Objective: We hypothesized that the mortality rate after nonelective hospital admission is higher during weekends than weekdays.

Design: Retrospective cohort analysis.

Setting: Patients admitted to hospitals in the Nationwide Inpatient Sample, a 20% sample of US community hospitals.

Patients: We identified all patients with a nonelective hospital admission from January 1, 2003, through December 31, 2007, in the Nationwide Inpatient Sample. Next, we abstracted vital status at discharge and calculated the Charlson comorbidity index score for all patients. We then compared odds of inpatient mortality after nonelective hospital admission during the weekend compared with weekdays, after adjusting for diagnosis, age, sex, race, income level, payer, comorbidity, and hospital characteristics.

Main Outcome Measure: Mortality rate.

Results: Discharge data were available for 29,991,621 patients with nonelective hospital admissions during the 5-year study period: 6,842,030 during weekends and 23,149,591 during weekdays. Inpatient mortality was reported in 185,856 patients (2.7%) admitted for nonelective indications during weekends and 540,639 (2.3%) during weekdays ($P < .001$). The regression revealed significantly higher mortality during weekends for 15 of 26 (57.7%) major diagnostic categories. The weekend effect remained, and mortality was noted to be 10.5% higher during weekends (odds ratio, 1.10; 95% confidence interval, 1.10-1.11) compared with weekdays after adjusting for all other variables with the imputed data set.

Conclusions: These data demonstrate significantly worse outcomes after nonelective admission during the weekend compared with weekdays. Although the underlying mechanism of this finding is unknown, it is likely that factors such as differences in hospital staffing and services offered during the weekend compared with weekdays are causal and mutable.
diagnostic categories have been used to evaluate hospitalization and outcomes, volume outcome relationships, and charge databases, the NIS has been used to review trends in survival at hospital discharge. Along with other hospital discharge databases, the NIS has been used to review trends in surgical care and outcomes, volume outcome relationships, and disparities in care. A data use agreement is held by the Agency for Healthcare Research and Quality, and our study was considered exempt by the Lahey Clinic Institutional Review Board.

PATIENT SELECTION AND PREDICTOR VARIABLE

All patients discharged during the time frame sampled were included. We used the elective variable to exclude all patients with an admission for elective reasons and included only those patients with nonelective admission. Thus, patients with emergency and urgent indications for admission were included.

The data set permits identification of admission day as a weekend or weekday. We recorded this variable as admitted during a weekend (ie, Saturday or Sunday) or a weekday (ie, Monday through Friday).

COVARIATES

Our analysis adjusted for the following covariates: age, sex, race, income level, payer, major diagnostic categories (subgroupings of diagnosis-related groups), and the Charlson comorbidity index score. Age was included as a continuous variable. Sex was entered as a dichotomous variable. Race was divided into white, black, Hispanic, Asian or Pacific Islander, Native American, or other. Income level was categorized into quartiles per estimated median household income of residents in the patient’s zip code. The median income quartiles are classified as follows: $0 to $38,999, $39,000 to $47,999, $48,000 to $62,999, and $63,000 or more. Payer was recorded as follows: Medicare, Medicaid, private including health maintenance organization, self-pay, no charge, or other. Major diagnostic categories were used to adjust for diagnoses and reflect larger groupings of diagnostic-related groups made available in the provided data set and downloadable for review from the US Department of Health and Human Services, Centers for Medicare and Medicaid Services. Major diagnostic categories have been used to evaluate hospitalization risk, mortality risk, and other outcomes. We also evaluated comorbidity with the Deyo modification of the Charlson comorbidity index. Briefly, we ascertained the presence of 17 comorbid conditions and then weighted them according to the original report. An elevated Charlson comorbidity index score has been demonstrated to correlate with higher mortality rate.

We also examined the effect of hospital characteristics on mortality rate as a function of admission day. Hospital bed size categories are based on the number of short-term acute care beds in a hospital and obtained from the American Hospital Association Annual Survey of Hospitals. Bed size was classified as small, medium, or large, depending on the location of the hospital and its teaching status. The category for ownership and control of the hospital was obtained from the American Hospital Association Annual Survey of Hospitals and included categories for government nonfederal (public), not-for-profit private (voluntary), and investor-owned private (proprietary). The census region for the hospital is defined by the US Census Bureau and categorized as Northeast, Midwest, South, and West. Hospital rurality was categorized as rural or urban based on Core Based Statistical Area codes. Before 2004, all metropolitan statistical areas were considered urban, and nonmetropolitan statistical areas were classified as rural. The teaching status of the hospital was obtained from the American Hospital Association Annual Survey of Hospitals. A hospital is considered to be a teaching hospital if it has an American Medical Association–approved residency program, is a member of the Council of Teaching Hospitals, or has a ratio of full-time equivalent interns and residents to beds of 0.25 or higher.

VITAL STATUS

The data set permits identification of vital status at the time of discharge. The variable is coded as died during hospitalization or did not die during hospitalization. Deaths that occurred after discharge are not identifiable from our data set.

STATISTICAL ANALYSIS

Statistical analyses were performed using SAS statistical software, version 9.2 (SAS Institute Inc, Cary, North Carolina). We used t tests to analyze continuous variables and χ² tests for categorical variables. Results were considered statistically significant at P < .05, and all statistical tests were 2-tailed. We included all covariates in our regression model. The analyses were conducted with and without missing variables. To confirm results, we performed imputation of missing data using the multiple imputation procedure from SAS Institute Inc. Imputation substitutes missing values with plausible values that characterize the uncertainty regarding the missing data. This process results in valid statistical inferences that properly reflect the uncertainty due to missing values, for example, confidence intervals with the correct probability coverage. The imputed data set was then analyzed by using standard logistic regression for the complete data.

Last, to assess whether the effect of admission day differed as a function of diagnosis, we tested for interactions between admission day and major diagnostic category. Because of the significant interaction between these variables, we reanalyzed the effect of admission day on mortality rate for each individual major diagnostic category with the same covariates in the larger analysis described herein.

RESULTS

COHORT

From January 1, 2003, through December 31, 2007, a total of 40,095,587 discharges were recorded at NIS hospitals. From this total, admission information was available for 29,991,621 patients (74.8%) who were admitted for nonelective reasons, of whom 726,495 patients (2.4%) died.

A total of 6,842,030 patients (22.8%) were admitted during the weekend, and 23,149,591 patients (77.2%) were admitted during a weekday, providing day-of-admission information for 29,991,621 patients. On average, patients admitted during the weekend were older and proportionately more likely to be male (Table 1). The NIS included a large number of white patients in the sample; however, proportionately more Asians came in during weekends compared with other NIS-designated racial groups. Income categories were more evenly dis-
tributed, but patients living in the lowest-annual-
icome areas were proportionately most likely to seek
treatment during the weekend. Most patients had health care coverage from Medicare, Medicaid, or private in-
surance. Of interest, those patients categorized as self-
pay were proportionately more likely to be admitted dur-

### Table 1. Demographics of Patients Admitted to the Hospital for Nonelective Indications on a Weekday Compared With the Weekend

<table>
<thead>
<tr>
<th>Demographic</th>
<th>Weekend</th>
<th>Weekday</th>
<th>All Patients, No.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age, mean (SE), y</strong></td>
<td>47.3 (0.01)</td>
<td>46.0 (0.01)</td>
<td>46.3 (0.01)</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>3 010 288 (23.1)</td>
<td>10 015 902 (76.9)</td>
<td>13 026 190</td>
</tr>
<tr>
<td>Female</td>
<td>3 809 421 (22.6)</td>
<td>13 065 024 (77.4)</td>
<td>16 874 445</td>
</tr>
<tr>
<td>Missing</td>
<td>22 321 (24.5)</td>
<td>68 665 (75.5)</td>
<td>90 986</td>
</tr>
<tr>
<td><strong>Race</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>3 220 315 (22.5)</td>
<td>11 097 824 (77.5)</td>
<td>14 318 139</td>
</tr>
<tr>
<td>Black</td>
<td>770 629 (23.2)</td>
<td>2 550 673 (76.8)</td>
<td>3 321 302</td>
</tr>
<tr>
<td>Hispanic</td>
<td>739 973 (23.0)</td>
<td>2 462 079 (77.0)</td>
<td>3 222 051</td>
</tr>
<tr>
<td>Asian or Pacific Islander</td>
<td>139 084 (23.6)</td>
<td>451 503 (78.4)</td>
<td>590 587</td>
</tr>
<tr>
<td>Native American</td>
<td>28 909 (23.3)</td>
<td>95 010 (76.7)</td>
<td>123 919</td>
</tr>
<tr>
<td>Other</td>
<td>160 541 (22.6)</td>
<td>551 156 (77.4)</td>
<td>711 697</td>
</tr>
<tr>
<td>Missing</td>
<td>1 782 579 (23.1)</td>
<td>5 921 347 (76.9)</td>
<td>7 703 939</td>
</tr>
<tr>
<td><strong>Annual income, $</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-38 999</td>
<td>1 974 533 (22.9)</td>
<td>6 666 323 (77.1)</td>
<td>8 640 856</td>
</tr>
<tr>
<td>39 000-47 999</td>
<td>1 716 207 (22.8)</td>
<td>5 801 677 (77.2)</td>
<td>7 517 884</td>
</tr>
<tr>
<td>48 000-62 999</td>
<td>1 565 569 (22.8)</td>
<td>5 291 453 (77.2)</td>
<td>6 857 022</td>
</tr>
<tr>
<td>63 000-113 999</td>
<td>1 411 489 (22.7)</td>
<td>4 808 723 (77.3)</td>
<td>6 220 212</td>
</tr>
<tr>
<td>Missing</td>
<td>174 232 (23.1)</td>
<td>581 415 (75.5)</td>
<td>775 647</td>
</tr>
<tr>
<td><strong>Payer</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medicare</td>
<td>2 642 010 (23.4)</td>
<td>8 637 881 (76.6)</td>
<td>11 279 891</td>
</tr>
<tr>
<td>Medicaid</td>
<td>1 377 211 (22.5)</td>
<td>4 754 107 (77.5)</td>
<td>6 131 318</td>
</tr>
<tr>
<td>Private</td>
<td>2 140 024 (21.9)</td>
<td>7 612 939 (78.1)</td>
<td>9 752 963</td>
</tr>
<tr>
<td>Self-pay</td>
<td>431 099 (25.3)</td>
<td>1 271 137 (74.7)</td>
<td>1 702 236</td>
</tr>
<tr>
<td>None (no reported payer)</td>
<td>38 027 (24.3)</td>
<td>118 438 (75.7)</td>
<td>156 465</td>
</tr>
<tr>
<td>Other</td>
<td>201 554 (22.0)</td>
<td>715 176 (78.0)</td>
<td>916 730</td>
</tr>
<tr>
<td>Missing</td>
<td>12 105 (23.3)</td>
<td>39 913 (76.7)</td>
<td>52 018</td>
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<td><strong>Charlson comorbidity index score</strong></td>
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<td></td>
</tr>
<tr>
<td>0</td>
<td>3 643 749 (22.4)</td>
<td>12 627 933 (77.6)</td>
<td>16 271 682</td>
</tr>
<tr>
<td>1</td>
<td>1 402 080 (23.5)</td>
<td>4 569 704 (76.5)</td>
<td>5 971 784</td>
</tr>
<tr>
<td>2 or more</td>
<td>1 796 201 (23.2)</td>
<td>5 951 954 (76.8)</td>
<td>7 748 155</td>
</tr>
<tr>
<td>Missing</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Mean (SE)</strong></td>
<td>1.08 (0.001)</td>
<td>1.07 (0.001)</td>
<td>1.07 (0.001)</td>
</tr>
<tr>
<td><strong>Hospital size</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>867 117 (22.6)</td>
<td>2 965 832 (77.4)</td>
<td>3 832 949</td>
</tr>
<tr>
<td>Medium</td>
<td>1 751 846 (23.0)</td>
<td>5 857 844 (77.0)</td>
<td>7 609 690</td>
</tr>
<tr>
<td>Large</td>
<td>4 217 949 (22.8)</td>
<td>14 309 014 (77.2)</td>
<td>18 526 363</td>
</tr>
<tr>
<td>Missing</td>
<td>571 852 (25.3)</td>
<td>16 901 (74.7)</td>
<td>22 619</td>
</tr>
<tr>
<td><strong>Hospital control</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government</td>
<td>4 052 649 (22.8)</td>
<td>13 720 395 (77.2)</td>
<td>17 773 044</td>
</tr>
<tr>
<td>Public</td>
<td>485 156 (22.8)</td>
<td>1 643 991 (77.2)</td>
<td>2 129 147</td>
</tr>
<tr>
<td>Not-for-profit private</td>
<td>1 343 449 (23.2)</td>
<td>4 458 160 (78.6)</td>
<td>5 801 609</td>
</tr>
<tr>
<td>Investor-owned private</td>
<td>690 375 (22.2)</td>
<td>2 423 092 (77.8)</td>
<td>3 113 467</td>
</tr>
<tr>
<td>Other private</td>
<td>264 683 (3.9)</td>
<td>887 052 (3.8)</td>
<td>1 151 735</td>
</tr>
<tr>
<td>Missing</td>
<td>571 852 (25.3)</td>
<td>16 901 (74.7)</td>
<td>22 619</td>
</tr>
<tr>
<td><strong>Hospital region</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Northeast</td>
<td>1 345 943 (22.5)</td>
<td>4 634 264 (77.5)</td>
<td>5 980 207</td>
</tr>
<tr>
<td>Midwest</td>
<td>1 474 302 (22.9)</td>
<td>4 962 317 (77.1)</td>
<td>6 436 619</td>
</tr>
<tr>
<td>South</td>
<td>2 647 705 (22.5)</td>
<td>9 101 920 (77.5)</td>
<td>11 749 625</td>
</tr>
<tr>
<td>West</td>
<td>1 374 080 (23.6)</td>
<td>4 451 090 (76.4)</td>
<td>5 825 170</td>
</tr>
<tr>
<td>Missing</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Hospital rurality</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>888 514 (22.7)</td>
<td>3 018 446 (77.3)</td>
<td>3 906 960</td>
</tr>
<tr>
<td>Urban</td>
<td>5 947 798 (22.8)</td>
<td>20 114 244 (77.2)</td>
<td>26 062 042</td>
</tr>
<tr>
<td>Missing</td>
<td>571 852 (25.3)</td>
<td>16 901 (74.7)</td>
<td>22 619</td>
</tr>
<tr>
<td><strong>Hospital teaching status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonteaching</td>
<td>3 803 611 (22.9)</td>
<td>12 810 765 (77.1)</td>
<td>16 614 376</td>
</tr>
<tr>
<td>Teaching</td>
<td>3 032 701 (22.7)</td>
<td>10 321 925 (77.3)</td>
<td>13 354 626</td>
</tr>
<tr>
<td>Missing</td>
<td>571 852 (25.3)</td>
<td>16 901 (74.7)</td>
<td>22 619</td>
</tr>
</tbody>
</table>

---

*All data are presented as number (percentage) of patients unless otherwise indicated. Missing variables were as follows: day of admission, 31 (0.0001%); age, 34 429 (0.1%); P < .001 for all entries.*
ing the weekend. The Charlson comorbidity index scores ranged from 0 to 20, and the mean (SE) Charlson comorbidity index score was 1.07 (0.001). Patients who came in during weekends had a higher comorbidity score than patients admitted during weekdays (Table 1). Also, slight differences existed in the types of hospitals to which patients were admitted on weekends compared with weekdays (Table 1).

### UNIVARIATE ANALYSIS

Inpatient mortality was documented in 185,856 patients (2.7%) admitted during a weekend compared with 540,639 patients (2.3%) admitted during a weekday (16.2% higher; P < .001). For 17 of 26 major diagnostic categories (65.4%), higher weekend mortality was documented (Table 2) by univariate analysis.

### MULTIVARIATE ANALYSIS

After adjusting for age, sex, race, payer, annual income level, comorbidity, hospital bed size, hospital control, hospital region, hospital rurality, hospital teaching status, and major diagnostic categories, we found that the odds of death with admission during a weekend were 10.5% higher than during a weekday (Table 3). Imputation of missing variables resulted in no significant change in the response variables with the complete data set. The weekend effect remained, and mortality was noted to be 10.3% higher during weekends (odds ratio, 1.10; 95% confidence interval, 1.10-1.11) compared with weekdays after adjusting for all other variables with the imputed data set.

Tests for interaction revealed that the effect of admission day on mortality rate was significantly altered by major diagnostic category. We reanalyzed the effect of admission day on mortality rate, adjusting for age, sex, race, payer, annual income level, and comorbidity for each major diagnostic category. The regression revealed significantly higher mortality during weekends: 12 of 26 major diagnostic categories (46.2%) by univariate analysis and 15 of 26 major diagnostic categories (57.7%) by multivariate analysis (Table 2). The highest odds ratios for weekend mortality were identified for myeloproliferative disorders (odds ratio, 1.50; 95% confidence interval, 1.43-1.58), pregnancy and childbirth (1.37; 1.08-1.75), and female reproductive system procedures (1.32; 1.16-1.51). Mortality rate was not statistically different during weekends and weekdays for 10 major diagnostic categories and it was lower during weekends for 1 major diagnostic category (mental health disorders) (Table 2).

---

**Table 2. MDCs of Patients Admitted to the Hospital for Nonelective Indications on a Weekday Compared With the Weekend**

<table>
<thead>
<tr>
<th>MDC</th>
<th>Weekend</th>
<th>Weekday</th>
<th>Univariate P Value</th>
<th>OR (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-MDC</td>
<td>4.4</td>
<td>3.5</td>
<td>.09</td>
<td>0.90 (0.60-1.32)</td>
<td>.60</td>
</tr>
<tr>
<td>Nervous system</td>
<td>5.0</td>
<td>4.5</td>
<td>&lt;.001</td>
<td>1.14 (1.12-1.16)</td>
<td>.001</td>
</tr>
<tr>
<td>Eyes</td>
<td>0.2</td>
<td>0.2</td>
<td>.001</td>
<td>0.85 (0.47-1.53)</td>
<td>.60</td>
</tr>
<tr>
<td>Otohinolaryngology</td>
<td>0.5</td>
<td>0.6</td>
<td>.002</td>
<td>0.95 (0.83-1.07)</td>
<td>.40</td>
</tr>
<tr>
<td>Respiratory</td>
<td>5.7</td>
<td>5.4</td>
<td>&lt;.001</td>
<td>1.08 (1.07-1.10)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Circulatory</td>
<td>3.0</td>
<td>2.6</td>
<td>&lt;.001</td>
<td>1.14 (1.12-1.16)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Digestive</td>
<td>2.1</td>
<td>2.0</td>
<td>&lt;.001</td>
<td>1.09 (1.07-1.12)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Hepatobiliary</td>
<td>3.5</td>
<td>3.4</td>
<td>.20</td>
<td>1.04 (1.01-1.08)</td>
<td>.008</td>
</tr>
<tr>
<td>Musculoskeletal</td>
<td>1.3</td>
<td>1.3</td>
<td>.60</td>
<td>1.05 (1.01-1.09)</td>
<td>.03</td>
</tr>
<tr>
<td>Skin or breast</td>
<td>0.7</td>
<td>0.8</td>
<td>&lt;.001</td>
<td>0.97 (0.90-1.05)</td>
<td>.50</td>
</tr>
<tr>
<td>Endocrine system</td>
<td>1.6</td>
<td>1.6</td>
<td>.10</td>
<td>1.04 (1.00-1.09)</td>
<td>.05</td>
</tr>
<tr>
<td>Kidneys</td>
<td>2.6</td>
<td>2.6</td>
<td>.99</td>
<td>1.01 (0.98-1.04)</td>
<td>.60</td>
</tr>
<tr>
<td>Male reproductive systemb</td>
<td>1.8</td>
<td>1.7</td>
<td>.20</td>
<td>1.12 (0.94-1.32)</td>
<td>.20</td>
</tr>
<tr>
<td>Female reproductive systemb</td>
<td>1.3</td>
<td>0.9</td>
<td>&lt;.001</td>
<td>1.32 (1.16-1.51)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Pregnancy and childbirth</td>
<td>0.02</td>
<td>0.01</td>
<td>.001</td>
<td>1.37 (1.07-1.75)</td>
<td>.01</td>
</tr>
<tr>
<td>Neonatal</td>
<td>0.5</td>
<td>0.4</td>
<td>&lt;.001</td>
<td>1.25 (1.20-1.30)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Immunologic</td>
<td>1.5</td>
<td>1.4</td>
<td>.04</td>
<td>1.19 (1.10-1.28)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Myeloproliferative</td>
<td>12.1</td>
<td>7.8</td>
<td>&lt;.001</td>
<td>1.50 (1.43-1.58)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Infectious</td>
<td>12.6</td>
<td>11.9</td>
<td>&lt;.001</td>
<td>1.07 (1.05-1.09)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Mental health</td>
<td>0.08</td>
<td>0.09</td>
<td>.03</td>
<td>1.03 (0.68-1.00)</td>
<td>.05</td>
</tr>
<tr>
<td>Alcohol or drug use</td>
<td>0.1</td>
<td>0.1</td>
<td>.80</td>
<td>0.91 (0.70-1.17)</td>
<td>.50</td>
</tr>
<tr>
<td>Poison</td>
<td>1.4</td>
<td>1.3</td>
<td>.009</td>
<td>1.12 (1.05-1.19)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Burns</td>
<td>3.7</td>
<td>3.5</td>
<td>.40</td>
<td>1.17 (0.97-1.41)</td>
<td>.10</td>
</tr>
<tr>
<td>Other health factors</td>
<td>1.5</td>
<td>1.2</td>
<td>&lt;.001</td>
<td>1.20 (1.08-1.34)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Trauma</td>
<td>9.3</td>
<td>9.9</td>
<td>.003</td>
<td>0.95 (0.90-1.01)</td>
<td>.10</td>
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<tr>
<td>HIV</td>
<td>7.2</td>
<td>7.0</td>
<td>.40</td>
<td>1.05 (0.98-1.12)</td>
<td>.20</td>
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</tbody>
</table>

Abbreviations: CI, confidence interval; HIV, human immunodeficiency virus; MDC, major diagnostic category; OR, odds ratio.

a Multivariable analysis adjusted for age, sex, race, annual income, payer, comorbidity, hospital bed size, hospital control, hospital region, hospital rurality, and hospital teaching status. Univariate results are reported after χ² comparisons of proportions who died across admission day. The multivariate results include ORs and 95% CIs for weekend compared with weekday admission for individual regression analyses of each MDC with adjustment for age, sex, race, annual income, payer, and Charlson comorbidity index score.

b No adjustment for sex in the MDCs of reproductive system health or childbirth.
<table>
<thead>
<tr>
<th>Variable</th>
<th>OR (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admission during weekend</td>
<td>1.10 (1.10-1.11)</td>
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</tr>
<tr>
<td>Increasing age</td>
<td>1.04 (1.04-1.04)</td>
<td>.001</td>
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<tr>
<td>Sex</td>
<td></td>
<td></td>
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<tr>
<td>Female</td>
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<tr>
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<tr>
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<td>Asian or Pacific Islander</td>
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<tr>
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<td>Annual income, $</td>
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<td>0-38 999</td>
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<td>39 000-47 999</td>
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<td>48 000-62 999</td>
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<tr>
<td>63 000</td>
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<td>Medicare</td>
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<td>Medicaid</td>
<td>1.27 (1.25-1.28)</td>
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<td>Self-pay</td>
<td>1.45 (1.42-1.47)</td>
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<td>Investor-owned private</td>
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<td>&lt;.001</td>
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<tr>
<td>Poison</td>
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<tr>
<td>Burns</td>
<td>1.85 (1.70-2.01)</td>
<td>&lt;.001</td>
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<td>Other health factors</td>
<td>0.26 (0.25-0.27)</td>
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</tr>
<tr>
<td>Trauma</td>
<td>5.34 (5.18-5.51)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>HIV</td>
<td>1.07 (1.04-1.11)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; HIV, human immunodeficiency virus; OR, odds ratio.

*Age and Charlson comorbidity index score were entered as continuous variables. Sex, race, income, payer, and major diagnostic categories were entered as categorical variables with referent values identified.*
In our study, using national all-payer discharge data from the United States, we examined mortality rate in more than 29 million patients admitted nonselectively during a 5-year period. We identified a significantly higher mortality rate for patients admitted during the weekend compared with weekdays. This mortality rate difference remained despite adjustment for age, sex, race, payer, associated medical comorbidities, and hospital characteristics. In addition, we identified mortality rate differences across most major diagnostic categories. These data are particularly concerning because the reported differences in mortality rate are noted across several key areas of health care and throughout the nation.

Differences in mortality rate based on day of admission have similarly been identified in smaller studies and for more limited sets of urgent care diagnoses. One of the largest and most inclusive studies from Ontario, Canada, revealed significantly higher in-hospital mortality rates for patients admitted during weekends for 23 of 100 leading causes of death. The differences in mortality rate were most pronounced in patients with emergent conditions, such as ruptured abdominal aortic aneurysm, acute epiglottitis, and pulmonary embolism. Of interest, no differences in mortality rate were observed for patients with myocardial infarction, intracerebral hemorrhage, or acute hip fracture. Other authors have demonstrated excess weekend mortality rates in patients with myocardial infarction, stroke, pulmonary embolism, gastrointestinal bleeding, cardiac arrest, and other individual diagnoses. Our study demonstrated an excess weekend mortality rate for nonelective admissions across many major diagnostic categories and at the national level.

An explanation for the differences in mortality rate is not immediately evident from our data. Health care outcomes, such as morbidity and mortality rate, are dependent on patient comorbidities, structural elements of care, and processes of care. Although our study demonstrated an attenuation of the mortality rate differences with adjustment for patient comorbidity, mortality rates remained higher during weekends despite adjustment for the Charlson comorbidity index score. Thus, the admission day outcome differences implicate a common structural or process measure. This theory is substantiated by the lack of a significant difference in admission mortality rate for trauma or burn care. The evaluation and management of trauma and burns incorporate structured algorithms for care that likely reduced much of the variability in care practice that may be appreciated with other conditions. In addition, many patients who require care for trauma or burns present during the night and/or weekends; thus, clinical services for these conditions have been refined to account for these presentation patterns. Although speculative, clinical trial evidence of an outcome benefit for advanced trauma life support is unavailable; yet, evidence exists that trauma educational initiatives improve hospital staff knowledge of available emergency interventions. It is unclear whether similar standardization of medical care in other major diagnostic categories may lead to improved outcomes and subsequent reduction in weekend admission mortality rates.

Another possible cause of increased weekend mortality rate is low staffing levels and reduced staffing experience during weekends. Staff who work weekends tend to have less experience and are often responsible for more patients than staff employed during weekdays. This scenario is particularly true for junior physicians and resident trainees; unfortunately, studies evaluating outcome in relation to physician staffing are few. Far more data exist that evaluate the role of nurse staffing regarding outcomes. Much of these data demonstrate worse outcomes with fewer nurses or reduced nurse staffing hours. For example, in a study from 210 adult general hospitals in Pennsylvania, the authors found that each additional patient per nurse was associated with a 7% increase in the likelihood of dying within 30 days of admission. Given these data, some researchers and policymakers have recommended mandatory staffing level legislation as a solution. However, at present, an analysis documenting an improved outcome with increased staffing levels is not available, and a determination of the role of nurse staffing regarding weekend mortality rate has not been conducted.

Our study is large and population based but it may be limited by information and misclassification bias given the administrative data used for analyses. However, our selected outcome (mortality rate), our covariates, and admission day are unlikely to be improperly abstracted from the medical record. The fact that the differences in mortality rate were identified across multiple medical diagnoses reduces the potential importance of diagnostic misclassification. However, it is possible that patients admitted during the weekend have more comorbidities or potentially more severe illnesses than those admitted during a weekday. We have adjusted for this possibility by evaluating comorbidity, but an assessment of disease severity at presentation is not possible with the available data.

In conclusion, our data reveal a significantly increased mortality rate for patients admitted during weekends across demographic groups for medical and surgical diagnoses. The consistency of the data across multiple diagnostic-related groups, patient demographics, comorbidities, and hospital characteristics indicates that a central and common factor is most likely responsible for the unfavorable outcomes. Given the comparatively similar weekend outcomes for those patients with disorders treated under the direction of standard algorithms, such as trauma and burns, our data raise serious concerns regarding the adequacy of health care during weekends for patients with many other diagnoses. An analysis of potential causative factors is needed to identify modifiable components of care. Quality improvement strategies can then be developed and implemented to standardize care across admission day.

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Author Contributions: Study concept and design: Ricciardi; acquisition of data: Ricciardi; analysis and interpretation of data: Ricciardi; drafting of the manuscript: Ricciardi; critical revision of the manuscript for important intellectual content: Ricciardi; obtained funding: Ricciardi; administrative, technical, or material support: Ricciardi; study supervision: Ricciardi.
ciardi. Acquisition of data: Ricciardi, Roberts, and Baxter. Analysis and interpretation of data: Ricciardi, Roberts, Read, Baxter, Marcello, and Schoetz. Drafting of the manuscript: Ricciardi, Roberts, Read, Baxter, Marcello, and Schoetz. Critical revision of the manuscript for important intellectual content: Ricciardi, Roberts, Read, Baxter, Marcello, and Schoetz. Statistical analysis: Ricciardi and Baxter. Administrative, technical, and material support: Ricciardi, Roberts, Read, Baxter, Marcello, and Schoetz. Study supervision: Ricciardi.

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REFERENCES


