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REPORTS OF ORIGINAL INVESTIGATIONS

Impact of ambulatory surgery day of the week on postoperative outcomes: a population-based cohort study

L'impact du jour de chirurgie ambulatoire sur les pronostics postopératoires: une étude de cohorte basée sur la population

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Abstract

Purpose *Ambulatory surgery is generally considered safe; however, as many as 3% of patients require unplanned acute postoperative care. The purpose of this study was to measure the impact of the day of the week of surgery on the outcomes of ambulatory surgery.*

Methods *Using population-based health administrative data, we conducted a historical cohort analysis by identifying patients who underwent ambulatory surgery from 2002-2012. Multivariable regression was used to measure the association between the day of the week of surgery and the primary outcomes of 30-day emergency department (ED) visit or hospital readmission after successful discharge on the day of surgery. The secondary outcome that was similarly compared was unsuccessful discharge on the day of surgery.*

Results *Of 296,497 patients identified, 32,100 (10.5%) returned to the ED or were readmitted to hospital within 30 days. Adjusting for demographics, comorbidities, and preoperative use of health resources, Friday surgery was most associated with the primary outcome (adjusted hazard ratio, 1.07; 95% confidence interval, 1.03 to 1.11) when compared with Monday surgery. This association was stronger in certain surgery types. There were 9,197 (3.1%) patients who were not discharged on the day of surgery; no association between day of the week and unsuccessful discharge was identified.*

Conclusion *On a population level, there was a small effect of the day of the week of ambulatory surgery on outcomes; however, the clinical impact is likely not relevant. Certain surgical types may be more susceptible to a day of the week effect, but more research is needed to elucidate this notion.*

Résumé

Objectif *En règle générale, les chirurgies ambulatoires sont considérées comme étant sécuritaires; toutefois, jusqu'à 3 % des patients nécessitent des soins postopératoires aigus non planifiés. L'objectif de cette étude était de mesurer l'impact du jour de la semaine durant lequel la chirurgie a eu lieu sur les pronostics de chirurgie ambulatoire.*

Méthode *À l'aide des données administratives de santé basées sur la population, nous avons réalisé une analyse de cohorte historique en identifiant les patients ayant subi une chirurgie ambulatoire entre 2002 et 2012. Nous avons utilisé une analyse par régression multivariée pour mesurer l'association entre le jour de la semaine au*

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Author contributions *Daniel I. McIsaac* designed the study, performed data management and analysis, and wrote the manuscript. *Gregory L. Bryson* and *Carl van Walraven* co-designed the study and participated in writing the manuscript. *Gregory L. Bryson* helped interpret the findings. *Carl van Walraven* oversaw the data analysis. *Daniel I. McIsaac* and *Carl van Walraven* interpreted the data.

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cours duquel la chirurgie a eu lieu et notre critère d'évaluation principal, soit les visites au département des urgences et les réadmissions à l'hôpital durant les 30 jours suivant un congé accordé le jour de la chirurgie. Le critère d'évaluation secondaire, comparé de la même façon, était un congé non accordé le jour de la chirurgie.

Résultats *Parmi les 296 497 patients identifiés, 32 100 (10,5 %) sont retournés à l'urgence ou ont été réadmis à l'hôpital au cours des 30 jours suivant leur opération. Si l'on ajuste ces données pour tenir compte des données démographiques, des comorbidités, et de l'utilisation préopératoire des ressources de santé, le vendredi était la journée la plus fréquemment associée à notre critère d'évaluation principal (taux de risque ajusté, 1,07; intervalle de confiance 95 %, 1,03 à 1,11), par rapport aux chirurgies ayant lieu le lundi. Cette association était plus forte pour certains types de chirurgie. Au total, 9197 (3,1 %) patients n'ont pas reçu leur congé le jour de leur chirurgie; aucune association entre le jour de la semaine et la non-obtention du congé le jour-même n'a été observée.*

Conclusion *Au niveau de la population, il existe un petit effet du jour de la chirurgie ambulatoire sur les pronostics; toutefois, l'impact clinique n'est probablement pas pertinent. Certains types de chirurgie pourraient être plus susceptibles à un effet du jour de la semaine, mais des recherches supplémentaires sont nécessaires pour déterminer si cet effet existe véritablement.*

Ambulatory surgery programs have enjoyed a remarkable record of safety and efficiency,[1,2] but complications can occur that result in significant patient harm.[3,4] Although mortality following ambulatory surgery is rare, over 3% of patients may require unplanned acute postoperative medical care, such as hospital admission, emergency department (ED) visits, or hospital readmission, often within the first week.[4-6] Discharge of hospital inpatients on Friday has been associated with increased rates of death and urgent hospital admission within 30 days, possibly because of a lack of service access over the weekend.[7] Beyond the impact of discharge day, evidence from a variety of areas of clinical medicine suggests that the day of the week on which medical care is provided may have a significant impact on health outcomes.[8-22]

For patients undergoing elective inpatient surgery, there is evidence that the risk of mortality differs between days of the work week. In the United Kingdom, each day following Monday was associated with an independent increase in the odds of 30-day mortality, with a marked relative increase (compared with Monday) of 44% on Friday and 82% on weekend days.[18] In the United States, patients whose operations occurred on Friday were more likely to die after surgery than those whose operations occurred on Monday, Tuesday, or Wednesday.[19] Although any causal factors underlying this relationship have not been fully elucidated, they are hypothesized to be related to gaps in the healthcare system which are potentially due to low staffing levels and physician cross-coverage of patients occurring during the weekend after surgery.[10,18,23-25]

Unplanned admissions or returns to the hospital or ED for surgical complications are considered to be important quality indicators in ambulatory surgery programs[1,26,27]; however, investigations are lacking on the impact of the day of the week on outcomes after ambulatory surgery. In this study, we hypothesized that the day of the week on which ambulatory surgery was performed would impact postoperative outcomes, primarily because patients having surgery late in the week may have limited access to care in a surgeon or family physician's office over the subsequent weekend. To test this hypothesis, we conducted a cohort study in Ontario, Canada using linked population-based health administrative data. We studied a composite primary outcome of hospital readmission or ED visit within 30 days of successful discharge following ambulatory surgery. We further hypothesized that the day of the week of surgery may impact successful discharge rates on the day of surgery. Finally, we hypothesized that a lack of access to the surgeon or family physician's office over the weekend may result in a peak in returns to hospital or the ED on Saturday or Sunday, regardless of the day on which ambulatory surgery was performed.

Methods

This study utilized de-identified data from the Institute of Clinical Evaluative Sciences, an independent research institute that houses the population-based health administrative data for the province of Ontario, Canada. The population of Ontario at the time of this study was approximately 12 million. Ethical oversight was provided and approved on a programmatic basis by the Ethical Review Board at Sunnybrook Health Sciences Centre (Toronto, ON, Canada). We conducted a population-based historical cohort study in Ontario where all hospital and physician services are funded through a public healthcare system. We used population-based health administrative data that were collected using standardized disease classification, procedural terminology,[28] and abstraction formats.[29] All data were linked deterministically using encrypted, patient-specific identifiers. Databases used for the study included the Same-day Surgery (SDS) database, which records all ambulatory surgeries; the Discharge Abstract Database (DAD), which captures all inpatient

hospitalizations; the National Ambulatory Care Reporting System (NACRS), which captures all ED visits; the Ontario Health Insurance Plan database, which captures physician service claims; and the Registered Persons Database (RPDB), which captures all death dates for Ontarians. This study conforms to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.[30]

Cohort

We identified all Ontario residents aged ≥ 40 yr who underwent knee surgery, shoulder surgery, inguinal or femoral hernia repair, cholecystectomy, lumpectomy, or transurethral resection of urinary obstruction (see specific procedures and associated codes in Appendix A; available as Electronic Supplementary Material). These surgeries are the most common non-ophthalmic or non-endoscopic ambulatory surgeries performed in the United States.[31] Surgeries were identified from the SDS, which specifically records all planned ambulatory surgeries in the province of Ontario (i.e., those in which hospital discharge is planned within 24 hr of surgery).

We conducted a patient-level analysis, studying only the first surgery for each patient in our observation window. Patients < 40 yr of age were excluded to increase outcome rates, since age is a known predictor of adverse outcomes after surgery.[32] We chose 2002 as the start year for our study as it coincides with the introduction of the International Classification of Diseases, 10th revision (ICD-10), which we used to identify diagnoses. We used the Canadian Classification of Health Interventions to identify procedures. The latest year in which all datasets were complete was 2012. Patients were excluded if they did not have a valid provincial health insurance number or if their 30-day observation window extended beyond the study end date. Our primary analysis was limited to individuals who were successfully discharged on the day of surgery, defined as discharge within 24 hr of surgery. Our secondary analysis involved individuals who did not achieve successful hospital discharge.

Outcomes

Our primary outcome was the composite of hospital readmission or an ED visit within 30 days of successful discharge following ambulatory surgery. The postoperative disposition status of each patient was derived from the SDS record and was categorized as discharged home or admitted to hospital (including admission to a critical care area or to another operating room, admitted to hospital as an inpatient, transferred to another acute care facility, transferred to another non-acute care facility, or died in the operating room). Unanticipated postoperative admissions immediately following surgery were verified by cross-referencing the DAD to confirm the recording of an inpatient hospitalization on the day of planned ambulatory surgery. Post-discharge hospital admission was defined as the creation of a record in the DAD within 30 days of discharge from hospital. All ED visits were identified from the NACRS within 30 days of discharge from hospital. All-cause mortality was captured from the RPDB, which captures both in- and out-of-hospital deaths. The specific date of each outcome was recorded.

Covariates

Patient demographics were collected from the RPDB. Validated algorithms were used to determine if patients had congestive heart failure,[33] hypertension,[34] a history of acute coronary syndromes,[35] diabetes mellitus,[36] asthma,[37] or chronic obstructive pulmonary disease.[38] Previously described methods were used to identify the following comorbidities based on ICD-9 and ICD-10 codes from the DAD in the two years preceding surgery[39]: atrial fibrillation or flutter; dementia; hemiplegia or hemiparesis; cerebrovascular disease; primary (excluding non-melanoma skin cancer) malignancy; metastatic tumours; peripheral vascular disease; renal disease; dialysis; liver disease; peptic ulcer disease; rheumatologic disease; and venous thromboembolism. Emergency department visits and acute care hospitalizations in the year prior to surgery were obtained from the NACRS and the DAD, respectively. Finally, the Mortality Risk Score[40] was used to estimate each patient's risk of death. The Mortality Risk Score is based on the Johns Hopkins Adjusted Clinical Groups (ACG®) System and measures the one-year risk of all-cause death with excellent discrimination (i.e., c-statistic 91.7%) and calibration (i.e., the absolute difference between the observed probability of death and the mean predicted probability of death was less than 0.01 in 97 of 100 centiles).

Main exposure

The day of the week on which surgery took place was determined from the SDS. We identified only those patients who had a record for surgery on a weekday since elective ambulatory surgery is not commonly performed on the weekend. We used a five-level main exposure variable to account for each weekday, using Monday as the reference category.

Data integrity

Outcome and main exposure status were complete for all patients without missing data. Covariate data, if missing for less than 1% of patients, were imputed with the group mean. Covariates missing more than 1% of data were excluded.

Statistical analysis

Demographic characteristics were compared between each day of the week using Chi square tests for categorical variables, analysis of variance for normally distributed continuous variables, and the Kruskal-Wallis test for continuous variables that were not normally distributed.

Table 1 Baseline characteristics of study population by day of the week

Demographics	Monday n = 54,726	Tuesday n = 64,021	Wednesday n = 58,931	Thursday n = 62,823	Friday n = 55,996	P value
Age (mean, SD)	58 (11)	58 (11)	57 (11)	57 (11)	57(11)	<0.001
Female (%)	50.07	49.54	50.19	49.91	50.03	0.192
Rural (%)	13.66	13.37	13.29	13.21	11.95	<0.001
Neighbourhood income quintile, median [IQR]	3 [4,2]	3 [4,2]	3 [4,2]	3 [4,2]	3 [4,2]	0.001
Comorbidities						
Atrial arrhythmia (%)	0.83	0.79	0.92	0.78	0.8	0.041
Heart failure (%)	2.41	2.53	2.54	2.29	2.31	0.016
Chronic obstructive pulmonary disease (%)	12.19	12.34	12.68	11.77	11.62	<0.001
Cerebrovascular disease (%)	0.43	0.40	0.43	0.39	0.37	0.453
Dementia (%)	0.09	0.09	0.10	0.10	0.10	0.917
Diabetes mellitus (%)	13.94	14.07	14.36	14.22	13.84	0.033
Dialysis (%)	0.22	0.18	0.20	0.22	0.27	0.012
Hemiplegia (%)	0.06	0.05	0.07	0.07	0.07	0.412
Hypertension (%)	40.26	40.13	41.47	40.33	40.11	<0.001
Liver disease (%)	0.18	0.21	0.21	0.16	0.23	0.086
Malignancy (%)	1.64	1.61	1.67	1.52	1.54	0.113
Metastases (%)	0.24	0.26	0.24	0.23	0.26	0.598
Prior myocardial infarction (%)	1.91	2.05	2.14	1.87	1.92	0.061
Peptic ulcer disease (%)	0.19	0.16	0.17	0.18	0.16	0.594
Renal disease (%)	0.31	0.31	0.37	0.35	0.41	0.038
Peripheral vascular disease (%)	0.30	0.33	0.33	0.27	0.25	0.057
Rheumatic disease (%)	0.14	0.14	0.11	0.11	0.13	0.334
Venous thromboembolism (%)	0.10	0.09	0.12	0.11	0.13	0.342
Asthma (%)	13.54	13.27	13.55	13.72	13.31	0.079
Healthcare resource use						
Hospitalization in last year (%)	9.22	9.26	9.51	9.12	8.88	0.021
Emergency department visit in last year (%)	37.74	37.15	37.39	37.54	37.32	0.344
Mortality risk score, mean (SD)	45 (16)	46 (16)	46 (16)	45 (16)	45 (16)	<0.001
Procedure						
Knee surgery (%)	25.23	23.59	26.71	29.67	33.13	<0.001
Shoulder surgery (%)	6.93	7.06	6.64	5.63	6.81	
Inguinal or femoral hernia repair (%)	30.32	30.68	29.07	27.32	25.37	
Cholecystectomy (%)	21.07	20.77	19.54	19.78	17.46	
Breast lumpectomy (%)	15.31	15.98	16.12	15.70	15.34	
Transurethral resection (%)	1.42	1.78	2.01	1.94	1.88	

IQR = interquartile range

The primary analysis consisted of time-to-event analysis using Cox proportional hazards regression. The primary outcome was the first occurrence of a visit to the ED or a hospital readmission following successful discharge after ambulatory surgery (i.e., the patient achieved discharge within 24 hr). Our time window spanned from the day of discharge to 30 days after discharge, at which time all remaining participants were censored. We did not consider death to be a substantive competing risk in our analysis because mortality following ambulatory surgery is rare. We accounted for clustering using a robust estimate of standard error based on the local health network as the unit of clustering. The local health network was chosen because we thought this would best address the nature of readmissions and ED visits after discharge from ambulatory surgery. Such events could happen at the index hospital or another hospital, but patients would be unlikely to leave their local health network. Adherence to the assumption of proportional hazards was tested using the significance of covariate-time interactions, and the hazard functions were also inspected. Since demographic variables, comorbid illnesses, and health system characteristics may confound the true association between surgical day and outcomes, we included age (used as a restricted cubic spline with five knots), sex, hospital type (teaching *vs* non-teaching), health system usage in the year prior to surgery, patient neighbourhood income quintile, patient residence (urban *vs* rural), comorbid diseases, the Mortality Risk Score (used as a continuous linear predictor), year of surgery (used as a categorical variable representing each calendar year), and surgery type. An interaction term between outcome and procedure was tested in the model to ensure the appropriateness of reporting a single effect measure for all procedures.

We performed several sensitivity analyses (using adjusted proportional hazards regression and the five-level exposure variable accounting for each weekday). We examined the impact of day of the week for each specific procedure, each time period (2002-2007 and 2008-2012), and each individual component of the primary composite outcome, as well as over a seven-day outcome period (an analysis which was performed *post hoc)*. Finally, for models where the main exposure variable (i.e., surgical day of the week) did not adhere to the proportional hazards assumption (based on covariate time interactions and inspection of the stratified hazard function), we constructed a *post hoc* proportional hazards regression model that contained a time-surgical day of the week interaction term. We determined the optimal continuous representation of time using fractional polynomials.[41] This allowed us to calculate the relative hazard of the primary outcome between Monday *vs* Friday surgery and to illustrate and explore the possible time-dependent nature of surgical day of the week on ED visits and readmission. As a secondary analysis, we used a multivariable logistic regression model that adjusted for the same covariates as our primary analysis and used the health region as the unit of clustering to measure the association between day of the week and failure to be discharged from hospital following surgery. We also calculated the number and proportion of ED visits and readmissions following successful discharge from ambulatory surgery that occurred on each day of the week (including Saturday and Sunday).

Results

We identified 297,092 patients having ambulatory surgery from 2002-2012 in Ontario. After excluding weekend patients (n = 595), 296,497 remained in our cohort. Although some statistically significant differences in characteristics were identified between patients on different days of the week, there were minimal differences that were likely to be clinically relevant (Table 1). Complete main exposure and outcome data were available for all patients. Covariate mean imputation was used for rurality (0.09% missing) and neighbourhood income quintile (0.6% missing).

Nine thousand one hundred ninety-seven (3.1%) patients were not discharged within 24 hr of their planned ambulatory surgery, and six (0.002%) patients died on the day of surgery. The primary composite outcome (either an ED visit or hospital admission within 30 days of surgery) occurred in 32,100 (10.5%) patients following successful discharge after ambulatory surgery. Twenty-eight thousand nine hundred twenty (9.8%) patients returned to the ED within 30 days, and 4,475 (1.5%) patients were readmitted to hospital; 1,295 (0.4%) of the readmitted patients did not visit the ED prior to hospital readmission. A visit to the ED or a readmission occurred in 18,703 (6.5%) patients within seven days of successful discharge following ambulatory surgery. Of the patients who were readmitted or visited the ED, 3,468 (12%) did so within two days, and 23,129 (80%) of returns occurred within 14 postoperative days. One hundred forty (0.05%) patients died within 30 days of surgery.

Table 2 presents the observed incidence of the composite outcome, each of the component outcomes, and crude and adjusted hazard ratios (HR) by day of the week (see model specification in Appendix B; available as Electronic Supplementary Material). The interaction term between procedure and outcome was not significant (P = 0.132). Accounting for potential confounders, patients whose surgeries occurred on Friday had the highest HR of experiencing readmission or ED visits after surgery; this was statistically significant. Tuesday patients had the next

Table 2 Impact of day of the week on primary and secondary outcomes

Outcomes	Monday	Tuesday	Wednesday	Thursday	Friday
Primary composite outcome					
30-day ED visit or readmission	5,363 (9.8%)	6,594 (10.3%)	5,893 (10.0%)	6,282 (10.0%)	5,600 (10.0%)
Unadjusted HR	1	1.05	1.02	1.02	1.02
Unadjusted 95% CI		(1.02 to 1.09)	(0.98 to 1.06)	(0.98 to 1.05)	(0.98 to 1.06)
Adjusted HR	1	1.05	1.02	1.04	1.07
Adjusted 95% CI		(1.01 to 1.09)	(0.99 to 1.06)	(0.99 to 1.08)	(1.03 to 1.11)
Components of primary outcome					
30-day ED visit					
Adjusted HR	1	1.05	1.02	1.02	1.07
Adjusted 95% CI		(1.01 to 1.09)	(0.99 to 1.06)	(0.99 to 1.06)	(1.03 to 1.11)
30-day Readmission					
Adjusted HR	1	1.02	1.01	1.05	1.05
Adjusted 95% CI		(0.93 to 1.12)	(0.90 to 1.13)	(0.91 to 1.22)	(0.94 to 1.17)
Secondary outcome					
Not discharged on day of surgery					
Adjusted OR	1	1.01	1.02	0.98	1.04
Adjusted 95% CI		(0.95 to 1.08)	(0.96 to 1.10)	(0.92 to 1.05)	(0.97 to 1.12)

CI = confidence intervals; ED = emergency department; HR = hazard ratio; OR = odds ratio

highest HR for the composite outcome, and Tuesday was the only other day of the week with a significantly higher hazard for readmission or ED visit. The combined incidence of readmissions or ED visits on Wednesday and Thursday did not differ from Monday. In our *post hoc* analysis restricted to the seven days after successful discharge from ambulatory surgery, compared with Monday, Friday patients were most likely to return to the ED or be readmitted (adjusted HR, 1.11; 95% confidence intervals [CI], 1.06 to 1.16), while Tuesday (adjusted HR, 1.07; 95% CI, 1.03 to 1.11) and Thursday (adjusted HR, 1.07; 95% CI, 1.01 to 1.13) patients were also significantly more likely to experience the primary outcome. Wednesday patients (adjusted-HR, 1.01; 95% CI, 0.97 to 1.05) were not more likely than Monday patients to return to the ED or be readmitted within seven days. Consistent with previous studies of ambulatory surgery, covariate coefficients measured in our primary analysis support a strong association between certain procedures (especially transurethral resections) and cardiopulmonary disease with the need for ED visits or readmission after ambulatory surgery. Overall, ED visits or readmissions occurred most often over the weekend and least often on Tuesday (Monday-12.6%; Tuesday-12.4%; Wednesday-12.6%; Thursday 14.0%; Friday-15.3%; Saturday-17.3%; Sunday-16.0%), regardless of the day of surgery.

The adjusted HRs for each surgery type for the composite outcome are presented in Table 3. Although most surgery types appeared crudely to mirror results for the entire cohort, notable interprocedural heterogeneity existed. Shoulder surgery and transurethral resection patients whose surgery was performed later in the week than Monday experienced markedly higher rates of ED visits and hospital readmissions, while other surgical subgroups trended with the entire cohort across weekdays. When the hazard functions were stratified by day of the week for our surgery-specific sub-analyses, shoulder and transurethral surgeries showed a possible violation of the proportional hazards assumption when the Monday and Friday hazards were compared. The results of the day of the week and postoperative day interaction models following shoulder surgery showed a significantly decreased risk of the primary outcome for Monday *vs* Friday patients. Nevertheless, the significant increase in the primary outcome following transurethral surgery was negated by the time interaction (Appendix C; available as Electronic Supplemental Material). No consistent trend or association was found between the day of the week of surgery and failure to be discharged from hospital.

Discussion

In a population-based cohort of 296,497 ambulatory surgery patients in Ontario, Canada, the day of the week of ambulatory surgery was statistically associated with utilization of healthcare resources following discharge from hospital. This effect, however, may not be clinically

Table 3 Impact of day of the week on ED visit or readmissions by surgery type and time period (adjusted hazard ratio and 95% CI)

Subgroup	Monday	Tuesday	Wednesday	Thursday	Friday
Year 2002-2007	1	1.04 (0.98 to 1.10)	1.02 (0.97 to 1.08)	1.05 (0.99 to 1.11)	1.06 (1.00 to 1.12)
Year 2008-2012	1	1.06 (1.01 to 1.12)	1.02 (0.97 to 1.07)	1.00 (0.96 to 1.06)	1.02 (0.97 to 1.08)
Laparoscopic cholecystectomy	1	1.01 (0.94 to 1.09)	0.99 (0.92 to 1.08)	1.02 (0.95 to 1.10)	1.01 (0.93 to 1.09)
Hernia repair	1	1.03 (0.97 to 1.10)	1.01 (0.94 to 1.09)	1.02 (0.96 to 1.09)	1.06 (0.99 to 1.13)
Lumpectomy	1	1.10 (0.99 to 1.21)	1.08 (0.98 to 1.19)	1.09 (0.99 to 1.20)	1.06 (0.96 to 1.18)
Shoulder surgery	1	1.11 (0.95 to 1.30)	1.21 (1.03 to 1.42)	1.22 (1.03 to 1.43)	1.45 (1.23 to 1.67)
Knee surgery	1	1.05 (0.96-1.14)	1.01 (0.92 to 1.10)	1.00 (0.92 to 1.09)	1.05 (0.96 to 1.14)
Transurethral resection	1	1.14 (0.93 to 1.41)	0.99 (0.80 to 1.23)	1.35 (1.10 to 1.65)	1.37 (1.11 to 1.68)

Emergency Department (ED) visit and readmission were treated as a composite outcome

important since the day of the week with the highest HR (i.e., Friday) was only 7% higher than the HR on Monday. The only other day with a significant association was Tuesday. In comparison, a recent study of elective inpatient surgery in the UK found that each day after Monday was associated with an increased risk of adverse outcome in a linear fashion that was consistent across surgery types.[18] This does not appear to be the case in the ambulatory setting; no linear group trend was seen and significant interprocedural heterogeneity existed. The small effect size makes it unlikely that performing ambulatory surgery on Friday significantly burdens the healthcare system or imposes significant risk to the individual patient. The reason for significantly increased risk of acute care visits after Tuesday surgery is unclear. Nevertheless, since Tuesday patients should have had access to the surgeon or family physician's office in the days immediately following surgery, this finding further weakens the assertion that Friday surgery imposes a substantive outcome burden.

Although a day of the week effect has been shown in a number of domains in clinical medicine, the effect does not appear to be universal. A report from the Canadian Institute for Health Information found that a small but significant weekend effect was present in acute care areas that operated differentially between the week and weekend, such as inpatient medical wards and inpatient surgical services.[42] Nevertheless, the report found that other areas, such as neonatal critical care units, obstetrical units, and mental health units, did not appear to show a weekend effect in terms of mortality after weekend admission. Furthermore, this study showed that people who present to hospital over the weekend tend to be sicker, and the authors postulate that less sick patients or those with more manageable conditions tend to wait to present to hospital on a weekday.[42]

In our study, patients undergoing shoulder surgery had the highest adjusted HR for ED visits or readmission after Friday surgery. While this may be a random occurrence, given that our study was not designed primarily to address surgical subtypes, it could reflect surgery-specific reasons for presenting for medical care. Pain is a common reason for seeking medical attention after surgery and is especially common after orthopedic surgery.[26] Shoulder surgery is especially painful, with numeric pain rating scales on postoperative day 1 typically at or exceeding 6 out of 10.[43] Our overall and surgery-specific findings may reflect a tendency for patients having shoulder surgery to present with issues that they perceive as being urgent, such as pain, earlier in the postoperative period than other ambulatory surgery patients. When surgery is performed later in the week, these presentations may shift from the surgeon or family doctor's office to the ED.

The rates of 30-day mortality, unsuccessful discharge, and ED visits and readmissions following discharge in our study are comparable with other studies, especially considering the invasiveness of the procedures studied and our older population. While these figures support the relative safety of ambulatory surgery, it is important to highlight that over 10% of patients visited the ED within 30 days of surgery. A recent qualitative assessment of patient experience after ambulatory surgery highlighted the difficulty patients experience in accessing care after surgery.[44] While the small increase in acute care visits after Friday surgery is unlikely to translate into significant risk at the patient level, this finding, in combination with the fact that acute care visits were highest on Saturday and Sunday, may indicate a need for ambulatory surgery programs to address issues of continuity and transitions in care to improve patient safety and experience.

Strengths and limitations

Amongst this study's strengths is the use of population-based data that allowed capture of all hospitalizations and

ED visits within our universal healthcare system. We studied common and invasive ambulatory surgery procedures, and findings should be generalizable to similar patients and healthcare settings. We were able to provide control for confounding, reliant not only on diagnostic codes but also on validated algorithms to identify important comorbidities and measures of inpatient and outpatient healthcare resource utilization before surgery. These factors, while also accounting for clustering in health regions, should enhance the robustness of our estimate of effect.

Our study has several limitations. We were able to control only for measured confounders, and we were not able to capture the specific indication for readmission or ED visitation; some of these events would not be directly attributable to surgery. Since adverse events requiring unplanned acute care are rare after ambulatory surgery, we combined multiple common ambulatory surgeries to provide a cohort adequately powered to find a meaningful difference in event rates while adequately controlling for confounders. As evidenced by our sub-analyses, heterogeneity in the effect of day of the week on our composite outcome was apparent between surgery types. We chose a 30-day follow-up window for our primary analysis; however, *post hoc* analyses showed a stronger effect over the first seven postoperative days. Future studies should consider a seven-day follow-up window. Finally, we were unable to identify specific postoperative family physician or surgeon visits during the week. These data would have provided more insight into patterns of resource use and patient need after surgery.

In conclusion, the day of the week of ambulatory surgery does not appear to have a clinically relevant impact on the utilization of postoperative or post-discharge healthcare resources. Specific surgery types may increase the risk of ED visits or readmission after Friday surgery; further study is needed to confirm this finding.

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Conflicts of interest None declared.

Competing interest None of the authors has any competing interests to declare.

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