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A 'weekend effect' in operative emergency general surgery

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ABSTRACT

Background: Evidence of a "weekend effect" is limited in emergency general surgery (EGS). We hypothesized that there are increased rates of complications, death, and failure-to-rescue (FTR) in patients undergoing weekend EGS operations.
Methods: National Inpatient Sample (NIS) data, January 2014–September 2015 were used. Operative EGS patients were identified by ICD-9 procedure code and timing to operation. Complications were defined by ICD-9 code. We performed survey-weighted multivariable regression analyses.
Results: Of 438,110 EGS patients, 103,450 underwent weekend operation. There was no association between weekend operation and FTR (OR 1.17; 95%CI 0.95–1.45) or complications (OR 1.04; 95%CI 0.97–1.13). There was a weekend effect on mortality (OR 1.22; 95%CI 1.02–1.46) and an interactive effect between weekend operation and teaching status on complications (teaching OR 1.22; 95%CI 1.15–1.29; interaction OR 1.13; 95%CI 1.03–1.25).
Conclusions: There is evidence for a "weekend effect" on mortality, but not complications or FTR, in this cohort.

Reduced staffing and continuity of care on weekends may cause a "weekend effect" that results in poor outcomes for patients admitted on weekends.[1] These outcomes may include complication rates, mortality, and/or failure-to-rescue (FTR; death after post-operative complication).[2] Evidence supporting this effect in operative emergency general surgery (EGS) is sparse. Though a modest "weekend effect" has been shown among those with an EGS diagnosis, previous studies that have done so included a large number of patients managed nonoperatively.[3,4] In a potentially related topic, some have demonstrated poor outcomes for EGS cases performed at night,[5] but this may or may not translate to a similar effect for weekend cases. Given a lack of clarity in the operative EGS population, we sought to better characterize the risk of weekend EGS operation under the hypothesis that there are increased rates of complications, death, and FTR in patients undergoing such operations.

We used National Inpatient Sample (NIS) data from January 2014 through September 2015. Adult operative EGS patients were identified by a) ICD-9 code for one of the 7 procedure groups that encompass over 80% of the national EGS burden,[6] b) an emergent admission as denoted in the NIS, and c) timing of operation (same calendar day). Same-day operations were identified using the NIS field for hospital day on which an operation occurred. Weekend admissions were defined by a NIS-provided weekend-admission flag; specific days of the week are not provided. Then, we defined complications using ICD-9 codes for pulmonary failure, pneumonia, myocardial infarction, deep venous thrombosis, pulmonary embolism, acute renal failure, hemorrhage, surgical site infection, and gastrointestinal bleed. FTR cases were flagged as those with a death after complication. We performed univariate logistic regression using hypothesized factors (age, sex, race, Charlson comorbidity index (CCI), weekend admission, teaching status, transfer status) and those with a p-value <0.2 were entered into a multivariable model. All analyses were survey weighted using a scaled variance estimation method to account for the design of the NIS.

Of 92,222 operative EGS patients, 87,622 had complete cases for analysis; these were survey weighted to estimate data from 438,110 complete operative EGS cases. Of these, 103,450 (23.6%; 95% CI

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23.2%–23.9%) were admitted on a weekend. 69,850 (15.9%; 95% CI 15.6%–16.3%) of the patients in this cohort suffered a complication; this constituted the cohort ("denominator") for FTR analyses. In multivariable analysis (Table 1), age, CCI, teaching status, and transfer status were associated with FTR. Age, sex, race, transfer status, CCI, weekend operation, and teaching status were associated with mortality, and age, sex, race, CCI, teaching status, and transfer status were associated with complication rate. There was no association between weekend operation and FTR (OR 1.17; 95% CI 0.95–1.45) or complication rate (OR 1.04; 95% CI 0.97–1.13). There was, however, a weekend effect on mortality (OR 1.22; 95% CI 1.02–1.46) and an interactive effect between weekend operation and teaching status on complication rate (teaching status OR 1.22; 95% CI 1.15–1.29; interaction term OR 1.13; 95% CI 1.03–1.25, Fig. 1).

Given our use of an administrative data set, it is difficult to draw conclusions about the reasons underlying the effect we see here. A logical assumption supported by previous literature in other fields is simply reduced staffing and lack of specialist care during off-hours.[7] An analysis of ICU patients attempting to more specifically delineate differences in clinical practices and care quality demonstrated higher median fluid balance and increased rates of ventilator-associated pneumonia and reintubations, suggesting discrepancies in process of care.[4] It is possible that contributing factors are similar in EGS; decreased staffing may lead to suboptimal care and poorer outcomes.

On the other hand, there is a familiar argument that patients requiring weekend care are necessarily sicker than those that receive care during regular work-week hours, generating selection bias.[8] One would hope that this effect would be diminished in EGS – that patients requiring immediate operative care receive it, regardless of the day of the week – but it is likely to be present even in this cohort. There may be variation in the degree of selection bias dependent on whether a given hospital has an EGS service and dedicated weekend staffing, as opposed to a general surgery service with weekend home call. Unfortunately, this information is not provided in the NIS. One also must consider not only *clinician* decision-making, but *patient* decision-making – perhaps patients who feel less acutely ill defer their presentation until Monday.

The finding that teaching status was associated with all three outcomes in this study is contrary to previous literature suggesting a protective effect.[9] This is likely due to case mix, with more complex cases concentrating at teaching hospitals.[10] However, the interactive effect between teaching status and weekend effect on complication rate may represent a more actionable finding. It is certainly possible that this is a true phenomenon by which patients undergoing weekend operations and receiving care from cross-covering residents suffer more complications.

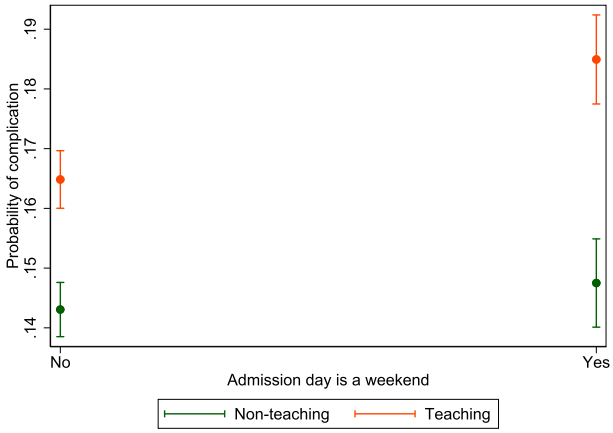

Fig. 1. Margins plot displaying predicted probabilities of complication in operative emergency general surgery patients based on weekend admission and teaching hospital status.

The most significant limitation to our study is a lack of more detailed time information. The NIS does not contain information about the amount of time a patient waits from admission to operation, nor does it contain information on the timing of postoperative complications, which may have implications for a "weekend effect" on FTR. Additionally, the need to categorize patients by admission (not operation) day necessarily fails to include those who were, for example, admitted late on a Friday and operated upon in the early hours of Saturday morning. As is common with administrative data, the clinical reasoning behind decision-making is not apparent; therefore, we lack information about why some operations were undertaken on weekends. However, we believe it is reasonable to assume that these were emergent cases, as they were all patients who were admitted emergently and underwent operation within 24 h.[6] Finally, as we do not have physiologic data, it is possible that our findings reflect incomplete risk-adjustment of sicker patients presenting on weekends referent to weekdays.

Nonetheless, there is some evidence for a "weekend effect" on mortality in this operative EGS cohort. The odds reported here are concordant with those reported in mixed operative/nonoperative

Table 1
Multivariable Regression Analyses. FTR, Failure-to-Rescue; OR, Odds Ratio; CCI, Charlson Comorbidity Index. Race recorded as a 6-level categorical variable. All analyses survey weighted.

Multivariable logistic regression analyses									
Factor	FTR (n = 69,850)			Mortality (n = 438,110)			Complication (n = 438,110)		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Age	1.02	1.02, 1.03	<0.001	1.05	1.04, 1.05	<0.001	1.04	1.04, 1.04	<0.001
Female	[n/a]			0.71	0.65, 0.78	<0.001	0.65	0.62, 0.67	<0.001
Race [ref: White]									
Black	1.06	0.90, 1.25	0.49	1.45	1.26, 1.67	<0.001	1.52	1.42, 1.62	<0.001
Hispanic	1.02	0.84, 1.22	0.87	0.81	0.68, 0.95	0.01	0.73	0.68, 0.79	<0.001
Asian/Pacific Islander	0.93	0.67, 1.29	0.66	0.76	0.58, 1.01	0.06	0.75	0.66, 0.84	<0.001
Native American	0.97	0.43, 2.18	0.95	0.82	0.42, 1.60	0.56	0.98	0.75, 1.28	0.86
Other	0.77	0.53, 1.13	0.19	0.79	0.58, 1.07	0.12	0.86	0.75, 0.97	0.02
CCI	1.09	1.07, 1.12	<0.001	1.22	1.20, 1.24	<0.001	1.28	1.27, 1.30	<0.001
Weekend operation	1.17	0.95, 1.45	0.15	1.22	1.02, 1.46	0.03	1.04	0.97, 1.13	0.28
Teaching hospital	1.45	1.27, 1.66	<0.001	1.60	1.42, 1.80	<0.001	1.22	1.15, 1.29	<0.001
Interaction teaching/weekend	0.89	0.69, 1.15	0.37	1.02	0.82, 1.27	0.84	1.13	1.03, 1.25	0.01
Transfer patient	1.91	1.61, 2.27	<0.001	2.98	2.56, 3.45	<0.001	2.30	2.07, 2.56	<0.001

EGS,[3] but increased risks of complication and FTR are not demonstrated here. Debate over whether the observed effect is due to reduced staffing or patient disease will inevitably continue, but regardless of the underlying cause of the effect, processes of care can be implemented to reduce rates of complication and death. If institutions do not deem it necessary to re-address weekend staffing models, the knowledge that acutely ill patients may inherently be at higher risk of death and complications on the weekend may nonetheless be valuable and prompt vigilance. Further investigation into the "weekend effect" on mortality as well as the effect modification between teaching status and weekend operation on complication rate may help better define targets for improvement.

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Declaration of competing interest

No authors have conflicts to declare.

References

1. Ricciardi R, Nelson J, Francone TD, et al. Do patient safety indicators explain increased weekend mortality? *J Surg Res*. 2016;200(1):164–170.
2. Silber JH, Williams SV, Krakauer H, Schwartz JS. Hospital and patient characteristics associated with death after surgery: a study of adverse occurrence and failure to rescue. *Med Care*. 1992;30(7):615–627.
3. Metcalfe D, Castillo-Angeles M, Rios-Diaz AJ, et al. Is there a "weekend effect" in emergency general surgery? *J Surg Res*. 2018;222:219–224.
4. Faust L, Feldman K, Chawla NV. Examining the weekend effect across ICU performance metrics. *Crit Care*. 2019;23(1).
5. Dalton MK, McDonald E, Bhatia P, et al. Outcomes of acute care surgical cases performed at night. *Am J Surg*. 2016;212(5):831–836.
6. Scott JW, Olufajo OA, Brat GA, et al. Use of national burden to define operative emergency general surgery. *JAMA Surg*. 2016;151(6), e160480.
7. Galloway M, Hegarty A, McGill S, et al. The effect of ICU out-of-hours admission on mortality: a systematic review and meta-analysis. *Crit Care Med*. 2018;46(2):290–299.
8. Pauls LA, Johnson-Paben R, McGready J, et al. The weekend effect in hospitalized patients: a meta-analysis. *J Hosp Med*. 2017;12(9):760–766.
9. Sheetz KH, Dimick JB, Ghaferi AA. Impact of hospital characteristics on failure to rescue following major surgery. *Ann Surg*. 2016;263(4):692–697.
10. Raval MV, Wang X, Cohen ME, et al. The influence of resident involvement on surgical outcomes. *J Am Coll Surg*. 2011;212(5):889–898.