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Safe on Saturday: Elective abdominal and perineal surgeries can be performed on Saturday without increased risk of poor post-operative outcome

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ABSTRACT

Background: The "weekend effect," whereby surgeries performed during weekend haven been associated with poorer postoperative outcomes. We explored whether Saturday elective procedures at our hospital were associated with poorer post-operative outcomes when compared with weekday surgeries.
Methods: A retrospective cohort study of patients undergoing elective surgery on the abdomen or perineum from 2008 to 2015 was performed. Procedures were classified by day (Group 1: Monday, Tuesday, Wednesday; Group 2: Saturday). Multivariate regression analyses were performed to determine group differences in procedure duration, length-of-stay (LOS) and complications.
Results: In adjusted analyses, there were no statistically significant differences between Group 1 (n = 816) and Group 2 (n = 269) procedures in terms of procedure duration (Group 2 - Group 1 = 13.6 min, p = .19), LOS (Group 2 - Group 1 = 1.9 days, p = .14) and complications (OR 0.58, p = .46).
Conclusion: Saturday elective procedures were not associated with poorer outcomes.

Introduction

Elective surgery on weekends compared to the start of a week has been associated with poorer outcomes.[1–13] This "weekend effect" has been explained because of a confluence of factors including reduced staffing level to care for patients, fewer ancillary supportive personnel, increased fatigue of providers and less experienced decision makers.[2,13] However, many of these studies have focused on patients undergoing either high-risk surgeries (i.e. intrathoracic, intraabdominal) or a specific type of procedure (i.e. orthopedic).[1,5,7,9,13] Further, there are reported differences in outcomes between different countries and between academic and non-academic hospitals.[9,11,13] Interestingly, contrary to previous studies, some recent studies that better adjusted for patient and institutional factors have failed to reveal any "weekend effect."[14–16] A recent study also indicates a diminishing "weekend" effect over time in some hospitals perhaps due to improvements in surgical services and working patterns.[17]

At our tertiary referral academic medical center, we typically schedule select general surgery procedures during Saturdays. In light of previous conflicting reports on the "weekend effect" and based on our cursory observation that the weekend surgeries at our institution are not associated with poor outcome, we explored the possibility of a "weekend effect" at our institution. We performed a retrospective cohort study comparing hospital length-of-stay (LOS) and post-operative complication rates of elective general surgeries performed on weekdays and Saturday.

Methods

Study population and setting

This study was performed in a large tertiary academic medical center performing over 18,000 surgical procedures per year. Per our

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institutional policies, this study was considered quality improvement and was exempt by the Institutional Review Board. Subsequently, we conducted a retrospective chart review of adult (age ≥18) patients who had elective abdominal or perineal surgeries (Anesthesia CPT codes: 00700–00952) between September 2008 and June 2015. These included the following surgeries: Anal Fistulectomy, Appendectomy, Cholecystectomy, Colectomy, Inguinal Hernia, and Ventral Hernia. This specific set of surgeries was chosen because only they were typically scheduled during Saturdays at our institution. Instead of selecting all surgeries performed on weekdays, we chose to only select the types of surgeries that are typically scheduled as electives during the weekend (Saturday). This selection process ensured a fair comparison of similar procedures. If a patient underwent multiple procedures during a single hospital encounter, only data from the first procedure was included.

Patients were further grouped based on the day of the procedure.

Group 1: Patients receiving scheduled surgery from 7:30 a.m. until 5:00 p.m. on Monday through Wednesday.

Group 2: Patients receiving elective procedures on Saturday.

Data collection

Demographic variables/covariates

Through a combination of electronic medical record database queries and manual review of medical records we collected preoperative data concerning patient demographics, American Society of Anesthesiologists (ASA) classification, medical comorbidities by organ system (cardiovascular, respiratory, renal, endocrine, other), chronic pain risk factors, and primary payer status (PPS). We also collected intraoperative data on procedure type, operating room location, surgeon, anesthesia type, anesthesia CPT and the anesthesia care model (e.g. solo attending anesthesiologist vs. certified registered nurse anesthetists [CRNAs] or resident trainee with attending anesthesiologist). The list of co-variates is listed in Appendix A.

Patient outcomes

Primary outcomes were in-hospital death, incidence of any major complication, hospital and post-anesthesia care unit (PACU) length-of-stay (LOS). Secondary outcomes included procedure duration, case delay time, operational & patient issues, estimated blood loss (EBL), and the incidence of post-operative nausea and/or vomiting (PONV) and post-operative pain levels. We used the 11-point Numeric Rating Scale (NRS; 0–10)[18] to assess the maximum pain score reported by patients while in the PACU. The list of outcome variables are listed in Appendix B.

Data analysis

Patient characteristics are summarized as percentages for categorical variables and mean ± SD (range) for continuous variables. Outcomes were compared between groups 1 and 2 using univariate and multivariate logistic regression models (binary outcomes) and linear regression models (continuous outcomes). The effects (weekend relative to weekday) are expressed as differences (95% CI) for the continuous outcomes and as odds ratios (95% CI) for binary outcomes. Both unadjusted effects and effects adjusted for age, gender, BMI, ASA, indicators of five medical history issues (respiratory, cardiovascular, renal, endocrine and other issues), the indicator of the presence of chronic pain risk factors, low-cost insurance (Medicare, Medicaid, welfare, charity care), anesthesiologist, solo anesthesiologist, surgeon, procedure type as expressed by anesthesia CPT and anesthesia type were calculated. As the distributions of the continuous outcomes were highly skewed the confidence intervals and p-values for the effects were calculated using the non-parametric bootstrap with 999 resamples. The 95% confidence interval and p-value for the adjusted effect of Saturday surgeries on the risk of any complication were calculated using profile likelihood and likelihood ratio test (standard methods) but are approximate as the logistic regression model includes a large number of adjustments (80 coefficients) relative to the sample size (N = 597). A better model for this situation (Firth's penalized logistic regression) did not converge. Diagnostics of the regression models for the primary outcomes included assessments of collinearity (was absent or limited), non-linear effects (no strong evidence) and interactions of the tested variable (weekend vs. weekday) with the covariates (none were statistically significant) as well as a sensitivity analysis where covariates were selected using the forward stepwise procedure ($p < .05$ for entry) (the adjusted effects were similar to the primary analysis).

All calculations were carried out in R version 3.2.3 (Vienna, Austria) (Citation: R Core Team (2015). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.)

Results

Table 1 outlines the demographic and procedure-specific variables for the study population. Out of 74,933 elective surgeries performed at our institution between September 2008 and June 2015, we identified 1084 procedures in 1050 patients during the study time frame. 816 procedures occurred during the weekdays, and 268 procedures occurred during the weekend. Compared to weekday procedures, a statistically significant lower proportion of Saturday patients were classified as ASA III or IV (20.9% vs. 32.4%; $p < .001$). The types of procedures were similar between the groups, though the weekend group had a greater proportion of Anal Fistula cases (22% weekend vs. 12% weekday) while the weekday group had a greater proportion of Inguinal Hernia cases (15% weekend vs. 22% weekday). Solo attending anesthesiologists more frequently administered anesthesia for procedures performed on a Saturday, when compared with weekdays (88.1% vs. 5.0% $p < .001$). The proportion of patients who had endocrine comorbidity (diabetes) was lower for weekend procedures when compared with weekdays (9.7% vs. 16.2%; $p = .009$). The staffing ratios for surgeons and anesthesia staff very similar between weekday and weekend groups though the minor differences were statistically significant.

Table 2 reports the perioperative variables and outcome measures for the study population. There were no statistically significant unadjusted differences regarding case start delays, including operational or patient issues, between the groups. Saturday procedures were of slightly shorter duration when compared to patients undergoing similar procedures during the weekdays (mean ± SD = 87 ± 54 min vs. 98 ± 60 min, $p = .008$). However, there were only small and statistically non-significant differences in mean EBL ($p = .81$).

There were no statistically significant unadjusted differences in PACU outcomes, including maximum patient-reported pain score, PONV incidence, and PACU LOS, between procedures performed on a weekday versus Saturdays. Among the patients included in the study population only one in-hospital death was encountered. The unadjusted incidence of any complications was lower in Saturday patients when compared with weekdays (5.2% vs 10.2%; unadjusted OR = 0.48, 95% CI 0.26, 0.84, $p = .015$).

In the adjusted analyses, there were no statistically significant differences in procedure duration, PACU or hospital LOS, or the incidence of major complication between weekday and Saturday procedures (Table 3). With the adjustments the Saturday effect on procedure duration changed from 10.7 min (95% CI -18.6, −2.8) to

Table 1
Demographic variables for study population.

	Weekday (M-W) (N = 813)	Saturdays(N = 268)	p-value
	n (%) or mean ± SD (range)	n (%) or mean ± SD (range)	
Age	49 ± 16 (16–88)	47 ± 15 (18–84)	0.076
Male	444 (55%)	148 (55%)	0.862
BMI*	30 ± 8 (15–74)	29 ± 6 (19–53)	0.203
ASA class III or IV	262 (32%)	56 (21%)	<0.001
Primary payer status (Low cost insurance)**	334 (43%)	95 (40%)	0.408
Medical history/Review of Systems			
Respiratory	256 (32%)	87 (32%)	0.766
Cardiovascular***	303 (37%)	100 (37%)	0.989
Renal****	51 (6%)	13 (5%)	0.390
Endocrine	132 (16%)	26 (10%)	0.009
Other (obesity)	147 (18%)	53 (20%)	0.535
Chronic pain risk factors*****	24 (3%)	14 (5%)	0.097
Procedure factors			
Procedure type			†
Anal Fistulectomy	100 (12%)	58 (22%)	<0.001
Appendectomy	53 (6%)	20 (7%)	0.68
Cholecystectomy	292 (36%)	90 (34%)	0.51
Colectomy	23 (3%)	10 (4%)	0.42
Inguinal Hernia	177 (22%)	41 (15%)	0.03
Ventral Hernia	168 (21%)	49 (18%)	0.46
Anesthesia and staffing factors			
Anesthesia type			0.053†
General	781 (96%)	265 (99%)	
Monitored Anesthesia Care	22 (3%)	3 (1%)	
Regional	10 (1%)	0 (0%)	
Solo anesthesiologist	41 (5%)	236 (88%)	<0.001
Ratio # cases/# anesthesiologists	1.25 ± 0.19 (0.69–1.81)	1.33 ± 0.37 (0.56–3.00)	<0.001
Ratio # cases/# surgeons	2.07 ± 0.32 (1.32–3.05)	1.86 ± 0.45 (1.00–4.00)	<0.001

p-value = *t*-test for continuous variables and chi-squared test for categorical variables, unless specified otherwise.
* = BMI data available in 1029 patients (Group1: n = 792; Group 2: n = 237).
** = Insurance type data available in 1020 patients. (Group 1: n = 781; Group 2: n = 239). The patient was considered to have low cost insurance if primary payer is Medicare, Medicaid, Welfare or Charity.
*** = Cardiovascular-related medical history data available in 1079 patients (Group 1: n = 811; Group 2: n = 268).
**** = Renal-related medical history data available in 1080 patients (Group 1: n = 812; Group 2: n = 268).
***** = Chronic pain risk factors data available in 1026 patients (Group 1: n = 766; Group 2: n = 260).
† = Fisher's exact test.
ASA, American Society of Anesthesiologists; BMI, body mass index; DOS, date of surgery; ROS, review of systems.

Table 2
Perioperative variables and primary outcomes: Univariate analysis.

	Group 1:Weekday		Group 2: Weekend			
	N	n (%) or mean ± SD (range)	N	n (%) or mean ± SD (range)	OR (95% CI) orDiff. (95% CI)	p-value
Perioperative QI factors						
Delay (Y/N)	813	101 (12.4)	268	29 (10.8)	0.86 (0.54, 1.31)	0.485
Operational issues (Y/N)	813	74 (9.1)	268	24 (9.0)	0.98 (0.60, 1.57)	0.942
Patient issues (Y/N)	813	12 (1.5)	268	5 (1.9)	1.27 (0.40, 3.46)	0.657
Delay time (min)	799	2.4 ± 10.1 (0.0–120.0)	261	2.0 ± 10.2 (0.0–120.0)	−0.45 (−1.79, 0.99)	0.482
OR and PACU outcomes						
Procedure Duration (min)	811	98 ± 60 (4–477)	267	87 ± 54 (5–359)	−10.72 (−18.59, −2.83)	0.008
EBL (ml)	695	22 ± 34 (0–350)	212	22 ± 33 (0–200)	0.59 (−4.47, 5.78)	0.810
Max NRS pain score	649	4.8 ± 3.2 (0.0–16.0)	222	4.8 ± 3.1 (0.0–10.0)	0.01 (−0.48, 0.43)	0.974
PONV (Y/N)	750	165 (22.0)	261	64 (24.5)	1.15 (0.82, 1.60)	0.402
PACU LOS (min)	668	2.2 ± 1. (0.2–7.7)	252	2.2 ± 1.3 (0.2–6.8)	−0.01 (−0.20, 0.17)	0.876
Hospital outcomes						
Hospital LOS (days)	716	2.0 ± 3.5 (1.0–57.0)	252	1.8 ± 2.8 (1.0–27.0)	−0.17 (−0.59, 0.31)	0.424
In-hospital death (Y/N)	763	1 (0.1)	261	0 (0.0)	–	–
Any complication (Y/N)	813	83 (10.2)	268	14 (5.2)	0.48 (0.26, 0.84)	0.015

EBL – Estimated Blood Loss.
PONV – Post Operative Nausea and Vomiting.
PACU – Post Anesthesia Care Unit.
LOS – Length of Stay.
NRS – Numeric Rating Scale.

Table 3
Perioperative variables and primary outcomes: Multivariate analysis.

	Adjusted effect (Weekend vs Weekday)		
	N	OR (95% CI) or Diff. (95% CI))	p-value
OR and PACU Outcomes			
Proc. Duration, minutes	596	13.6 (−6.1, 32.4)	0.188
PACU LOS, days	537	−0.10 (−0.68, 0.47)	0.728
Hospital Outcomes			
Hospital LOS, days	546	1.89 (−0.72, 4.93)	0.144
Any complication (Y/N)	596	0.58 (0.13, 2.43)	0.457[a]

Analyses utilizing linear regression (procedure duration, PACU LOS, hospital LOS) and logistic regression (any complication).
Presented weekend effects were adjusted for age, gender, BMI, ASA III&IV (yes/no), medical history/ROS variables (respiratory, cardiovascular, renal, endocrine, other (obesity) and chronic pain risk factors), low cost insurance, solo anesthesiologist care(yes/no), personnel − surgeon and anesthesiologist, anesthesia CPT, anesthesia type, case number to anesthesiologist # ratio and case number to surgeon # ratio.
Analysis was limited to surgeries with complete data and anesthesiologists, surgeons, anesthesia CPTs and anesthesia types that included both weekday and weekend surgeries.
[a] Likelihood ratio test. The p-value is approximate as the model includes a large number of adjustments (82 coefficients) relative to the sample size (N = 596). A better method (Firth's penalized logistic regression) did not converge.

13.6 min (95% CI -6.1, 32.4), the effect on PACU changed from −0.01 days (95% CI -0.20, 0.17) to −0.10 days (95% CI -0.68, 0.47), the effect on hospital LOS changed from −0.17 days (95% CI -0.59, 0.31) to 1.89 days (95% CI -0.72, 4.93) and the effect on any complications changed from RR = 0.48 (95% CI 0.26, 0.84) to RR = 0.58 (95% CI 0.13, 2.43).

Discussion

Financial pressure and increasing patient volume are driving more hospitals to expand their elective surgery services to the weekends. Towards this, an institutional evaluation of post-operative patient outcomes in the context of "weekend effect" is warranted. Unlike some previous studies that demonstrated a higher incidence of morbidity and mortality with procedures scheduled towards the end of the week,[1–13] our study did not reveal this effect in a cohort of patients undergoing elective abdominal or perineal surgeries. A primary reason is that our study focused on "low-risk" surgeries which we typically schedule during weekends. In addition, data analyses also highlight some factors that may have contributed to the lack of "weekend effect". First, comparatively healthier patients (lower ASA class, fewer diabetic patients) were scheduled to have surgery on Saturdays when compared with weekdays. Second, a higher proportion of our Saturday cases were managed by a "solo anesthesiologist" whereby an attending anesthesiologist directly administers anesthesia care rather than supervising a resident or nurse anesthetist. Healthier patients undergoing Saturday surgery with anesthesia care administered directly by experienced providers may have reduced the risk of poorer outcome.

Kothari et al. highlights the importance of how a hospital's perioperative infrastructure can overcome the "weekend effect".[19] Infrastructural and staffing factors may also have played a role in blunting the "weekend effect." At our hospital, the staffing ratio for perioperative support staff (anesthesia technicians, hospital assistants, PACU nurses) is the same during weekends and weekdays. By providing the same support infrastructure during weekends, similar patient outcomes can be expected. The use of electronic medical records have also been attributed to decreasing the weekend effect.[20] During the entire period of our study, our institution utilized real-time decision support to improve quality of care and ensure safe transitions of care.[21] Availability of electronic medical records and ancillary software likely enabled easy access to clinical information while reducing the risk of miscommunication and errors.

The overall study cohort complication rate (9.0%; n = 98) was lower than that reported by other studies, which also found a higher rate of complications during weekday surgeries.[2,4,7,11] An explanation for this difference could be that other studies included high-risk patients (for example intra-abdominal operations) in their study cohort. In addition, many of these studies focused on older patients who are prone to worse outcomes by virtue of the greater medical complexity and increased time to recovery.[4,5,11]

There were no clinically or statistically significant differences in PACU LOS or hospital LOS between patients receiving surgery on the weekday versus Saturday in our study, although confidence intervals were wide. PACU LOS can be confounded by systems-level issues (delays) that could equalize the LOS between Saturday and weekday surgery patients, even in the presence of significant obesity and cardiopulmonary disease. One would expect the LOS to be higher in patients who have experienced one or more complications, as was demonstrated in patients receiving weekday surgeries throughout the univariate analyses. However, the inpatient team that takes care of post-operative patients after a Saturday surgery may delay patient discharge until Monday (post-operative day 2) or thereafter, whereas patients receiving similar surgeries during the week may be discharged on post-operative day 1. Similar findings were reported in previous studies of procedural timing and LOS.[22] Next, socioeconomic factors such as low-cost PPS (e.g. Medicare, Medicaid) are associated with poor outcomes including mortality, longer post-operative LOS, and healthcare expenditures.[23] However, we found a similar proportion of low-cost PPS patients in the weekday and Saturday groups, which could detract from the contribution of this variable to any differences in post-operative outcomes. Furthermore, there were no uninsured patients in the study cohort, a characteristic which itself is associated with higher mortality and a potential driver for the "weekend" effect in other studies.[8,11,22]

There are several limitations to our study. First, it is a single-center study which limits the generalizability of the findings. We also did not consider several potential confounders. For example, aside from primary payer status, we did not evaluate for the confounding effect of other socioeconomic factors such as income, factors which can affect the elective scheduling of a case on a weekday vs. weekend. Another potential limitation could be the use of ASA to summarize comorbidities. Although ASA is widely measured and reported in all procedures, there is significant inter-rater variability when it comes to assessing patient medical comorbidities. An alternative would be an index that takes into account diagnosis groups, such as the Charlson morbidity index. However, in our dataset, we could not ascertain accurate diagnosis codes to calculate this score. We were also not able to gather data related to long-term outcomes, such as 30-day mortality and readmission rates. Lastly, we did not consider timeliness of care and the care delivery costs when evaluating weekday and weekend surgeries.

Conclusion

Low-risk elective surgery can be performed on a Saturday without increased risk of postoperative complications. Scheduling healthier patients for Saturdays and providing adequate perioperative infrastructure uniform between weekdays and weekends can be strategies to ensure that the risk of postoperative complications does not increase for Saturday surgeries.

Conflicts of interest statement

Aalap Shah, MD is Founder and Principal of PRPmobile LLC, a paid blog writer at Xenon Health.

Bala G. Nair, PhD is co-founder of Perimatics LLC and holds equity in Perimatics LLC.

Contribution

Aalap C. Shah: This author helped prepare the manuscript and execute statistical tests.

Bala Nair: This author helped prepare original artwork, the figure layout, manuscript preparation.

Courtney Lang: Data abstraction, curation and analysis.

Kevin Ma Study design, data collection, data quality assurance, manuscript preparation.

Moni B. Neradilek: This author helped prepare the manuscript and choose and execute statistical tests.

Frank H. Zucker, PhD: This author helped with electronic health record data extraction and analysis.

John D. Lang, MD: This author helped prepare the manuscript and to choose and execute the statistical tests.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amjsurg.2019.06.026.

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