Original article

In-hospital Mortality Due to Acute Myocardial Infarction. Relevance of Type of Hospital and Care Provided. RECALCAR Study

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A B S T R A C T

Introduction and objectives: To investigate the relationship between in-hospital mortality due to acute myocardial infarction and type of hospital, discharge service, and treatment provided.
Methods: Retrospective analysis of 100 993 hospital discharges with a principal diagnosis of myocardial infarction in hospitals of the Spanish National Health Service. In-hospital mortality was adjusted for risk following the models of the Institute for Clinical Evaluative Sciences (Canada) and the Centers for Medicare & Medicaid Services (United States).
Results: Hospital characteristics are relevant to explain the variation in the individual probability of dying from myocardial infarction (median odds ratio: 1.3561). The risk-adjusted in-hospital mortality in cluster 3 and especially in cluster 4 hospitals (500 beds to 1000 beds and medium-high complexity) was significantly lower than in hospitals with less than 200 beds. Cluster 5 (more than 1000 beds), which includes a diverse group of hospitals, had a higher mortality rate than clusters 3 and 4. The adjusted mortality in the groups with the best and worst outcomes was 6.74% (cluster 4) and 8.49% (cluster 1), respectively. Mortality was also lower when the cardiology unit was responsible for the discharge or when angioplasty had been performed.
Conclusions: The typology of the hospital, treatment in a cardiology unit, and percutaneous coronary intervention are significantly associated with the survival of a patient hospitalized for myocardial infarction. We recommend that the Spanish National Health Service establish health care networks that favor percutaneous coronary intervention and the participation of cardiology units in the management of patients with acute myocardial infarction.

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Mortalidad intrahospitalaria por infarto agudo de miocardio. Relevancia del tipo de hospital y la atención dispensada. Estudio RECALCAR

R E S U M E N

Introducción y objetivos: Investigar la relación entre mortalidad intrahospitalaria por infarto agudo de miocardio y tipología del hospital, servicio de alta y tratamiento dispensado.
Métodos: Análisis retrospectivo de 100.993 altas por infarto en los hospitales del Sistema Nacional de Salud. La mortalidad se ajustó por riesgo utilizando los modelos del *Institute of Clinical Evaluative Sciences* (Canadá) y de los *Centers for Medicare & Medicaid Services* (Estados Unidos).
Resultados: Las características de los hospitales son relevantes para explicar la variación de la probabilidad individual de morir por infarto (*odds ratio* mediana = 1,3561). La mortalidad intrahospitalaria ajustada por riesgo fue significativamente menor en los hospitales de los *clusters* 3 y 4 (500 a 1.000 camas y complejidad mediana-alta) que en hospitales de menos de 200 camas. El *cluster* 5 (más de 1.000 camas), que es muy heterogéneo, tenía mayor mortalidad que los *clusters* 3 y 4. Las diferencias de la mortalidad ajustada entre el grupo con mejores y peores resultados fueron del 6,74% (*cluster* 4) y el 8,49% (*cluster* 1) (p < 0,001). La mortalidad también fue menor cuando el servicio de cardiología se encargó del alta, así como cuando se practicó angioplastia.
Conclusiones: Las características del hospital, ser atendido por un servicio de cardiología y el intervencionismo coronario se asocian con la supervivencia intrahospitalaria del paciente con infarto.

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Abbreviations

AMI: acute myocardial infarction
NHS: National Health Service
RSMR: risk-standardized mortality ratio

INTRODUCTION

In Spain and the majority of the developed countries, heart disease[1] constitutes a considerable health care burden as it is responsible for 22% of overall mortality and is the most common cause of in-hospital morbidity.[1–3] Improvements in its treatment have contributed to the increase in life expectancy, with returns on the investment made in terms of cost-effectiveness.[4] These achievements are due in large part to new therapies and management strategies and to good clinical administration practices.[5,6]

In contrast to the efforts devoted to investigating the efficacy of technological innovations,[7] the relevance of the organization and administration of clinical services to their effectiveness has warranted less attention.[8] However, the study of the outcomes in health care services is gaining in interest, especially with regard to the provision of cardiology services.[9–13]

The objective of the RECALCAR project is to investigate the relationship between organizational and administrative aspects of the cardiology units of the Spanish National Health Service (NHS) and patient outcomes. Among other activities, RECALCAR has analyzed the episodes of discharges from NHS hospitals recorded in the minimum basic data set in 2009-2010. In this article, we report the results obtained from the use of the minimum basic data set concerning the relationship between the characteristics of the hospital, the care provided (clinical services and procedures), and the in-hospital mortality due to acute myocardial infarction (AMI).

METHODS

For a more detailed description of the methodology used, the reader can consult the supplementary material.

Spanish National Health Service Databases

Of all the discharges from Spanish NHS hospitals corresponding to 2009-2010, included in the minimum basic data set and coded according to the ICD-9-CM (International Classification of Diseases, Ninth Revision, Clinical Modification),[14] we selected the 100 993 episodes in which the "principal diagnosis" was AMI (codes 410.*1 of the ICD-9-CM, which include AMI with and without persistent ST segment elevation, with the exception of postindex care episodes).

Risk-adjustment of In-hospital Mortality Due to Acute Myocardial Infarction

To improve data consistency and eliminate entries with problems in terms of the quality of the diagnosis,[15,16] we excluded patients under 35 years or over 94 years of age, those whose stay was less than 1 day, and those treated in hospitals with fewer than 25 episodes a year (1319, 3445, and 1061 cases, respectively). This resulted in a sample of 95 177 episodes, with a crude in-hospital mortality rate of 7.26%.

The in-hospital mortality has been adjusted for risk, according to the model published[15] by the Institute for Clinical Evaluative Sciences (ICES) of Ontario, Canada, in 1999, using SPSS 15.0 and considering the risk factors described in Table 1. The adjustment coefficients and the factors ultimately included in the model were derived from our own data and were used to estimate the expected mortality and to calculate the risk-adjusted in-hospital mortality ratio as the ratio of observed to expected mortality. However, the actual probability of a patient dying is considered to be a combination of his or her individual risk factors (case history) and the quality of the care provided (hospital-specific functionality).[17–19] In addition to the patients' demographic and clinical variables, hierarchical models of risk adjustment (multilevel models)[20–22] take into consideration a specific effect at the "hospital" level. Applying this approach, we applied a multilevel logistic regression model using MLwiN 2.25 and the same variables as the 1999 ICES model.

Using the multilevel model, the in-hospital mortality ratio (risk-standardized mortality ratio [RSMR]) was calculated as the ratio of the predicted mortality (which considers, on an individual basis, the functionality of the hospital in which the patient is being treated) to the expected mortality (which considers a standard functionality according to the average of all the hospitals), multiplied by the crude mortality rate.[18,23] Thus, if the RSMR of a hospital is higher than the crude mortality rate, the probability of a patient dying in that hospital is greater than the average of the hospitals considered.

The results obtained show high correlation between the different estimations of mortality: expected (ICES, 1999), predicted (multilevel), and expected (multilevel), with Pearson correlation coefficients between 0.990 and 1 ($P<.01$) (Fig. 1), as well as good fit and discrimination, both in the ICES model of 1999 (Table 2) and with the multilevel model (Table 3), although the results are better with the latter.

The weights of the adjustment variables are nearly the same in both models and similar to those of the adjustment model used as a reference.[15] The variable with the greatest weight as a predictor of mortality is the presence of shock, followed by others related to heart failure (acute pulmonary edema, acute renal failure). In contrast to the reference model, "chronic renal failure" is not significant in terms of the adjustment.

The estimation according to the multilevel model indicates that approximately 3% of the total variance is explained by the differences between hospitals (intrahospital correlation coefficient=0.0301) and that the characteristics of the hospitals in which the patients are being treated help to explain the variation in the individual probability of dying from AMI (median odds ratio=1.3561).

Analysis of Risk-adjusted In-hospital Mortality Due to Acute Myocardial Infarction

We studied the existence of statistically significant differences between the means of the RSMR, which resulted in a better fit than the risk-adjusted mortality ratio, corresponding to the following