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Effect of weekend admission for acute myocardial infarction on in-hospital mortality: A retrospective cohort study

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ABSTRACT

Background: No previous nationwide study has examined whether there is a 'weekend effect' of higher mortality after admission for acute myocardial infarction (AMI) when percutaneous coronary intervention (PCI) is easily accessible.

Methods: Using the Diagnosis Procedure Combination inpatient database in Japan, we identified AMI patients aged ≥20 years who were admitted to acute care hospitals between July 1, 2010 and March 31, 2013. Multivariable regression models fitted with generalized estimating equations were used to determine the association between weekend admission and in-hospital mortality. Eligible patients were also classified into subgroups according to Killip class at admission.

Results: Of 111,200 eligible patients, 30,847 patients were admitted on weekends and 80,353 patients on weekdays. Overall, the in-hospital mortality was significantly higher for weekend admission than for weekday admission (13.6% *versus* 11.4%; $P < 0.001$; unadjusted odds ratio [OR] 1.222; 95% confidence interval [CI] 1.172 to 1.274), despite the higher rate of PCI performed on the day of admission (68.9% *versus* 64.8%; $P < 0.001$). The association remained significant after adjusting for baseline characteristics, invasive procedures, and medications (adjusted OR 1.144, 95% CI 1.079 to 1.214). In subgroup analyses, the effect of weekend admission remained significant in the Killip II to IV subgroups, but became insignificant in the Killip I subgroup (adjusted OR 1.002, 95% CI 0.828 to 1.213).

Conclusions: This study showed that weekend admission for AMI was significantly associated with higher in-hospital mortality even in a setting where PCI was highly available.

1. Introduction

A 'weekend effect' of hospital admission has been reported, whereby there is higher mortality in patients admitted on a weekend compared with admission on a weekday [1–3]. Hospitals generally provide comprehensive care on weekdays but have decreased staffing levels on weekends, with possible reductions in the quality of care [4–6]. The differences in the level of care between weekdays and weekends may cause 'weekend effect' in several diseases [1–3].

The management of acute myocardial infarction (AMI) generally requires emergency invasive cardiac procedures, such as percutaneous coronary intervention (PCI) [7,8], which are often less available during off-hours (weekends and nights) than during regular hours because of limited staff availability [4,5,9]. The effect of off-hour admission for AMI on mortality has been controversial because previous studies have shown inconsistent results [1,3–5,9–15]. Recently, a study using data from an administrative database in New Jersey reported that 30-day mortality for AMI was higher in patients admitted on weekends than on weekdays [10]. On the other hand, a study from an American Heart Association database reported no significant difference in in-hospital mortality between off-hour and regular hour admissions for AMI [9]. Most recently, a meta-analysis of 48 related studies suggested that patients with AMI admitted during off-hours had higher short-term mortality, and patients with ST-elevation myocardial infarction (STEMI) had longer door-to-balloon times [16]. Off-hour admission for AMI, therefore, could affect the performance of invasive procedures and short-term mortality. In studies from Western countries, however,

Abbreviations: DPC, Diagnosis Procedure Combination.

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less than 50% of patients with AMI and less than 60% of patients with STEMI underwent PCI during hospitalization [4,5,9–12].

In the above-mentioned study from New Jersey, the difference in 30-day mortality between weekend and weekday admissions became insignificant after adjustment for invasive cardiac procedures [10]. Thus, the higher mortality for weekend admissions could partially be a result of the decreased availability of PCI [4,10]. In Japan, many hospitals are equipped to perform PCI [17–19], and previous studies revealed that the proportion of patients undergoing primary PCI for AMI was much higher in Japan (75–97%) than in Western countries (6–60%) [4–6,9–12,14,19,20]. It remains unclear whether weekend admission for AMI is associated with higher mortality when there are many hospitals equipped to perform PCI.

It also remains unknown whether the effect of weekend admission for AMI is different according to the severity of AMI at admission. To our knowledge, no study has examined the effect of weekend admission in patients with different severities of AMI. The Killip classification is a classical but still useful predictor of short-term mortality in patients with AMI [21–23]. A higher Killip class is associated with a greater need for mechanical circulatory support such as intra-aortic balloon pumping (IABP) and extracorporeal membrane oxygenation (ECMO), which require high staff input for prompt administration in the acute phase.

The present study therefore had two objectives: to determine whether weekend admission for AMI was associated with higher in-hospital mortality compared with weekday admission in a nationwide setting in Japan, where PCI is easily accessible; and to assess whether the effect of weekend admission for AMI was different according to the Killip class at admission.

2. Methods

2.1. Data source

Data for this study were extracted from the Diagnosis Procedure Combination (DPC) database in Japan, which includes hospital administrative claims data and discharge abstracts, and is described in detail elsewhere [24]. Since July 1, 2010, data have been continuously collected by the DPC Study Group, and in 2012 the database included data of approximately 7 million inpatients from over 1000 hospitals, representing approximately 50% of all inpatient admissions during the year to acute care hospitals in Japan. Attending physicians are obliged to record all discharge abstract data for each patient. Anonymized patient data are sent to the study group by the hospitals each month. The requirement for informed consent was waived because of the anonymous nature of the data. The Institutional Review Board at The University of Tokyo approved the present study.

The DPC database includes the following data: unique identifiers of hospitals; patient age and sex; diagnoses at admission, comorbidities at admission, and complications after admission recorded with text data in the Japanese language and the International Classification of Diseases, Tenth Revision (ICD-10) codes; Killip class at admission; surgical and non-surgical procedures; drugs and devices used; length of stay; dead or alive within the first 24 h after admission; and discharge status. This database partially corresponds to the National Inpatient Sample in the United States [25], but has several unique advantages. First, in the DPC database, comorbidities already present at admission are clearly distinguished from complications that occur after admission. Second, the database contains data about not only the types of therapeutic approaches (drugs, devices, and procedures), but also the dates of starting and ending each treatment during hospitalization. The attending physicians are obliged to record the diagnoses with reference to the medical charts to optimize the accuracy of the recorded diagnoses. At discharge, diagnoses and comorbidities are registered in the database once per admission. Physicians and hospitals have a strong incentive for data compliance because it is mandatory to obtain DPC-based reimbursement of medical fees.

2.2. Study population

We identified adult patients aged ≥20 years who were admitted with AMI (ICD10 code I21.x) and were discharged between July 1, 2010 and March 31, 2013. We excluded patients who were discharged alive on the day of admission because they were transferred to another hospital for treatment. The eligible patients were stratified according to admission on a weekday or weekend. In this study, weekdays included Monday through Friday, while weekends included Saturday, Sunday, Japanese statutory holidays, and New Year (from December 29 to January 3).

2.3. Baseline variables

As covariates, we included age, sex, ambulance use, Killip class at admission, comorbidities at admission, type of hospital (academic or non-academic), and hospital volume. For Killip class in the DPC database, attending physicians could record an 'unclassified class' if they could not choose any specific class (I to IV). We identified comorbidities at admission using ICD-10 codes based on the Ontario AMI mortality predictive rule, which was validated for predicting death within 30 days and 1 year after AMI [26,27]. We defined hospital volume as the annual number of AMI patients admitted to each hospital, and categorized it into quartiles with approximately equal numbers of patients in each group.

We also identified invasive procedures and medications as potential confounding factors. Reperfusion therapies included PCI and fibrinolytic therapy; revascularization procedures included PCI and coronary artery bypass graft; mechanical support included IABP, ECMO, mechanical ventilation, and renal replacement therapy; and medications included aspirin, thienopyridinic derivatives (clopidogrel or ticlopidine), renin-angiotensin system inhibitors (angiotensin converting enzyme-inhibitors [ACE-I] or angiotensin II receptor blockers [ARB]), β-blockers, and hydroxymethylglutaryl-CoA reductase inhibitors (statins).

2.4. Outcome measures

The primary outcome was in-hospital mortality. The secondary outcomes were mortality within the first 24 h after admission, 7-day mortality, and 30-day mortality.

2.5. Statistical analyses

Categorical variables are presented as numbers and proportions. Continuous variables are presented as mean and standard deviation if they followed a normal distribution, or otherwise as median and interquartile range (IQR). The chi-square test was used to compare proportions in baseline characteristics, invasive procedures, and drugs between weekend and weekday admissions. We used the Fisher exact test to compare mortality rates. When comparing continuous variable data, we used the Student *t*-test for normally distributed data, and the non-parametric Mann–Whitney *U* test for skewed data.

In the DPC database, data are derived from multiple hospitals and are structured by two strata (patients and hospitals). We therefore accounted for clustering within hospitals using generalized estimating equations [28]. Instead of using basic regression models, we used generalized estimating equations with a unique hospital identifier as a subject variable because the outcomes of patients with AMI in the same hospital would be correlated. An adjusted model for outcomes was created using the following measured variables as covariates: baseline characteristics; reperfusion therapies on the day of admission; mechanical support on the day of admission; revascularization procedures during hospitalization; and drugs administered during hospitalization. The odds ratios (ORs) and 95% confidence intervals (CIs) were determined. The model included reperfusion therapies and mechanical support performed on the day of admission as covariates, because the therapies would have potential to modulate the association between weekend and weekday admissions. Furthermore, to assess whether any effect of weekend admission for AMI was different according to Killip class, patients were divided into five subgroups (Killip I to IV and unclassified) and the ORs and 95% CIs were estimated for each subgroup with multivariable adjustment.

All hypothesis tests had a two-sided significance level of 0.05. All statistical analyses were conducted using IBM SPSS Statistics, version 22 (IBM SPSS, Armonk, NY, USA).

3. Results

3.1. Study population

Among approximately 18 million inpatients in the database between July 2010 and March 2013, 111,885 patients aged ≥20 years were admitted with AMI. After exclusion of 685 patients who were discharged alive on the day of admission, there were 111,200 patients eligible for inclusion in the study, 30,847 admitted during weekends and 80,353 admitted during weekdays.

3.2. Patient characteristics

Table 1 shows the baseline characteristics of the study population. Fewer hospitals were available on weekends than weekdays. Patients admitted on weekends were slightly younger and more often male, tended to have higher Killip class, used an ambulance more frequently, and were treated in hospitals with higher hospital volume. Patients admitted on weekends also showed higher rates of shock, pulmonary edema, and cardiac arrhythmias, but showed lower rates of diabetes mellitus with complications, neoplasms, and chronic renal failure.

Table 2 shows invasive procedures and drugs used during hospitalization. Patients admitted on weekends were more likely to undergo coronary angiography, PCI, and mechanical support on the day of admission. They were also more likely to undergo revascularization procedures and to receive clopidogrel/ticlopidine during hospitalization.