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Patterns of inpatient care for acute myocardial infarction and 30-day, 3-month and 1-year cardiac diseases readmission rates in Spain

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ABSTRACT

Background: Acute myocardial infarction (AMI) is a common cause of hospital discharges and readmissions. Readmissions may indicate poor patient care and avoidable health expenditure, being key in quality improvement strategies. Our aim was to analyse cardiac diseases (CDs) readmissions in patients with AMI in Spain.
Methods: A retrospective analysis of 33,538 hospital discharges with AMI being the "principal diagnosis" at hospitals of the Spanish National Health System in 2012 was performed using administrative data. We developed a logistic regression model and calculated 30-day, 3-month and 1-year CDs risk-standardized readmission rates (RSRRs) using a multivariate mixed model.
Results: Variables of the model (AMI location, age, previous angina pectoris/myocardial infarction or acute coronary syndrome, chronic kidney disease, rheumatic valvular disease, diabetes mellitus, vascular disease, female sex, chronic pulmonary disease, and anemia) were able to predict 30-day, 3-month and 1-year readmission rates and RSRRs after AMI (5.4%, 9.3% and 20.2%, respectively). For RSRRs the area under the ROC curve was 0.74 ($p = 0.0037$), 0.77 ($p = 0.0041$), and 0.73 ($p = 0.0025$) for 1, 3 months and 1-year readmission rate, respectively. Angioplasty, cardiology as the medical unit responsible for the discharge and a higher volume of activity (>204 AMI) were all significantly ($p < 0.001$) associated with lower mortality, risk of development of heart failure and RSRRs.
Conclusions: Angioplasty, cardiology as the medical unit responsible for the discharge and a higher volume of activity explain variability in CDs readmission rates after AMI, which can have implications for strategies to reduce readmissions rates.

1. Introduction

A sizable number of acute myocardial infarction (AMI) patients that are discharged from hospitals are readmitted within 30 days because of various medical conditions, which in turn increases spending [1]. Since these medical readmissions may be an indicator of poor inpatient care [2] with many of these potentially being preventable, it may be worthwhile gaining further knowledge of the profile of patients who are most frequently readmitted [3]. Furthermore, current quality improvement strategies are aimed at not only improving the process of care but also measuring and improving short-term outcomes, such as readmission rates, as they are expensive for the system, risky for patients and can, to some extent, be prevented [4].

The Spanish Society of Cardiology, in collaboration with the Spanish Ministry of Health, launched the RECALCAR Study, aimed at gathering and analysing information about the processes and results of hospital assistance regarding these diseases [5].

This paper provides information based on the discharge minimum basic data set (MBDS) of Spain's National Health System (SNHS), including all SNHS hospitals, and its aim is to study the 30-day, 3-month and 1-year cardiac diseases readmission rates after an AMI by hospital

Abbreviations: AMI, acute myocardial infarction; CABG, coronary artery bypass graft; ICD-9-CM, International Classification Disease Ninth Review, Clinical Modification; MBDS, minimum basic data set; SNHS, Spain's National Health System; PCI, percutaneous coronary intervention; RSRRs, risk standardized readmission rates.

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characteristics, medical unit responsible for the care and type of treatment applied, as well as to analyse the characteristics of the patients associated to readmission.

2. Methods

2.1. Spanish national health service database

Using the MBDS of the SNHS a total of 364,148 episodes with AMI being the "principal diagnosis" (codes 410.** of ICD-9-CM, which include patients with and without ST segment elevation) have been selected out of the total number of patients discharged from hospital during the period between 2007 and 2013, codified by ICD-9-CM (International Classification Disease Ninth Review, Clinical Modification) [6]. To have at least a 1-year follow-up, 51,566 discharge episodes were selected from the 2012 data, 50,706 of which (98.3%) had a Personal Identification Code in the MBDS allowing the follow-up of hospital morbid-mortality rates of these patients. These 50,706 episodes corresponded to the 42,611 patients.

2.2. Risk adjustment of readmissions after acute myocardial infarction

To improve the consistency and quality of the data and avoid data with problems in diagnosis, patients under 35 years of age and over 94 years of age (567), intra-hospital deaths (3284), hospital admissions under than 24 h (1350), voluntary discharges (159) and transfers to different hospitals (4954) in the "index episode" (first discharge with AMI as the principal diagnosis in 2012) were excluded [7]. After the exclusions 33,538 patients were identified. Only readmissions related to "cardiac diseases" as the principal episode were taken into account. Cardiac diseases considered were rheumatic heart disease (ICD-9-CM codes 390–398), hypertensive heart disease (codes 401–405), ischemic heart disease (codes 410–414), diseases of pulmonary circulation (codes 415–417), other forms of heart disease (codes 420–429), and aortic aneurysm and dissection (codes 441.01, 441.1, 441.2, 444.1).

Hospital risk standardized readmission rates (RSRRs) were calculated using a multilevel model that took into account several variables (Table 1) [8]. At the patient level, it models the log-odds of hospital readmission using age, sex, selected clinical covariates, and a hospital-specific intercept [9]. The adjustment coefficients and the factors ultimately included in the model were derived from our own data. In addition to the patients' demographic and clinical variables, multilevel models of risk adjustment take into consideration a specific effect at a "hospital" level [10–12]. The RSRR is calculated as the ratio of the number of "adjusted actual" readmissions (also referred to as "predicted") to the number of "expected"" readmissions at a given hospital, multiplied by the all-hospitals unadjusted readmission rate. For each hospital, the "numerator" of the ratio is the number of readmissions predicted on the basis of the hospital's performance with its observed case mix, and the "denominator" is the number of readmissions expected on the basis of the all-hospitals performance with that hospital's case mix [9].

Table 1
Variables considered in the risk adjustment.

1. Age. Continuous variable (excluding patients younger than 35 or older than 94).
2. Gender.
3. History of angioplasty.
4. History of previous revascularization.
5. Angina/MI previous (CC 83) = CIE-9-MC: 412, 413.0, 413.1, 413.9.
6. Heart failure (CC 80).
7. Acute coronary syndromes (CC 81, 82).
8. Arrhythmias (CC 92, 93).
9. Rheumatic valvular disease (CC 86).
10. Cerebrovascular disease (CC 97–99, 103).
11. Stroke (CC 95–96).
12. Vascular disease (CC 104–106).
13. Hemiplegia, paraplegia, paralysis, disability (CC 67–69, 100–102, 177, 178).
14. Diabetes and diabetic complications (CC 15–20, 119, 120).
15. Chronic kidney disease (CC 131).
16. End stage renal disease or dialysis (CC 129, 130).
17. Other urinary diseases (CC 136).
18. Chronic lung disease (CC 108).
19. History of pneumonia (CC 111–113).
20. Asthma (CC 110).
21. Alterations of fluid, electrolytes and acid-base balance (CC 22, 23).
22. History of infection (CC 1, 3–6).
23. Metastatic cancer and acute leukemia (CC 7).
24. Cancer (CC 8–12).
25. Iron deficiency, other anemias and blood diseases (CC 47).
26. Decubitus ulcer and chronic skin ulcer (CC 148, 149).
27. Dementia and senility (CC 49, 50).
28. Caloric and protein malnutrition (CC 21).
29. Anterior MI (ICD-9-CM 410.00–410.19)
30. MI of other locations (ICD-9-CM 410.20–410.69)

Observed (non-adjusted) mortality and the development of heart failure after an index episode of AMI were calculated at 1 year.

2.3. Hospitals, services and treatment characteristics

The hospitals were classified into four groups according to their typology of cardiac unit. This classification considers the following types of hospitals: group 1, no structured cardiac unit: <1500 "cardiac disease" discharges a year, no specific coding for cardiac unit discharges or <500 cases coded for cardiology each year; group 2, structured cardiac unit without an angioplasty laboratory: >1500 cardiac disease cases a year and that encodes >500 discharges to cardiology, or that even encoding >1500 cases do not perform >200 PCI a year; group 3, structured cardiac unit with an angioplasty laboratory, but without cardiac surgery: >1500 discharges of cardiac diseases per year, encoding >500 cases to cardiology, performing >200 PCI and <50 CABG; and group 4, structured cardiac unit with a hemodynamic laboratory and cardiac surgery: >1500 discharges of cardiac disease per year, encoding >500 cases to cardiology, performing >200 PCI and >50 CABG a year.

The services responsible for the treatment were considered to be either cardiology or any other service, excluding the intensive care unit. For service responsible comparisons RSRRs were calculated separately for each patient population within each hospital.

We used ICD-9-CM diagnosis and procedure codes to identify whether patients received thrombolysis (V45s.88, 99.10) or percutaneous coronary intervention (PCI; 00.66, 36.01, 36.02, 36.05, 36.06, and 36.07). The treatments performed during the index episode considered were PCI, fibrinolysis, both (PCI and fibrinolysis), and neither PCI nor fibrinolysis.

2.4. Mathematical model

Using the multilevel regression model RSRRs were calculated and the relationship of these rates were analysed against the hospital typology, hospital volume (number of AMIs discharged in a year), medical service responsible for discharge and the type of treatment used. Observed mortality and development of heart failure at one year after the index episode were also measured. Categorical variables were expressed by n (%). Quantitative variables were expressed as mean and standard deviation, comparisons of categorical variables were performed by the χ^2 test and comparisons of quantitative variables were performed by the ANOVA test, correcting by employing the Bonferroni test.

To discriminate between high and low volume centres a K means clustering algorithm was used, excluding hospitals with <17 cases of AMI admissions per year (79 exclusions), with the aim of obtaining the maximal intragroup and the minimal intergroup density. The mathematical model was developed with 2/3 of the dataset and validated with the remaining 1/3.

Statistical significance was defined as a p value < 0.05 for all the contrasts studied. Analyses were performed using STATA 13.0.

3. Results

3.1. Patients

Characteristics of the 33,538 patients included are displayed in Table 2

3.2. Outcomes. Readmissions, mortality rates and heart failure

Readmission rates were 5.4% at 30 days, 9.3% at 3 months and 20.2% at 1 year. At 1 year, the mortality for cardiac diseases after being discharged alive for an AMI was 2% and the presence of heart failure was 26.7%. The main causes of readmission are shown in Table 3

Observed (non-adjusted) mortality at 1 year for cardiac diseases was associated with the same variables of readmissions, and significant differences in mortality rates were noted between hospitals 1 (3.2%) and 3 and 4, (1.8%); p < 0.001) type of medical service (1.6% vs. 3.7%, for cardiology and other medical service respectively; p < 0.001); and between PCI (1%) or PCI plus fibrinolysis (0.01%) versus neither of them (3.9%), (p < 0.001).

A total of 2864 (26.8%) patients developed heart failure at one year after an AMI, 52.5% of these patients had a secondary diagnosis of heart failure in the index episode. Significant differences were noted in the risk of developing heart failure at 1 year between hospitals types 1 and 2 (30.3% and 31.3% respectively) versus hospitals of group 3 (24%) (p < 0.001); type of medical service (24.4% vs. 36.0%, for cardiology and other medical service respectively; p < 0.001); and kind of therapy used (37.8%, for no therapy and 20.3%, 22.1% and 17.3% for PCI, fibrinolysis or both respectively) (p < 0.001).

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