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Thirty-Year Trends in Heart Failure in Patients Hospitalized With Acute Myocardial Infarction

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Abstract

Despite significant advances in its treatment, acute myocardial infarction (AMI) remains an important cause of heart failure (HF). Contemporary data remain lacking, however, describing long-term trends in the incidence rates, demographic and clinical profile, and outcomes of patients who develop HF as a complication of AMI. Our study sample consisted of 11,061 residents of the Worcester (MA) metropolitan area hospitalized with AMI at all greater Worcester hospitals in 15 annual study periods between 1975 and 2005. Overall, 32.4% (n=3,582) of patients with AMI developed new onset HF during their acute hospitalization. Patients who developed HF were generally older, more likely to have pre-existing cardiovascular disease, and were less likely to receive cardiac medications or undergo revascularization procedures during their hospitalization than patients who did not develop HF ($p < 0.001$). Incidence rates of HF remained relatively stable between 1975 and 1991 at 26%, but declined thereafter. Declines were also noted in the hospital and 30-day death rates among patients with acute HF ($p < 0.001$). However, patients who developed new-onset HF remained at significantly higher risk for dying during their hospitalization (21.6%) than patients who did not develop this complication (8.3%) ($p < 0.001$). Our large community-based study of patients hospitalized with AMI demonstrates that the incidence rates of, and mortality attributable to, HF have declined over the last 3 decades. In conclusion, HF remains a common and frequently fatal complication of AMI to which increased surveillance and treatment efforts should be directed.

Keywords

epidemiology; heart failure; myocardial infarction

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Introduction

In this investigation, we provide a 30-year (1975–2005) perspective into changing trends in the incidence rates of heart failure (HF), hospital treatment practices, and short-term death rates associated with HF complicating acute myocardial infarction (AMI).

Methods

The Worcester (MA) Heart Attack Study is a population-based investigation examining long-term trends in the incidence and death rates of greater Worcester (MA) (2000 census = 478,000) residents hospitalized with AMI at all metropolitan Worcester medical centers. The methods used in this study have been previously described.^{1–3} Patients with possible AMI were identified through the review of computerized hospital databases for patients with discharge diagnoses consistent with possible AMI or coronary heart disease-related rubrics. Trained study physicians and nurses individually reviewed the medical records of all geographically eligible patients in a standardized manner.¹ The diagnosis of AMI was confirmed according to pre-established criteria and a patient was included in the study if they met at least 2 of 3 pre-defined criteria. Autopsy-proven cases of AMI were included in the sample, irrespective of the other criteria. Patients with peri-operative or trauma-related AMI were not included.

Our study population consisted of 11,061 patients without a history of HF who developed a validated AMI at all hospitals in the Worcester metropolitan area during the 15 study years of 1975 (n= 680), 1978 (n=722), 1981 (n=830), 1984 (n=609), 1986 (n=642), 1988 (n=589), 1990 (n=641), 1991 (n=702), 1993 (n=772), 1995 (n=786), 1997 (n=849), 1999 (n=766), 2001 (n=947), 2003 (n=874), and 2005 (n=652).

Study physicians and nurses abstracted clinical and demographic data from the medical records of patients with confirmed AMI. Abstracted data included patient's age, sex, race, medical history, AMI order (initial vs. prior), type of AMI (Q wave vs. non-Q wave), physiologic factors (e.g., blood pressure) laboratory measures (e.g., serum total cholesterol, glucose), as well as length of hospital stay, presenting symptoms, and discharge status. Use of cardiac medications, thrombolysis, cardiac catheterization, intra-aortic balloon counterpulsation, percutaneous coronary intervention (PCI), and coronary artery bypass surgery, as well as development of important clinical complications, was determined by trained reviewers using pre-established criteria.³ Patients with a medical history of HF were excluded. New-onset HF was considered to be present if a patient was described in his/her medical record as having clinical or radiographic evidence of pulmonary edema or bilateral basilar rales with an S₃ gallop on admission or at any time during his/her hospitalization.⁴ Survival status after hospital discharge was determined through a review of hospital medical records and a search of death certificates and social security files for residents of the Worcester metropolitan area. Follow-up after discharge was obtained for more than 99% of discharged patients.

Differences in the demographic and clinical characteristics as well as in the receipt of various treatment practices among AMI patients who did and did not develop new onset HF were examined using chi-square tests for discrete variables and Student's *t* test for continuous variables. Similar methods were used to compare differences between those with HF who survived, as compared to those who did not survive, to hospital discharge. Short-term prognosis was examined in each study year and overall by calculating in-hospital and 30-day case fatality rates (CFRs) separately for patients who did, as well as for those who did not, develop HF.

Multivariate logistic regression modeling was used to evaluate the influence of potential confounding and/or mediating factors on the odds of developing HF. We examined the relation of incident HF to the following factors: age, sex, AMI type, AMI order, body mass index, history of stroke, hypertension, diabetes and angina, hospital development of complete heart block, atrial fibrillation, stroke, and cardiogenic shock, and hospital survival status. Although body mass index and estimated glomerular filtration (eGFR) rates differed between our respective comparison groups, these variables were not included in our multivariable adjusted models because information about these factors was missing in a large percentage of hospitalized patients. Multivariable logistic regression analyses were also used to assess the overall effect of HF on in-hospital and 30-day mortality, while controlling for similar potentially confounding prognostic factors.

Changes over time in the incidence rates of HF complicating AMI, as well as in-hospital and 30-day post-admission CFRs, were examined using the Mantel-Haenszel chi square test for trends. Logistic regression models, controlling for previously described covariates, were utilized to examine differences in the incidence rates of HF and short-term CFRs in those with HF during the 30-year period under study.

Results

A total of 11,061 greater Worcester residents without previously diagnosed HF were hospitalized with confirmed AMI between 1975 and 2005. The sample was elderly and predominantly Caucasian, with a high prevalence of cardiovascular risk factors (Table 1). Thirty-two percent of patients (n=3,582) experienced a first episode of HF during their hospitalization for AMI.

Patients who developed new-onset HF were on average older, more frequently female, and were more likely to have a history of prior MI, diabetes, angina, hypertension, and stroke than patients who did not develop this complication (Table 1). Patients with HF complicating AMI were also more likely to have developed atrial fibrillation, complete heart block, and cardiogenic shock during their hospitalization. Patients with HF had lower diastolic blood pressure, lower total serum cholesterol levels, lower hemoglobin levels, and a lower eGFR rate, but higher heart rates and blood glucose levels on hospital admission, than patients who did not develop HF. In contrast to patients admitted during earlier study years, patients with HF admitted in 2001, 2003, and 2005 did not differ from those who did not develop HF with respect to a history of angina, total serum cholesterol levels, body mass index, or likelihood of developing complete heart block during their index hospitalization.

Patients who developed new-onset HF were less likely to be treated with aspirin, beta-blockers, thrombolytics, and lipid-lowering agents during their hospitalization for AMI than patients who did not develop HF (p for all < 0.001; Table 2). As compared to those who did not develop HF, patients with HF complicating AMI were more likely to be prescribed calcium channel blockers and either an angiotensin-converting enzyme inhibitor or angiotensin receptor blocker during their hospitalization (p for both < 0.001). Patients with incident HF were less likely to have undergone cardiac catheterization or PCI, but were more likely to have undergone placement of an intra-aortic balloon pump (p < 0.001).

Irrespective of HF status, patients hospitalized with AMI during the 3 most recent study years were more likely to have received effective cardiac medications and were more likely to have undergone cardiac catheterization, PCI, and intra-aortic balloon placement than patients hospitalized with AMI during early study years (Table 2). The prescribing of thrombolytic medications declined during recent years in both study groups. Differences in the use of various treatment practices between patients who did and did not develop HF

during recent study years were similar to those observed over the 30-year study period, with the exception of aspirin prescription which did not differ between our 2 primary comparison groups during the most recent study years.

The incidence rates of HF complicating AMI declined significantly over the 30-year study period ($p < 0.01$). Between 1975 and 1990, the proportion of patients who developed HF remained relatively stable at approximately 35% (Table 3, Figure 1). Beginning in 1991, the incidence rates of acute HF began to decrease, reaching lows of 23.8% in 1997 and 25.8% in 2005. Compared to patients hospitalized in 1975, patients admitted between 1991 and 2005 had a lower unadjusted odds of developing HF (Table 3). Results were qualitatively similar for models adjusting for important demographic and clinical factors (Table 3).

Since declining rates of new-onset HF complicating AMI were noted contemporaneously with changes in the proportion of patients developing a Q wave or an initial AMI over time, and because these factors are known to relate to extent of myocardial injury, we examined changes over the period under study in the incidence rates of HF separately for patients with Q wave versus non-Q wave AMI and for patients with an initial versus prior AMI. The results of these analyses revealed similar trends to those noted in the overall study sample. For example, between 1975 and 1990, the proportion of patients with a Q wave MI who developed HF was 38.1% compared to 35.1% in patients with a non-Q wave AMI. Beginning in 1991, the incidence rates of HF declined in both groups reaching rates of 27.9% and 25.2%, respectively, in 2005.

Overall, 21.6% of patients with AMI who developed HF died during their acute hospitalization compared to 8.3% of those who did not develop this complication ($p < 0.001$). In multivariate models adjusting for previously described demographic, medical history, and clinical factors known to be associated with increased mortality from AMI (Figure 2), development of HF was associated with a two-fold higher odds (OR = 1.99, 95% CI 1.73, 2.28) of dying during hospitalization for AMI. Results remained similar and statistically significant in multivariable-adjusted analyses restricted to patients hospitalized at all metropolitan Worcester medical centers during our 3 most recent study years (OR = 1.84, 95% CI 1.32, 2.56).

Hospital CFRs in patients with HF declined over the 30-year study period (Table 4, Figure 2). After controlling for previously described demographic and clinical factors (Table 2), the adjusted odds of dying in patients with HF declined for each study year (with the exception of 1978) in relation to 1975 (Table 4). Similar to declining hospital CFR's, the proportion of patients with HF who died within 30-days of hospitalization declined significantly over time, from 29.1% in 1975 to 16.0% in 2003 ($p < 0.001$).

Patients who survived an episode of new-onset HF were on average younger, more frequently male, more likely to have a history of hypertension, less likely to have a history of stroke, and less likely to have developed atrial fibrillation, Q waves, or complete heart block during their hospital stay than patients with HF who died (Table 5; p for all ≤ 0.05). Hospital survivors with incident HF had higher admission blood pressure values, higher eGFR rates, and higher admission heart rate values than patients with HF who died. Patients with AMI who survived an episode of HF were also more likely to have received effective cardiac medications and interventional procedures than patients with HF who died.

Discussion

The results of this study in more than 11,000 residents of a large, central New England metropolitan area hospitalized with AMI at all area medical centers demonstrate that the incidence rates of, and short-term death rates from, HF declined appreciably between 1975

and 2005. Despite these encouraging trends, short-term death rates remained considerably higher in patients with HF complicating AMI in comparison to those who did not develop this clinical syndrome.

Estimates of the contemporary incidence rates of HF complicating AMI vary widely, ranging from 6% to upwards of 45% in the published literature.^{5,6} The incidence rates of HF observed in our study were higher than those reported in recent randomized trials.⁷ Use of more restrictive inclusion criteria in the context of randomized controlled trials may partially account for differences in these findings, a hypothesis supported by the fact that our results are more similar to those reported in other observational studies.^{6,8} Although a greater proportion of older patients were hospitalized for AMI during our most recent study years, we noted a decline in the frequency of acute HF during the period under study, with the sharpest decline occurring over the most recent decade. These patterns were observed in patients with an initial or prior AMI, as well as in those with a Q wave or non-Q wave AMI.

Although relatively little data exist on contemporary trends in the magnitude of HF complicating AMI, investigators from the multinational GRACE study observed a similar trend toward lower rates of HF complicating AMI over a 10-year period beginning in 1995.^{4,6,8,9} Our investigation confirms the findings of that large registry study, extends them to a large, community-based population, and places them in the context of a 30-year study period. On the other hand, the incidence rates of HF in the 30 days after an initial AMI in the Framingham Heart Study increased in the 1990's (1990–1999) as compared to the 1970's (1970–1979).¹⁰ Reasons for the discrepant findings between these 2 community-based studies may be attributed to differences in the clinical and demographic characteristics of the study samples, inclusion of all patients with AMI as opposed to only first events, varying duration of follow-up (hospital versus 30-day follow-up), and time periods under study.

From 1991 on, the odds of developing HF decreased relative to the baseline year of 1975, even after adjustment for important AMI and patient-related characteristics. The lower odds of HF observed in our study's recent years may, therefore, have resulted from treatment-related factors.¹¹ The observational nature of the present investigation does not allow us to establish causality, but declines in the frequency of HF occurred contemporaneously with increased use of effective cardiac therapies. Since early revascularization has been shown to reduce infarct size, improve cardiac function, and decrease the attack rates of cardiogenic shock, it is possible that fewer AMI patients developed HF as a result of a larger proportion undergoing PCI.^{12,13} Greater use of effective cardiac medications in hospitalized persons with AMI may also have contributed to the lower incidence rates and odds of acute HF observed.¹¹

Caution in interpreting our findings is warranted, however, since the average length of hospital stay declined over the 30-year period under study and we did not examine HF developing after hospital discharge. Moreover, the majority (83%) of cases of acute HF developed within the first 24 hours of hospitalization and, in some cases, preceded administration of AMI therapies. Further studies are needed to better delineate the relative contributions of patient, disease, and treatment-related factors to declining rates of HF complicating AMI.

Prior studies have reported in-hospital death rates ranging from 20–40% in patients with new-onset HF complicating AMI.^{5,14} Notably, death rates among patients with HF complicating AMI admitted during our study's most recent years were lower than those reported in prior investigations. Death rates in patients with incident HF complicating AMI declined by 14% between 1975 and 2005, with the most impressive decreases occurring

during the late 1990's. Declining 30-day death rates after hospital admission for AMI paralleled improved in-hospital survival. As such, improved short-term survival was not attributable to shorter lengths of stay or increased post-discharge death rates. When viewed in the context of recent registry and community-based data showing a decline in age and sex-adjusted hospital or short-term CFRs among patients with AMI, our results suggest that survival gains among patients with AMI may be accounted for by improvements in the prognosis of patients with HF.^{15,16}

Although death rates declined for all AMI patients, the greatest improvement in hospital prognosis occurred in patients with incident HF (Figure 2). This finding is of significance since treatment disparities, including lower rates of PCI, beta-blocker, and lipid-lowering agent use persisted over the period under study between those who developed HF relative to those who did not develop this complication. Although it is possible that the natural history of HF complicating AMI has changed during the years under study, with fewer patients developing "higher risk" HF and/or a greater number of cases identified earlier in the course of their disease, we hypothesize that reductions in death rates among patients with HF are related to improved monitoring and treatment of all patients hospitalized with AMI.^{17,18} Reasons for under-use of evidence-based cardiac procedures among patients with AMI and new-onset HF are unclear, but ours and other data suggest that this may relate to the age and disease burden of these patients.¹⁹ Since AMI patients developing HF were generally older and affected by a greater number of comorbid illnesses, providers may have been less willing to recommend cardiac medications or procedures despite a favorable risk-to-benefit ratio due to concerns regarding adverse effects.^{19,20}

Despite survival gains in patients with HF complicating AMI, new-onset HF remains one of the most powerful prognostic markers of increased mortality in patients hospitalized with AMI. The odds of dying in patients with incident HF was 2-fold higher than in patients not developing this complication. These findings are consistent with those of the NRMI-2 investigators and, when viewed in light of treatment disparities between those with and without HF complicating AMI, suggest that more concerted efforts should be undertaken to enhance the monitoring and treatment of patients with HF as well as those at high-risk for developing HF.²¹ Particular attention should be devoted to older patients, women, and those with an unfavorable hemodynamic or laboratory profile, because these patients were at the highest risk of dying from HF.

The strengths of the present study include its large sample size, its population-based design, and its multi-decade long perspective. Our study has several limitations. Due to our methods of data abstraction, we could not determine the timing of HF-onset relative to the use of medications or procedures, or other AMI-related complications. Although the use of various treatment approaches might have affected both the odds of developing or dying from HF, we did not control for the hospital use of medications or procedures in our regression models due to concerns about potential confounding by treatment indication and timing. In addition, since data on eGFR was lacking from patients with AMI hospitalized before 1995, we did not adjust for eGFR in our multivariable models. We were unable to differentiate between HF attributed to systolic versus diastolic function due to the infrequent use of echocardiography in our study population. We were also unable to systematically categorize the sample according to the presence of ST-segment elevation, as this data was unavailable prior to 1997. Information on troponins was incorporated into our diagnostic AMI criteria in 2003, perhaps increasing AMI detection and influencing the natural history of AMI, including the odds of developing or dying from HF. Lastly, our study population consisted predominantly of older, Caucasian individuals with a high prevalence of cardiovascular risk factors, and our findings may not be generalizable to other patient groups hospitalized with AMI.

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Figure 1.
Percentages of patients with heart failure from 1975 to 2005.

Figure 2.
Case fatality rates from 1975 to 2005.

Table 1
 Characteristics of Patients With AMI According to the Presence of New-Onset Heart Failure

Characteristic	Total Sample			Patients Hospitalized in 2001, 2003, and 2005		
	Heart Failure Present (+)(n=3,582)	Heart Failure Absent (-)(n=7,479)	p Value	Heart Failure Present (+)(n=702)	Heart Failure Absent (-)(n=1770)	p Value
Age (mean, yrs)	71.7 (12.4)	64.9 (14.0)	<0.001	75.5 (12.1)	66.9 (14.5)	<0.001
Age (years)						
<55	9.6%	23.4%	--	6.6%	23.0%	--
55–64	17.0%	24.1%	--	12.5%	20.8%	--
65–74	28.3%	25.6%	--	22.1%	21.5%	--
75–84	30.7%	19.5%	--	34.1%	23.0%	--
≥85	14.5%	7.5%	<0.001	24.8%	11.7%	<0.001
Male	54.4%	65.1%	<0.001	47.9%	62.4%	<0.001
Race						
White	96.7%	94.6%	<0.001	91.3%	90.5%	0.53
Other	3.4%	5.4%	<0.001	8.7%	9.5%	0.46
Body mass index (Kg/m ²)						
<25	37.6%	33.1%	--	34.1%	30.7%	--
25–29.9	35.5%	38.6%	--	35.3%	39.3%	--
≥30	27.1%	28.3%	0.002	30.5%	30.0%	0.46
<u>Pre-Existing Conditions</u>						
Angina pectoris	25.1%	21.2%	<0.001	17.7%	17.8%	NS
Diabetes mellitus	30.3%	21.4%	<0.001	35.9%	25.2%	<0.001
Hypertension	59.3%	52.7%	<0.001	74.5%	66.2%	<0.001
Stroke	11.9%	6.3%	<0.001	14.7%	7.9%	<0.001
<u>Acute Presenting Symptoms</u>						
Chest pain *	64.9%	81.3%	<0.001	64.0%	81.8%	<0.001
Diaphoresis *	35.5%	42.9%	<0.001	32.1%	42.1%	<0.001
Dyspnea *	67.9%	47.9%	<0.001	68.0%	51.0%	<0.001
<u>AMI type</u>						
Initial	65.8%	74.4%	<0.001	67.7%	74.5%	<0.001

Characteristic	Total Sample			Patients Hospitalized in 2001, 2003, and 2005		
	Heart Failure Present (+)(n=3,582)	Heart Failure Absent (-)(n=7,479)	p Value	Heart Failure Present (+)(n=702)	Heart Failure Absent (-)(n=1770)	p Value
Q wave	48.7%	43.9%	<0.001	24.2%	24.0%	<0.001
Clinical Complications						
Third degree heart block	6.1%	3.3%	<0.001	2.8%	2.6%	0.78
Atrial fibrillation	24.8%	10.9%	<0.001	29.3%	15.6%	<0.001
Cardiogenic shock	12.5%	3.3%	<0.001	12.5%	2.0%	<0.001
Stroke [†]	1.3%	1.1%	0.32	2.3%	1.7%	0.38
Physiologic findings at the time of hospital admission (mean)						
Systolic blood pressure (mmHg)	142.9 (35.2)	143.4 (32.6)	0.66	142.0 (35.9)	143.0 (33.0)	0.48
Diastolic blood pressure (mmHg)	77.5 (21.9)	79.6 (19.7)	0.005	75.9 (21.7)	79.0 (19.9)	<0.001
Heart rate (bpm) [‡]	91.3 (25.7)	81.5 (21.8)	<0.001	92.8 (26.1)	82.9 (21.7)	<0.001
Laboratory findings at the time of hospital admission (mean, mg/dL)						
Serum glucose [§]	201.0 (124.8)	168.8 (133.6)	<0.001	199.6 (137.8)	168.2 (161.5)	<0.001
Estimated GFR findings (%) [§]	56.1 (23.3)	69.0 (26.3)	<0.001	53.3 (22.0)	67.0 (25.6)	<0.001
Serum cholesterol	209.0 (61.7)	210.1 (56.0)	0.050	176.7 (60.2)	181.5 (49.3)	0.12
Serum hemoglobin	13.3 (4.2)	14.0 (3.3)	<0.001	13.2 (5.5)	14.0 (4.2)	<0.001

Data available from

* 1997–2005 only;

[†] 1986–2005 only;

[‡] 1991–2005 only;

[§] 1995–2005 only;

AMI = acute myocardial infarction; BPM = beats per minute; GFR = glomerular filtration rate

Table 2

Treatment Practices in Patients Hospitalized With Acute Myocardial Infarction According to the Presence of New-Onset Heart Failure

	Total Sample			Patients Hospitalized in 2001, 2003, and 2005	
	Heart Failure Present (+) (n=3582)	Heart Failure Absent (-) (n=7479)	p Value	Heart Failure Present (+) (n=702)	Heart Failure Absent (-) (n=1770)
<u>Medications</u>					
ACE-I or ARB	56.2%	38.2%	<0.001	68.4%	62.6%
Aspirin	58.8%	68.3%	<0.001	92.0%	93.3%
Beta blockers	53.2%	69.2%	<0.001	88.3%	92.0%
Calcium channel blockers [†]	39.3%	34.9%	<0.001	27.8%	21.3%
Lipid lowering Agents [‡]	24.1%	33.3%	<0.001	65.4%	71.9%
Thrombolytics [‡]	16.2%	20.6%	<0.001	5.4%	7.3%
<u>Procedures</u>					
Cardiac catheterization	27.7%	37.2%	<0.001	53.1%	69.4%
Coronary artery bypass graft surgery [*]	4.2%	4.5%	0.58	7.0%	7.3%
Percutaneous coronary intervention [‡]	16.3%	24.9%	<0.001	33.3%	50.7%
Intra-aortic balloon counterpulsation	6.8%	2.9%	<0.001	12.8%	4.4%

Data available from

^{*} 1981–2005 only;[†] 1984–2005 only;[‡] 1986–2005 only;

ACEI = Angiotensin converting enzyme inhibitor; ARB = angiotensin receptor blocker

Table 3

Odds of Developing New-Onset HF in Patients Hospitalized With Acute Myocardial Infarction Over Time

Study Year	n	Developing HF	Age and Sex Adjusted Odds of Developing HF	Multivariable Adjusted Odds of Developing HF*
1975	680	35.4%	1.0	1.0
1978	722	35.3%	0.95 (0.76, 1.20)	0.91 (0.72,1.15)
1981	830	34.5%	0.84 (0.68, 1.05)	0.83 (0.66,1.04)
1984	609	48.3%	1.66 (1.31, 2.09)	1.59 (1.25,2.03)
1986	642	36.5%	0.92 (0.73, 1.16)	0.89 (0.70,1.13)
1988	589	33.3%	0.77 (0.61, 0.99)	0.73 (0.57,0.94)
1990	641	36.0%	0.85 (0.67, 1.07)	0.85 (0.67,1.08)
1991	702	31.6%	0.71 (0.56, 0.89)	0.69 (0.54,0.88)
1993	772	31.6%	0.69 (0.55, 0.87)	0.68 (0.54,0.86)
1995	786	32.9%	0.74 (0.59, 0.93)	0.73 (0.58,0.92)
1997	849	23.8%	0.44 (0.35, 0.56)	0.44 (0.35,0.56)
1999	766	28.2%	0.57 (0.46, 0.72)	0.57 (0.45,0.73)
2001	947	29.3%	0.56 (0.45, 0.69)	0.55 (0.44,0.70)
2003	874	29.4%	0.57 (0.46, 0.71)	0.57 (0.45,0.72)
2005	652	25.8%	0.47 (0.37, 0.60)	0.46 (0.35,0.60)

* Adjusted for patient's age, sex, and history of angina, hypertension, diabetes, or stroke, acute myocardial infarction order, acute myocardial infarction type, and development of complete heart block, atrial fibrillation, and cardiogenic shock during hospitalization.

Table 4

Odds of Dying During Hospitalization in Patients with New-Onset Heart Failure Complicating Acute Myocardial Infarction Over Time

Study Year	n	Hospital Case- Fatality Rates	Age and Sex Adjusted Odds of Dying	Multivariable Adjusted Odds of Dying [*]
1975	241	31.1%	1.0	1.0
1978	255	32.6%	1.01 (0.69, 1.49)	0.89 (0.58,1.36)
1981	286	28.7%	0.78 (0.53, 1.14)	0.70 (0.46,1.06)
1984	294	21.8%	0.58 (0.39, 0.86)	0.54 (0.35,0.83)
1986	234	26.1%	0.66 (0.44, 0.99)	0.59 (0.37,0.93)
1988	196	28.6%	0.74 (0.49, 1.13)	0.65 (0.41,1.05)
1990	231	19.9%	0.45 (0.29, 0.69)	0.46 (0.29,0.74)
1991	222	17.1%	0.39 (0.25, 0.61)	0.38 (0.23,0.62)
1993	244	19.3%	0.43 (0.28, 0.66)	0.37 (0.23,0.60)
1995	259	14.7%	0.31 (0.20, 0.48)	0.26 (0.16,0.42)
1997	202	17.8%	0.38 (0.24, 0.60)	0.32 (0.19,0.53)
1999	216	16.7%	0.34 (0.21, 0.53)	0.36 (0.22,0.60)
2001	277	18.4%	0.37 (0.24, 0.56)	0.35 (0.22,0.56)
2003	257	11.7%	0.20 (0.13, 0.33)	0.23 (0.13,0.38)
2005	168	17.3%	0.31 (0.19, 0.51)	0.28 (0.16,0.49)

* Adjusted for patient's age, sex, and history of angina, hypertension, diabetes, or stroke, acute myocardial infarction order, acute myocardial infarction type, and development of complete heart block, atrial fibrillation and cardiogenic shock during hospitalization.

Table 5
 Characteristics of Patients with Heart Failure Complicating AMI According to Hospital Survival Status

Characteristic	Survived (n=2810)	Died (n=772)	P Value
Age (mean) (yrs)	70.7 (12.6)	75.2 (10.9)	<0.001
Male	55.3%	51.3%	0.05
Body mass index (Kg/m ²)			
<25	36.3%	45.3%	
25–29.9	36.2%	30.0%	
≥30	27.6%	24.7%	0.08
Duration of pre-hospital delay (mean hrs) [†]	3.0 (21.5)	4.1 (7.9)	0.14
Angina pectoris	25.0%	25.8%	0.63
Diabetes mellitus	30.8%	28.6%	0.24
Hypertension	60.4%	55.7%	0.02
Stroke	10.9%	15.5%	<0.001
<u>Acute Presenting Symptoms</u>			
Chest pain*	22.3%	13.1%	<0.001
Diaphoresis*	12.2%	7.0%	<0.001
Dyspnea*	22.9%	15.2%	<0.001
<u>AMI characteristics</u>			
Initial	66.4%	63.7%	0.16
Q wave	45.9%	58.9%	<0.001
<u>Clinical Complications</u>			
Atrial fibrillation	22.7%	32.5%	<0.001
Third degree heart block	4.1%	13.6%	<0.001
Stroke [‡]	1.1%	1.9%	0.066
<u>Physiologic findings at the time of hospital admission (mean)</u>			
Systolic blood pressure (mmHg)	144.6 (34.8)	133.8 (35.9)	<0.001
Diastolic blood pressure (mmHg)	78.8 (21.7)	70.5 (21.9)	<0.001
Heart rate (bpm) [‡]	91.4 (25.1)	90.7 (28.0)	<0.001
<u>Laboratory findings at the time of hospital admission (mean, mg/dl)</u>			
eGFR (%) [§]	57.6 (23.4)	47.5 (21.0)	<0.001

Characteristic	Survived (n=2810)	Died (n=772)	P Value
Serum glucose [§]	201.2 (129.4)	200.2 (96.8)	0.88
Serum cholesterol	208.8 (61.2)	209.7 (63.4)	0.79
Hemoglobin	13.4 (4.5)	13.1 (2.0)	0.31
<u>Medications</u>			
Angiotensin converting enzyme inhibitors*	36.5%	18.3%	<0.001
Aspirin	63.9%	40.3%	<0.001
Beta blockers	59.9%	28.8%	<0.001
Calcium channel blockers	40.6%	33.6%	0.003
Lipid lowering agents [†]	27.1%	10.9%	<0.001
Thrombolytics	17.3%	11.6%	0.002
<u>Procedures</u>			
Cardiac catheterization	31.2%	15.2%	<0.001
Coronary artery bypass graft	4.5%	2.9%	0.085
Percutaneous coronary intervention	17.7%	10.5%	<0.001
Intra-aortic balloon counterpulsation	5.9%	10.1%	<0.001

Data available from

1990–2005 only;

[†] 1986–2005 only;

[‡] 1991–2005 only;

[§] 1995–2005 only;

AMI = acute myocardial infarction; BPM = beats per minute; GFR = glomerular filtration rate