International Journal of Cardiology 210 (2016) 164–172

Contents lists available at ScienceDirect

International Journal of Cardiology

journal homepage: www.elsevier.com/locate/ijcard

Changes in mortality on weekend versus weekday admissions for Acute Coronary Syndrome in the United States over the past decade

Mahdi Khoshchehreh [a,b], Elliott M. Groves [c], David Tehrani [a], Alpesh Amin [d], Pranav M. Patel [a,d], Shaista Malik [a,d,*]

[a] Division of Cardiology, University of California, Irvine, USA
[b] Department of Preventive Medicine, Division of Biostatistics, Keck School of Medicine, University of Southern California, USA
[c] Scripps Clinic, Division of Interventional Cardiology, La Jolla, CA, USA
[d] Department of Internal Medicine, University of California, Irvine, USA

ARTICLE INFO

Article history:
Received 16 September 2015
Received in revised form 11 February 2016
Accepted 14 February 2016
Available online 17 February 2016

Keywords:
In-hospital mortality
Acute Coronary Syndrome
NSTE-ACS
STEMI
Weekend effect

ABSTRACT

Background: We assessed in-hospital mortality and utilization of invasive cardiac procedures following Acute Coronary Syndrome (ACS) admissions on the weekend versus weekdays over the past decade in the United States.

Methods: We used data from the Nationwide Inpatient Survey (2001–2011) to examine differences in all-cause in-hospital mortality between patients with a principal diagnosis of ACS admitted on a weekend versus a weekday. Adjusted and hierarchical logistic regression model analysis was then used to identify if weekend admission was associated with a decreased utilization of procedural interventions and increased subsequent complications as well.

Results: 13,988,772 ACS admissions were identified. Adjusted mortality was higher for weekend admissions for Non-ST-Elevation Acute Coronary Syndromes [OR: 1.15, 95% CI, 1.14–1.16] and only somewhat higher for ST-Elevation Myocardial Infarction [OR: 1.03; 95% CI, 1.01–1.04]. Additionally, patients were significantly less likely to receive coronary revascularization intervention/therapy on their first day of admission [OR: 0.97, 95% CI: 0.96–0.98 and OR: 0.75, 95% CI: 0.75–0.75 for STEMI and NSTE-ACS respectively]. For ACS patients admitted during the weekend who underwent procedural interventions, in-hospital mortality and complications were higher as compared to patients undergoing the same procedures on weekdays.

Conclusion: For ACS patients, weekend admission is associated with higher mortality and lower utilization of invasive cardiac procedures, and those who did undergo these interventions had higher rates of mortality and complications than their weekday counterparts. This data leads to the possible conclusion that access to diagnostic/interventional procedures may be contingent upon the day of admission, which may impact mortality.

1. Introduction

Acute Coronary Syndrome (ACS) accounts for approximately 1.4 million hospital admissions per year in the United States [1]. With an annual incidence of approximately six cases per every 10,000 persons [2], ACS represents a common medical emergency that has shown marked improvement in morbidity and mortality when diagnostic procedures as well as percutaneous or thrombolytic therapies are initiated within an appropriate timeframe. Studies have consistently shown that timeliness of revascularization through percutaneous coronary intervention (PCI) and fibrinolytic therapy in the absence of contraindications and when PCI is not available, are the major prognostic factors in improving patient survival in ST-Elevation myocardial infarction (STEMI) [3–6]. Current guidelines dictate no more than a 90-minute window for the door-to-balloon time interval [6]. For this reason, patients with clinical suspicion of ACS are rapidly assessed to determine if they are suffering from acute ischemia. While STEMI patients have been clearly shown to benefit from early revascularization, patients with Non-ST-Elevation Acute Coronary Syndromes (NSTE-ACS) also derive a benefit. The current American College of Cardiology/American Heart Association (ACC/AHA) guidelines for the treatment of NSTE-ACS endorse an early invasive approach, given the clinical benefit [7].

Although many hospitals provide emergency care on weekends, studies have shown that the level of expertise is reduced, and health care staffs are significantly less accessible during weekends [8]. Consequently, patients presenting with time-sensitive medical emergencies such as intracerebral hemorrhage, ruptured aortic aneurysm and acutely decompensated heart failure on the weekend have shown increased mortality and poor outcomes [9–11]. Similarly, patients with acute

* Corresponding author at: Division of Cardiology, Department of Medicine, University of California Irvine Medical Center, 333 City Boulevard West, Suite 400, Orange, CA 92868-3298, USA.
E-mail address: smalik@uci.edu (S. Malik).

http://dx.doi.org/10.1016/j.ijcard.2016.02.087
0167-5273/

myocardial infarction (MI) admitted during off-hours have been shown to have an increase in mortality, in addition to less usage of and increased time to invasive cardiac procedures [12,13]. However, previous studies have been limited by either only including those suffering from ST-Elevation Myocardial Infarction (STEMI), a single component of ACS, or they have been limited by using a restricted regional cohort, such as data from a single state [14]. While the underlying cause of ACS dictates the appropriate intervention, and its timing, it is likely that those patients who present with ACS requiring revascularization are likely to have worse outcomes when admitted during the weekend, compared to those admitted during the weekdays.

In order to quantify the potential differences in admission timing outcomes, a direct comparison between patients admitted from Monday to Friday with those admitted on the weekend is necessary. Here eleven-year data abstracted from the 2001–2011 Nationwide Inpatient Sample (NIS) was used in order to compare outcomes of those admitted with a principal diagnosis of STEMI or NSTE-ACS on the weekends and weekdays. Additionally, the rates of procedural usage were compared, as were procedural complication rates.

2. Methods

2.1. Data sources

We conducted a retrospective cohort study using the eleven-year data from Agency for Healthcare Research and Quality Healthcare Cost and Utilization Project National Inpatient Sample (NIS) database. NIS is the largest publicly available all-payer inpatient care database, including discharge codes from more than 1000 hospitals in 44 states. The NIS database was designed as a stratified, 20% representative sample of all nonfederal US hospitals, and is regularly used to identify national trends in healthcare utilization, charges, quality and outcomes.

Each hospitalization record includes patient-level characteristics such as discharge status, demographic information, length of stay, primary payer status, and clinical data coded using International Classification of Disease, Ninth Revision (ICD-9) diagnosis and procedure codes. The NIS database sample has been validated using Medicare inpatient claims for percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG) [15]. Additionally, this database includes hospital-level characteristics such as the number of hospitals beds and hospital location as abstracted from the AHA Annual Survey of Hospitals. Similarly, NIS classifies hospitals with teaching affiliation if the hospitals are either accredited through the Accreditation Council for a Graduate Medical Education-approved residency program, are a member of the Council of Teaching Hospitals, or have a ratio of full-time equivalent interns and residents to beds of ≥0.25%.

2.2. Study population

We included all patients aged ≥18 who were hospitalized with a primary diagnosis code of ACS (ICD-9 code 410, 411, and 413). The positive predictive value of ICD-9 codes for ACS has been validated in prior studies [16–18]. We limited the patient population to those with less than 7-day hospital stays, as patients with longer length of stays tend to have other complications and comorbidities not related to ACS. Lengthier hospital stays have been linked with less evidence-based care [19,20]. Additionally, hospitals without the capability to perform ACS related procedures (e.g. Diagnostic Angiography, PCI, CABG) were excluded from the study. Finally, patients transferred to the hospital from a different acute care hospital, or from another type of health facility were also excluded, as this would in most cases delay the time to procedural intervention.

The patients were additionally stratified by the classification of their ACS. STEMI and NSTE-ACS were separated in order to examine the differences between both groups. This distinction is important, as while STEMI patients should be, and are typically treated with urgent revascularization, the early invasive strategy has been less adopted in the treatment of NSTE-ACS [6,7].

2.3. Independent variables of interest

As in previous studies, weekend admissions were defined as those occurring between 12:00 AM Saturday and 11:59 PM Sunday [9,21]. All other admissions were considered to be weekday admissions. This is the definition used by NIS and cannot be modified. For those patients included in the study, their patient-level demographics (age, gender and race), primary payer status, and individual comorbid conditions were identified.

The agency for healthcare research and quality Elixhauser adjustment scheme was used for the presence of 29 chronic comorbidities, including cardiovascular risk factors such as hyperlipidemia and hypertension, which are likely to have been present on admission and have been associated with increased in-hospital mortality [22,23]. Additionally, we used All Patient refined Diagnosis Related Groups (APR-DRG) severity measure developed by 3 M Health Information symptoms, as well as the number of chronic conditions, to identify if ACS patients admitted during the weekend were at a higher risk for mortality compared to those admitted during the weekdays.

3 M developed APR-DRG methodology to allow large cohort analyses of outcomes for a given diagnostic group [24]. The APR-DRG scores use primary and secondary diagnosis, age, and preexisting medical conditions from discharge billing codes to rank the risk of mortality as low, medium, high, and extreme. This scoring system designed to specifically exclude codes reflecting in-hospital complications.

A chronic condition in NIS dataset is defined as a condition that lasts 12 months or longer and meets one or both of the following: (a) it places limitations on self-care, independent living, and social interactions; (b) it results in the need, for ongoing intervention with medical products, services, and special equipment [23]. Finally, we identified hospital characteristics, which included hospital bed-size (small, medium, or large) as assessed by the number of short-term acute-care beds, hospital location (rural or urban) and teaching affiliation.

2.4. Outcomes

The primary outcome of this study was in-hospital mortality among ACS patients admitted during the weekend as compared to the weekdays. Furthermore, differences in procedural usage and length of stay (LOS) between weekday and weekend ACS admissions were investigated. Finally, the differential usage of coronary revascularization intervention/therapy (Coronary angiography/PCI, thrombolytic therapy, and CABG) in ACS during weekday versus weekend admissions was evaluated, along with the effects on in-hospital mortality and major procedural complications (ICD-9 defined vascular, neurological, and mechanical complications; Appendix 1).

2.5. Statistical analysis

For ACS patients admitted during the weekend and the weekdays, the admissions were compared based upon patient demographics, primary payer status, comorbidities, and previously identified hospital-level characteristics using chi-square tests for categorical variables and a two-sample t-test for continuous variables. Univariate logistic regression analysis was used to compare the mortality rates between weekend and weekday admissions. A separate multivariate logistic model was conducted based on adjustments for patient demographics, primary payer status, Elixhauser comorbidities, hospital bed-size, hospital location, and hospital teaching affiliation. Variables were additionally tested for mutlicollinearity through the use of two-way interaction terms. Interaction terms that were significant at $p < 0.05$ have been included in the final model. The hospital ID was then added as random