Risk Factors and Trends in Incidence of Heart Failure Following Acute Myocardial Infarction

Jennifer Wellings, MD, John B. Kostis, MD*, Davit Sargsyan, MS, Javier Cabrera, PhD, and William J. Kostis, PhD, MD for the Myocardial Infarction Data Acquisition System (MIDAS 31) Study Group

Patients who develop heart failure (HF) after an acute myocardial infarction (AMI) are at higher risk of adverse fatal and nonfatal outcomes. Published studies on the incidence and associations of HF after infarction have been contradictory, with some reporting increasing and others decreasing incidence. Between 2000 and 2015, 109,717 patients admitted for a first AMI in New Jersey were discharged alive. In the 15 years from 2000 to 2015, the rates of admission for HF in AMI patients who were discharged alive decreased by 60%, from 3.48% to 1.4%, at 1-year follow-up. At 5 years of follow-up, the decline was more pronounced, from 7.21% to 1.4%, an 80% decline. All-cause death, and the combined end point of admission for HF or death, showed decreasing trends. Cox regression indicated a decrease in the risk of admission for HF over time (hazard ratio [HR] 0.955, 95% confidence interval [CI] 0.949 to 0.961). Younger age, male gender, and commercial insurance were associated with lower HRs for HF (p < 0.001), whereas history of hypertension, diabetes, kidney, or lung disease were associated with higher HRs (p < 0.001). There was no significant difference in the rate of HF between subendocardial and transmural AMI (adjusted OR was 0.96, CI 0.90 to 1.03, p = 0.241). Revascularization was associated with a marked decrease in HF admissions (adjusted OR 0.22, 95% CI 0.19 to 0.25, p < 0.001 for percutaneous coronary intervention and OR 0.44, 95% CI 0.38 to 0.51, p < 0.001 for CABG). In conclusion, the rate of admission for HF after discharge for a first myocardial infarction as well as all-cause death decreased markedly from 2000 to 2015. © 2018 Elsevier Inc. All rights reserved. (Am J Cardiol 2018;122:1–5)

Acute myocardial infarction (AMI) remains one of the leading causes of death in the United States.1–3 Treatment advancements have resulted in a decrease in mortality following AMI, but heart failure (HF) remains a significant complication.4–6 Patients with HF after AMI are at higher risk of adverse outcomes including recurrent AMI, longer hospitalization, stroke, ventricular arrhythmias, cardiac arrest, and death.4–9 Published studies on the incidence and associations of HF after infarction have been contradictory with some reporting increasing and others decreasing incidence. The purpose of the present report is to investigate the rate of developing HF in first-time AMI patients admitted to New Jersey hospitals, to evaluate co-morbid conditions associated with the development of HF, and to examine time trends of these rates from 2000 to 2015.

Methods

The Myocardial Infarction Data Acquisition System (MIDAS) is a statewide database that includes all cardiovascular disease admissions to nonfederal hospitals in New Jersey with longitudinal follow-up for up to 30 years. MIDAS contains discharge data, including the reason for admission, and up to 8 additional diagnoses derived from the New Jersey Statewide Hospital Uniform Billing System. MIDAS data are merged with the New Jersey death registration files for date of death and cause of death. Death information is validated using the National Death Index for deaths outside the state. In this retrospective study with a 5-year follow-up, we used a subset of MIDAS records for patient admissions with a first AMI, where the AMI was the reason for admission who did not have an AMI admission within 5 years before the index AMI.

Diagnoses were encoded using International Classification of Disease 9th Revision (ICD-9) billing codes. Patients older than 18 years who were admitted between the years 2000 to 2015 with codes of transmural AMI (anterior, ICD-9 410.0x, 410.1x; inferior, ICD-9 410.2x, 410.4x; lateral, ICD-9 410.3x, 410.5x; posterior, ICD-9 410.6x), subendocardial (ICD-9 410.7x), and other/unspecified (ICD-9 410.8x, 410.9x) were included in the data set. Covariates were patient demographics and co-morbidities: age (by decade), gender, first AMI discharge year, hypertension (401.xx to 405.xx), diabetes (250.xx), chronic liver disease (571.xx), chronic kidney disease (CKD, 585.xx), chronic obstructive pulmonary disease (COPD, 490.xx to 496.xx), and disorder of lipid metabolism (272.x). This subset of records for 109,717 patients was used to estimate the rate of admission for HF (ICD-9 codes 428.0, 428.20, 428.21, 428.23, 428.30, 428.31, 438.33, 428.40, 428.41, and 428.43) at 30 days, 90 days, 180 days, 1 year, and 5 years. Patients with cancer (ICD-9 codes 140.xx to

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*Corresponding author: Tel: (732) 235-7685; fax: (732) 235-7039.

E-mail address: Kostis@rwjms.rutgers.edu (J.B. Kostis).

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165.xx, 170.xx to 176.xx, and 180.xx to 239.xx) were excluded from the analysis.

Statistical analyses were performed using R version 3.4.1 software. Odds ratios (ORs) for HF admission, all-cause death, and the combined end point of HF admission or all-cause death after the first AMI discharge were estimated using generalized linear models with logit link function (logistic regression). The models estimated the OR at 30 days, 90 days, 180 days, 1 year, and 5 years, adjusted for age, gender, ethnicity, first AMI discharge year, type of insurance, and history of hypertension, diabetes, chronic liver disease, CKD, COPD, and disorder of lipid metabolism. Additionally, the Cox proportional hazard model was used to estimate hazard ratios of readmissions for HF associated with the previously mentioned risk factors.

Results

From 2000 to 2015, 109,717 patients were admitted with a first AMI in New Jersey. The mean age of patients discharged alive after a first AMI admission was 63.3 (SE 14.4). Thirty-four percent of the patients were women; about half of the patients (53.8%) had commercial insurance (including Blue Cross and HMO), and 37.3% had Medicare (Table 1).

At 1-year follow-up, the rate of admission for HF in patients discharged alive after a first AMI decreased by 60% from 3.48% in 2000 to 1.4% in 2015. The rates of admission for HF in 2000 were 0.9%, 1.9%, 2.84%, and 3.48% at 30 days, 90 days, 180 days, and 1 year, respectively. At 5 years of follow-up, the decline was more pronounced than at 1 year from 7.21% to 1.4%, an 80% versus 60% decline at 1 year. The rate of HF in patients with AMI discharged in 2015 was significantly lower, 0.67% 1.1%, 1.3%, and 1.4% at 30 days, 90 days, 180 days, and 1 year, respectively, than those discharged in 2000 (Table 2). Figure 1 displays the trend in HF admission rates in patients discharged alive after a first AMI between the years 2000 and 2015. All-cause death, as well as the combined end point of admission for HF or death, also showed a decreasing trend.

Estimates from logistic regression models adjusted for all risk factors listed earlier are presented in Figure 2. Older age, female gender, history of diabetes, Medicare (vs commercial insurance), history of hypertension, CKD, and COPD were associated with a higher risk of admission for HF or death (p <0.001) at follow-up. History of disorder of lipid metabolism showed a negative association for HF. Cox regression hazard ratios for admission for HF yielded similar to the logistic regressions (Figure 3). There was no significant difference in the rate of HF between subendocardial and transmural AMI (adjusted OR was 0.96, confidence interval [CI] 0.90 to 1.03, p = 0.241). Revascularization was associated with a marked decrease in HF admissions (adjusted OR 0.22, 95% CI 0.19 to 0.25, p <0.001 for percutaneous coronary intervention and OR 0.44, 95% CI 0.38 to 0.51, p <0.001 for CABG).

Discussion

This study shows a 60% decrease in rate of admission for HF in patients discharged alive after a first AMI from 2000 to 2015 with follow-up periods up to 1 year and 80% at 5 years. Similar declines were observed for all-cause death and for the combined end point of admission for HF or death. To our knowledge, this is the first study to report data from a statewide all-inclusive database. This study is in agreement with older studies that were not based on a defined population. These studies reported a decline in the incidence of HF ranging from 10% to 40% between 1990 and 2002. A decline in the occurrence of HF after myocardial infarction (MI) between 1979 and 1994 was observed in the Olmsted County Study. A more recent study from Denmark reported a decrease in HF incidence and mortality at 90 days after MI between 1997 and 2010 and in a study from Sweden where HF declined between 1993 and 2004. An increase in the incidence of HF after MI between 1975 and 2001, in the Worcester Heart Attack Study, was attributed to the survival of patients with more severe MIs because of new treatments.

An explanation for the decline in HF incidence after AMI may be the use of increasingly sensitive biomarkers for the diagnosis of AMI that would result in the diagnosis of smaller AMIs with a lower risk of developing HF. Improved treatment methods for AMI and HF, more frequent use of HF medications, and prompt reperfusion therapy may also have contributed to the decreasing incidence of HF. A similar effect

Table 1
Demographics of acute myocardial infarction patients

<table>
<thead>
<tr>
<th>Mean/SD; %</th>
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<tbody>
<tr>
<td>Mean Age (Years) at First AMI Admission +/- SD.</td>
</tr>
<tr>
<td>Women</td>
</tr>
<tr>
<td>Insurance (%)</td>
</tr>
<tr>
<td>Commercial</td>
</tr>
<tr>
<td>Medicaid/Self-Pay/Other</td>
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<tr>
<td>Number of AMI Patients</td>
</tr>
</tbody>
</table>

AMI = acute myocardial infarction.
was observed in the Framingham Heart Study, where a higher incidence of first AMI between 1970 and 1999 was associated with a decrease in mortality after AMI.

In the current study, the development of HF was associated with older age, female gender, history of diabetes, and history of CKD, confirming some of the co-morbidities associated with HF in previous studies. In addition, revascularization with either percutaneous coronary intervention or CABG was associated with a marked decrease in HF admissions. Patient demographics and co-morbid conditions were associated with the development of HF after AMI in previous studies, including the HORIZONS-AMI trial, where HF at 1 year was associated with diabetes, dyslipidemia, previous AMI, previous revascularization, and anterior ST-elevation MI in patients undergoing percutaneous coronary intervention. Significant predictors of HF in the Cholesterol and Recurrent Events trial were age and left ventricular ejection fraction. Additional predictors included diabetes, history of hypertension, previous MI, and baseline heart rate. Older age, anterior MI, lower systolic blood pressure, lower pulse pressure, and diabetes were predictors of HF in patients who received intravenous thrombolytic therapy in the Thrombolysis and Angioplasty in Myocardial Infarction trials. Hellermann et al identified older age, female gender, diabetes, and increased heart rate as the most consistent risk factors for the development of HF after MI.

Only a few studies examined the association of COPD, CKD, and Medicare (vs commercial insurance) with the
development of HF after AMI as was observed in our study. Patients with CKD have accelerated cardiovascular disease, experience poorer outcomes, and have a high prevalence of developing AMI and HF. Medicare insurance was also associated with increased risk of developing HF compared with commercial insurance. This interesting association may be examined on a national level to confirm the association and determine potential causes.

Interestingly, patients with disorders of lipid metabolism were found to have a negative association with developing HF in our study in contrast to the finding in the HORIZONS-AMI trial. This may, in part, be due to the protective effect of statin therapy of patients diagnosed with dyslipidemia. De Gennaro et al reported that statin therapy does not decrease all-cause death but does significantly decrease the rate of hospitalization for worsening HF.

There are several limitations to the study. MIDAS, although comprehensive and including all nonfederal admissions for AMI in New Jersey, does not provide information on smoking status, medications, the etiology of HF hospitalization, the severity of HF, hospitalization or deaths outside the state, and the influence of unknown confounders. However, this study has significant strengths because it includes all admissions in the state and all deaths were identified with a high level of accuracy.

Better understanding of risk factors for developing HF, effective and early implementation of HF therapies, and lifestyle modification will lead to improved outcomes. This statewide study indicates that the rate of admission for HF after discharge for a first AMI as well as all-cause death decreased markedly from 2000 to 2015. It is in agreement with older, smaller studies. Further exploration of trends in the incidence of HF after AMI on a national level may lead to greater understanding of the reasons behind the rate changes in HF incidence and ultimately lead to strategies to decrease morbidity and mortality from HF.

Disclosures

The authors have no conflicts of interest to disclose.


