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Changing Trends in the Landscape of Patients Hospitalized With Acute Myocardial Infarction (2001 to 2011) (from the Worcester Heart Attack Study)

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Et al.

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During the past several decades, new diagnostic tools, interventional approaches, and population-wide changes in the major coronary risk factors have taken place. However, few studies have examined relatively recent trends in the demographic characteristics, clinical profile, and the short-term outcomes of patients hospitalized for acute myocardial infarction (AMI) from the more generalizable perspective of a population-based investigation. We examined decade long trends (2001 to 2011) in patient's demographic and clinical characteristics, treatment practices, and hospital outcomes among residents of the Worcester metropolitan area hospitalized with an initial AMI (n = 3,730) at all 11 greater Worcester medical centers during 2001, 2003, 2005, 2007, 2009, and 2011. The average age of the study population was 68.5 years and 56.9% were men. Patients hospitalized with a first AMI during the most recent study years were significantly younger (mean age = 69.9 years in 2001/2003; 65.2 years in 2009/2011), had lower serum troponin levels, and experienced a shorter hospital stay compared with patients hospitalized during the earliest study years. Hospitalized patients were more likely to received evidence-based medical management practices over the decade long period under study. Multivariable-adjusted regression models showed a considerable decline over time in the hospital death rate and a significant reduction in the proportion of patients who developed atrial fibrillation, heart failure, and ventricular fibrillation during their acute hospitalization. These results highlight the changing nature of patients hospitalized with an incident AMI, and reinforce the need for surveillance of AMI at the community level. **(Am J Cardiol 2020;125:673−677)**

Despite significant advances in patient management and population-wide lifestyle changes in several predisposing factors, acute myocardial infarction (AMI) continues to be a major cause of morbidity and mortality in the United States.[1,2] A limited number of community-based studies have described changes over time in the clinical epidemiology and outcomes of patients hospitalized with AMI in the United States.[3] These studies include the Worcester Heart Attack Study, the Minnesota Heart Survey, and Rochester Epidemiology Project.[4−12] However, few relatively recent data exist describing the potentially changing landscape of AMI at the community level. The primary objective of this population-based study was to describe decade long trends in the demographic and clinical characteristics, hospital management practices, and in-hospital clinical outcomes among residents of central Massachusetts hospitalized with a first AMI at all 11 metropolitan Worcester medical centers on a biennial basis between 2001 and 2011.

Methods

Details of the Worcester Heart Attack Study have been previously described.[4−7] In brief, residents of the Worcester metropolitan area hospitalized with a possible AMI at all 11 greater Worcester (MA) medical centers during 2001, 2003, 2005, 2007, 2009, and 2011 comprised the study population. The medical records of residents of these patients were individually reviewed and validated according to preestablished criteria.[5−8] Information was collected by trained study staff about patient's age, sex, co-morbidities, AMI type (ST-segment elevation vs non-ST-segment elevation), and occurrence of clinically significant hospital complications. Information was collected about the prescribing of different cardiac medications during the patient's acute hospitalization and about the receipt of coronary diagnostic and interventional procedures. Patients with a history of AMI were excluded from the present study to provide insights into the descriptive epidemiology of AMI among patients with a first AMI.

To facilitate the interpretation of trends in the epidemiology of AMI, the 6 one-year study years were aggregated into 3 two-year periods, namely 2001 and 2003, 2005 and 2007, and 2009 and 2011. Differences in the distribution of

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demographic factors, medical history, physiologic findings, clinical characteristics, and treatment practices were examined with the use of chi-square tests for trends and analysis of variance for discrete and continuous variables, respectively. To assess changes over time in the occurrence of important clinical complications and in-hospital case-fatality rates, while controlling for potentially confounding factors of prognostic importance, several logistic multivariable adjusted regression analyses were performed.

Results

This report is based on the 3,730 residents of the Worcester metropolitan area who satisfied the diagnostic criteria for an initial AMI. The mean age of study patients was 68.5 years, 43.1% were women, and 89.9% were white. Patients hospitalized with a first AMI during the most recent study years were significantly younger compared with patients who had been hospitalized in the earliest study years (Table 1). There were a greater proportion of individuals with previously diagnosed anemia, chronic kidney disease, hyperlipidemia, hypertension, and peripheral vascular disease during the most recent study years. A modest decrease in mean systolic blood pressure and estimated glomerular filtration rate values was observed over time. There was a decline in the mean serum troponin levels at the time of hospital admission as well as in the average length of hospital stay during the years under study (Table 1).

The in-hospital use of aspirin and lipid lowering agents increased markedly during the years under study (Figure 1). A statistically significant, but inconsistent increase in the use of β-blockers was observed whereas there was a marked decrease in the use of calcium channel blockers, diuretics, and thrombolytic therapy (Figure 1). The proportion of patients who underwent diagnostic cardiac catheterization and a percutaneous coronary intervention (PCI) increased markedly between 2001 and 2011. In 2009/2011, the percentage of hospitalized patients that received diagnostic catheterization or a PCI was 72.0% and 54.7%, respectively (Figure 2). The proportion of patients who underwent a subsequent PCI following cardiac catheterization increased significantly over time, whereas the proportion of patients who underwent acute coronary artery bypass surgery declined.

In examining changes over time in the occurrence of several major in-hospital complications and all-cause in-hospital death rates, we observed a progressive decline in the proportion of patients who developed ventricular fibrillation, atrial fibrillation, and heart failure as well as a marked decrease in hospital death rates (Table 2). Multivariable adjusted regression analyses were performed to more systematically examine trends in hospital death rates and in major clinical complications (Table 3). Results of the unadjusted analysis (model 1) showed significant declines over time in the odds of dying in the hospital while declines in the odds of developing atrial fibrillation, heart failure, and ventricular fibrillation were noted. These results essentially

Table 1
Characteristics of patients Hospitalized with an initial acute myocardial iInfarction according to time period of hospitalization

Variable	2001/2003 (n = 1,547)	2005/2007 (n = 1,170)	2009/2011 (n = 1,013)	p *Value*
Age (mean, years)	69.9	69.3	65.2	
Age (years)				
<55	17.8 %	19.1%	22.0%	
55-64	17.5%	16.8%	21.5%	
65-74	20.9%	17.9%	19.9%	
75-84	27.2%	27.1%	18.3%	
≥85	16.7%	19.1%	18.3%	<0.001
Men	56.9%	54.9%	59.1%	0.09
White	87.9%	90.6%	91.9%	<0.001
Length of stay (mean, days)	5.9%	5.7%	4.6%	<0.001
Medical history				
Angina	16.7%	8.9%	4.1%	<0.001
Anemia	4.5%	11.8%	10.0%	<0.001
CKD	11.8%	17.5%	18.0%	<0.001
COPD	15.0%	16.5%	12.2%	<0.005
Diabetes	28.0%	28.8%	31.7%	0.33
Heart failure	15.0%	16.5%	12.2%	<0.005
Hyperlipidemia	44.2%	55.6%	65.6%	<0.001
Hypertension	65.0%	70.6%	69.6%	<.01
PVD	11.6%	16.3%	16.3%	< 0.001
Stroke	9.3%	9.2%	7.5%	0.42
Systolic BP (mean, mm Hg)	143	142	140	0.08
Diastolic BP (mean, mm Hg)	79	78	79	0.08
eGFR (ml/min/1.73 m^2)	60	62	54	<0.001
Serum Glucose (mean, mg/dl)	169	163	167	0.20
ST-segment elevation	39%	35%	35%	0.08
Troponin I (mean, ng/ml)	34	12	9	<0.001

CKD = Chronic kidney disease; COPD = chronic obstructive pulmonary disease; PVD = peripheral vascular disease; BP = blood pressure; eGFR = estimated glomerular filtration rate.

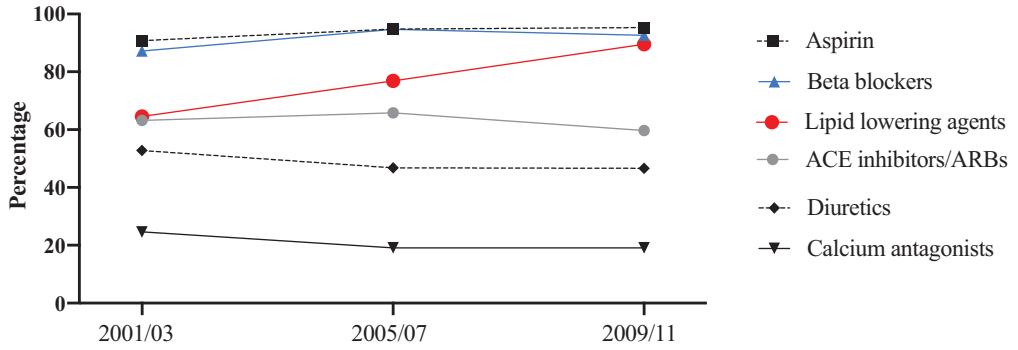

Figure 1. Changing trends in hospital medication practices. ACE = angiotensin-converting-enzyme; ARBs = angiotensin II receptor blocker.

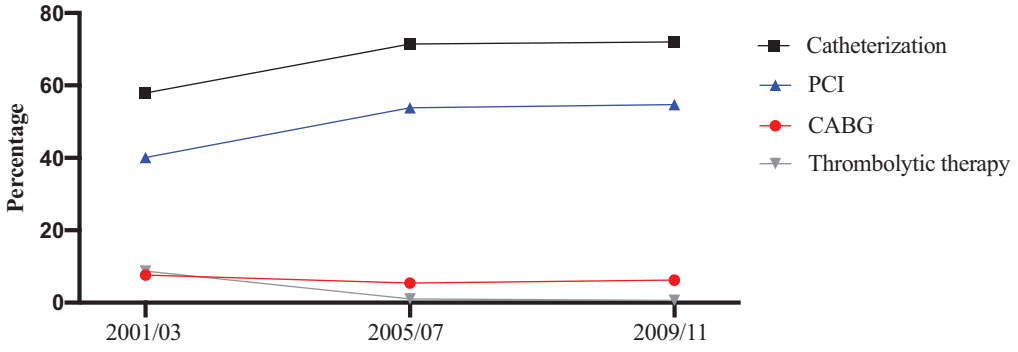

Figure 2. Changing trends in hospital coronary diagnostic and revascularization procedures. CABG = coronary artery bypass grafting; PCI = percutaneous coronary intervention.

Table 2
Frequency of clinical outcomes according to time period of hospitalization

Complications	2001/2003 (n = 1,547)	2005/2007 (n = 1,170)	2009/2011 (n = 1,013)	p *Value*
Atrial fibrillation	21.7%	21.5%	15.1%	<0.005
Cardiogenic shock	4.9%	6.1%	4.6%	0.87
Death	9.6%	9.8%	6.5%	<0.005
Heart failure	34.4%	33.9%	28.2%	<0.05
Stroke	1.7%	0.6%	1.8%	0.88
Ventricular fibrillation	4.8%	3.8%	2.6%	<0.05

Table 3
Multivariable-adjusted risk of in-hospital outcomes

		Model 1 OR (95% CI)		Model 2 OR (95% CI)		Model 3 OR (95% CI)	
Outcomes	2001/2003*	2005/2007	2009/2011	2005/2007	2009/2011	2005/2007	2009/2011
Atrial fibrillation	1	0.99 (0.82, 1.19)	0.65 (0.52, 0.80)	0.98 (0.799, 1.19)	0.71 (0.56, 0.89)	1.07 (0.87, 1.32)	0.81 (0.64, 1.03)
Cardiogenic shock	1	1.27 (0.91, 1.77)	0.95 (0.65, 1.38)	1.27 (0.90, 1.79)	0.97 (0.66, 1.43)	1.51 (1.06, 2.15)	1.25 (0.83, 1.87)
Death	1	1.03 (0.80, 1.33)	0.66 (0.49, 0.89)	1.02 (0.77, 1.34)	0.76 (0.55, 1.05)	1.02 (0.78, 1.34)	0.76 (0.55, 1.05)
Heart failure	1	0.98 (0.84, 1.15)	0.75 (0.63, 0.89)	0.91 (0.76, 1.09)	0.81 (0.66, 0.98)	1.02 (0.84, 1.23)	0.95 (0.77, 1.17)
Stroke	1	0.35 (0.15, 0.81)	1.05 (0.57, 1.93)	0.37 (0.16, 0.88)	1.39 (0.73, 2.66)	0.37 (0.16, 0.88)	1.39 (0.73, 2.66)
Ventricular fibrillation	1	0.80 (0.54, 1.16)	0.52 (0.33, 0.82)	0.82 (0.56, 1.21)	0.52 (0.33, 0.83)	0.88 (0.60, 1.30)	0.60 (0.38, 0.97)

Model 1: Unadjusted; Model 2: Adjusted for age, gender, race and medical history of: anemia, COPD, heart failure, hyperlipidemia, hypertension, PVD; Model 3: Adjusted for characteristics in Model 2 plus type of AMI and hospital length of stay. COPD = chronic obstructive pulmonary disease; PVD = peripheral artery disease.

* Referent period.

remained after adjusting for a variety of patient associated demographic and clinical characteristics and duration of the acute hospitalization (regression models 2 and 3) (Table 3).

Discussion

Our results highlight the changing landscape of patients hospitalized with AMI at all medical centers in central Massachusetts. We found significant changes in the demographic characteristics, clinical profile, and hospital management of patients with a first AMI. Moreover, encouraging declines in the proportion of patients who died or experienced major clinical complications during their acute hospitalization were observed.

Greater Worcester residents hospitalized with a first AMI during the most recent study years were significantly younger and more likely to be men. This shift to a younger age at diagnosis is in contrast with those observed in the Cardiovascular Research Network[13] and the Rochester Epidemiology project.[14] Although the reasons underlying differences in the findings between the present study and other population-based studies are unknown, we believe they could be due, in part, to the introduction of novel biomarkers and the use of more sensitive diagnostic tests over time as well as to differences in the sociodemographic and clinical characteristics of the respective study populations. If real, however, these changes could be the result of a worsening coronary risk factor profile in residents of the Worcester metropolitan area, creating a younger vulnerable population at risk for acute coronary disease.

We observed marked changes over time in the occurrence of clinically important chronic diseases in our patient population. This shift in patient profile toward the admission of predominantly younger patients with a greater prevalence of co-morbidities could be secondary to changes in clinical guidelines for the identification of patients with various chronic conditions that took place during the years under study.[15,16] We observed a steady decline in the average length of hospital stay for residents of the Worcester metropolitan area hospitalized with a first AMI, likely due to improved treatment strategies and cost considerations.

Patients with an incident AMI were more likely to have developed a non-ST-segment elevation myocardial infarction during the years under study, results consistent with trends observed in the Rochester epidemiology project during a relatively similar period.[11] Our data also showed that serum troponin levels decreased considerably. Although this could be an artifact created by the introduction of high-sensitivity troponin assays and new test guidelines, the lower serum troponin levels observed over time, and the increasing proportion of smaller infarcts as reflected by patient's serial electrocardiogram findings, may be suggestive of a progressive decline in the severity of patients hospitalized with a first AMI during the period under study.

A number of community-based studies, including previous reports from the Worcester Heart Attack Study,[4,10,13,17] as well as large coronary disease registries,[18] have shown evidence of a progressive increase in the prescribing of effective cardiac therapies in patients hospitalized with AMI during the past 2 decades. Moreover, a gradual reduction in the utilization of cardiac medications with questionable therapeutic value or a narrow therapeutic/toxic ratio was observed. Increases in the proportion of patients that underwent nonsurgical revascularization and diagnostic procedures were noted, consistent with evidence-based guidelines for the hospital management of patients with AMI. As new treatment recommendations and approaches evolve, it remains of importance to monitor trends in the management of these patients and factors associated with different treatment approaches and patient's in-hospital and long-term outcomes.

A marked change over time in the occurrence of clinically important AMI-related complications was observed in our patient population. We found a significant reduction in the proportion of patients who developed atrial fibrillation, heart failure, and ventricular fibrillation. These meaningful changes are consistent with other findings.[19–21] We documented a significant increase in patient's in-hospital survival, a finding consistent with previous reports from this study during earlier periods.[4,17] These findings are consistent with those derived from population-based studies in Northern California and Minneapolis/St Paul, Minnesota[10,13] and studies in Canada, Europe, and Australia.[22,23]

The strengths of our investigation include a large community-based population of patients hospitalized with confirmed initial AMI at all central Massachusetts medical centers. Our study cohorts were, however, comprised largely of Caucasians and may lack generalizability to other race/ethnic groups. The influence of possible changes over time in the magnitude of out-of-hospital deaths due to cardiac disease or changes in the occurrence of silent unrecognized AMIs on the characteristics and outcomes of patients hospitalized with AMI remains unknown.

In conclusion, the results of this study highlight the changing demographic and clinical nature of patients hospitalized with AMI and the importance of surveillance at the community level.

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Disclosures

The authors have no other relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript.

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