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Original article

Impact of weekend admission on in-hospital mortality among U.S. adults, 2003–2013

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ABSTRACT

Purpose: Over the past decade, the media, politicians, practitioners, and researchers paid increasing attention to the risks involved in hospital admission at weekends. This study examined the impact of weekend admission on in-hospital mortality among U.S. adults and by sex, age, race/ethnicity, and disease category and tracked changes from 2003 to 2013.
Methods: Over 50 million hospital discharge data came from 2003 to 2013 National Inpatient Sample. Cox regressions were performed to estimate the hazard ratios of in-hospital mortality associated with weekend admission, adjusting for individual and hospital characteristics and National Inpatient Sample sampling design.
Results: Compared to weekday admissions, weekend admissions were associated with increased in-hospital morality risk by 5% among all inpatients. Young adults (2.7%) had lower incremental mortality risk than middle aged (5.3%) and older adults (5.2%). Among the 10 leading causes of death, patients hospitalized at weekends due to malignant neoplasms (12.1%), diabetes mellitus (11.7%), and heart diseases (8.2%) had the highest incremental mortality risk. The estimated weekend effects tended to be more prominent among inpatients with higher assessed mortality risk. Incremental morality attributable to weekend hospitalization decreased from 6.9% in 2003 to 2.5% in 2013.
Conclusions: Weekend admissions were associated higher in-hospital mortality, but the impact declined during 2003–2013.

Introduction

Health care systems deliver services differently during weekend days compared to weekdays [1]. Lower levels of staffing including nurses, primary care doctors and specialists, provider coverage issues, and limited availability of medical tests and procedures at weekends may compromise the quality of care and negatively impact patient outcomes [2]. In 2001, Bell and Redelmeier [3] reported elevated mortality rates for weekend relative to weekday admissions for 23 of the 100 leading causes of death in Canadian hospitals. Since then, the media, politicians, practitioners, and researchers have paid increasing attention to the risks involved in hospital admission at weekends [4]. A growing number of studies documented the "weekend effect" in several developed countries (e.g., U.S., U.K., Canada, and Spain), across inpatient and outpatient settings, and among all hospital admissions as well as within subgroups of patients [5–13].

The quality of health care in the United States tends to be improved over the past few decades [14,15], and as a result, the influence of weekend admission on patient outcomes including in-hospital mortality might change as well. To date, little is known regarding the temporal trajectory of the "weekend effect." Hospital inpatients are a highly diverse population. It is plausible that the "weekend effect" differs across sociodemographic and disease subgroups, but such population heterogeneity data remain scarce. Built upon previous literature, this study examined the impact of weekend admission on in-hospital mortality among U.S. adults and by sex, age, race/ethnicity, disease category, and assessed mortality risk and tracked changes from 2003 to 2013.

Methods

Study sample

Hospitalization data came from the 2003–2013 National Inpatient Sample (NIS). Sponsored by the Agency of Healthcare Research

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and Quality (AHRQ), NIS is a nation's largest database of hospital inpatients derived from billing data submitted annually by hospitals to statewide data organizations across the United States. These inpatient data contain clinical and resource use information typically available from discharge abstracts, including patient demographic characteristics, primary and secondary diagnoses and procedures, length of stay, severity and comorbidity measures, payment source, total charges, discharge status, and hospital characteristics. NIS sampling frame covers 97% of the U.S. population and nearly the entire universe of discharges. Detailed information on NIS can be found on its website (https://www.hcup-us.ahrq.gov/nisoverview.jsp).

NIS tracks hospital discharges rather than unique patients, so that the same patient with multiple hospitalizations in a year is potentially sampled more than once. Therefore, the unit of analysis in this study was discharge. Over the period of 2003–2013, a total of 71,004,360 discharges were recorded in NIS pertaining to adult inpatients aged 18 years and above. Among these discharges, over a quarter (27.1%) were elective, that is, a doctor requested a bed be reserved for a patient on a specific day. Removing those elective discharges resulted in 51,762,178 nonelective discharges, which served as the study sample. The study sample contained 18.7% of missing values resulted from nonreporting of patients' race/ethnicity by some hospitals and states. We constructed a dummy variable for unreported race/ethnicity so that the regressions could be performed over the entire sample. In a sensitivity analysis, we excluded the proportion of data with missing values for race/ethnicity. The estimated impact of weekend admission on in-hospital mortality remains fairly comparable as the one based on the entire sample incorporating the missing values. Therefore, we reported the modeling results based on the entire sample.

We chose to include data from NIS 2003 and onward because inpatient severity and comorbidity measures were only available from NIS 2002 and onward, and multiple inpatient characteristics such as residential ZIP Code's median household income and urbanicity were unavailable or inconsistent in NIS 2002.

Weekend versus weekday admissions

NIS defined weekend admissions as those occurring between 12:01 AM Saturday through 11:59 PM on Sunday and considered all other admissions as weekday admissions (including national holidays that occurred at weekdays). We constructed a dichotomous variable for weekend admissions (with weekday admissions in the reference group).

Inpatient characteristics

The following inpatient characteristics were controlled for in the regression analysis: a dichotomous variable for sex (men, with women in the reference group); two continuous variables for age in years and age squared (to account for potential nonlinear relationship between age and in-hospital mortality); five categorical variables for race/ethnicity (blacks, Hispanics, Asian or Pacific Islanders, other race/ethnicity, and nonreport of race/ethnicity, with whites in the reference group); five categorical variables for payer type (Medicaid, private insurance, self-pay, no charge, and other payers, with Medicare in the reference group); three categorical variables for median household income in the inpatient's residential ZIP Code (second, third, and fourth quartiles of median household income, with the first/lowest quartile in the reference group); three categorical variables for urbanicity (large metropolitan areas with one million and above population, small metropolitan areas with 50,000–999,999 population, and micropolitan areas with 10,000–49,999 population, with noncore areas with less than 10,000 population in the reference group); 11 categorical variables for admission month (February–December, with January in the reference group); three categorical variables for assessed severity level based on refined diagnosis-related groups (DRGs) (moderate, major, and extreme loss of function, with minor loss of function including cases with no comorbidity/complications in the reference group); three categorical variables for assessed mortality risk based on refined DRGs (moderate, major, and extreme likelihood of dying, with minor likelihood of dying in the reference group); 24 categorical variables for major disease categories based on principle diagnosis (excluding diseases/disorders of newborn and other neonates in perinatal period); and 29 categorical variables for each of the following AHRQ comorbidity measures—acquired immune deficiency syndrome, alcohol abuse, deficiency anemias, rheumatoid arthritis/collagen vascular diseases, chronic blood loss anemia, congestive heart failure, chronic pulmonary disease, coagulopathy, depression, diabetes mellitus, diabetes mellitus with chronic complications, drug abuse, hypertension, hypothyroidism, liver disease, lymphoma, fluid and electrolyte disorders, metastatic cancer, other neurologic disorders, obesity, paralysis, peripheral vascular disorders, psychoses, pulmonary circulation disorders, renal failure, solid tumor without metastasis, peptic ulcer disease excluding bleeding, valvular disease, and weight loss.

Hospital characteristics

The following hospital characteristics were controlled for in regression analysis: two continuous variables for annual total discharges and discharges squared (to account for potential nonlinear relationship between number of hospital discharges and in-hospital mortality); two categorical variables for bed size (medium and large bed size classified by NIS, with small bed size in the reference group); two categorical variables for teaching status (urban nonteaching and urban teaching hospitals, with rural hospitals in the reference group); and three categorical variables for location (Midwest, South, and West, with Northeast in the reference group).

Statistical analysis

Weekend admission rate, length of stay, in-hospital mortality, and inpatient and hospital characteristics were summarized in descriptive statistics. Kaplan–Meier estimator was used to estimate the unadjusted survival function stratified by weekend/weekday admission. Cox proportional hazards regressions were performed to estimate the hazard ratios of in-hospital mortality associated with weekend admission, adjusting for individual and hospital characteristics and accounting for the NIS sampling design.

In subgroup analysis, Kaplan–Meier estimator and regression analysis were performed on subsamples stratified by sex (men and women); age group (young adults 18–44 years of age, middle-aged adults 45–64 years of age and above, and older adults 65 years of age and above); race/ethnicity (whites, blacks, Hispanics, and Asians or Pacific Islanders); assessed morality risk (minor, moderate, major, and extreme likelihood of dying); and disease category. The disease categories comprise 10 leading causes of death according to the *2013 National Vital Statistics Reports* [16], including diseases of heart (ICD-9 codes: 390–398, 402, 404, 410–429); malignant neoplasms (ICD-9 codes: 140–208); chronic lower respiratory diseases (ICD-9 codes: 490–494, 496); accidents (unintentional injuries) (ICD-9 codes: E800–E869, E880–E929); cerebrovascular diseases (ICD-9 codes: 430–434, 436–438); Alzheimer's disease (ICD-9 code: 331.0); diabetes mellitus (ICD-9 code: 250); influenza and pneumonia (ICD-9 codes: 480–487); nephritis, nephrotic syndrome and nephrosis (ICD-9 codes: 580–589); and intentional self-harm (suicide) (ICD-9 codes: E950–E959). Disease categories were classified based on the ICD-9 codes of a patient's primary diagnosis.