Incidence of “never events” among weekend admissions versus weekday admissions to US hospitals: national analysis

Frank J Attenello,1 Timothy Wen,2 Steven Y Cen,3,4 Alvin Ng,5 May Kim-Tenser,3 Nerses Sanossian,3 Arun P Amar,1 William J Mack1

ABSTRACT

OBJECTIVE
To evaluate the association between weekend admission to hospital and 14 hospital acquired hospital acquired conditions recently considered by the Centers for Medicare and Medicaid as “never events,” serious, costly, and preventable medical errors, for which resulting healthcare costs are not reimbursed.

DESIGN
National analysis.

SETTING
US Nationwide Inpatient Sample discharge database.

PARTICIPANTS
351 million patients discharged from US hospitals, 2002–10.

MAIN OUTCOME MEASURES
Univariate rates and multivariable likelihood of hospital acquired conditions among patients admitted on weekdays versus weekends, as well as the impacts of these events on prolonged length of stay and total inpatient charges.

RESULTS
From 2002 to 2010, 351170 803 patients were admitted to hospital, with 19% admitted on a weekend. Hospital acquired conditions occurred at an overall frequency of 4.1% (5.7% among weekend admissions versus 3.7% among weekday admissions). Adjusting for patient and hospital cofactors the probability of having one or more hospital acquired conditions was more than 20% higher in weekend admissions compared with weekday admissions (odds ratio 1.25, 95% confidence interval 1.24 to 1.26, P<0.01). Hospital acquired conditions have a negative impact on both hospital charges and length of stay. At least one hospital acquired condition was associated with an 83% (1.83, 1.77 to 1.90, P<0.01) likelihood of increased charges and 38% likelihood of prolonged length of stay (1.38, 1.36 to 1.41, P<0.01).

CONCLUSION
Weekend admission to hospital is associated with an increased likelihood of hospital acquired condition, cost, and length of stay. Future protocols and staffing regulations must be tailored to the requirements of this high risk subgroup.

Introduction

“Never events” are an assembly of purportedly egregious and preventable hospital occurrences first introduced by the National Quality Forum in 2001. The list was generated in response to a heightened awareness of avoidable errors leading to in-hospital morbidity and mortality.1 Defined as serious, costly, and preventable medical errors, these events were subsequently consolidated by the Centers for Medicaid and Medicare Services (CMS) into a list of hospital acquired conditions that would not qualify for federal compensation for any subsequent treatment relating to the condition (see supplementary table).2 The creation of these events is designed to shift the burden of complications from the patient and government to the individual hospitals and to motivate hospitals to accelerate patient safety programs.3 However, these events have been met with considerable resistance, with many leaders of American healthcare systems suggesting that not all hospital acquired conditions are preventable.2–4 Others suggest that CMS’s policy for hospital acquired conditions could potentially drive hospitals to be less likely to treat sicker patients.5 However, a press release in December 2014 highlights the correlation between saving 50 000 lives and $12bn (£8bn; €11bn) from 2010 to 2014, with a 17% decrease in hospital acquired conditions over that period.6 Hospital acquired conditions have been aptly increasing as a metric for quality of patient healthcare.

Previous investigations have tackled risk factors associated with inpatient complications.12–12 Though studies have attempted to isolate exposures associated with hospital acquired conditions and quantify resultant increases in attributable costs, published reports are restricted to specific medical or surgical subspecialties or patient demographics.12,7–13 The occurrence of hospital acquired conditions has not been evaluated across all patient subgroups on a national scale.

Hospital acquired conditions are events thought to be preventable through effective hospital systems and administrative processes. However, healthcare delivery may be most susceptible to the occurrence of these conditions at times when staffing or standard leadership is reduced. Total numbers of hospital staff and available expertise are often diminished on weekends,14 with differences in mortality between weekend and weekday admissions documented for conditions that require aggressive intervention. Weekend admission is associated with increased mortality among all hospital admissions and within subgroups of patients with pulmonary
embolism, stroke, subarachnoid hemorrhage, intracerebral hemorrhage, and myocardial infarction.\textsuperscript{19-22}

We established standards for rates of hospital acquired conditions across an entire inpatient sample of greater than 350 million admissions. Incidence rates are determined for weekend versus weekday admissions across all patients included in the Nationwide Inpatient Sample hospital discharge database from 2002 to 2010. We hypothesized that weekend admission would be associated with a higher frequency of hospital acquired conditions.

**Methods**

**Data source**

We carried out a cross sectional analysis study using data from the 2002 to 2010 extracts of the Nationwide Inpatient Sample. This is the largest publicly available all payer inpatient database in the United States, capturing 20\% of all US hospital discharges.\textsuperscript{21} This database is assembled annually by the Agency for Healthcare Research and Quality and provides information on more than eight million annual admissions from more than 40 states and more than 1000 hospitals.\textsuperscript{23} The Nationwide Inpatient Sample is a stratified sample of hospitals drawn from existing state databases that make their information available to the Healthcare Cost and Utilization Project (HCUP) with data that can be matched to the American Hospital Association annual survey of hospitals.\textsuperscript{24} It also contains a weighting system that allows for population estimates to be calculated.\textsuperscript{23} The discharge weights are calculated within each sampling stratum as a ratio of discharges in the universe to the sample.\textsuperscript{24} Universe discharges are calculated from the total discharges reported in American Hospital Association hospital survey data from non-rehabilitation hospitals.\textsuperscript{20} Multiple prior studies have utilized this database and the weighting system, focusing on subspecialty cohorts.\textsuperscript{2,12,12-30}

**Study population**

We included all patients admitted to hospital between 2002 and 2010. Because the National Inpatient Sample does not contain unique patient identifiers we treated each discharge as an independent event, even if it might represent repeated admissions by the same patient. For each hospital stay we recorded covariates at both patient and hospital level.

**Outcomes**

The primary outcome of interest was the ever occurrence of a hospital acquired condition; these were identified using international classification of diseases, ninth edition, clinical modification (ICD-9CM) codes and verified with literature from CMS (see supplementary table).\textsuperscript{21} We tabulated the frequency of individual hospital acquired conditions in this population and the demographic relation to patient and hospital variables. Secondary outcomes of interest included inpatient charges ($\geq 90$th centile, $\geq$S$118\ 505.27) and prolonged length of stay ($\geq 90$th centile, $\geq$11 days).

**Covariates**

For the analysis we used nominal covariates such as race (white American, black American, Hispanic, Asian Pacific Islander, Native American, other), payer information (Medicare, Medicaid, private insurance, no charge, self pay, other), and sex (male, female), and ordinal covariates, such as age categories (<18, 19–30, 31–40, 41–50, 50–65, 66–80, >80 years) and length of stay. Similarly, hospital factors, such as bed size (small <200, medium 201–400, large >400 beds), teaching status (teaching, non-teaching), hospital region (north east, Midwest, south, west), and location (rural, urban) were included covariates. We coded missing data fields as missing values and included these in analysis.

The severity of the cause for hospital admission was defined by the All Patient Refrined Disease Related Group algorithm (3M Health Information Systems, Wallingford, CT), admission type (emergency, urgent, elective, newborn, trauma, other), and admission source (emergency department, another hospital, other health facility, court or law enforcement, routine admissions, including births, and other sources). The All Patient Refrined Disease Related Groups are a system of proprietary risk adjustment methods that builds upon the existing structure of the disease related group and classifies patient admissions in approximately 500 categories with similar clinical features and patterns of resource utilization. The All Patient Refrined Disease Related Group from the National Inpatient Sample is categorized into five primary designations: no class specified, minor loss of function, moderate loss of function, major loss of function, and extreme loss of function. To adjust for the severity of injuries requiring admission, we included All Patient Refrined Disease Related Group, admission type, and admission source in our models for analysis.

**Statistical analysis**

We used survey adjusted univariate and means analysis to calculate population demographics. To assess the relation between the outcome of having at least one hospital acquired condition with patient and hospital factors we conducted multivariable logistic regressions using survey adjusted generalized estimating equations. The primary predictor variable of interest was the timing of admission (weekend versus weekday). We ran secondary analyses to assess the outcome of inpatient mortality with adjustments for the occurrence of a hospital acquired condition and patient, hospital, and severity factors. Similarly, we assessed the impact of neurological comorbidities on occurrence of hospital acquired conditions. We also fit multivariable survey logistic regression models to examine the risk factors of prolonged length of stay and charges. We also conducted a multiple imputation using the methods outlined elsewhere.\textsuperscript{22}

For a complex sample data with categorical variables we used a four step procedure for multiple imputation. We created five imputed datasets using the Markov Chain Monte Carlo method and produced a monotone missing data pattern in this large dataset. Using the
Inpatient mortality:

Race:

- White American: 33,408,370 (49.2), 145,479,404 (51.4), <0.01
- Black American: 7,847,842 (11.6), 29,895,824 (10.6), <0.01
- Hispanic: 7,219,628 (10.6), 27,677,183 (9.8), <0.01
- Asian Pacific Islander: 721,751 (1.0), 2,768,293 (2.0), <0.01
- Other: 1,816,788 (0.5), 1,289,827 (0.5), <0.01
- Missing: 15,783,920 (23.3), 66,059,651 (23.3), 0.5037

Sex:

- Female: 28,533,139 (42.0), 116,172,863 (41.0), <0.01
- Male: 39,159,898 (57.7), 166,350,325 (58.7), <0.01
- Missing: 749,506 (1.1), 3,116,851 (1.1), <0.01

Age group (years):

- <18: 12,684,772 (18.7), 48,733,195 (17.2), <0.01
- 19–30: 8,631,399 (12.7), 32,684,847 (11.5), <0.01
- 31–40: 6,467,587 (9.5), 27,657,135 (9.8), <0.01
- 41–50: 6,389,447 (9.4), 29,082,664 (10.3), <0.01
- 51–65: 10,937,715 (16.1), 51,617,250 (18.2), <0.01
- 66–80: 12,909,567 (19.0), 58,095,331 (20.5), <0.01
- >80: 9,848,759 (14.5), 35,408,152 (12.5), <0.01

Payer information:

- Medicare: 25,403,449 (37.4), 104,560,419 (36.9), <0.01
- Medicaid: 14,088,122 (20.8), 53,514,983 (18.9), <0.01
- Private insurance: 21,708,750 (32.0), 100,817,045 (35.6), <0.01
- Self pay: 4,153,791 (6.1), 13,406,659 (4.7), <0.01
- Missing: 2,345,040 (3.4), 12,293,679 (4.3), <0.01

No of comorbidities:

- 0: 24,033,497 (35.4), 102,447,854 (36.2), <0.01
- 1: 38,859,052 (56.8), 166,350,325 (58.7), <0.01
- ≥2: 30,845,040 (45.4), 122,931,679 (43.4), <0.01
- Missing: 176,209 (0.3), 755,387 (0.3), <0.01

No of hospital acquired conditions:

- No of hospital acquired conditions: 0.01
- No hospital acquired conditions: 0.01
- Missing hospital acquired conditions: 0.01

All Patient Refined Disease Related Group—severity:

- No class specified: 44,743 (0.1), 177,046 (0.1), <0.01
- Minor loss of function: 24,858,060 (36.6), 113,347,265 (40.0), <0.01
- Moderate loss of function: 24,897,962 (36.7), 102,080,742 (36.3), <0.01
- Major loss of function: 13,415,105 (19.8), 50,876,315 (18.0), <0.01
- Extreme loss of function: 3,903,870 (5.8), 12,952,355 (4.6), <0.01
- Missing: 749,506 (1.1), 3,116,851 (1.1), <0.01

Hospital region:

- North east: 13,434,138 (19.8), 55,559,783 (19.6), <0.01
- Midwest: 15,550,498 (22.9), 65,236,854 (23.0), <0.01
- South: 25,455,415 (37.5), 108,789,617 (38.4), <0.01
- West: 13,429,195 (19.8), 53,692,320 (19.0), <0.01

Hospital location:

- Rural: 9,169,797 (13.5), 37,241,211 (13.1), <0.01
- Urban: 58,431,027 (86.1), 244,913,991 (86.5), <0.01
- Missing: 268,422 (0.4), 1,123,162 (0.4), 0.7530

Hospital teaching status:

- Non-teaching: 37,086,724 (54.6), 152,161,037 (53.7), <0.01
- Teaching: 30,514,100 (45.0), 129,994,375 (45.9), <0.01
- Missing: 268,422 (0.4), 1,123,162 (0.4), 0.7530

(Continued)
teaching versus non-teaching institutions) ranking as another significant predictor (table 4). The associations between medium and large bed size facilities were statistically similar, showing an increased probability of incurring a hospital acquired condition (1.06, 1.01, 1.12, P<0.01, medium versus small; 1.11, 1.06 to 1.16, P<0.01, large versus small). Hospital region, though statistically significant, had marginal associations with the probability of incurring a hospital acquired condition during admission. Patients with comorbid neurological conditions were 35% more likely than those without to incur a hospital acquired condition during admission (1.35, 1.34, 1.37, P<0.01; results not shown).

Being from a minority ethnic group and of a younger age were associated with a decreased likelihood of incurring a hospital acquired condition, compared with being older and of white ethnicity (table 4). Patient payer type had mixed associations with the probability of incurring a hospital acquired condition; the likelihood was decreased in Medicare and Medicaid patients, whereas all other payers experienced an increased odds compared with privately insured patients (table 4). Additionally, females were 12% less likely to incur a hospital acquired condition than male patients in our sample (table 4). More severe All Patient Refined Disease Related Groups, admission types, and admission sources were associated with higher likelihoods of incurring a hospital acquired condition compared with less severe All Patient Refined Disease Related Group, routine admissions, and elective admissions (table 4).

During our multiple imputation analysis, we found that patients admitted on the weekends were 21% more likely to incur a hospital acquired condition than patients admitted on a weekday (1.21, 1.20 to 1.22, P<0.01). This result was seen to be similar to our non-imputed analysis (see supplementary table).
Higher inpatient charges and prolonged length of hospital stay

The presence of one or more hospital acquired conditions was associated with higher inpatient charges (1.83, 1.77, 1.90, P<0.01), when adjusting for timing of admission, patient factors (age, race, payer status, sex, admission severity), and hospital factors (region, location, teaching status, bed size). The occurrence of one or more hospital acquired conditions was also associated with prolonged length of stay (1.38, 1.36 to 1.41, P<0.01) (table 5). Mean inpatient charges for patients with at least one hospital acquired condition was $48788 and length of stay was 6.56 days, significantly greater than patients with no hospital acquired conditions (table 6).

Discussion

Medical care throughout the world has faced scrutiny and increased public awareness as focus has turned to improving public safety, outcomes, and access.33 The current US healthcare focus on public safety and cost effectiveness mandates increased attention to quality outcome measures. Estimates suggest that $ 5.3bn have been attributed annually to the treatment of potentially preventable medical errors, with recent estimates of $12bn saved with a 17% reduction in hospital acquired conditions since 2010.6 Determining incidence rates and characterizing the external factors associated with such events is critical. The current study is the first to examine the occurrence of Centers for Medicaid and Medicare Services (CMS) defined hospital acquired conditions—hospital events for which resulting costs of treatment are not federally reimbursed—across all inpatient admissions using a large, administrative database. The data provide baseline frequencies and enable subsequent monitoring of trends over time.

National rates for hospital acquired conditions

Analysis of 351 million US hospital admissions from 2002 to 2010 at least one hospital acquired condition in 4.8% of hospital admissions (16.7 million inpatient stays). This rate is concordant with previous estimates for hospital acquired conditions reported across the subspecialty literature (range 2.4–15.0%).22 13 Falls were the most common event, occurring in 14 million admissions and accounting for 85% of all hospital acquired conditions.

Hospital acquired conditions occurred more often among patients admitted on weekends (5.7%) than among those admitted on weekdays (3.7%). Weekend admission was associated with a 21% increased likelihood of incurring a hospital acquired condition (odds ratio 1.25, 95% confidence interval 1.24 to 1.26, P<0.01) after adjusting for patient, hospital, and severity of admission characteristics.

Factors potentially affecting rates of hospital acquired conditions

Multiple factors may impact the association between weekend admission and the occurrence of a hospital acquired condition. Staff volume (physicians, nurses, and ancillary staff) and level of medical expertise are diminished during weekend shifts.14 35 36 Reduced staffing may result in more limited attention to each patient at the point of admission. Further, medical staff often provide weekend coverage for one another and may be less familiar with both the acute and the chronic medical conditions of patients requiring hospital admission. Typically, a reduced infrastructure and fewer resources are allocated towards diagnostic testing and operative intervention on weekends. At weekends, delays have been reported in door to balloon time in the setting of acute myocardial infarction, placement of triple lumen catheters in those with acute myeloid leukemia, and performance of endoscopy in patients with hemorrhagic peptic ulcers and esophageal varices.22 37–39 Delays have been noted in patients with metastatic spine tumors receiving surgical intervention on weekends.40 These disparities are not restricted to hospitals in the United States. In a retrospective English population cohort study, the authors reported a decrease in quality and safety of stroke care for patients presenting on weekends.41

Numerous studies from multiple countries have shown significant increases in mortality (from 3% to 20%) associated with weekend hospital admissions.18–21 41–43 This finding was also consistent with our tertiary analysis, indicating that the likelihood of mortality in patients admitted at weekends was 11% higher than that of patients admitted on weekdays (odds ratio 1.11, 95% confidence interval 1.10 to 1.12, P<0.01). However, the frequency of preventable hospital events may actually be a more accurate reflection of overwhelmed medical systems in the weekend environment. Such events reflect errors in systems and processes. Though mortality rates are heavily influenced by disease severity, medical comorbidities, and goals of care, hospital acquired conditions represent perceived deficiencies in healthcare delivery and are theoretically preventable. Further, deficiencies in weekend care may not always result in mortality but can impact patient care, length of stay, and hospital costs. Studies have found that delays in endoscopy during weekend admissions for patients presenting with hemorrhage from peptic ulcers and esophageal varices do not result in mortality but are associated with significant increases in hospital charges.37

| Year | No with hospital acquired condition | % of population |
|------|-----------------------------------|----------------|
| 2002 | 3,455,274                         | 3.6            |
| 2003 | 3,455,274                         | 3.7            |
| 2004 | 3,455,274                         | 3.8            |
| 2005 | 3,455,274                         | 3.7            |
| 2006 | 3,455,274                         | 3.8            |
| 2007 | 3,455,274                         | 3.8            |
| 2008 | 3,455,274                         | 4.2            |
| 2009 | 3,455,274                         | 4.7            |
| 2010 | 3,455,274                         | 5.2            |

Table 3 | Number of cases with hospital acquired conditions by year
Disease severity

Severity of illness at the time of admission could predispose to adverse events and hospital acquired conditions.\textsuperscript{44} Adverse outcome, with our results also noting increased hospital acquired conditions among those with neurologic impairments (P<0.01).

Secondary outcomes

The occurrence of hospital acquired conditions was associated with a 76% higher inpatient hospital charge. The mean charge of hospital stay for patients who experienced at least one hospital acquired condition was $47,066, and for patients who had no hospital acquired condition was $27,092. The rise in cost was independent of patient and hospital factors or day of admission (odds ratio 1.76, 95% confidence interval 1.69 to 1.82, P<0.001). That hospital acquired conditions are associated with increased costs is not surprising. Early data reports on surgical complications suggest a total cost of $58,237 for each nursing related event (fracture from fall) and $86,833 per infection. The cost of surgery in the absence of an associated event was reported to be $18,284.\textsuperscript{45} Though increases in cost associated with hospital acquired conditions seem implicit, the magnitude of the calculated increase is notable. As current policy holds reimbursement for costs associated with hospital acquired conditions, the financial burden on treating institutions remains substantial. Hospital acquired conditions are also associated with increased length of stay, independent of admission day, as well as hospital and patient characteristics. Mean length of stay is increased from 4.53 to 6.26 days in patients with at least one hospital acquired condition. This is concordant with findings from previous studies. In patients undergoing head and neck surgeries, deep vein thrombosis was associated with significant increases in length of hospital stay.\textsuperscript{46} Surgical site infections and decubitus ulcers were associated with a 5.6 to 10 day increase in hospital stay.\textsuperscript{8} It is notable that increased length of stay in the presence of hospital acquired conditions is independent of admission day. This suggests that the reported length of stay variables are not confounded by patients admitted on weekends waiting longer in the hospital for availability of relevant tests or their primary doctor. It is not clear

### Table 4 | Predictors of hospital acquired conditions by multivariable analysis

| Predictors                  | Odds ratio (95% CI) | P value |
|-----------------------------|---------------------|---------|
| **Patient predictors**      |                     |         |
| Admission day:              |                     |         |
| Weekend                     | 1.25 (1.24 to 1.26) | <0.01   |
| Weekday                     | Reference           |         |
| Race:                       |                     |         |
| White American              | Reference           |         |
| Black American              | 0.66 (0.63 to 0.68) | <0.01   |
| Hispanic                    | 0.73 (0.69 to 0.77) | <0.01   |
| Asian Pacific Islander      | 0.65 (0.62 to 0.68) | <0.01   |
| Native American             | 0.93 (0.84 to 1.03) | 0.17    |
| Other                       | 0.90 (0.85 to 0.95) | <0.01   |
| No of comorbidities:        |                     |         |
| 0                           | Reference           |         |
| 1                           | 0.72 (0.71 to 0.74) | <0.01   |
| ≥2                          | 0.57 (0.56 to 0.59) | <0.01   |
| Age (years):                |                     |         |
| <18                         | 0.47 (0.45 to 0.49) | <0.01   |
| 19–30                       | 0.41 (0.40 to 0.42) | <0.01   |
| 31–40                       | 0.37 (0.35 to 0.38) | <0.01   |
| 41–50                       | 0.41 (0.40 to 0.42) | <0.01   |
| 51–65                       | 0.41 (0.40 to 0.42) | <0.01   |
| 66–80                       | 0.56 (0.56 to 0.57) | <0.01   |
| >80                         | Reference           |         |
| Payer information:          |                     |         |
| Medicare                    | 0.89 (0.86 to 0.91) | <0.01   |
| Medicaid                    | 0.67 (0.66 to 0.70) | <0.01   |
| Private insurance           | Reference           |         |
| Self pay                    | 1.45 (1.38 to 1.51) | <0.01   |
| No charge                   | 1.16 (1.03 to 1.30) | 0.01    |
| Other                       | 2.07 (1.97 to 2.18) | <0.01   |
| Sex:                        |                     |         |
| Female                      | 0.88 (0.86 to 0.90) | <0.01   |
| Male                        | Reference           |         |
| All Patient Refined Disease Related Group—severity: | | |
| Minor loss of function      | Reference           |         |
| Moderate loss of function   | 1.40 (1.37 to 1.43) | <0.01   |
| Major loss of function      | 1.77 (1.72 to 1.83) | <0.01   |
| Extreme loss of function    | 2.60 (2.50 to 2.71) | <0.01   |
| **Hospital predictors**     |                     |         |
| Hospital region:            |                     |         |
| North east                  | Reference           |         |
| Midwest                     | 1.14 (1.05 to 1.23) | <0.01   |
| South                       | 1.21 (1.13 to 1.30) | <0.01   |
| West                        | 1.25 (1.13 to 1.37) | <0.01   |
| Hospital location:          |                     |         |
| Rural                       | 0.97 (0.94 to 1.01) | 0.13    |
| Urban                       | Reference           |         |
| Hospital teaching status:   |                     |         |
| Non-teaching                | Reference           |         |
| Teaching                    | 1.29 (1.23 to 1.35) | <0.01   |
| Hospital bed size:          |                     |         |
| Small (<200)                | Reference           |         |
| Medium (200–400)            | 1.06 (1.01 to 1.12) | <0.01   |
| Large (>400)                | 1.11 (1.06 to 1.16) | <0.01   |
| Admission type:             |                     |         |
| Emergency                   | 2.09 (1.97 to 2.22) | <0.01   |
| Urgent                      | 1.42 (1.35 to 1.49) | 0.06    |
| Elective                    | Reference           |         |
| Newborn                     | 0.02 (0.02 to 0.02) | <0.01   |
| Trauma                      | 60.39 (23.24 to 70.21) | <0.01   |
| Other                       | 2.51 (1.67 to 3.76) |      |
from the current analysis whether hospital acquired conditions contribute to increased hospital costs and prolonged length of stay or if the reverse is true. The analysis simply establishes an association; causative inference is not possible with the data provided. Increased time spent in hospital typically results in higher inpatient costs and certainly may render an individual susceptible to hospital acquired conditions.

Limitations of this study
The current study is limited by the natural constraints of a large administrative database. ICD-9 coding within an administrative data source is reported to be 80% accurate.47 Coding is performed by a wide variety of staff without strict oversight. Reported data are therefore subject to information bias and local variability. It is unlikely, however, that the weekend and weekday cohorts would be differentially affected. Also, patients admitted on a Sunday night for elective surgery were included as weekend admits, though we adjusted for this population by controlling for elective admission within our multivariable model.

Two of the codes for hospital acquired conditions were not present in the earlier years of the National Inpatient Sample. Pressure ulcers were not coded prior to 2008 and vascular catheter infections were not coded prior to 2007. This prohibits their inclusion in the analysis of hospital acquired conditions in the years with missing data. This could marginally lower the overall reporting frequency of hospital acquired conditions but would unlikely exhibit differential effects on the weekend and weekend rates of hospital acquired conditions. Furthermore, our study sample includes significant heterogeneity and limits the ability in this mixed cohort to make procedure specific or admission specific conclusions. An inherent limitation in the use of the National Inpatient Sample is not being able to distinguish patients with multiple admissions, resulting in an inability to follow subsequent hospital admissions from the original admission of hospital acquired conditions. Because of this, long term implications of hospital acquired conditions may result in prolonged and subsequent hospital stays that cannot be taken into account. Also, patients who sustain a hospital acquired condition may have subsequent repeat hospital admissions where their prior hospital acquired condition may be either documented as a new occurrence or not documented at all, with the former leading to a possibly inflated estimate. Finally, documentation of hospital acquired conditions does not distinguish events that occur after admission from pre-existing conditions. However, most of the hospital acquired conditions studied are single events or conditions highly unlikely to have occurred prior to hospital admission.

Improving future rates of hospital acquired conditions
The volume of hospital admissions on weekends is unlikely to decline substantially in the foreseeable future. Added resources and efforts of healthcare administrators and providers are needed to tackle the potential shortcomings in quality of patient care during susceptible periods. Hospital acquired conditions reflect deficiencies in systems and processes. The reasons for an increased frequency of “never events” in patients admitted to hospitals over the weekend is likely multifactorial. Staffing problems are a universal concern. Further training and implementation of prescribed protocols may help mitigate the “weekend effect.” Studies attribute human factors such as medical errors to systemic inadequacies within a larger context of less stringent adherence to safety.48 Improved implementation of protocols for patient care may prevent hospital acquired conditions, especially during times of decreased staffing. It is estimated that at least 20% of hospital acquired infections are preventable with proper training.50 Current nationwide efforts to implement technical practices designed to reduce urinary tract infections are underway.51 Such programs, providing a standard for the initiation of common practice treatments, whether on weekends or weekdays, may be of large scale benefit.

Conclusion
Documentation of hospital acquired conditions represents a reproducible metric for quality of patient care, whereas event occurrence is a large financial burden for healthcare providers and institutions. Evaluation of the frequency of hospital acquired conditions across all medical specialties and admission profiles from 2002–10 showed a significant increase in hospital acquired conditions for patients admitted on weekends, with associated increases in hospital costs and length of patient stay. Improved education, staffing, and protocols may reduce this observed effect.
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Ethical approval. Not required.

Data sharing. No additional data available.

Transparency. The lead author (FJA) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported, that no important aspects of the study have been omitted, and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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