Perioperative Medicine

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Unplanned hospital admissions within 24 h after 53,185 surgical procedures at a U.S. ambulatory surgery center

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Abstract

Background Unplanned admission after surgery at an ambulatory surgery center (ASC) is an established measure of the quality of care and can affect the patient's experience. Previous studies on this topic are generally dated, focused on a single specialty, or studied 30-day admissions after ambulatory surgery. Few studies have reported admission within 24 h after surgery at an ASC which is a different but important measure of the quality of anesthetic and surgical care. Understanding admissions within 24 h of surgery can identify opportunities for improvement immediately after surgery. Therefore, our study was designed to assess the incidence and risk factors for unplanned hospital admissions within 24 h after surgery performed at a hospital ASC.

Methods After Institutional Review Board approval, a retrospective analysis was performed on all adult patients who underwent surgery at a US ASC between January 1, 2016, and December 31, 2022. Data were obtained from the hospital's electronic medical record. The study sample was divided into two groups: those with an unplanned hospital admission within 24 h after surgery and those without an unplanned hospital admission. To evaluate risk factors for unplanned hospital admissions, univariate analyses with p value < 0.05 were utilized to identify significant patient variables related to hospital admissions. These variables were further adjusted using a multivariable Firth logistic regression. Descriptive statistics were used to explore the number of patients in different variable categories.

Results Overall, 53,185 cases were identified for the 7-year period. The incidence of unplanned hospital admission over this period was 0.09% (95% CI 0.07–0.1122%; ranging from 0.05 to 0.12% per year. In the multivariable model, surgery duration (OR 1.010, 95% CI 1.007–1.012, p value < 0.0001), peripheral vascular disease (OR 14.489, 95% CI 4.862–43.174, p value < 0.0001), and deep venous thrombosis (OR 5.527, 95% CI 1.909–16.001, p value = 0.0016) were significantly associated with unplanned hospital admission.

Conclusion The overall incidence of unplanned hospital admission after surgery at a large tertiary care ambulatory surgery center is very low. This admission rate can also serve as a reference point for future studies and quality improvement initiatives.

Keywords Ambulatory, Surgery, Unplanned admissions, Hospital, 24 h

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Introduction

The future of healthcare will be largely shaped by ambulatory surgery centers (ASCs) (Davis 1987). More than 35 million procedures are performed annually in ambulatory settings in the USA (Suskind et al. 2015; Hall et al. 2017). ASCs have played an important role in enhancing patient satisfaction, improving patient outcomes, and providing high-quality services at a lower cost (Gardner et al. 2005; Yellen and Davis 2001; Bain et al. 1999). Despite advancements in ASC practices, unplanned hospital admission after ambulatory surgery negatively impacts the patient experience and can result in increased costs to an already stressed healthcare system (Imasogie and Chung 2001; Siragusa et al. 2023; Rosen et al. 2024). The incidence of unplanned hospital admission after ambulatory surgery has been a measure of quality in anesthesia care (Shnaider and Chung 2006; Warner et al. 1993; Vila et al. 2003; Martinez Rodenas et al. 2014). The US Center for Medicare and Medicaid Services (CMS) considers unplanned admission directly from an ambulatory surgery facility or to the hospital after initial discharge to home as one of the quality metrics for ambulatory surgery facilities (Available from: https://www.cms.gov/medicare/quality/initiatives/asc-quality-reporting).

Few studies have assessed hospital admissions within 24 h of surgery at ASCs (Melton et al. 2021; Whippey et al. 2013; Brown et al. 2021; Garcea et al. 2008). Most of the previous studies are dated, focused on a single specialty, or studied 30-day admissions after ambulatory surgery (Garcea et al. 2008; Mezei and Chung 1999; Coley et al. 2002; Khan et al. 2005; Caelenberg et al. 2019; Dallas et al. 2017; Teja et al. 2020; Doersch et al. 2019; Bongiovanni et al. 2021; Fancourt-Smith et al. 1990; Gold et al. 1989; Levin et al. 1990; Keller et al. 2023; Paez et al. 2007). Therefore, the primary objective of this study was to study the incidence of unplanned hospital admission within 24 h after surgery at an ASC; a key secondary objective was to identify risk factors associated with these unplanned admissions.

Methods

This retrospective study was approved by the Institutional Review Board (IRB 202300138) at Stony Brook University Hospital. The requirement for written informed consent was waived by the IRB.

Stony Brook Hospital is a tertiary care academic institution. Its ambulatory surgery center has 10 operating rooms and performs approximately 8–9000 procedures annually. Surgical specialties include orthopedics, plastic, general surgery, ophthalmology, ear nose and throat (ENT), urology, gynecology, colorectal, breast, and dental. Unplanned hospital admission was defined as patients who had an unplanned hospital admission within 24 h of surgery at our ASC. Admissions included any patient that was directly transferred from the ASC to the hospital as well as patients who were discharged home from the ASC but then were admitted within 24 h of their anesthetic care.

A query was submitted through our hospital's Enterprise Reporting Department to obtain data for all adult patients ≥ 18 years. who underwent surgery at this ASC between January 1, 2016, to December 31, 2022. Data were extracted from the anesthesia EMR (Cerner, North Kansas City, Missouri). Missing data were treated as missing, i.e., not imputed. The query included patient information such as demographics including age, gender, Body mass index, duration of surgery (< 1 h, 1–3 h, and > 3 h), American Society of Anesthesiology (ASA 1–4) postoperative nausea and vomiting (PONV) score (0–5), type of anesthesia (general anesthesia, monitored anesthesia care, local, regional), surgical specialty (orthopedics, ophthalmology, urology, gynecology, plastic, breast, ENT, Dental, general and colorectal). We further condensed surgical specialty into General, (Colorectal, Breast, Plastic, Vascular, Surgical Oncology, Trauma), Ortho (Ortho, Pain), Gyn/Urology (Gyn, OB service, Urology), Ophthalmology, and others (Dental, OMFS, ENT, Neuro, Endo, Special procedures). Surgical duration was defined as surgical start time (time of incision) to surgical stop time (dressing applied). To avoid confounding, surgical duration was considered as a surrogate for surgical complexity with less than an hour as low, 1–3 h being moderate, and above 3 h as high. We collected comorbidities (defined as a history of the disorder during the patient's lifetime) including diabetes mellitus, hypertension, obstructive sleep apnea, hyperlipidemia, coronary artery disease, peripheral vascular disease, atrial fibrillation, supraventricular tachycardia, anemia, asthma, valvular heart disease, congestive heart failure, chronic obstructive pulmonary disease, chronic kidney disease, thyroid disease, deep venous thrombosis, and cancer. Cases with age < 18 years, ASA > 4, and epidural, IV regional, and spinal anesthesia were excluded. Data were divided into those with (cases) and without (controls) admission to the hospital. Cases were studied by the author S. Shah to extract information for reasons of admission.

Statistical analysis

Chi-square tests with exact p values based on Monte Carlo simulation were utilized to examine the marginal association between categorical variables and unplanned readmission status. Wilcoxon rank sum tests were utilized to examine the marginal difference in continuous variables, such as age or surgical duration, between patients who did and did not have an

unplanned admission following surgery. Due to the small number of admissions (49 cases), a maximum of five variables could be used in the multivariable logistic regression. Surgical duration time in mins, surgical specialty, anesthesia type, PVD, and DVT were significantly related to admission status based on univariate analyses with p value < 0.05. These variables were further adjusted in a multivariable logistic regression model. Firth's correction was applied to mitigate the bias caused by rare events and low cell counts for unplanned admissions. Because there was an extremely small number of unplanned readmissions, Firth correction was used to adjust for bias allowing for more reliable estimates in the presence of the low event rate, while also providing more accurate confidence intervals and p values (D Firth 1993).

The odds ratio (OR) > 1 indicated a higher risk of unplanned admission, while an OR < 1 indicated a lower risk of unplanned admission. Statistical analyses were performed by a Biostatistician co-author (S. Stanley) using SAS 9.4.

Results

A total of 61,193 surgeries were performed at the ASC during the 7-year period (2016–2022). We excluded cases ≤ 18 years of age, surgeries with a duration of 0 min reflecting nerve injection procedures, ASA > 4 (incorrect assignments), and anesthesia type (epidural, IV regional, spinal). This resulted in a final sample of 53,185 surgeries.

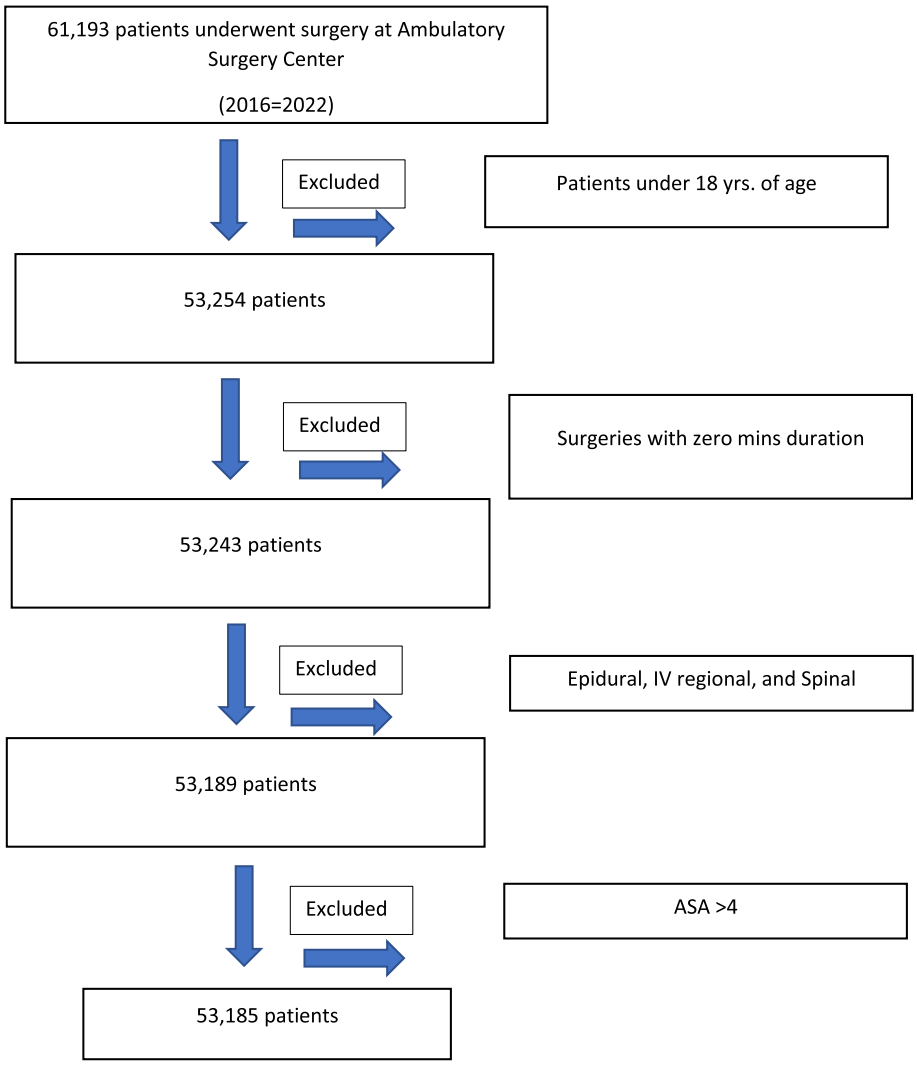


Fig. 1 53,185 surgeries were included in the sample. We excluded cases < 18 years of age, surgeries with a duration of zero minutes reflecting nerve injection procedures, ASA > 4 (incorrect assignments), and anesthesia type (epidural, IV regional, spinal)

There were 53,136 (99.9079%) uneventful discharges and 49 (0.09213%) unplanned admissions (Fig. 1).

The overall incidence of unplanned hospital admissions (2016–2022) was 0.09%; (95% CI 0.07–0.1122%); Because the incidence of unplanned hospital admission was very low, a Poisson Distribution was used to determine the 95% confidence limits, which are labeled by the horizontal bars (Fig. 2).

The median (interquartile range) age of the entire cohort was 57 (43–69) and the median [interquartile range] BMI for the study was 28.1 (24.7–32.3) kg/m^2. The majority of subjects were female (60.8%; $n=32,345$) and classified as ASA class 2 (56.1%; $n=29,842$). General Anesthesia was the most common anesthesia type (49.3%; $n=26,232$) followed by MAC (48.3%; $n=25,690$) and local (2.4%; $n=1263$). Orthopedics was the surgical specialty with the highest number of surgical cases (28.8%; $n=15,302$).

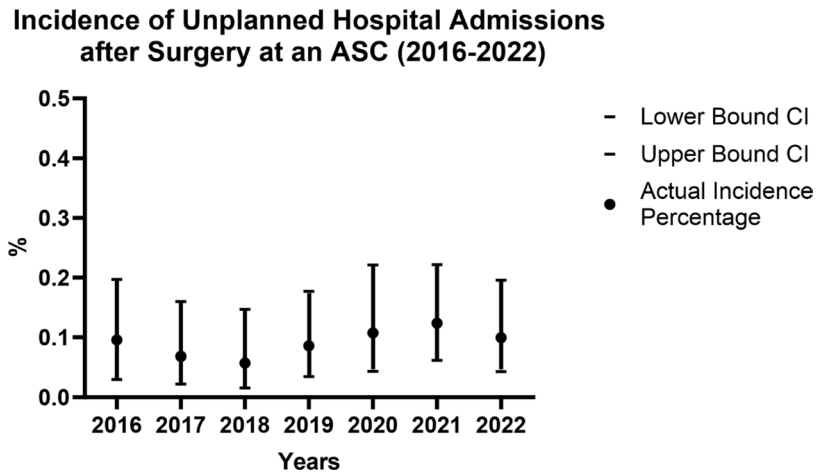
Univariate analyses showed significant differences in anesthesia type, surgical duration, and surgical specialty between the two groups. Patients who had an unplanned admission were more likely to have General Anesthesia (cases 75.5%; $n=37$ vs. controls 49.3%; $n=26,195$, $P=0.0030$), a longer surgical duration (cases 64.0 min; 29.0–119.0 vs. controls 29.0; 18.0–58.0, $P<0.0001$) and underwent general surgery (cases 36.7%; $n=18$ vs. controls 19.1%; $n=10,150$). Among comorbidities, PVD (cases 6.1%; $n=3$ vs. controls 0.8%; $n=448$) and DVT (cases 6.1%; $n=3$ vs. controls 1.5%; $n=818$) were significantly different (univariate analysis) between the two groups (Table 1).

Variables with a $p<0.05$ from the univariate analyses were further used in the multivariable logistic regression. Anesthesia type, surgical duration time, surgical specialty, PVD, and DVT were included in this model, which showed increased odds of unplanned admission associated with longer surgical duration time (odds ratio (OR), 1.01; 95% confidence interval (CI), 1.007 to 1.012, $P=<0.0001$ PVD (OR, 14.489; 95% CI, 4.862 to 43.174, $P=<0.001$), and DVT (OR, 5.527; 95% CI 1.909 to 16.001, $P=0.0016$ (Table 2)). No significant collinearity was observed.

Surgical causes (55%) were the most common reason for admission followed by medical (22%), anesthesia (16%), and other (6%) (Table 3).

Discussion

The overall incidence of unplanned hospital admissions was very low after surgery at a large US academic tertiary care ASC. General Anesthesia, longer surgery duration, and co-morbidities (peripheral vascular disease, and deep venous thrombosis) were associated with a higher risk of



	Percent Unplanned Admission		
Year	Actual	Lower Limit of 95% CI	Upper Limit of 95% CI
2016	0.09567	0.02985	0.1971
2017	0.06855	0.02226	0.1600
2018	0.05736	0.01563	0.1469
2019	0.08597	0.03457	0.1771
2020	0.1074	0.0432	0.2214
2021	0.1238	0.06182	0.2216
2022	0.09926	0.04285	0.1956

Fig. 2 Percentage of unplanned hospital admissions after surgery at the ASC from the years 2016–2022. Ninety-five percent confidence limits are shown in the table and also represented by the horizontal bars around the actual/average incidence for that year

Table 1 Patient characteristics and univariate regression model for patients with and without unplanned hospital admission

	Unplanned Admission			
	No (*N* = 53,136)	**Yes (*N* = 49)**	**Total (*N* = 53,185)**	***P*-value**
Gender, *n* (%)				0.3035[1]
Female	32,319 (60.8)	26 (53.1)	32,345 (60.8)	
Male	20,815 (39.2)	23 (46.9)	20,838 (39.2)	
X	2 (0.0)	0 (0.0)	2 (0.0)	
Anesthesia type, *n* (%)				0.0030[1]
General	26,195 (49.3)	37 (75.5)	26,232 (49.3)	
Local	1262 (2.4)	1 (2.0)	1263 (2.4)	
MAC	25,679 (48.3)	11 (22.4)	25,690 (48.3)	
Age				0.2007[2]
Median	57.0	52.0	57.0	
IQR	43.0, 69.0	42.0, 65.0	43.0, 69.0	
Age categorical, *n* (%)				0.3411[1]
18–64	35,641 (67.1)	36 (73.5)	35,677 (67.1)	
≥ 65	17,495 (32.9)	13 (26.5)	17,508 (32.9)	
Surgical duration (mins)				< .0001[2]
Median	29.0	64.0	29.0	
IQR	18.0, 58.0	29.0, 119.0	18.0, 58.0	
Surgical complexity, *n* (%)				< .0001[1]
Low (< 60 min)	40,344 (75.9)	22 (44.9)	40,366 (75.9)	
Moderate (60 to 179 min)	12,115 (22.8)	18 (36.7)	12,133 (22.8)	
High (≥ 180 min)	677 (1.3)	9 (18.4)	686 (1.3)	
BMI				0.3763[2]
Median	28.1	28.4	28.1	
IQR	24.7, 32.3	25.4, 33.4	24.7, 32.3	
BMI categorical, *n* (%)				0.4925[1]
< 30	33,257 (62.6)	28 (57.1)	33,285 (62.6)	
30, 35	11,820 (22.2)	11 (22.4)	11,831 (22.2)	
35, 40	5254 (9.9)	5 (10.2)	5259 (9.9)	
≥ 40	2805 (5.3)	5 (10.2)	2810 (5.3)	
Condensed surgical specialty, *n* (%)				0.0077[1]
Gen	10,150 (19.1)	18 (36.7)	10,168 (19.1)	
Gyn/Uro	11,088 (20.9)	13 (26.5)	11,101 (20.9)	
Opth	11,454 (21.6)	5 (10.2)	11,459 (21.5)	
Ortho	17,459 (32.9)	10 (20.4)	17,469 (32.8)	
Other	2985 (5.6)	3 (6.1)	2988 (5.6)	
Surgical specialty, *n* (%)				0.0887[1]
Breast	2509 (4.7)	0 (0.0)	2509 (4.7)	
ColoRectal	785 (1.5)	1 (2.0)	786 (1.5)	
Dental	136 (0.3)	0 (0.0)	136 (0.3)	
ENT	434 (0.8)	1 (2.0)	435 (0.8)	
Endo	17 (0.0)	0 (0.0)	17 (0.0)	
Gen	2272 (4.3)	7 (14.3)	2279 (4.3)	
Gyn	6321 (11.9)	6 (12.2)	6327 (11.9)	
Neuro	2388 (4.5)	2 (4.1)	2390 (4.5)	
OB Service	22 (0.0)	0 (0.0)	22 (0.0)	
OMFS	2 (0.0)	0 (0.0)	2 (0.0)	
Opth	11,454 (21.6)	5 (10.2)	11,459 (21.5)	

Table 1 (continued)

	Unplanned Admission			
	No (*N* = 53,136)	**Yes (*N* = 49)**	**Total (*N* = 53,185)**	***P*-value**
Ortho	15,293 (28.8)	9 (18.4)	15,302 (28.8)	
Pain	2166 (4.1)	1 (2.0)	2167 (4.1)	
Plastic	3090 (5.8)	8 (16.3)	3098 (5.8)	
Special procedures	8 (0.0)	0 (0.0)	8 (0.0)	
SurgOnc	42 (0.1)	0 (0.0)	42 (0.1)	
Trauma	789 (1.5)	1 (2.0)	790 (1.5)	
Uro	4745 (8.9)	7 (14.3)	4752 (8.9)	
Vasc	663 (1.2)	1 (2.0)	664 (1.2)	
ASA CLASS, *n* (%)				0.0602[1]
1	5564 (10.5)	3 (6.1)	5567 (10.5)	
2	29,819 (56.1)	23 (46.9)	29,842 (56.1)	
3	17,545 (33.0)	22 (44.9)	17,567 (33.0)	
4	208 (0.4)	1 (2.0)	209 (0.4)	
PONV SCORE, *n* (%)				0.6067[1]
0	1187 (2.2)	1 (2.0)	1188 (2.2)	
1	8347 (15.7)	8 (16.3)	8355 (15.7)	
2	20,210 (38.0)	18 (36.7)	20,228 (38.0)	
3	16,756 (31.5)	14 (28.6)	16,770 (31.5)	
4	5204 (9.8)	8 (16.3)	5212 (9.8)	
5	1432 (2.7)	0 (0.0)	1432 (2.7)	
Diabetes mellitus, *n* (%)				1.0000[1]
No	45,611 (85.8)	42 (85.7)	45,653 (85.8)	
Yes	7525 (14.2)	7 (14.3)	7532 (14.2)	
Obstructive sleep apnea *n* (%)				0.1667[1]
No	45,021 (84.7)	38 (77.6)	45,059 (84.7)	
Yes	8115 (15.3)	11 (22.4)	8126 (15.3)	
Hypertension, *n* (%)				0.3941[1]
No	42,695 (80.4)	37 (75.5)	42,732 (80.3)	
Yes	10,441 (19.6)	12 (24.5)	10,453 (19.7)	
Asthma, *n* (%)				0.4737[1]
No	47,361 (89.1)	41 (83.7)	47,402 (89.1)	
Yes	5775 (10.9)	8 (16.3)	5783 (10.9)	
Hyperlipidemia, *n* (%)				0.7445[1]
No	38,566 (72.6)	37 (75.5)	38,603 (72.6)	
Yes	14,570 (27.4)	12 (24.5)	14,582 (27.4)	
Coronary artery disease, *n* (%)				0.0753[1]
No	51,406 (96.7)	45 (91.8)	51,451 (96.7)	
Yes	1730 (3.3)	4 (8.2)	1734 (3.3)	
Peripheral vascular disease, *n* (%)				0.0090[1]
No	52,688 (99.2)	46 (93.9)	52,734 (99.2)	
Yes	448 (0.8)	3 (6.1)	451 (0.8)	
Angina, *n* (%)				1.0000[1]
No	52,880 (99.5%)	49 (100.0%)	52,929 (99.5%)	
Yes	256 (0.5)	0 (0.0)	256 (0.5)	
Myocardial infarction, *n* (%)				1.0000[1]
No	52,220 (98.3)	48 (98.0)	52,268 (98.3)	
Yes	916 (1.7)	1 (2.0)	917 (1.7)	

Table 1 (continued)

	Unplanned Admission			
	No (*N* = 53,136)	**Yes (*N* = 49)**	**Total (*N* = 53,185)**	***P*-value**
Atrial fibrillation, *n* (%)				0.7243[1]
No	50,682 (95.4)	46 (93.9)	50,728 (95.4)	
Yes	2454 (4.6)	3 (6.1)	2457 (4.6)	
Supraventricular Tachycardia, *n* (%)				1.0000[1]
No	52,724 (99.2)	49 (100.0)	52,773 (99.2)	
Yes	412 (0.8)	0 (0.0)	412 (0.8)	
VHD, *n* (%)				0.6546[1]
No	51,593 (97.1)	47 (95.9)	51,640 (97.1)	
Yes	1543 (2.9)	2 (4.1)	1545 (2.9)	
Congestive heart failure, *n* (%)				0.6270[1]
No	52,040 (97.9)	47 (95.9)	52,087 (97.9)	
Yes	1096 (2.1)	2 (4.1)	1098 (2.1)	
Seizures, *n* (%)				1.0000[1]
No	52,382 (98.6)	48 (98.0)	52,430 (98.6)	
Yes	754 (1.4)	1 (2.0)	755 (1.4)	
Cerebrovascular accident, *n* (%)				1.0000[1]
No	52,021 (97.9)	48 (98.0)	52,069 (97.9)	
Yes	1115 (2.1)	1 (2.0)	1116 (2.1)	
Transient ischemic attack, *n* (%)				0.6842[1]
No	52,576 (98.9)	49 (100.0)	52,625 (98.9)	
Yes	560 (1.1)	0 (0.0)	560 (1.1)	
Anemia, *n* (%)				0.0965[1]
No	49,141 (92.5)	42 (85.7)	49,183 (92.5)	
Yes	3995 (7.5)	7 (14.3)	4002 (7.5)	
COPD, *n* (%)				0.1480[1]
No	52,401 (98.6)	47 (95.9)	52,448 (98.6)	
Yes	735 (1.4)	2 (4.1)	737 (1.4)	
ESKD, *n* (%)				1.0000[1]
No	52,979 (99.7)	49 (100.0)	53,028 (99.7)	
Yes	157 (0.3)	0 (0.0)	157 (0.3)	
CKD, *n* (%)				0.6512[1]
No	51,651 (97.2)	47 (95.9)	51,698 (97.2)	
Yes	1485 (2.8)	2 (4.1)	1487 (2.8)	
Thyroid disease, *n* (%)				0.3162[1]
No	45,717 (86.0)	45 (91.8)	45,762 (86.0)	
Yes	7419 (14.0)	4 (8.2%)	7423 (14.0%)	
DVT, *n* (%)				0.0442[1]
No	52,318 (98.5)	46 (93.9)	52,364 (98.5)	
Yes	818 (1.5%)	3 (6.1)	821 (1.5)	
Smoking, *n* (%)				0.6938[1]
No	45,377 (85.4)	43 (87.8)	45,420 (85.4)	
Yes	7759 (14.6)	6 (12.2)	7765 (14.6)	
Cancer, *n* (%)				0.3951[1]
No	49,448 (93.1)	44 (89.8)	49,492 (93.1)	
Yes	3688 (6.9)	5 (10.2)	3693 (6.9)	

[1] Monte Carlo simulation chi-square exact *p*-value;[2]Wilcoxon rank-sum *p*-value

No = no admission, Yes = unplanned admission

BMI body mass index, *ASA* American Society of Anesthesiologists, *PONV* postoperative nausea and vomiting, *COPD* chronic obstructive pulmonary disease, *EKSD* end-stage renal disease, *CKD* chronic kidney disease, *DVT* deep vein thrombosis

Table 2 Multivariate logistic regression model for unplanned hospital admission

	Odds ratio estimate + (95% CI)	*P*-value
Anesthesia type		0.2626
General	Reference	
Local	1.029 (0.165 to 6.420)	
MAC	0.522 (0.230 to 1.182)	
Surgical complexity		< 0.0001
Low (< 60 min)	Reference	
Moderate (60 to179 min)	2.347 (1.188 to 4.635)	
High (≥ 180 min)	17.931 (7.370 to 43.622)	
Surgical specialty (condensed)		0.2148
General	Reference	
GYN/Urology	1.152 (0.531 to 2.498)	
Ophthalmology	0.624 (0.218 to 1.791)	
Orthopedics	0.532 (0.247 to 1.146)	
Other	1.615 (0.463 to 5.632)	
PVD	14.151 (4.883 to 43.120)	< 0.0001
DVT	5.259 (1.822 to 15.176)	0.0021

MAC monitored anesthesia care, *PVD* peripheral vascular disease, *DVT* deep venous thrombosis, *GYN* gynecology

Table 3 Patient reasons for unplanned hospital admissions

Reasons for admission	*n* (%)
Surgical	27 (55)
Bleeding hematoma (*n* = 12)	
Pain (*n* = 6)	
Observation for a surgical complication (*n* = 4)	
Urinary retention (*n* = 3)	
Infection (*n* = 2)	
Medical	11 (22)
New onset atrial fibrillation/flutter (*n* = 3)	
Hyperglycemia (*n* = 1)	
Chest pain (*n* = 1)	
Shortness of breath (*n* = 1)	
Bigeminy (*n* = 1)	
Right lower extremity weakness (*n* = 1)	
Altered mental status (*n* = 1)	
Hypokalemia (*n* = 1)	
Tachycardia (*n* = 1)	
Anesthesia	8 (16)
Postoperative nausea and vomiting (*n* = 3)	
Aspiration on induction (*n* = 1)	
Negative pressure pulmonary edema (*n* = 1)	
Postoperative hypoxia (*n* = 2)	
Delayed Emergence (*n* = 1)	
Other	3 (6)
Patient does not have care support at home (*n* = 3)	

Patient reasons for unplanned admissions distributed into surgical, medical, anesthesia, and other

unplanned hospital admission. The incidence of hospital admission within 24 h observed in our study (0.09%) was lower than reported in previous studies [0.3–9.5%] (Whippey et al. 2013; Brown et al. 2021; Garcea et al. 2008; Mezei and Chung 1999; Coley et al. 2002; Khan et al. 2005; Caelenberg et al. 2019; Dallas et al. 2017; Teja et al. 2020; Doersch et al. 2019; Bongiovanni et al. 2021; Fancourt-Smith et al. 1990; Gold et al. 1989; Levin et al. 1990). This may be because some of these data are old and modern ASC practices might result in better patient care and thus outcomes. In addition, in our study, there was no statistically significant change noted in incidence during the COVID-19 pandemic.

Comparing our results to previous reports, some previous studies reported admissions within 30 days of discharge, which we agree is important for some surgical complications, e.g., infection (Mezei and Chung 1999; Coley et al. 2002; Teja et al. 2020; Bongiovanni et al. 2021; Keller et al. 2023; Paez et al. 2007). The incidence of unplanned admissions reported in these studies ranges from 1.1 to 2%, which is higher than ours and likely due to the longer follow-up duration in those studies (30 days) vs. ours (24 h). Bongiovanni and colleagues, also presenting data that is older (2009–2011), found that the majority of these unplanned visits were within the first few days of surgery (Bongiovanni et al. 2021). Mezei et al., reporting data from two decades ago, found that surgical complications were the most common reason for admission, followed by medical and anesthesia-related events (Mezei and Chung 1999). Teja et al. proposed an instrument to predict unplanned hospital admissions, however, it did not include disease severity, e.g., ASA physical status, which may be important (Teja et al. 2020). Other studies presenting 30-day admissions after surgery at an ASC include studies focused on a single surgical specialty like urological surgery or a single procedure, e.g., robotic-assisted radical prostatectomy (Keller et al. 2023; Paez et al. 2007) which are important but not helpful to understand outcomes for the larger ASC population.

We observed that patients who had surgery of moderate or high complexity or had general anesthesia were more likely to have an unplanned admission. This is similar to earlier reports (Melton et al. 2021; Whippey et al. 2013; Garcea et al. 2008; Khan et al. 2005; Caelenberg et al. 2019; Levin et al. 1990). It is important to note that ASA was not associated with an increased risk of admissions in our study as has been reported in previous studies (Melton et al. 2021; Whippey et al. 2013; Brown et al. 2021; Caelenberg et al. 2019; Gold et al. 1989; Levin et al. 1990), which

may reflect our short-term 24-h definition that might possibly reflect different types of complications than those observed over a longer 30 day period. Consistent with this, we also did not find age to be associated with an increased risk for hospital admissions in contrast to risk.

Melton et al. 2021; Brown et al. 2021; Khan et al. 2005; Fancourt-Smith et al. 1990; Levin et al. 1990). In addition, BMI and OSA were not found to be associated with an increased risk for unplanned admissions in our analysis compared to other studies where a higher BMI was associated with a higher rate of admissions (Whippey et al. 2013). Our findings of a very low admission rate despite many patients with higher age, ASA classification, and BMI, suggest that it may be feasible to expand ASC eligibility to even higher-risk patients.

Surgical causes (55%) were the most common reasons for admission in this cohort. This was followed by admissions due to medical reasons (22%), anesthesia (16%), and other reasons (6%) (Table 3). This is consistent with other studies where surgical causes including bleeding, pain, observation for a surgical complication, and urinary retention were the most common causes (Whippey et al. 2013; Brown et al. 2021; Garcea et al. 2008; Mezei and Chung 1999; Coley et al. 2002; Teja et al. 2020; Paez et al. 2007). Interestingly, only a few patients were admitted due to reasons, e.g., postoperative nausea and vomiting ($n=3$), more directly linked to anesthesia.

Some limitations of our study should be considered. The study was a retrospective analysis, so associations (not "cause and effect") are reported, and potential biases may have been introduced. It was also from a single center so its results might not be generalizable to other ASCs. Our analysis did not include ED visits or hospital admissions to a different hospital outside of our healthcare system since it was not feasible to identify those visits or admissions retrospectively in such a large cohort $n=53{,}185$. However, given the short time frame for our primary endpoint (i.e., 24 h) it seems unlikely that many patients presented to another hospital for care so soon after surgery at our ASC. Our study presents data from a single center and future studies could be a multicenter design to increase external validity. Finally, our study did not include pediatric cases and patients who were ASA > 4 so we cannot generalize our findings to that population.

Our study has numerous strengths including standardized definitions and a large sample of patients [$n=53{,}185$] over a 7-year period with recent data (2016–2022). This is important since many previous studies that reported unplanned admissions within 24 h following ambulatory surgery reflect surgery that occurred 8 to 10 years ago.

Conclusion

The incidence of unplanned hospital admission after surgery at a large US academic center ASC was very low which suggests that modern ambulatory anesthetic care can be safely given to large numbers of patients. This admission rate can also serve as a reference point benchmark for future studies and Quality Improvement initiatives. It is interesting to note that few admissions appeared to be due to classically reported anesthesia-related issues such as PONV.

Abbreviations

ASC	Ambulatory surgery center
CMS	Centers for Medicare and Medicaid Services
IRB	Institution Review Board
ENT	Ear, nose, and throat
EMR	Electronic medical record
BMI	Body mass index
ASA	American Society of Anesthesiologists
OSA	Obstructive sleep apnea
PONV	Postoperative nausea and vomiting
PVD	Peripheral vascular disease
DVT	Deep venous thrombosis
OR	Odds ratio
SAS	Statistical Analysis System
CI	Confidence interval

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Authors' contributions

All authors have read and approved the manuscript. SS, conception and design of the study, drafting and revising the manuscript, data interpretation and approval of final draft of the manuscript. FQ, conception and design of the study, drafting and revising the manuscript, data interpretation and approval of final draft of the manuscript. SSt, data management and statistical analyses, critical review, and final approval of the manuscript. EBG- study design, interpretation of results, critical review, revision and final approval of the manuscript.

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Availability of data and materials

The datasets used and or analyzed during the current study are available from the corresponding author on reasonable request.

Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

This retrospective study was approved by the Institutional Review Board IRB # 202300138 at Stony Brook University Hospital. The requirement for written informed consent was waived by the IRB.

Consent for publication

Not applicable. The study did not contain any individual person's data in any form including individual details, images, or videos.

Competing interests
The authors declare no competing interests.

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References

Bain J, Kelly H, Snadden D, Staines H. Day surgery in Scotland: patient satisfaction and outcomes. Qual Health Care. 1999;8(2):86–91.
Bongiovanni T, Parzynski C, Ranasinghe I, Steinman MA, Ross JS. Unplanned hospital visits after ambulatory surgical care. PLoS ONE. 2021;16(7):e0254039.
Brown CR, Ghenbot S, Magnussen RA, Harangody S, Flanigan DC, Miller TL. Unplanned Emergency Visits and Admissions After Orthopaedic Ambulatory Surgery in the First 2 Years of Operation of a University Ambulatory Surgery Center. Am J Sports Med. 2021;49(2):505–11.
Coley KC, Williams BA, DaPos SV, Chen C, Smith RB. Retrospective evaluation of unanticipated admissions and readmissions after same day surgery and associated costs. J Clin Anesth. 2002;14(5):349–53.
Dallas KB, Rogo-Gupta L, Elliott CS. Unplanned Hospital Visits in the First 30 Days After Urethral Sling Procedures. Urology. 2017;103:79–83.
Davis JE. The future of major ambulatory surgery. Surg Clin North Am. 1987;67(4):893–901.
Doersch KM, Thai KH, Machen GL, Bird ET, Reilly TP, El Tayeb MM. A Comparison of Clinical Outcomes of Operating Room Versus Office-based Ureteral Stenting With the Novel Use of Nitrous Oxide Sedation. Urology. 2019;132:37–42.
Fancourt-Smith PF, Hornstein J, Jenkins LC. Hospital admissions from the Surgical Day Care Centre of Vancouver General Hospital 1977–1987. Can J Anaesth. 1990;37(6):699–704.
Firth D. Bias Reduction of maximum likelihood estimates. Biiometrika. 1993;80(1):27–38.
Garcea G, Majid I, Pattenden CJ, Sutton CD, Neal CP, Berry DP. Predictive factors for unanticipated admission following day case surgery. J Eval Clin Pract. 2008;14(1):175–7.
Gardner TF, Nnadozie MU Sr, Davis BA, Kirk S. Patient anxiety and patient satisfaction in hospital-based and freestanding ambulatory surgery centers. J Nurs Care Qual. 2005;20(3):238–43.
Gold BS, Kitz DS, Lecky JH, Neuhaus JM. Unanticipated admission to the hospital following ambulatory surgery. JAMA. 1989;262(21):3008–10.
Hall MJ, Schwartzman A, Zhang J, Liu X. Ambulatory Surgery Data From Hospitals and Ambulatory Surgery Centers: United States, 2010. Natl Health Stat Report. 2017;102:1–15.
Imasogie N, Chung F. Effect of return hospital visits on economics of ambulatory surgery. Curr Opin Anaesthesiol. 2001;14(5):573–8.
Keller K, Keller K, Baribeault T, Wofford KA. Short-Term Patient Outcomes After Implementation of Robotic-Assisted Radical Prostatectomy Under Opioid Free Anesthesia at an Ambulatory Surgery Center. J Perianesth Nurs. 2023;38(3):488–92.
Khan M, Ahmed A, Abdullah L, Nizar A, Fareed A, Khan FA. Unanticipated hospital admission after ambulatory surgery. J Pak Med Assoc. 2005;55(6):251–2.
Levin P, Stanziola A, Hand R. Postoperative hospital retention following ambulatory surgery in a hospital-based program. Qual Assur Util Rev. 1990;5(3):90–4.
Martinez Rodenas F, Codina Grifell J, Deulofeu Quintana P, Garrido Corchon J, Blasco Casares F, Gibanel Garanto X, et al. Indicators of healthcare quality in day surgery (2010–2012). Rev Calid Asist. 2014;29(3):172–9.
Melton MS, Li YJ, Pollard R, Chen Z, Hunting J, Hopkins T, et al. Unplanned hospital admission after ambulatory surgery: a retrospective, single cohort study. Can J Anaesth. 2021;68(1):30–41.
Mezei G, Chung F. Return hospital visits and hospital readmissions after ambulatory surgery. Ann Surg. 1999;230(5):721–7.
Paez A, Redondo E, Linares A, Rios E, Vallejo J, Sanchez-Castilla M. Adverse events and readmissions after day-case urological surgery. Int Braz J Urol. 2007;33(3):330–8.
Rosen DC, Drescher MR, Arias Villela NL, Abbott JE, Dunne MM, Davalos JG. Advancements in Performance of Percutaneous Nephrolithotomy in Ambulatory Surgery Centers: Outcomes and Lessons From 1250+ Cases. Urology. 2024;184:26–31.
Shnaider I, Chung F. Outcomes in day surgery. Curr Opin Anaesthesiol. 2006;19(6):622–9.
Siragusa L, Pellino G, Sensi B, Panis Y, Bellato V, Khan J, et al. Ambulatory laparoscopic colectomies: a systematic review. Colorectal Dis. 2023;25(6):1102–15.
Suskind AM, Zhang Y, Dunn RL, Hollingsworth JM, Strope SA, Hollenbeck BK. Understanding the diffusion of ambulatory surgery centers. Surg Innov. 2015;22(3):257–65. https://doi.org/10.1177/1553350614546004.
Teja B, Raub D, Friedrich S, Rostin P, Patrocinio MD, Schneider JC, et al. Incidence, Prediction, and Causes of Unplanned 30-Day Hospital Admission After Ambulatory Procedures. Anesth Analg. 2020;131(2):497–507.
Van Caelenberg E, De Regge M, Eeckloo K, Coppens M. Analysis of failed discharge after ambulatory surgery: unanticipated admission. Acta Chir Belg. 2019;119(3):139–45.
Vila H Jr, Soto R, Cantor AB, Mackey D. Comparative outcomes analysis of procedures performed in physician offices and ambulatory surgery centers. Arch Surg. 2003;138(9):991–5.
Warner MA, Shields SE, Chute CG. Major morbidity and mortality within 1 month of ambulatory surgery and anesthesia. JAMA. 1993;270(12):1437–41.
Whippey A, Kostandoff G, Paul J, Ma J, Thabane L, Ma HK. Predictors of unanticipated admission following ambulatory surgery: a retrospective case-control study. Can J Anaesth. 2013;60(7):675–83.
Yellen E, Davis GC. Patient satisfaction in ambulatory surgery. AORN J. 2001;74(4):483–6, 9–94, 96–8.

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