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PACU discharge: equally safe and more cost-effective than floor admission for uncomplicated laparoscopic appendectomy

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Abstract

Background Laparoscopic appendectomy is a common emergency surgical procedure worldwide, known for its benefits of reduced pain, shorter hospital stays, and quicker recovery times. Although postoperative care typically involves observation on the surgical floor, advances in surgical techniques and perioperative care have introduced the potential for discharging patients directly from the post-anesthesia care unit (PACU). This study aims to evaluate the safety and cost-effectiveness of direct PACU discharge compared to traditional floor admission for patients undergoing uncomplicated laparoscopic appendectomy.

Methods This retrospective cohort study analyzed adult patients diagnosed with uncomplicated appendicitis between January 2021 and December 2023. Patients were divided into two cohorts: those discharged directly from PACU and those admitted to the floor before discharge. Primary outcomes included 30-day readmission rates, reoperation rates, and postoperative complications. Secondary outcomes assessed costs, surgery times, and demographic variables. Statistical analysis involved Pearson's chi-square tests, *t*-tests, and multivariate logistic regression.

Results A total of 203 patients were included, with 103 in the PACU cohort and 100 in the floor cohort. PACU patients were younger and had fewer comorbidities than floor patients. No significant differences were found in 30-day readmission, reoperation rates, or complications between the groups. PACU discharge was associated with significantly shorter hospital stays (8 h vs. 26 h, $p < 0.001$) and lower costs, with average charges of $27,739 for PACU discharges versus $31,593 for floor discharges, primarily due to reduced labor costs.

Conclusion Direct discharge from the PACU following uncomplicated laparoscopic appendectomy is both safe and cost-effective compared to floor admission. These findings suggest that PACU discharge is a viable option for well-selected patients, with the potential for significant healthcare savings. Future research should focus on refining patient selection criteria and validating these findings in diverse healthcare settings.

Introduction

Laparoscopic appendectomy is among the most performed emergency surgery worldwide (Moris et al. 2021). While open appendectomy is still performed in certain instances, laparoscopic appendectomy has now become the standard of care and this widespread adoption has been driven by its associated benefits, including reduced postoperative pain, shorter hospital stays, and quicker recovery times (Genser and Vons 2015; Cosse et al. 2014;

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Sabbagh et al. 2014; Hobeika et al. 2017; Cairo et al. 2017).

The incidence of appendicitis varies globally, with an estimated lifetime risk of 7–8% in Western populations (Yang et al. 1990). While the overall mortality and complication rate associated with laparoscopic appendectomy is low, the management of postoperative care remains a topic of ongoing debate (Wijkerslooth et al. 2021). Traditionally, patients undergoing laparoscopic appendectomy were admitted to the surgical floor for observation before discharge. However, with advancements in surgical techniques and perioperative care, the feasibility of discharging patients directly from the post-anesthesia care unit (PACU) has emerged as a potential strategy to optimize resource utilization without compromising patient safety (Grewal et al. 2004; Halter et al. 2016; Gee et al. 2018; Benedict et al. 2018; Trejo-Ávila et al. 2019; Rochon et al. 2019; Putnam et al. 2014; Trejo-Avila et al. 2019; Sabbagh et al. 2019; Grigorian et al. 2019).

Despite the potential benefits, the practice of discharging patients directly from the PACU remains relatively underexplored in the literature, with limited studies, especially in relation to its global incidence, examining its safety and cost-effectiveness compared to the traditional approach of floor admission and subsequent discharge. This study aims to address this gap by comparing the outcomes of patients discharged directly from the PACU following uncomplicated laparoscopic appendectomy to those admitted to the floor. It was hypothesized that direct PACU discharge is as safe as floor discharge and offers significant cost savings for both the hospital and the patient.

Methods

This IREB-approved (#2343–23, October 24, 2023) retrospective cohort study was conducted on adults aged 18 or older diagnosed with uncomplicated appendicitis (no perforation, abscess, or phlegmon) from January 01 2021 to December 312,023. The study involved two cohorts originally based off surgeon preference: the first were patients discharged directly from the PACU, and the second were patients admitted to and subsequently discharged from the hospital floor. Patients' charts were randomly selected and reviewed until groups had similar sample sizes to avoid bias. A power analysis was not performed due to the retrospective design. Patients were excluded if they were of a vulnerable population (pregnant, incarcerated), younger than 18 years of age, or had complicated appendicitis. The primary outcome variables analyzed were 30-day readmission rates and reoperations, and postoperative complications (wound complications, infection). The secondary outcome variable assessed was the cost associated with each discharge method, surgery times (time of day, time to the operating room, duration of surgery), and demographic variables (gender, age, body mass index, race, ethnicity, smoking status, number of comorbidities).

Pearson's chi-square tests were used to analyze categorical variables, such as gender, race, and comorbid conditions, while t-tests were applied to compare continuous variables, including age and body mass index (BMI), between the two cohorts. Differences in postoperative outcomes, including 30-day readmission rates, reoperations, and complications, were also assessed using these tests. To determine independent associations for the primary outcome variables and account for confounders, multivariate logistic regression analysis was performed. Variables adjusted for include demographics and surgical times. Statistical significance was defined as $p < 0.05$. All statistical analyses were performed using R.

Results

Two hundred three patients were included in the study: 103 patients discharged directly from PACU and 100 patients who were admitted and discharged from the floor. Patients in the PACU cohort were, on average, 9 years younger (35.2 vs. 44.3 years; $p < 0.001$) and had significantly fewer comorbidities, with 70.9% (73) of PACU patients having no comorbidities compared to 45% (45) of floor patients ($p < 0.001$). The racial distribution also differed, with a higher proportion of American Indian or Alaska Native patients in the floor cohort (15 vs. 8) and a higher proportion of White or Caucasian patients in the PACU cohort (84 vs. 71; $p < 0.001$). Additionally, the PACU cohort had a higher percentage of Hispanic or Latino patients (26 vs. 12; $p = 0.012$) (Table 1).

In terms of surgical timing, patients discharged from the PACU had significantly shorter times from hospital arrival to operating room (OR) arrival, averaging 5.1 h compared to 9.4 h for the floor cohort ($p < 0.001$). However, the time from OR arrival to surgery start was similar between the two groups (24 vs. 24.7 min; $p = 0.241$). The distribution of surgeries throughout the day (morning, afternoon, evening, and night) did not differ significantly between the cohorts ($p = 0.197$). The PACU group had a higher percentage of shorter surgical times, with 36% of surgeries lasting 10–20 min and only 7.8% exceeding 40 min, compared to 29% and 22% in the floor cohort, respectively ($p = 0.021$). The average surgical time was shorter for the PACU cohort at 25.9 min versus 30.18 min for the floor cohort. PACU patients' length of hospital stay (LOS) on average was 8 h with a standard deviation (SD) of 3. Floor patients' average length of stay was 26 h and a SD of 18 (Table 2).

Multivariate analysis showed no significant differences in postoperative outcomes, including complications

Table 1 Demographics of patients discharged from PACU vs. floor

	PACU	Floor	*p*-value
n	103	100	
Gender			
Male	51	33	0.274
Female	52	67	0.025
Age, years	35.2	44.3	**< 0.001**
BMI	28.2	27.9	0.74
Race			
American Indian or Alaska Native	8	15	< 0.001
Asian	4	2	
Black or African American	3	7	
Multiracial	1	2	
Other	1	1	
White or Caucasian	84	71	
Unknown	2	2	
Ethnicity			
Hispanic or Latino	26	12	0.019
Not Hispanic or Latino	77	88	0.025
Comorbidities			
None	73	45	< 0.001
1	21	26	
2 +	9	29	
Smoking status			
Current smoker	12	17	0.374
Not current smoker	91	83	

Table 2 Surgical statistics comparison

	PACU	Floor	*p*-value
Average time from arrival to OR, hour (SD)	5.1 (2.6)	9.4 (7.5)	**< 0.001**
Average time from arrival to OR to surgery start time, min. (SD)	24 (7)	24.7 (6.6)	0.241
Time of day (surgery)			
Morning (0500–1159)	22	13	0.198
Afternoon (1200–1759)	32	29	
Evening (1800–2159)	19	16	
Night (2200–0459)	30	42	
Average surgical time, min (SD)	25.9 (11)	30.2 (14.4)	0.021
Average length of stay, hours (median, (IQR))	8 (4.4)	21.1 (14.1)	**< 0.001**

(OR 0.723; $p=0.651$), 30-day readmissions (OR 1.596; $p=0.759$), or the need for reoperations (OR 0.233; $p=0.107$) (Table 3).

In terms of cost, patients discharged from the PACU incurred lower overall charges, with an average total amount charged of $27,739.20 compared to $31,592.93 for patients discharged from the floor. This cost difference was primarily driven by lower labor costs, averaging $2,106.74 for PACU discharges versus $3,172.58 for floor discharges, indicating that discharging patients directly from the PACU is both safe and cost-effective (Table 4).

Table 3 Multivariate analysis comparison between PACU and floor

	Odds ratio	95% Lower	95% Upper	*p*-value
Complications	0.723	0.427	2.956	0.651
Readmission	1.596	0.477	5.335	0.759
Reoperation	0.233	0.040	1.374	0.107

Table 4 Financial cost

	PACU	Floor
Surgery supplies	1488.74	1467.49
Labor	2106.74	3172.58
Total amount charged[a] (average)	27,739.20	31,592.93

[a] Included in total: OR charges, anesthesia and facility fees, medications, imaging and diagnostics, post-op. care charges, miscellaneous (labs, consumables, special equipment)

Discussion

This study provides evidence that direct discharge from the PACU following uncomplicated laparoscopic appendectomy is both safe and cost-effective when compared to traditional floor admission. No significant differences were observed in the primary outcomes, including 30-day readmission rates, reoperation rates, and postoperative complications between patients discharged directly from the PACU and those admitted to the floor. These findings are consistent with previous studies that support the feasibility of early discharge following minimally invasive surgeries, further validating the safety of PACU discharge in well-selected patient groups (Grewal et al. 2004; Halter et al. 2016; Gee et al. 2018; Benedict et al. 2018; Trejo-Ávila et al. 2019; Rochon et al. 2019; Putnam et al. 2014; Trejo-Avila et al. 2019; Sabbagh et al. 2019; Grigorian et al. 2019).

In addition to confirming safety, our results highlight the substantial cost savings associated with direct PACU discharge. The reduction in overall hospital charges, driven by lower labor costs, underscores the economic advantage of this approach. This is particularly important in today's healthcare environment, where there is an increasing emphasis on optimizing resource utilization and reducing unnecessary expenditures.

However, the success of PACU discharge is highly dependent on patient selection. Our univariate analysis

showed that patients discharged from the PACU were younger and had fewer comorbidities, indicating that patient-specific factors such as age, health status, and disease severity must be considered when determining eligibility for PACU discharge. Future research should focus on developing standardized criteria to identify candidates who are most likely to benefit from this practice.

While this study contributes to the growing body of literature on PACU discharge, several limitations must be acknowledged. The retrospective design introduces potential selection bias, and although multivariate analysis was used to adjust for confounding factors, certain variables—such as preoperative patient condition and the decision-making process for discharge—may not have been fully accounted for. Moreover, the study was conducted at a single institution, limiting the generalizability of our findings. Prospective studies with larger, more diverse patient populations are needed to validate our results and refine patient selection protocols for PACU discharge.

In conclusion, this study supports the safety and cost-effectiveness of direct PACU discharge following uncomplicated laparoscopic appendectomy. While the practice is well-established, further research is required to ensure its broader applicability, particularly in diverse healthcare settings and among high-risk patient populations. Standardized discharge criteria and careful patient selection will be crucial to maximizing the benefits of this approach.

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Authors' contributions
Conception and Study design: JS. Literature Review: CH, RK, TS, JS. Data acquisition: CH, SS, JS. Data Analysis and Interpretation: JA, CH, SS, JS. Drafting of the manuscript: CH, SS, RK, TS, JS Critical revision: CH, SS, RK, TS, JS.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
The study was approved by the Institutional Review Board representing Saint Francis Health System.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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