Mortality, Length of Stay, and Cost of Weekend Admissions

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BACKGROUND: Apparent increase in mortality associated with being admitted to hospital on a weekend compared to weekdays has led to controversial policy changes to weekend staffing in the United Kingdom. Studies in the United States have been inconclusive and diagnosis specific, and whether to implement such changes is subject to ongoing debate.

OBJECTIVE: To compare mortality, length of stay, and cost between patients admitted on weekdays and weekends.

DESIGN: Retrospective cohort study.

SETTING: National Inpatient Sample, an administrative claims database of a 20% stratified sample of discharges from all hospitals participating in the Healthcare Cost and Utilization Project.

PATIENTS: Adult patients who were emergently admitted from 2012 to 2014.

INTERVENTION: The primary predictor was whether the admission was on a weekday or weekend.

MEASUREMENT: The primary outcome was in-hospital mortality and secondary outcomes were length of stay and cost.

RESULTS: We included 13,505,396 patients in our study. After adjusting for demographics and disease severity, we found a small difference in inpatient mortality rates on weekends versus weekdays (odds ratio [OR] 1.029; 95% confidence interval [CI], 1.020-1.039; $P < .001$). There was a statistically significant but clinically small decrease in length of stay (2.24%; 95% CI, 2.16-2.33; $P < .001$) and cost (1.14%; 95% CI, 1.05-1.24; $P < .001$) of weekend admissions. A subgroup analysis of the most common weekend diagnoses showed substantial heterogeneity between diagnoses.

CONCLUSIONS: Differences in mortality of weekend admissions may be attributed to underlying differences in patient characteristics and severity of illness and is subject to large between-diagnoses heterogeneity. Increasing weekend services may not result in desired reduction in inpatient mortality rate. *Journal of Hospital Medicine* 2018;13:476-481. Published online first January 25, 2018.

The "weekend effect" refers to the association between weekend hospital admissions and poorer outcomes, such as higher mortality rates. Analysis of National Health Service claims data from the United Kingdom suggested a 10% increase in 30-day mortality in patients admitted on Saturdays and 15% in patients admitted on Sundays,[1] leading to the push for a 7-day work week and invoking controversial changes in their junior doctor (residency) working contract. Studies in the United States highlighting differences in outcomes for patients admitted on weekends compared to weekdays have mostly focused on specific diagnoses and results have been variable. Few have gone on to look at the association of weekend hospital admissions on cost[2,3] and length of stay[3] but results are overall inconclusive. Some have suggested that such poorer outcomes for patients admitted on weekends are due to reduced staffing and delayed procedures on weekends compared to weekdays, although this has been debated.[4] The lack of consensus has made it difficult for hospitals to plan if and how to expand weekend manpower or services.

In the United States, increase in mortality rate for patients admitted on weekends has been demonstrated for a range of diagnoses, including pulmonary embolism,[5] intracerebral hemorrhage,[6] upper gastrointestinal hemorrhage,[7,8] ruptured aortic aneurysm,[9] heart failure,[10] and acute kidney injury.[11] However, other diagnoses such as atrial flutter or fibrillation,[2] hip fractures,[12] ischemic stroke,[13] and esophageal variceal hemorrhage,[14] show no difference in mortality between weekday and weekend admissions. Yet, other conditions such as myocardial infarction[15,16] and subarachnoid hemorrhage[17,18] have multiple studies with conflicting results. None of these studies have comprehensively looked at the effect of weekend admissions across all diagnoses nor compared the effect size between common diagnoses in the United States using the same risk adjustment. Reporting of differences in length of stay and cost is also rare.

We postulated that the weekend admissions are associated with increased mortality and length of stay, but that the effect would be heterogeneous between different diagnosis groups. Using a large nationally representative inpatient database, we investigated the association between weekend versus weekday admissions on in-hospital mortality, length of stay, and cost for acute hospitalizations in the United States. We performed

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subgroup analyses of the top 20 diagnoses to determine which diagnoses, if any, should be targeted for expanded weekend manpower or services.

METHODS

Data Sources

We used information from the National Inpatient Sample (NIS) database for this study,[19] which is the largest all-payer inpatient healthcare database in the United States. It contains administrative claims information on a 20% stratified sample of discharges from all hospitals participating in the Healthcare Cost and Utilization Project (HCUP), which includes over 90% of hospitals and 95% of discharges in the country. The NIS contains clinical and nonclinical data elements, including diagnoses, severity and comorbidity measures, demographics, admission characteristics, and charges.

Study Patients

The study included all patients who were 18 years or older and were admitted to hospitals participating in HCUP from 2012 to 2014. Elective or planned admissions were excluded from this study because of the anticipated degree of unmeasured confounding that would be present between patients electively admitted on weekends compared to weekdays.

Study Variables

The primary exposure variable was admission on weekends (defined as Friday midnight to Sunday midnight) compared to the rest of the week. The primary outcome variable was in-hospital mortality. The secondary outcome variables were length of stay (measured in integer days) and cost. Length of stay was compared only using only patients who survived the hospital admission to eliminate the effect of death in shortening the length of stay. Cost was calculated by using charges available in the NIS and multiplied by the accompanying cost-to-charge ratios. Charges reflect total amount that hospitals billed for services but do not reflect how much these services actually cost. The HCUP cost-to-charge ratios are hospital-specific data based on hospital accounting reports collected by the Centers for Medicare & Medicaid Services.[19]

Covariates included age, sex, race, income, payer, presence or absence of comorbidities as defined by the Elixhauser comorbidity index,[20] risk of mortality, and severity of illness scores as defined by the 3M Health Information Systems.[21] Mortality risk and severity of illness groups are defined by using a proprietary iterative process developed by 3M Health Information Systems using *International Classification of Diseases, 9th Revision-Clinical Modification* (ICD-9-CM) principal and secondary diagnosis codes and procedure codes, age, sex, and discharge disposition, evaluated with historical data.[21] Severity of illness refers to the extent of physiologic decompensation or loss of function of an organ system, whereas risk of mortality refers to the likelihood of dying.

Statistical Analysis

We compared patient characteristics and other covariates between patients emergently admitted on weekends and

TABLE 1. **Baseline Demographics of Weekday and Weekend Admissions**

Demographics	Weekday (n = 10,242,614)	Weekend (n = 3,262,782)
Age, median [IQR]	61 [43,76]	61 [43,77]
Sex		
Male	43.3%	44.0%
Female	56.7%	56.0%
Race		
White	67.3%	67.3%
Black	15.9%	17.0%
Hispanic	10.7%	10.8%
Asian or Pacific Islander	2.5%	2.5%
Native American	0.6%	0.7%
Other	3.0%	2.9%
Income		
1st quartile	31.0%	31.0%
2nd quartile	26.3%	26.3%
3rd quartile	23.2%	23.2%
4th quartile	19.6%	19.5%
Payer		
Medicare	49.8%	50.1%
Medicaid	16.6%	16.3%
Private insurance	24.0%	23.4%
Self-pay	5.8%	6.5%
No charge	0.6%	0.6%
Other	3.1%	3.0%
Risk of Mortality		
Minor likelihood of dying	44.7%	43.9%
Moderate likelihood of dying	28.2%	27.9%
Major likelihood of dying	20.2%	20.5%
Extreme likelihood of dying	7.0%	7.7%
Severity of illness		
Minor loss of function	22.8%	22.3%
Moderate loss of function	40.0%	40.0%
Major loss of function	29.1%	29.0%
Extreme loss of function	8.1%	8.7%
Total number of comorbidities		
0	15.0%	14.5%
1	16.2%	16.2%
2	18.9%	19.1%
3	17.4%	17.6%
≥4	32.5%	32.7%

NOTE: Mortality risk and severity of illness groups are defined using a proprietary iterative process developed by 3M Health Information Systems using ICD-9-CM diagnosis and procedure codes, age, sex and discharge disposition, and further evaluated with historical data.[21] Severity of illness refers to the extent of physiologic decompensation or loss of function of an organ system, whereas risk of mortality refers to the likelihood of dying. Abbreviations: ICD-9-CM, *International Classification of Diseases, 9th Revision-Clinical Modification*; IQR, interquartile range.

TABLE 2. **Effect of Weekend Admission on Mortality**

Mortality Rate		Crude		Adjusted for Demographics, Severity, and Comorbidities	
Weekday	Weekend	OR (95% CI)	*P* value	OR (95% CI)	*P* value
2.54%	2.80%	1.110 (1.105-1.113)	<.0001	1.029 (1.020-1.039)	<.0001

NOTE: Abbreviations: CI, confidence interval; OR, odds ratio.

weekdays. Continuous variables that were not normally distributed were either categorized (age, risk of mortality, and severity of illness scores) or log-transformed if right skewed (length of stay and cost). Categorical data were reported as percentages and continuous data as medians (interquartile range). We compared the inpatient mortality rate between weekend and weekday admissions by using χ^2 tests. Multivariable logistic regression was used to adjust for covariates of age, gender, race, payer, income, risk of mortality and severity of illness scores, number of comorbidities, and the presence or absence of each of the 29 comorbidities available in the database to determine an adjusted odds ratio (OR), *P* values, and confidence intervals (CIs).

We also compared the length of stay amongst survivors and costs between weekend and weekday admissions. Multivariable linear regression was applied to the natural log of these outcome variables and the coefficients exponentiated to determine the difference in length of stay and cost of weekend admissions as compared to weekday. Covariates in the model were the same as those used for the primary outcome.

To determine if particular diagnoses had a pronounced weekend effect, the above analyses were repeated in subgroups of the top 20 most prevalent diagnoses on weekends by using the Clinical Classifications Software for ICD-9-CM diagnosis groups. For subgroup analyses, a Bonferroni correction was used, so *P* values of <.0025 were considered significant.

Statistical analyses were performed by using SAS version 9.4 (SAS Institute Inc, Cary, NC). All regression models were run using PROC SURVEYREG for continuous outcomes and PROC SURVEYLOGISTIC for binary outcomes to account for the sampling structure of NIS. Two-sided *P* values of .05 were considered significant, apart from the Bonferroni correction applied to the subgroup analysis. As this study involved publicly available deidentified data, our study was exempt from institutional board review.

RESULTS

Patient Characteristics

We included 13,505,396 patients in our study, 24.2% of whom were admitted on weekends. Patients who were admitted on weekends tended to be slightly older, more likely to be male, more likely to be black, had higher risks of mortality and severity of illness scores and more comorbidities (Table 1). The income and payer distribution were similar between weekend and weekday admissions.

Mortality

The crude in-hospital mortality rate was 2.8% for patients admitted on weekends and 2.5% for patients admitted on weekdays (unadjusted OR, 1.110; 95% CI, 1.105-1.113; $P < .0001$). This relationship was attenuated after adjustment for demographics, severity, and comorbidities, but remained statistically significant (OR 1.029; 95% CI, 1.020-1.039; $P < .0001$; Table 2), which corresponds to an adjusted risk difference of 0.07% increase in mortality of weekend admissions. The OR for mortality on weekends compared to weekdays was further calculated for each of the top 20 diagnoses (Table 3). Out of all the diagnosis groups, only 1 (urinary tract infection) had a statistically significant *P* value after Bonferroni correction. We also looked separately at patients who were electively admitted—there was a highly significant OR of mortality of 1.67 (95% CI, 1.60-1.74). Patients classified as elective admissions were excluded for subsequent analyses.

Length of Stay

The median length of stay was 3 days in both the weekend and weekday group. Patients who survived the hospital admission had a 2.24% (95% CI, 2.16%-2.33%) shorter length of stay than those admitted on weekdays after adjustment ($P < .0001$; Table 4). Subgroup analyses for the top 20 diagnoses revealed a marked heterogeneity in length of stay amongst different diagnoses (Table 3), ranging from 8.91% shorter length of stay (mood disorders) to 7.14% longer length of stay (nonspecific chest pain). Diagnoses associated with longer length of stay in weekend admissions included acute myocardial infarction (3.90% increase in length of stay), acute cerebrovascular disease (2.15%), cardiac dysrhythmias (1.39%), nonspecific chest pain (7.14%), biliary tract disease (4.88%), and gastrointestinal hemorrhage (1.97%). All other diagnoses groups had a significantly shorter length of stay, except for intestinal obstruction which showed no significant difference.

Cost

The median cost was $6609 in the weekday group and $6562 in the weekend group. Patients admitted on weekends incurred 1.14% (95% CI, 1.05%-1.24%) lower costs compared to those admitted on weekday after adjustment ($P < .0001$; Table 4). Subgroup analyses showed a side range from 8.0% lower cost (mood disorders) to 1.73% higher cost (biliary tract disease; Table 3). Fourteen of the 20 top diagnoses were associated with a significant decrease in cost of weekend admissions compared to weekdays. Weekend admissions for cerebrovascular disease, biliary tract disease, and gastrointestinal hemorrhage

TABLE 3. **Subgroup Analysis of Top 20 Diagnoses on Effect of Weekend Admission Mortality, Length of Stay, and Cost**

Diagnosis	% of Weekend Admissions	Mortality		Length of Stay		Cost	
		OR	*P* value	% Increase	*P* value	% Increase	*P* value
Sepsis	6.07	1.00	.68	–1.78	<.0001	–0.98	<.0001
Pneumonia	3.74	1.02	.40	–2.10	<.0001	–0.81	<.0001
Congestive heart failure	3.61	0.99	.77	–2.36	<.0001	–1.55	<.0001
Acute myocardial infarction	2.8	1.04	.06	3.90	<.0001	–0.85	<.0001
COPD and bronchiectasis	2.76	0.99	.70	–1.16	<.0001	–0.50	.0007
Cerebrovascular disease	2.68	1.00	.87	2.15	<.0001	1.61	<.0001
Cardiac dysrhythmias	2.56	1.07	.09	1.39	<.0001	–1.51	<.0001
Mood disorders	2.32	0.81	.61	–8.91	<.0001	–8.00	<.0001
Skin and subcutaneous tissue infection	2.27	0.99	.94	–2.88	<.0001	–1.24	<.0001
Urinary tract infection	2.23	1.09	<.0001	–2.05	<.0001	–0.95	<.0001
Diabetes with complications	2.03	1.04	.55	–2.47	<.0001	–1.45	<.0001
Renal failure	1.91	1.05	.09	–2.82	<.0001	–0.09	.64
Respiratory failure	1.73	1.02	.22	–0.71	.001	–0.13	.55
Nonspecific chest pain	1.7	1.01	.95	7.14	<.0001	–0.98	.002
Biliary tract disease	1.64	1.18	.04	4.88	<.0001	1.73	<.0001
Complication of device	1.58	1.01	.78	–1.71	<.0001	–7.46	<.0001
Gastrointestinal hemorrhage	1.57	1.08	.02	1.97	<.0001	0.92	<.0001
Intestinal obstruction	1.52	1.00	.95	0.19	.62	0.01	.98
Complications of care	1.51	0.89	.03	–2.99	<.0001	–4.58	<.0001
Fracture of neck of femur	1.47	0.96	.27	–3.70	<.0001	–0.90	.002

NOTE: Abbreviations: COPD, chronic obstructive pulmonary disease; OR, odds ratio.

were associated with a significant increase in cost of 1.61%, 1.73%, and 0.92%, respectively.

DISCUSSION

Our analysis of more than 13 million patients in the NIS showed a clinically small difference in overall mortality (OR 1.029), but there were no differences in diagnosis-specific mortality for the 20 most prevalent diagnoses for patients admitted on weekends compared to weekdays after adjustment for confounders. We also found that there was a large heterogeneity between different diagnoses on the effect of being admitted on weekdays on length of stay and cost of hospital admission.

The magnitude of association between weekend admissions and mortality in this large administrative database contradicts existing literature, which some believe conclusively proves the international phenomenon of the weekend effect.[22,23] However, our results support a minimal increase in odds of death of 2.9%, with no consistent effect amongst the top 20 diagnoses. Only 1 diagnosis group (urinary tract infection) showed a statistically significant increase in mortality, which could be due to chance. In contrast, the policy-influencing paper in the United Kingdom reports that patients admitted on Saturdays and Sundays have an increased risk of death of 10% and 15%, respectively, compared to patients admitted on Wednesdays.[24] They also repeated their measurements on a United Health Care Systems database, comprising 254 leading managed care hospitals in the US, over a time period of 3 months in 2010, and found a hazard ratio of 1.18 (95% CI, 1.11-1.26). Ruiz et al.[22] combined almost 3 million medical records from 28 metropolitan hospitals in 5 different countries in the Global Comparators Project, including 5 in the United States, and showed increased mortality on weekends in all countries, concluding that the weekend effect is a systematic phenomenon.

There are several possible explanations for differences in our findings. Freemantle's study differed to ours by comparing outcomes of weekends to an index of Wednesday; they also found an increased mortality on Mondays and Fridays, which could suggest the presence of residual confounding and

TABLE 4. **Effect of Weekend Admission on Length of Stay and Cost**

	Median [IQR]		Crude		Adjusted for Demographics, Severity, and Comorbidities	
	Weekday	Weekend	% Increase on Weekends (95% CI)	*P* value	% Increase on Weekends (95% CI)	*P* value
Length of stay	3 [2,6]	3 [2,5]	−1.72% (−1.82 to −1.62]	<.0001	−2.24 (−2.33 to −2.16)	<.0001
Cost	$6609 [3974, 11,888]	$6562 [3985, 11,669]	−0.45% (−0.56 to −0.34)	.00049	−1.14 (−1.24 to −1.05)	<.0001

NOTE: Abbreviations: CI, confidence interval; IQR, interquartile range.

doubt as to whether Wednesday is the ideal control group. A further difference is the definition of mortality—we looked at in-hospital mortality, as compared to 30-day mortality. In addition, Freemantle's study included elective admissions. When we looked at the effect of weekend admissions on mortality, we found a highly significant OR of 1.67, compared to 1.03 in emergency admissions. We attributed this discrepancy to unmeasured confounding, such as preference of physicians or difference in classification of elective admissions in different hospitals. Because of significant effect modification of elective compared to emergency admissions, we decided to restrict our analysis to emergency admissions only. This also enabled direct associations with potential policy recommendations on whether to expand weekend clinical care, which is most relevant to emergency admissions. Finally, the Global Comparators Project only samples a small proportion of hospitals in each country, leading to limited generalizability; in addition, international comparisons are difficult to interpret due to differing health systems.

The overall and diagnosis-specific difference in length of stay was small and of doubtful clinical significance. With an adjusted decrease in length of stay in patients admitted on weekends of 2.24%, when applied to a median length of stay of 3 days, it translates into a 1.7-hour difference in length of stay. However, there was striking heterogeneity noted between diagnoses, with a difference ranging from 8.91% decrease in length of stay (mood disorders) to 7.14% increase in length of stay (nonspecific chest pain), which is likely to explain the overall small magnitude of effect. We noted that the diagnoses associated with increased length of stay for weekend admissions tended to be those requiring inpatient procedures or investigations, such as acute myocardial infarction (3.90% increase), acute cerebrovascular disease (2.15% increase), cardiac dysrhythmias (1.39% increase), nonspecific chest pain (7.14% increase), and biliary tract disease (4.88% increase). As hospitals often do not provide certain nonemergent procedures or investigations on weekends, delay in procedures or investigations may explain the increase in length of stay. These include percutaneous coronary intervention or stress testing for evaluation of cardiac ischemia and endoscopic procedures for biliary tract disease and gastrointestinal hemorrhage. It must, however, be noted in conjunction that numerous studies have established higher complication rates when nonemergent surgeries are performed out of hours or on weekends.[25-28] Therefore, we suggest further studies to compare the effect of weekends on increased procedural complications as to any morbidity caused by increased length of stay, which the present dataset was unable to capture. Another potential explanation for the heterogeneity in length of stay could be the greater availability of caregivers to assist with discharge on weekends, such as for patients admitted for mood disorders.

Surprisingly, weekend admissions appeared to be less costly than weekday admissions overall. Because of the large sample size, very minor differences in cost are likely to be statistically significant. Indeed, for the absolute difference of 0.45%, given a median cost of $6562 on weekends, this only represents a cost saving of approximately $30 per patient admission. There was also heterogeneity observed amongst the different diagnosis groups, and cerebrovascular disease, biliary tract disease and gastrointestinal hemorrhage, which were also associated with increase length of stay, were associated with an increased cost. However, our study is unable to establish causation, and differences in staffing numbers and reimbursement on weekends may confound cost estimates. We propose that further studies using hospital databases with greater granularity in data are necessary to determine the etiology of cost differences between weekends and weekdays.

Our study's key strengths are the large sample size and generalizability to the US. As a large administrative database, we recognize the likelihood of inconsistencies in hospital coding for covariates, diagnoses, and charges, which may lead to misclassification bias. The NIS definition of weekend (Friday midnight to Sunday midnight) may differ from other definitions of weekend; ideally Friday 5 PM to Monday 8 AM may be more clinically representative. This cohort of hospital admissions also does not account for the day of presentation to the emergency department, but rather only the day that ward admission was documented. The variable delays in emergency department, for example if emergency departments are busier on weekends, leading to delays in ward admission, may confound our results. Our exclusion of elective admissions was dependent on the administrative coding of elective versus emergency admissions, of which the definition may differ between hospitals. Finally, despite adjustment on clinical and sociodemographic covariates, there is a possibility of residual confounding in this retrospective comparison between weekend and weekday admissions.

CONCLUSION

Our study does not suggest that system-wide policies to increase weekend service coverage will impact mortality, although effects on length of stay and cost are inconclusive. Hospitals wishing to improve coverage may consider focusing on procedural diagnoses as listed above which may shorten length of stay, although the out-of-hours complication rate should be carefully monitored.

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References

1. Freemantle N, Ray D, McNulty D, et al. Increased mortality associated with weekend hospital admission: a case for expanded seven day services? *BMJ*. 2015;351:h4596.
2. Weeda ER, Hodgdon N, Do T, et al. Association between weekend admission for atrial fibrillation or flutter and in-hospital mortality, procedure utilization, length-of-stay and treatment costs. *Int J Cardiol*. 2016;202:427-429.
3. Khanna R, Wachsberg K, Marouni A, Feinglass J, Williams MV, Wayne DB. The association between night or weekend admission and hospitalization-relevant patient outcomes. *J Hosp Med*. 2011;6(1):10-14.
4. Aldridge C, Bion J, Boyal A, et al. Weekend specialist intensity and admission mortality in acute hospital trusts in England: a cross-sectional study. *Lancet*. 2016;388(10040):178-186.
5. Coleman CI, Brunault RD, Saulsberry WJ. Association between weekend admission and in-hospital mortality for pulmonary embolism: An observational study and meta-analysis. *Int J Cardiol*. 2015;194:72-74.
6. Crowley RW, Yeoh HK, Stukenborg GJ, Medel R, Kassell NF, Dumont AS. Influence of weekend hospital admission on short-term mortality after intracerebral hemorrhage. *Stroke*. 2009;40(7):2387-2392.
7. Dorn SD, Shah ND, Berg BP, Naessens JM. Effect of weekend hospital admission on gastrointestinal hemorrhage outcomes. *Dig Dis Sci*. 2010;55(6):1658-1666.
8. Shaheen AA, Kaplan GG, Myers RP. Weekend versus weekday admission and mortality from gastrointestinal hemorrhage caused by peptic ulcer disease. *Clin Gastroenterol Hepatol*. 2009;7(3):303-310.
9. Groves EM, Khoshchehreh M, Le C, Malik S. Effects of weekend admission on the outcomes and management of ruptured aortic aneurysms. *J Vasc Surg*. 2014;60(2):318-324.
10. Horwich TB, Hernandez AF, Liang L, et al. Weekend hospital admission and discharge for heart failure: association with quality of care and clinical outcomes. *Am Heart J*. 2009;158(3):451-458.
11. James MT, Wald R, Bell CM, et al. Weekend hospital admission, acute kidney injury, and mortality. *J Am Soc Nephrol*. 2010;21(5):845-851.
12. Boylan MR, Rosenbaum J, Adler A, Naziri Q, Paulino CB. Hip Fracture and the Weekend Effect: Does Weekend Admission Affect Patient Outcomes? *Am J Orthop (Belle Mead NJ)*. 2015;44(10):458-464.
13. Myers RP, Kaplan GG, Shaheen AM. The effect of weekend versus weekday admission on outcomes of esophageal variceal hemorrhage. *Can J Gastroenterol*. 2009;23(7):495-501.
14. Hoh BL, Chi YY, Waters MF, Mocco J, Barker FG 2nd. Effect of weekend compared with weekday stroke admission on thrombolytic use, in-hospital mortality, discharge disposition, hospital charges, and length of stay in the Nationwide Inpatient Sample Database, 2002 to 2007. *Stroke*. 2010;41(10):2323-2328.
15. Kostis WJ, Demissie K, Marcella SW, Shao YH, Wilson AC, Moreyra AE. Weekend versus weekday admission and mortality from myocardial infarction. *N Engl J Med*. 2007;356(11):1099-1109.
16. Noad R, Stevenson M, Herity NA. Analysis of weekend effect on 30-day mortality among patients with acute myocardial infarction. *Open Heart*. 2017;4:1-5.
17. Crowley RW, Yeoh HK, Stukenborg GJ, Ionescu AA, Kassell NF, Dumont AS. Influence of weekend versus weekday hospital admission on mortality following subarachnoid hemorrhage. *J Neurosurg*. 2009;111(1):60-66.
18. Nguyen E, Tsoi A, Lee K, Farasat S, Coleman CI. Association between weekend admission for intracerebral and subarachnoid hemorrhage and in-hospital mortality. *Int J Cardiol*. 2016;212:26-28.
19. Healthcare Cost and Utilization Project. Overview of the National (Nationwide) Inpatient Sample (NIS). https://www.hcup-us.ahrq.gov/nisoverview.jsp. Accessed June 20, 2017.
20. Healthcare Cost and Utilization Project. Elixhauser Comorbidity Software, Version 3.7. https://www.hcup-us.ahrq.gov/toolssoftware/comorbidity/comorbidity.jsp. Accessed Feburary 20, 2017.
21. 3M Health Information Systems. All Patient Refined Diagnosis Related Groups (APR-DRGs), Version 20.0, Methodology Overview. 2003; https://www.hcup-us.ahrq.gov/db/nation/nis/APR-DRGsV20MethodologyOverviewandBibliography.pdf. Accessed on Feburary 20, 2017.
22. Ruiz M, Bottle A, Aylin PP. The Global Comparators project: international comparison of 30-day in-hospital mortality by day of the week. *BMJ Qual Saf*. 2015;24(8):492-504.
23. Lilford RJ, Chen YF. The ubiquitous weekend effect: moving past proving it exists to clarifying what causes it. *BMJ Qual Saf*. 2015;24(8):480-482.
24. Freemantle N, Richardson M, Wood J, et al. Weekend hospitalization and additional risk of death: an analysis of inpatient data. *J R Soc Med*. 2012;105(2):74-84.
25. Aylin P, Alexandrescu R, Jen MH, Mayer EK, Bottle A. Day of week of procedure and 30 day mortality for elective surgery: retrospective analysis of hospital episode statistics. *BMJ*. 2013;346:f2424.
26. Bendavid E, Kaganova Y, Needleman J, Gruenberg L, Weissman JS. Complication rates on weekends and weekdays in US hospitals. *Am J Med*. 2007;120(5):422-428.
27. Zapf MA, Kothari AN, Markossian T, et al. The "weekend effect" in urgent general operative procedures. *Surgery*. 2015;158(2):508-514.
28. Glaser R, Naidu SS, Selzer F, et al. Factors associated with poorer prognosis for patients undergoing primary percutaneous coronary intervention during off-hours: biology or systems failure? *JACC Cardiovasc Interv*. 2008;1(6):681-688.