total	15.7	8.2

Overall difference $p < 0.001$.
PACU, postanesthesia care unit.

at which they embraced outpatient appendectomy. During data analysis, we found numerous patients admitted to observation in the postimplementation period who seemed to be appropriate to be discharged home, but who were treated by surgeons who had not yet chosen to adopt to the protocol. Conversely, there were also surgeons who were discharging patients home from the PACU even before formal implementation of the protocol. Evidence suggests that more than half of new perioperative protocols meet barriers to initiation, including logistical issues, time constraints, and opposition from colleagues.¹⁰ A greater comfort level with outpatient appendectomy developed among our providers over time. Implementing outpatient appendectomy protocol requires a culture change and effects are likely to appear gradually.

Appendicitis severity can be graded using numerous methods.¹¹ We sought to determine whether appendicitis grading would determine which patients could be discharged home from the PACU. The AAST grading system has been the most extensively studied, and we have shown AAST grade correlates with cost and operative duration.¹² Data shown here indicate that patients with high-grade appendicitis are more likely to require an inpatient bed. High-grade appendicitis is characterized clinically by abdominal tenderness, mass, and peritonitis, and operatively by perforation, phlegmon, or generalized peritonitis. It is therefore not surprising that patients with high-grade appendicitis more often require inpatient admission. However, 80% of patients in our study had clinical or operative grade I or II appendicitis. Within these low grades, we could not discriminate who required an observation bed based on grading. This lack of discrimination leads us to conclude that in the majority of patients, the decision to discharge home from the PACU is more dependent on the surgeon than the patient.

Culture change in the postoperative management of appendicitis occurred at our academic medical center, evidenced by fewer patients admitted to observation and inpatient beds. Despite gradual and incomplete adoption of the protocol, we still report an eightfold increase in patients discharged from the PACU and this required no bed at all. Even those patients admitted to observation stayed fewer hours. Gurien *et al*³ reported increased hospital charges in patients not discharged directly from the PACU, and these charges appear primarily related to longer hours of hospital stay.³

Cost savings data reported here are on a per-case basis. For each patient discharged from the PACU, there will be incremental cost savings of over \$1000 compared with patients admitted to observation. Considering data shown in table 2, the greatest cost savings appears to be related to bed cost, since costs related to ED, pharmaceuticals, and imaging were the same, and operating room services and supply costs were only slightly greater in patients admitted to observation.

To estimate total opportunity cost savings at our institution, we applied the percentage increase in patients discharged home after the protocol was implemented, or 26.0%, to the number of patients treated before implementation, 295. Based on this estimate, 77 patients would have avoided being admitted to observation, resulting in a total cost savings of \$80 619 during the 30-month period. Other authors have estimated that nationwide implementation of an outpatient appendectomy protocol could save \$921 500 000 in annual direct healthcare costs; therefore, our work, combined with that of others, suggests a potential significant cost savings for the healthcare community.¹³ Total cost savings may be underestimated by only considering objective cost data. For example, additional cost savings could be realized by avoiding bed turnover and cleaning, and the downstream effects of bed occupancy, such as ED boarding and lost transfers.

**Table 5** Predictive factors for post-PACU disposition

Variable	Home	Observation	P value	Inpatient	Total	P value
Patients, n	58	209	Observation vs. home	186	453	
Case ended 21:00–05:00 (%)	32.8	49.0	0.036	36.6	41.8%	0.014
AAST clinical grade (%)			0.171			<0.001
1	86.2	84.7		42.5	67.5	
2	13.8	11.0		13.4	12.4	
3	0.0	3.8		39.8	18.1	
4	0.0	0.5		1.1	0.7	
5	0.0	0.0		3.2	1.3	
AAST operative grade (%)			0.345			<0.001
1	93.1	90.4		50.4	74.5	
2	5.2	5.3		6.5	5.7	
3	1.7	3.8		32.3	15.2	
4	0.0	0.0		6.5	2.6	
5	0.0	0.5		4.3	2.0	
ASA class (%)			0.943			<0.001
1	48.3	48.3		29.0	40.4	
2	39.7	40.7		41.4	40.8	
3	12.1	10.5		26.3	17.2	
4	0.0	0.5		3.2	1.5	
Age quintile (%)			0.292			<0.001
≤20	36.2	26.8		12.9	22.3	
21–27	17.2	23.0		13.4	18.3	
28–35	12.1	22.0		19.4	19.6	
36–49	24.1	20.1		19.9	20.5	
50+	10.3	8.1		34.4	19.2	

AAST, American Association for the Surgery of Trauma; ASA, American Society of Anesthesiologists; PACU, postanesthesia care unit.

Revenue was highest in the inpatient group. However, indirect and direct costs for inpatients were also higher, resulting in a margin slightly less than for outpatient appendectomy group. Increased direct cost was multifactorial. Imaging costs were greater in the PACU-to-home and admitted to observation groups, probably because more complex cases of appendicitis required more complex imaging to treat complications. Pharmacy costs were higher because of prolonged antimicrobial therapy in complicated cases. As with the other two groups, the majority of direct costs were related to bed cost, determined directly by length of stay. Increased revenue was likely due to higher illness severity and additional or alternative diagnosis-related groups (DRGs) in the inpatient group. It is unlikely that significant opportunity cost savings lies in this higher acuity group; however, based on our data, we think strongly that there is a definite opportunity cost savings that lies in the low acuity appendicitis population by avoiding admitting patients to observation beds. Outpatient appendectomy cases outperformed both cases placed in an observation bed and inpatients.

Cost is a relevant and objective financial target, and cost reduction is a viable financial strategy. Performance of the acute care surgery service includes financials and can influence organization resource allocation. Reimbursement is primarily based on DRG and payer type, both of which are difficult to control. The simple outpatient appendectomy protocol described here results in savings greater than those reported in a same-day discharge protocol in children and an outpatient protocol performed in Canada.^{3,5} Our data corroborate previous reports showing that shorter length of stay, even by a few hours, results in cost savings. These results should be easily reproducible.

A larger population of Medicare payer type in the inpatient group was likely due to a greater majority of elderly patients in this population, with greater comorbidity that were more likely to require an inpatient stay. In the postimplementation period, the decrease in self-pay/charity payer type was likely due to Kentucky being an early adopter of the Affordable Care Act, resulting in more patients with Medicaid. Payer status will definitely affect profit margin. Our focus in this study is cost, which we think to be the most relevant financial target to try to influence because it is most directly modifiable.

Readmission rates are a concern in outpatient appendectomy; however, readmission rates are low using this protocol, reported at 3% in a multicenter trial.⁹ In our study, only two patients returned within 3 days of discharge. No patient managed with the outpatient protocol returned to the ED within 3 days as a result of being treated on an outpatient basis. One patient who returned to the ED with constipation related to his appendectomy was not English-speaking, a factor known to be associated with increased use of the ED for access to care.¹⁴ The 3-day threshold determined for the readmission period in this study is arbitrary. The median length of stay for observation and inpatient groups were both 2 days, which are both less than the 3-day threshold. From this, we think that that 3-day threshold is a valid defining point for readmission rates in this study.

This was a retrospective study in which the decision to discharge the patient home was left to the discretion of the operating surgeon. There is inevitable selection bias in the outpatient appendectomy group; however, the dramatic increase in patients discharged from the PACU after protocol implementation affirms a significant opportunity to avoid admission to

an observation bed. A recent multicenter trial sponsored by the Southwestern Surgical Congress affirmed that a laparoscopic appendectomy protocol can be successfully generalized to multiple institutions, with low rates of readmission and complication rates.⁹ We were not able to measure PACU flow in these patients and whether the protocol negatively effected throughput; however, no PACU flow issues were reported anecdotally during either period.

CONCLUSION

Development of an outpatient laparoscopic appendectomy protocol will be associated with significant cost savings in eligible patients. The exact amount of total cost savings from implementing this protocol will depend on the percentage of patients who are clinically appropriate to be discharged home, surgeon comfort, organizational efficiency, and appendicitis grade. Profit margin will ultimately depend on total cost savings and payer mix.

Contributors ETB designed the study, collected the data, analyzed the data, and wrote the article. DLD designed the study, analyzed the data, and edited the article. CMC collected and analyzed the AAST grading data. BAB designed the study, collected the data, and edited the article. ACB designed the study, analyzed the data, edited the article, and supervised the project.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

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