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Thirty-Year (1975–2005) Trends in the Incidence Rates, Clinical Features, Treatment Practices, and Short-term Outcomes of Patients < 55 Years of Age Hospitalized with an Initial Acute Myocardial Infarction

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Abstract

Sparse data are available describing recent trends in the magnitude, clinical features, treatment practices, and outcomes of comparatively young adults hospitalized with acute myocardial infarction (AMI). The objectives of this population-based study were to describe 3 decade-long trends (1975–2005) in these endpoints among adults less than 55 years old who were hospitalized with an initial AMI. The study population consisted of 1,703 residents of the Worcester (MA) metropolitan area between the ages of 25–54 years who were hospitalized with an initial AMI at all central Massachusetts medical centers during 15 annual periods between 1975 and 2005. The overall hospital incidence rate (per 100,000 persons) of initial AMI in our study population was 66 (95% confidence interval 63–69) and the incidence rates of AMI declined inconsistently over time. Patients hospitalized during the most recent study years were more likely to have important cardiovascular risk factors and comorbidities present but were less likely to have developed heart failure during their index hospitalization. In-hospital and 30-day death rates declined by approximately 50% ($p = 0.04$) during the years under study concomitant with increasing use of effective cardiac therapies. In conclusion, the results of this community-wide investigation provide insights into the magnitude, changing characteristics, and short-term outcomes of comparatively young patients hospitalized with a first AMI. Declining odds of developing, or dying from, an initial AMI during the 30 years under study likely reflect enhanced primary and secondary prevention and treatment efforts.

Keywords

acute myocardial infarction; young adults; community trends

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Introduction

The Worcester Heart Attack Study (WHAS) has been conducting surveillance of acute myocardial infarction (AMI) in adult residents of the Worcester (MA) metropolitan area for the past 3 decades.¹ Using data from this ongoing study of central Massachusetts residents, we examined 30-year trends (1975–2005) in disease incidence rates, patient characteristics, hospital treatment practices, and short-term outcomes in comparatively young adults who had been hospitalized for AMI at all greater Worcester medical centers. In light of regional data highlighting the increasing prevalence of obesity and diabetes among young greater Worcester residents, we hypothesized that we would observe increasing incidence rates of initial AMI.² We also hypothesized that better monitoring and treatment of comparatively young adults hospitalized with AMI over time would be associated with favorable declines in post-AMI complication and mortality rates.¹

Methods

The study population consisted of greater Worcester residents between the ages of 25–54 years who were hospitalized with a discharge diagnosis of AMI at all medical centers in the Worcester metropolitan area during 15 individual study years between 1975 and 2005. A total of 16 hospitals were originally included in this investigation but fewer hospitals (n=11) have been included in recent years due to hospital closures or conversion to chronic care or rehabilitation facilities. We restricted the present sample to adults between the ages of 25–54 years who were hospitalized with an independently validated initial AMI because we were interested in describing the clinical epidemiology of AMI in a comparatively young population and examining the occurrence of initial (incident) acute coronary events. Based on the careful review of prior and current hospital medical records, diagnostic test results, and electrocardiograms by trained nurse and physician abstractors, patients with a clinical history of MI were excluded. A total of 1,703 patients meeting these criteria were hospitalized with an initial AMI during the following study years: 1975 (n=131), 1978 (n=128), 1981 (n=129), 1984 (n=77), 1986 (n=92), 1988 (n=75), 1990 (n=77), 1991 (n=118), 1993 (n=116), 1995 (n=128), 1997 (n=124), 1999 (n=129), 2001 (n=147), 2003 (n=130), and 2005 (n=102). These years were selected due to funding availability and for purposes of examining trends in our principal study outcomes on an approximate alternating yearly basis.

The details of this study have been extensively described.^{1,3,4} In brief, potentially eligible patients were identified through a review of computerized hospital databases of patients with discharge diagnoses consistent with the possible presence of AMI. The medical records of residents of the Worcester metropolitan area (2000 census =478,000) were reviewed in a standardized manner, and the diagnosis of AMI was confirmed according to pre-established criteria.^{1,3,4} Beginning in 2003, troponin assays were incorporated into the diagnostic criteria for AMI.⁵ Trained study physicians and nurses abstracted information from hospital medical records on patient's demographic characteristics, presenting symptoms, medical history, clinical and laboratory findings, receipt of cardiac treatments, length of hospital stay, pre-hospital delay, as well as hospital discharge and 30-day post-admission survival status. Heart failure, cardiogenic shock, atrial fibrillation, and stroke were defined on the basis of information contained in hospital charts and characterized according to established criteria previously utilized in this ongoing surveillance study.^{1,3,4} Follow-up information after hospital discharge was obtained for more than 99% of discharged patients.

The incidence rates of initial AMI were calculated in a standard manner using census and intercensal estimates of the greater Worcester population. Chi-square tests for categorical

variables and ANOVA for continuous variables were used to examine potentially changing trends in various demographic and clinical factors. The short-term outcomes in each period were examined by calculating in-hospital and 30-day case-fatality rates (CFRs) and trends in these endpoints were examined through the use of chi-square tests for trends. Logistic regression modeling was used to assess the significance of 30-year trends in short-term death rates while controlling for several potentially confounding demographic, medical history, and clinical characteristics of prognostic importance. Since length-of-stay declined markedly over the study period, we included duration of hospital stay in our regression models. The Committee for the Protection of Human Subjects at the University of Massachusetts Medical School approved this study.

Results

The demographic, clinical, and treatment characteristics of the study sample are shown in Table 1. Approximately 1 in every 5 of all greater Worcester residents hospitalized with an initial AMI at all area hospitals between 1975 and 2005 was between the ages of 25 and 54 years. The overall incidence rate of AMI during the 30-year period under study was 66 per 100,000 (95% confidence interval 63–69) in patients between the ages of 25 and 54 years. The incidence rates of initial AMI in patients < 55 years decreased over the first 10 years of our study, then remained relatively flat thereafter (Figure 1).

For ease of analysis and interpretation, we aggregated the individual study years into selected groupings [1975/78 (earliest), 1990/91 (middle), 2005 (most recent)] for purposes of examining changing trends in the characteristics of patients hospitalized with AMI (Table 1). In examining changing trends in the prevalence of obesity during the most recent years under study, the proportion of patients presenting with a body mass index ≥ 30 kg/m² increased markedly over a relatively short period (40% in 2001; 49% in 2005). Since we began collecting information on the type of AMI (ST-segment elevation and non-ST segment elevation) in 1997, we examined nearly decade long-trends in the incidence rates of ST-segment elevation AMI between 1997 and 2005. Although the incidence rates of ST-elevation AMI declined among patients of all ages hospitalized with AMI in our study (121 to 77), there was an increase in the proportion of patients diagnosed with ST-elevation AMI among patients < 55 years of age (30% in 1997; 38% in 2005; p for trend <0.05).

There was a marked and steady increase in the use of effective medical therapies and revascularization procedures during the years under study (all p<0.001). Although the outpatient use of effective cardiac therapies remained low throughout the study period, we observed a considerable increase in the proportion of hospitalized patients who were prescribed these medications prior to hospital admission. In 1975, 16% of hospitalized patients reported being on aspirin and only 9% reported chronic use of a beta-blocker prior to hospitalization for AMI. These percentages rose steadily over time, reaching 20% and 13%, respectively, in 2005. Similarly, in examining the prior use of 2 or more effective cardiac medications (e.g., aspirin, beta blockers, ACE inhibitors, lipid-lowering agents) prior to the patient's index hospitalization, the percentage of patients receiving any 2 of these 4 effective cardiac therapies rose steadily over time (Figure 2; p <0.001).

The incidence rates of heart failure declined significantly between 1975 and 2005 among young patients hospitalized with an initial AMI (Table 2, p for trend <0.001). Although we did not observe a decline in the incidence rates of atrial fibrillation, cardiogenic shock, and stroke during the years under study, the frequency of these complications during hospitalization for AMI remained relatively low (5.2%, 3.1%, and 0.5% overall, respectively).

Short-term mortality among young patients admitted with an initial AMI declined significantly over the 30-year study period (Table 3). To more systematically examine trends in short-term death rates, we carried out a series of multivariable-adjusted regression analyses while simultaneously controlling for several potentially confounding prognostic factors (Table 4). The results of this analysis were consistent with the results of our univariate analyses, showing marked declines in hospital and 30-day post-admission death rates over the study period.

Discussion

In this community-wide study of patients < 55 years old who were hospitalized with an independently validated AMI in a large, central New England metropolitan area between 1975 and 2005, the incidence rates of initial AMI declined over the 1st decade of study and then remained relatively constant thereafter. These trends were observed concomitant with an increase in the frequency of previously diagnosed hypertension, diabetes, and heart failure over time, as well as in the presence of a persistently high rate of cigarette smoking. The complications and short-term death rates after AMI declined over the 30-year period under study, even after adjustment for factors known to affect these endpoints. Our results may be partially explained by the increasing in-hospital and outpatient use of effective cardiac therapies in this population during recent years, though the exact reasons for the observed trends remain speculative.⁷

The overall hospital incidence rate of initial AMI observed in our study is consistent with the relatively limited data available describing the incidence rates of AMI in younger adults.⁸ Given the increasing prevalence of several cardiovascular risk factors among young U.S. adults,^{8–10} we hypothesized that the incidence rates of AMI in the greater Worcester population would increase over time. Although we observed high rates of current smoking, and an increase in the proportion of hospitalized patients with a history of hypertension, diabetes, and obesity during the years under study, the incidence rate of initial AMI did not change significantly over the last 2 decades.

Although the non-randomized nature of our study precluded any assumption of causality, it was notable that an increasing proportion of hospitalized greater Worcester residents reported receiving medications prior to admission that have been shown to reduce the likelihood of developing cardiovascular events in high-risk patients, including aspirin, beta-blockers, statin drugs, and renin-angiotensin-system antagonists. Although our results must be interpreted with caution, the increased outpatient prescribing of these medications in the greater Worcester community may have exerted a positive effect on the overall incidence rate of AMI and potentially counter-balanced an increased risk factor burden in our study sample.

Previous studies have demonstrated that young patients with AMI tend to be predominantly male, smokers, and hyperlipidemic.^{6,11–16}; we confirmed a male predominance among young patients hospitalized with AMI. Although the rates of smoking observed in our study are high relative to contemporary community-based studies involving patients of all ages, they are consistent with smoking rates reported in other investigations involving comparatively young patients with AMI.¹³ Our findings emphasize the strong pathophysiologic association between smoking, increased risk for coronary thrombosis, and the development of AMI in patients < 55 years of age.¹⁷

We observed a steady increase in the prevalence of diabetes and hypertension in our study sample. To our knowledge, these findings have not been previously demonstrated in comparatively young patients with AMI. Although the increasing proportion of patients

diagnosed with these conditions may be related to enhanced surveillance and/or changing criteria for defining their presence, the increasing prevalence of hypertension and diabetes may be related to the high and ever increasing population burden of obesity.¹⁸

Our findings confirm expected increases in the utilization of effective in-hospital treatments that have become the standard of care for patients hospitalized with AMI during the last several decades.^{19–23} Reported outpatient use of aspirin, beta-blockers, renin-angiotensin system antagonists, and statin drugs also increased markedly over time. Since our study sample was restricted to patients hospitalized with an initial AMI, our findings also suggest a steady incorporation of guideline-supported primary and secondary prevention therapies into everyday clinical practice.²⁴

Twenty percent of patients < 55 years of age with an initial AMI developed a major cardiovascular complication during their index hospitalization. Although complications associated with AMI developed less frequently in our cohort than have been previously noted in populations including older patients, they paralleled those reported in other contemporary community-based studies with respect to new onset heart failure.^{25,26} Declining rates of heart failure after AMI, especially when viewed in the context of increased use of early coronary revascularization strategies and enhanced care seeking behavior, suggest that the early institution of effective inpatient therapies over time, and/or increasing baseline use of beneficial cardiac medications, may have contributed to the lower rates of heart failure observed in our patient population.²⁷

Relatively young patients presenting to greater Worcester hospitals with an initial AMI had a favorable short-term prognosis. Our short-term death rates were consistent with those reported in prior population-based studies but slightly higher than the rates that have been observed in clinical studies involving patients < 50 years old with AMI.²⁸ This is likely due to differences in age as well as variations in the socio-demographic and clinical characteristics of patients participating in community-based studies relative to persons included in randomized clinical trials.

Short-term mortality in our study sample declined over the 30-year study period. The greatest decline in death rates occurred between 1975 and 1990, after which time mortality rates slightly increased. A similar flattening in the decline in mortality associated with coronary disease was noted among patients < 54 years old in a European community-based study conducted between 1986 and 2006.⁶ Improved public health awareness and increasing use of efficacious therapies for AMI have likely contributed to the decline in mortality observed.²⁹ However, since the prevalence of hypertension, obesity, and diabetes has increased, and smoking rates remained high, an increasing burden of cardiovascular risk factors and comorbid disease among young patients hospitalized with AMI may be responsible for the leveling off of mortality gains noted during recent years.¹ Our findings call into question whether or not changing demographic and clinical characteristics, such as increasing body mass, have diminished the efficacy of, or increased complications from, AMI therapies.³⁰

The strengths of the present study include its population-based design, its relatively large sample, and its multi-decades long perspective. Our study also has several limitations. Possible changes in the definition of AMI during the years under study, and in the incidence rates of pre-hospital sudden cardiac death, may have contributed to the findings observed. The non-randomized nature of our design precluded adjustment for differences in treatment practices over time. Third, because data on body mass index, cigarette smoking, and serum cholesterol levels were not available for earlier study cohorts, our examination of trends in these modifiable risk factors was limited to more recent years. Lastly, we studied

predominantly Caucasian patients and our findings may lack generalizability to other racial or ethnic groups.

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Figure 1.
Incidence Rates of Initial Acute Myocardial Infarction Among Patients Less Than 55 Years of Age
* 95% Confidence Intervals
** Time periods = 1975/1978, 1981/1984, 1986/1988, 1990/1991, 1993/1995, 1997/1999, 2001/2003, and 2005

Figure 2.
Proportion of Patients Less Than 55 Years of Age Receiving At Least 2 Evidence-Based Cardiac Medications Prior to, and During, Hospitalization for Acute Myocardial Infarction According to Time Period of Hospitalization
* Time periods = 1975/1978, 1981/1984, 1986/1988, 1990/1991, 1993/1995, 1997/1999, 2001/2003, and 2005

Characteristics of Young Patients with Initial Acute Myocardial Infarction Overall and According to Time Period of Hospitalization

Table 1

Characteristic [†]	Total Population (n=1,703)	Time Period		
		1975/1978 (n=259)	1990/1991 (n=195)	2005 (n=102)
Age (mean, yrs)	46.7 (6.0)	47.0 (5.9)	45.4 (6.5)	47.8 (5.3)
Age (years)				
<40	12.1 %	10.8 %	17.4 %	7.8 %
40-44	18.9 %	15.8 %	21.0 %	17.7 %
45-50	29.9 %	31.3 %	31.8 %	27.5 %
50-54	39.1 %	42.1 %	29.7 %	47.1 %
Men	79.2 %	78.4 %	81.5 %	70.6 %
White	88.7 %	90.4 %	86.2 %	89.2 %
Medical History				
Angina pectoris	10.3 %	12.4 %	10.3 %	6.9 %
Diabetes mellitus	14.7 %	14.7 %	9.2 %	13.7 %
Hypertension	38.1 %	34.0 %	38.5 %	47.1 %
Stroke	1.8 %	1.5 %	1.0 %	0 %
Heart failure	1.6 %	1.5 %	0.5 %	4.9 %
Current smoker ^{**}	51.1 %	-	-	48.0 %
Total Cholesterol (mg/dL)	219.2 (56.0)	242.4 (56.3)	222.9 (45.4)	193.0 (55.9)
Prehospital delay (median, hrs) [*]	1.8	-	1.7	1.5
Length of stay (mean, days)	8.8 (7.6)	17.3 (8.3)	8.7 (5.9)	4.0 (4.7)
Q wave AMI	60.7 %	75.3 %	66.7 %	32.4 %
In-Hospital Therapies				
ACE/ARBs ^{****}	44.6 %	-	14.9 %	69.6 %
Aspirin	69.8 %	20.1 %	88.7 %	98.0 %
Beta Blockers	73.6 %	23.6 %	86.7 %	96.1 %
Calcium channel blockers ^{***}	27.9 %	-	44.6 %	9.8 %
Lipid lowering agents [*]	37.4 %	-	9.7 %	64.7 %
Thrombolytics [*]	32.2 %	-	42.6 %	2.9 %

Characteristic [†]	Total Population (n=1,703)	Time Period			
		1975/1978 (n=259)	1990/1991 (n=195)	2005 (n=102)	
Cardiac Catheterization	48.7 %	4.6 %	39.5 %	92.2 %	
PCI ^{**}	37.3 %	-	11.3 %	78.4 %	
Coronary artery bypass Graft surgery	3.2 %	0 %	2.1 %	2.9 %	

[†] mean values (SD)

* 1986–2005 only

** 1995–2005 only

*** 1990–2005 only

Table 2

Risk of Selected Clinical Complications in Patients Hospitalized With an Initial Acute Myocardial Infarction

<u>Study Period</u>	<u>Heart Failure</u>	<u>Atrial Fibrillation</u>	<u>Cardiogenic Shock</u>	<u>Stroke</u>
1975/1978	19.7 %	4.3 %	2.3 %	0 %
1981/1984	21.8 %	4.4 %	2.9 %	0 %
1986/1988	13.8 %	5.4 %	1.8 %	1.8 %
1990/1991	19 %	5.6 %	3.1 %	0 %
1993/1995	14.3 %	5.7 %	4.5 %	0 %
1997/1999	14.2 %	6.3 %	4.4 %	0.8 %
2001/2003	11.9 %	4.7 %	2.5 %	0.7 %
2005	5.9 %	2.0 %	2.0 %	1.0 %

Table 3

Short-Term Death Rates in Patients Hospitalized With an Initial Acute Myocardial Infarction

<u>Study Period</u>	<u>In-Hospital Death Rates</u>	<u>30-Day Death Rates</u>
1975/1978	5.4 %	6.6 %
1981/1984	4.4 %	4.4 %
1986/1988	3.0 %	3.6 %
1990/1991	1.0 %	1.0 %
1993/1995	1.2 %	1.6 %
1997/1999	3.2 %	3.6 %
2001/2003	2.5 %	2.9 %
2005	2.9 %	2.9 %

Table 4
Odds of Dying in Younger Patients Hospitalized with an Initial Acute Myocardial Infarction

<u>Study Period</u>	<u>Crude Odds of In-Hospital Death</u>	<u>Age- and Sex-Adjusted Odds of In-Hospital Death</u>	<u>Multivariable Adjusted Odds of In-Hospital Death</u>
1975/1978 ^a	1.0	1.0	1.0
1981/1984	0.80 (0.34–1.89)	0.79 (0.33–1.89)	0.41 (0.16–1.08)
1986/1988	0.54 (0.19–1.52)	0.61 (0.21–1.75)	0.21 (0.07–0.66)
1990/1991	0.18 (0.04–0.81)	0.22 (0.05–0.98)	0.06 (0.01–0.27)
1993/1995	0.22 (0.06–0.77)	0.22 (0.06–0.79)	0.05 (0.01–0.18)
1997/1999	0.57 (0.24–1.39)	0.61 (0.25–1.48)	0.09 (0.03–0.26)
2001/2003	0.45 (0.18–1.14)	0.46 (0.18–1.17)	0.05 (0.02–0.17)
2005	0.54 (0.15–1.89)	0.46 (0.13–1.65)	0.05 (0.01–0.21)

* Adjusted for age, sex, length of stay, and history of angina, diabetes mellitus, hypertension, stroke, or heart failure

^a referent period