ORIGINAL RESEARCH

In-Hospital Mortality Among Patients With Type 2 Diabetes Mellitus and Acute Myocardial Infarction: Results From the National Inpatient Sample, 2000–2010

Bina Ahmed, MD; Herbert T. Davis, PhD; Warren K. Laskey, MD, MPH, FAHA

***Background*—**Case-fatality rates in acute myocardial infarction (AMI) have significantly decreased; however, the prevalence of diabetes mellitus (DM), a risk factor for AMI, has increased. The purposes of the present study were to assess the prevalence and clinical impact of DM among patients hospitalized with AMI and to estimate the impact of important clinical characteristics associated with in-hospital mortality in patients with AMI and DM.

***Methods and Results*—**We used the National Inpatient Sample to estimate trends in DM prevalence and in-hospital mortality among 1.5 million patients with AMI from 2000 to 2010, using survey data-analysis methods. Clinical characteristics associated with in-hospital mortality were identified using multivariable logistic regression. There was a significant increase in DM prevalence among AMI patients (year 2000, 22.2%; year 2010, 29.6%, $P_{trend}<0.0001$). AMI patients with DM tended to be older and female and to have more cardiovascular risk factors. However, age-standardized mortality decreased significantly from 2000 (8.48%) to 2010 (4.95%) ($P_{trend}<0.0001$). DM remained independently associated with mortality (adjusted odds ratio 1.069, 95% CI 1.051 to 1.087; $P<0.0001$). The adverse impact of DM on in-hospital mortality was unchanged over time. Decreased death risk over time was greatest among women and elderly patients. Among younger patients of both sexes, there was a leveling off of this decrease in more recent years.

***Conclusions*—**Despite increasing DM prevalence and disease burden among AMI patients, in-hospital mortality declined significantly from 2000 to 2010. The adverse impact of DM on mortality remained unchanged overall over time but was age and sex dependent. **(*J Am Heart Assoc*. 2014;3:e001090 doi: 10.1161/JAHA.114.001090)**

Key Words: Diabetes mellitus • mortality • myocardial infarction

Mortality following acute myocardial infarction (AMI) in the United States has steadily declined over many decades.[1,2] Numerous factors have been proposed to explain this favorable trend and include better adherence to contemporary guideline-based therapies, more efficient and effective in-hospital and postdischarge processes of care, and changes in the cardiovascular (CV) risk profile of patients presenting with AMI.[3–5]

From the Divisions of Epidemiology, Biostatistics and Prevention (H.T.D., W.K.L.) and Cardiology, Department of Medicine (B.A., W.K.L.), University of New Mexico School of Medicine, Albuquerque, NM.

Correspondence to: Warren K. Laskey, MD, MPH, FAHA, Division of Cardiology, Department of Internal Medicine, MSC10-5550, 1 University of New Mexico, Albuquerque, NM 87131. E-mail: wlaskey@salud.unm.edu

Received May 7, 2014; accepted August 4, 2014.

Despite this favorable trend in AMI-related mortality, certain patients continue to carry disproportionate risk. The presence of diabetes mellitus (DM) among patients with CV disease has historically predicted worse outcomes compared with patients without DM.[6–8] CV disease or, more specifically, coronary heart disease is the leading cause of death among patients with DM,[9] and a history of DM has been considered equivalent in risk to a known history of coronary heart disease.[10] Among patients with AMI and DM, female sex has been observed to confer increased risk of adverse CV outcomes compared with men,[11,12] although more recent data suggest that this differential risk may be narrowing.[13] A recent report pointed to a reversal of the above-mentioned secular trend in CV-related mortality in persons younger than 55 years along with an increase in risk factors for DM in this cohort.[14]

Given the increasing prevalence of DM in the US population[15,16] and a continuing focus on the impact of age and sex on CV outcomes,[16,17] we examined trends among patients hospitalized for AMI to assess trends in the prevalence of DM among patients hospitalized for AMI from 2000 to 2010, to

assess trends in in-hospital mortality among AMI patients with DM, and to describe the factors associated with in-hospital mortality with a focus on the impact of age, sex, and time.

Methods

Data Source

The National Inpatient Sample (NIS) is the largest available all-payer inpatient database in the public domain and is sponsored by the Agency for Healthcare Research and Quality (AHRQ) and the Healthcare Cost and Utilization Project. The NIS consists of discharge data from more than 1000 hospitals across a majority of states and is designed to approximate a 20% stratified sample of US community hospitals.[18] The NIS provides patient discharge-level demographic and clinical characteristics that are searchable using International Classification of Diseases, ninth revision, clinical modification (ICD-9-CM) or Clinical Classification System codes. Each release of the NIS includes patient-level hospital discharge abstract data for 100% of discharges from the sample of hospitals in participating states. We used NIS severity files to extract clinician-verified comorbid conditions of patients established by AHRQ. Statistical sampling weights provided by the NIS allow extrapolation to estimate hospital discharge rates for the nation.[19] After weighting, this reflects ≈95% of hospital discharges within the United States. The study was considered exempt from formal review by the University of New Mexico institutional review board because the NIS is a public database without personal identifiers.

Data Quality

A summary data quality report is available for review for each year of the NIS.[20] Individual reports for the years 2000–2010 were reviewed by one of us (W.K.L.). Edit check failure (missing data) rates were consistently <0.5% for key data elements (eg, age, diagnoses, procedures).

Study Samples

We analyzed data in NIS for patients aged 18 years or older from 2000 to 2010. All records with a primary discharge diagnosis of AMI using ICD-9-CM codes 410.0 to 410.8 were identified (sample 1). The total number of AMI hospitalizations was calculated as the sum over all AMI ICD-9-CM codes. We then obtained the proportion of AMI discharges that occurred over the same time interval with a diagnosis of type 2 DM (T2DM; sample 2), identified by ICD-9-CM code 250.0 to 250.9 with a fifth digit of 0 or 0 or 2 because the majority of diagnosed cases of DM in adults are of the type 2 variety.[21] These ICD-9-CM codes allow for the concomitant use of insulin in persons with T2DM, and an additional diagnosis code (v.58.67) allows for the specific identification of insulin use.

Data Analysis

We excluded records from analysis if they were missing vital status at discharge, DM status, age, or sex. Weighted continuous variables are summarized as mean±SE, and weighted categorical variables are summarized as counts or percentages ±SE. For analysis purposes, age was categorized as <55, 55 to 64, 65 to 74, 75 to 84, and ≥85 years, with the "<55 years" category serving as the reference group. We used survey regression procedures designed to incorporate NIS-specified weights for descriptive statistics and multivariable models. Trends in categorical variables were tested using the Wald chi-square statistics (SAS PROC SURVEYFREQ; SAS Institute Inc.).

Multivariable Analysis

Demographic, clinical, and hospital characteristics in the NIS data sets from 2002 to 2010 were used to develop a model for in-hospital death (data sets from 2000 and 2001 were missing information on obesity and tobacco and were excluded from this portion of the analysis). Our first model (compare with sample 1 under "Study Samples") included all patients with AMI regardless of DM status, and a second model (compare with sample 2 under "Study Samples") included only those records that included AMI and T2DM diagnoses. Covariates identified as AHRQ-defined comorbidities likely present before admission were chosen for their clinical relevance, their presence in the NIS data sets, and their known association with in-hospital mortality (the dependent variable). Additional covariates that may have been identified during hospitalization and are known to be associated with mortality (eg, shock, ventricular fibrillation) were also included in this explanatory model. An indicator variable encoding for any ICD-9-CM–identified coronary revascularization procedure (surgical or percutaneous) that was performed during the hospitalization was created and added to the list of covariates. Multivariable logistic regression models that accounted for survey methodology and hospital clustering (SAS PROC SURVEYLOGISTIC) were developed to estimate the magnitude of the association between T2DM status and in-hospital mortality (using sample 1); the magnitude of association between clinical, temporal, and demographic covariates and in-hospital mortality in patients with AMI and T2DM (sample 2); and whether survival at discharge had improved over time.

In the above-noted models, the overall effects of sex, year, and age on the odds of mortality are represented by their respective β-coefficients. We added the interaction terms

"year×sex," "year×age (category)," and "year×sex×age (category)" to the above-described multivariable model to test for modification of the effect of time (year) by sex or age. Year was modeled as a continuous, linear function, whereas age and sex maintained their categorical status. Model fit was excellent (test for linear fit, $P<0.001$) and was not further improved with consideration of nonlinear relationships with time. Predicted probabilities were calculated from the inverse logit transformation and plotted and smoothed for display using a Hamming's window filter (MATLAB; MathWorks Inc.).

Rate Decomposition Analysis

In order to distinguish age versus age-independent factors driving the observed decrease in mortality rate over time, the method of rate decomposition was used.[22] Briefly, the difference in crude mortality rate (CMR) from 2000 to 2010 can be viewed as the sum of a "composition effect" (reflecting the difference in the age composition of the sample from 2000 to 2010) and a "rate effect" (reflecting the differences in the distribution of age stratum-specific mortality rates from 2000 to 2010): Δ $CMR_{2000–2010}$=composition effect+rate effect. Age standardization was performed using the average of the 2000 and 2010 NIS data sets as the standard population.

Sensitivity Analysis

Due to changing biomarker-defined criteria for AMI (particularly for the non–ST-segment elevation myocardial infarction [non-STEMI] category) as well as dissemination of these criteria into routine coding practice over the time interval of this study, we performed a subgroup analysis confined to patients with STEMI—a more consistently defined group—to assess the impact of coding (for AMI) certainty on the conclusions. Additional sensitivity analyses were conducted in 2 important subgroups of patients with AMI and T2DM: patients receiving adjunctive insulin and patients with morbid obesity.

All analyses were conducted using SAS version 9.1 and higher (SAS Institute). Given the large sample size and the multiplicity of comparison testing, 2-sided P values were considered statistically significant at ≤ 0.001. Estimated measures of association (logistic regression) are expressed as odds ratios (ORs) and 95% CIs.

Results

Data Quality and Data Quality Assurance

Differences in the number of states contributing data over time could result in biased estimates despite the sampling methodology used in the NIS. Over the 10 years from 2000 to 2010, the number of states contributing data to the NIS increased (Figure 1). Although there was "drop-out" in the number of states contributing data in the first half of the decade, these same states "dropped in" in subsequent years. However, loss of states contributing data was infrequent, and the number of participating states increased steadily from 28 in 2000 to 45 states by 2010. Due to the sampling methodology used in the NIS, the number of hospitals and the number of discharge records in the sample remained relatively flat.

There were 86 622 872 records in the combined 2000–2010 data sets, with 0.2% missing one of the above-mentioned key variables (ie, these records were excluded from further analysis). Of 86 593 459 primary diagnoses at discharge, full data were available for 99.97%. There were 1 547 859 unique principal discharge diagnoses of AMI (1.8%) in our sample and more than 7.5 million AMI records in the weighted sample (Table 1).

AMI Sample (Sample 1)

In the weighted AMI sample, the mean age was 68.1±0.2 years in 2000 and 67.4±0.2 years in 2010 ($P<0.0001$). Women represented ≈40% of the sample (Table 1). There were statistically significant increases in the prevalence of T2DM, obesity, hypertension, dyslipidemia, prior AMI, and tobacco use over time (Table 1). There was a significant change in sex ratio over time as well as a change in the age distribution over time, with an increase in the proportion of the <55 years and 55 to 64 years age groups and a decrease in the proportion of the 65 to 84 years age

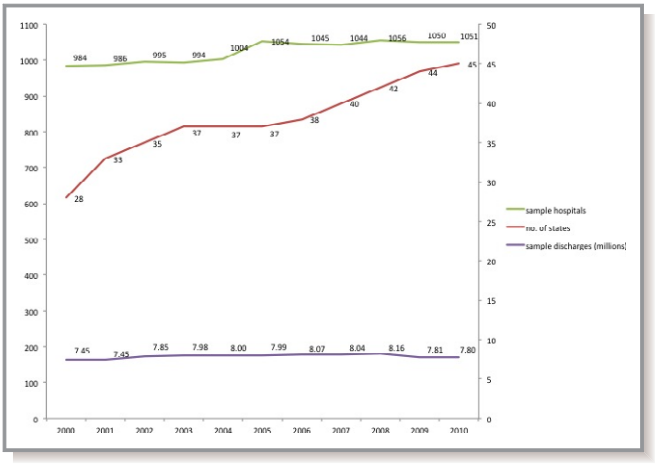

Figure 1. National Inpatient Sample activity, 2000–2010. Participation by states increased over time. Sampling methodology maintained the number of hospitals and discharges within a narrow range from 2000 to 2010.

Table 1. Pre- and In-Hospital Patient Characteristics Among All Patients With Acute Myocardial Infarction From 2000 to 2010

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	*P* Value (Trend)
N (sample)	157 263	154 693	158 029	156 672	143 222	135 141	138 374	126 231	131 380	125 777	121 077	
N (weighted)	768 407	773 858	764 133	760 718	695 063	662 345	675 121	624 936	644 657	633 356	604 784	
Prehospital, %												
Sex												
Female	41.9	41.1	41.0	40.9	40.8	40.7	39.9	40.4	40.3	39.5	39.6	<0.0001
Male	59.1	58.9	59.0	59.1	59.2	59.3	60.1	59.6	59.7	60.5	60.4	
Age group, y												
<55	19.6	19.5	20.1	20.1	19.8	20.3	21.4	21.1	20.6	21.2	20.9	<0.0001
55 to 64	18.9	18.8	19.5	20.1	20.3	20.3	21.3	21.4	21.5	22.1	22.7	<0.0001
65 to 74	24.1	23.4	22.8	22.0	22.1	21.3	21.1	21.2	21.3	21.8	21.7	<0.0001
75 to 84	25.2	25.4	24.7	24.6	24.5	23.9	23.0	22.2	22.1	21.1	20.7	<0.0001
>84	12.1	12.9	13.0	13.3	13.4	14.2	13.3	14.0	14.5	13.8	14.0	<0.0001
Race												
Non-Hispanic White	83.1	82.2	79.7	78.1$	78.9	80.2	78.6	76.8	77.6	76.6	75.9	<0.0001
Black	7.4	7.6	8.4	8.7	9.0	7.2	8.6	9.9	9.0	9.2	11.2	<0.0001
Hispanic	5.5	5.9	6.7	8.3	6.9	7.4	7.6	7.2	6.5	7.2	7.0	<0.0001
Asian	1.5	1.5	1.9	2.1	2.1	1.7	1.9	2.3	2.4	2.2	2.3	<0.0001
AI/NA	0.3	0.4	0.2	0.2	0.3	0.3	0.5	0.7	0.9	0.6	0.9	<0.0001
Other	2.2	2.4	3.1	2.6	2.8	3.1	2.9	3.2	3.6	4.3	2.7	<0.0001
Type of AMI												
STEMI	41.2	38.7	37.5	35.0	32.5	30.6	31.4	29.5	28.6	27.2	27.2	<0.0001
Comorbidities												
T2DM	22.2	22.3	24.1	24.1	25.0	26.0	26.3	26.6	27.9	29.2	29.6	<0.0001
TIA/stroke	3.8	3.8	3.9	3.9	3.9	3.9	4.0	3.9	4.3	4.2	4.0	<0.0001
Heart failure	32.2	31.6	31.9	34.1	35.0	34.6	33.3	33.9	33.6	33.9	33.9	<0.0001
Prior MI	66.2	67.8	69.1	70.4	71.0	72.3	74.3	74.9	76.7	78.4	78.3	<0.0001
Hypertension	50.7	52.7	55.2	57.1	59.1	60.8	62.9	64.2	66.1	67.8	68.8	<0.0001
Renal failure	5.7	6.4	7.0	7.7	8.3	10.9	15.7	21.5	22.7	24.4	25.5	<0.0001
AFib	16.1	16.5	16.6	16.5	16.9	17.1	17.0	16.8	15.8	15.9	16.0	<0.0001
Dyslipidemia	28.4	31.5	35.6	37.3	40.8	44.0	47.1	50.7	52.3	54.4	56.7	<0.0001
PAD	4.2	4.4	4.7	5.0	5.0	5.1	5.2	5.8	6.2	6.2	6.3	<0.0001
Cancer	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.9	0.9	0.9	<0.0001
Dementia	0.9	0.9	0.8	0.9	0.8	0.9	0.8	0.7	0.8	0.7	0.6	<0.0001
Tobacco use	—	—	16.5	16.6	17.5	19.0	20.4	21.0	21.9	22.6	22.8	<0.0001
Obesity	—	—	6.4	6.8	7.0	7.7	8.0	9.3	10.8	12.1	11.9	<0.0001
In-hospital, %												
Shock	4.1	4.1	4.3	4.5	4.5	4.6	4.7	5.1	5.4	5.8	5.7	<0.0001
VFib	2.7	2.5	2.6	2.4	2.5	2.4	2.5	2.6	2.6	2.6	2.7	0.007
Revasc	56.9	59.1	59.8	61.2	61.8	63.8	66.5	65.9	66.4	69.5	69.7	<0.0001

AFib indicates atrial fibrillation; AI/NA, American Indian or Native American; MI, myocardial infarction; PAD, peripheral arterial disease; Revasc, coronary revascularization procedure; STEMI, ST-segment elevation myocardial infarction; T2DM, type 2 diabetes mellitus; TIA, transient ischemic attack; VFib, ventricular fibrillation.

group ($P<0.0001$). The type of AMI also changed over the study interval, with an increase in the proportion of non-STEMI to STEMI.

AMI and T2DM Sample (Sample 2)

Within the AMI sample, there were 435 265 records (28.1%) with a coexistent T2DM diagnosis code (Table 2). As seen in Figure 2, there was a significant increase in the prevalence of T2DM over time (year 2000, 22.2%; year 2010, 29.6%, *P* for trend <0.0001). AMI patients with T2DM were younger in 2010 compared with 2000 (mean age in 2000, 68.9±0.4 years; mean age in 2010, 67.8±0.3 years; *P* for overall trend <0.0001) but were older than AMI patients without T2DM ($P<0.0001$) (Table 3). The majority of CV risk factors increased in prevalence over the study period (Table 2), and the proportions of these risk factors were significantly higher compared with patients without T2DM (Table 3). As observed in the overall AMI sample, the proportion of non-STEMI to STEMI increased significantly over time. Coronary revascularization procedures, the vast majority (>75%) of which were percutaneous, steadily and significantly increased over the observed time (Figure 3). The use of these procedures in patients with AMI and coexistent T2DM was consistently greater than in AMI patients overall (Tables 1 and 2).

In-Hospital Mortality in AMI With T2DM

The CMR decreased by 3.1% in all AMI patients (year 2000, 8.4%; year 2010, 5.3%; $P<0.0001$). Among AMI patients with T2DM, there was a 3.2% absolute reduction in CMR (year 2000, 8.0%; year 2010, 4.8%; $P<0.0001$). Figure 4 depicts the significant downward trend in CMR and age-standardized mortality rate among AMI patients with T2DM stratified on sex. Although women with T2DM had a higher initial age-standardized mortality rate than men with T2DM, there was a greater absolute decline in mortality over the study period among women (women, −3.4%; men, −2.3%; $P<0.0001$).

Rate Decomposition Analysis

Using the method of rate decomposition as described under "Methods," the rate effect for men was 0.025 and the composition effect was 0.001. The total, 0.025+0.001, or 0.026, matches the difference in CMR for men from 2000 to 2010 and suggests that a change in stratum-specific risk for mortality is the main driver of the observed decrease in mortality in men and is not due to differences in age structure of the populations. For women, the rate effect was 0.035 and the composition effect was 0.001. The sum of these 2 components, 0.034, matches the difference in CMR for women from 2000 to 2010 and suggests that, as with men, the main driver for the decrease in mortality is a change in risk structure rather than a change in age structure of the populations.

Characteristics Associated With In-Hospital Mortality in Patients With AMI

Table 4 reports adjusted ORs and their respective 95% CIs for the associations between relevant clinical, demographic, year, and hospital-level characteristics and in-hospital mortality. Most notable is the significant overall adverse impact of DM on mortality (adjusted OR 1.069, 95% CI 1.051 to 1.087; $P<0.001$). The magnitude of this association, however, did not change significantly over time, as indicated by the adjusted OR for the interaction term DM×year (OR 1.04, 95% CI 0.989 to 1.090; $P=0.132$). There was a significant increase in the odds of mortality for each age group compared with the reference age group of <55 years. The use of coronary revascularization procedures was strongly and inversely associated with the odds of in-hospital death.

Characteristics Associated With In-Hospital Mortality in Patients With AMI and T2DM

A primary interest in the present study centers on the group with AMI and coexistent T2DM. Table 5 reports adjusted ORs and their respective 95% CIs for the association between the same covariates listed in Table 4 and in-hospital mortality. In the fully adjusted model, the nominal increase in the odds of mortality among women was not significant (OR 1.033, 95% CI 0.997 to 1.072; $P=0.0765$). Older age (compared with the reference age group of <55 years) was significantly associated with mortality. There was a significant decrease in the odds of death for each successive year when year was modeled as a continuous variable (OR 0.774, 95% CI 0.722 to 0.830; $P<0.0001$). Noted again is a strong and inverse association between the use of coronary revascularization procedures and in-hospital death (OR 0.292, 95% CI 0.276 to 0.308; $P<0.0001$).

Modification of the Effect of Time on Mortality by Age and Sex

As described under "Methods," interaction terms were added to the final multivariable regression model with year modeled as a continuous linear function. The triple interaction term year×sex×age was statistically significant (OR 0.774, 95% CI 0.726 to 0.824; $P<0.0001$), as were the interaction terms year×age (OR 0.94, 95% CI 0.915 to

Table 2. Pre- and In-Hospital Patient Characteristics Among Patients With AMI and Coexistent Diabetes Mellitus

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	*P* Value (Trend)
N (sample)	36 753	37 752	40 673	41 633	39 107	38 635	40 745	38 993	41 235	40 238	39 501	
N (weighted)	179 646	188 898	196 987	200 244	189 870	189 348	198 903	193 004	202 011	202 774	197 492	
Prehospital, %												
Sex												
Male	55.3	55.5	55.6	55.4	56.2	55.9	56.6	56.9	56.9	57.8	57.5	<0.0001
Female	44.7	44.5	44.4	44.6	43.8	44.1	43.4	43.1	43.1	42.2	42.5	
Age group, y												
<55	14.5	14.4	15.1	14.9	15.2	15.6	16.9	16.6	16.3	16.9	16.9	<0.0001
55 to 64	20.4	20.0	21.0	21.5	22.3	22.3	22.6	23.1	23.0	23.5	23.8	<0.0001
65 to 74	28.5	28.2	27.3	26.7	26.2	25.5	25.4	25.3	25.7	25.9	25.6	<0.0001
75 to 84	26.6	27.5	26.6	26.5	26.2	25.6	24.8	24.4	24.2	22.8	22.8	<0.0001
>84	9.9	10.0	10.1	10.4	10.2	11.0	10.2	10.7	10.9	10.8	10.9	<0.0001
Race												
Non-Hispanic White	77.7	76.4	73.1	71.0	72.3	73.9	71.8	70.2	71.3	70.1	69.3	<0.0001
Black	9.3	9.5	10.8	10.9	11.0	9.2	10.9	11.9	11.1	11.5	13.4	<0.0001
Hispanic	8.2	9.0	9.6	11.9	10.0	10.5	11.0	10.4	9.4	10.1	9.9	<0.0001
Asian	2.0	2.1	2.6	2.9	3.1	2.3	2.4	3.0	3.2	2.8	3.1	<0.0001
AI/NA	0.3	0.4	0.4	0.3	0.4	0.5	0.7	0.9	1.0	0.7	1.0	<0.0001
Other	2.5	2.6	3.6	3.0	3.2	3.7	3.2	3.6	4.0	4.9	3.3	<0.0001
Type of AMI												
STEMI	34.8	32.4	30.9	28.5	26.5	24.2	24.8	23.2	22.4	21.0	21.1	<0.0001
Comorbidities												
TIA/stroke	4.0	4.0	4.1	4.2	4.2	4.3	4.3	4.2	4.6	4.5	4.3	<0.0001
Heart failure	40.1	39.6	40.2	41.7	42.5	42.1	40.2	41.4	40.4	40.8	40.3	0.017
Prior MI	69.5	71.3	72.3	74.1	74.6	76.3	77.7	78.7	80.0	81.8	81.7	<0.0001
Hypertension	62.5	64.0	67.1	69.0	71.2	72.5	74.6	75.6	76.6	78.4	79.4	<0.0001
Renal failure	6.6	7.5	8.5	9.0	9.4	13.1	20.7	28.7	30.3	32.8	33.7	<0.0001
AFib	15.5	15.5	16.1	15.6	15.7	15.9	16.3	16.4	15.7	15.9	15.9	<0.0001
Dyslipidemia	30.7	34.6	39.6	42.0	46.1	49.2	52.7	56.8	58.2	59.9	62.5	<0.0001
PAD	6.1	6.4	6.7	7.1	7.2	7.4	7.3	8.4	8.8	8.5	8.7	<0.0001
Cancer	0.5	0.6	0.6	0.5	0.6	0.7	0.6	0.8	0.7	0.7	0.6	<0.0001
Dementia	0.9	0.9	0.8	0.9	0.9	0.9	0.8	0.7	0.8	0.7	0.6	<0.0001
Tobacco use	—	—	11.1	11.2	12.1	13.4	14.5	15.6	16.5	16.8	17.4	<0.0001
Obesity	—	—	10.3	10.8	11.4	12.5	13.3	15.1	17.2	18.9	18.9	<0.0001
In-hospital, %												
Shock	3.4	3.4	3.7	3.5	3.6	3.6	3.7	4.1	4.6	5.0	5.0	<0.0001
VFib	1.6	1.5	1.6	1.4	1.6	1.5	1.5	1.6	1.7	1.6	1.6	<0.0001
Revasc	58.2	60.5	61.3	62.7	63.2	65.4	68.1	67.5	67.8	70.9	71.1	<0.0001

AFib indicates atrial fibrillation; AI/NA, American Indian or Native American; AMI, acute myocardial infarction; MI, myocardial infarction; PAD, peripheral arterial disease; Revasc, coronary revascularization procedure; STEMI, ST-segment elevation myocardial infarction; TIA, transient ischemic attack; VFib, ventricular fibrillation.

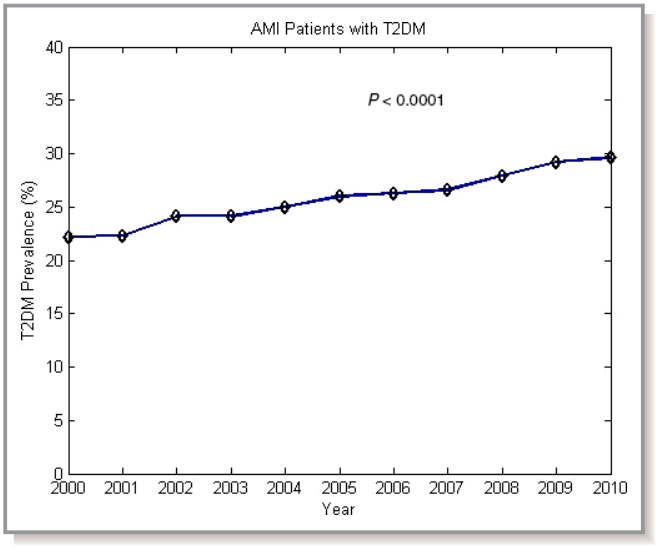

Figure 2. Prevalence of T2DM over time in patients with AMI. Steady and significant increase in prevalence of T2DM among patients with AMI from 2000 to 2010. AMI indicates acute myocardial infarction; T2DM, type 2 diabetes mellitus.

0.965; $P<0.0001$) and year×sex (OR 1.157, 95% CI 1.088 to 1.230; $P<0.0001$). Figure 5 attempts to graphically depict this complex set of interactions another way by showing the probability of death (*y*-axis) as a function of time (*x*-axis) by sex (taking into account the interaction of age and sex), whereas Figure 6 shows the probability of death as a function of time for each age category (taking into account the interaction of age category and sex). The presence of effect modification is reflected in the nonparallel relationship between group-specific plots. Notably, the annual change in the probability of (lower) mortality was less in men than in women and less in younger patients than in older patients.

Sensitivity Analyses

A sensitivity analysis was undertaken to assess the effect of potential information bias in the coding of type of AMI by limiting the analysis to only patients with STEMI (Tables 6 through 8). In STEMI patients with T2DM (Table 7), in-hospital crude mortality was higher compared with the overall STEMI group (Table 6), although mortality rates in all patients with STEMI and those with T2DM significantly declined over the observation period. In patients with STEMI, the frequency of CV risk factors increased over time, although the impact of diabetes was similar to the effect in AMI patients overall (T2DM: OR 1.11, 95% CI 1.066 to 1.156; $P<0.0001$) (Table 9).

Additional sensitivity analyses were undertaken in 2 important subgroups: those coded for adjunctive insulin use (ICD-9-CM V58.67) and those coded for morbid obesity (ICD-9-CM 278.01). Adjunctive insulin use was identified in only 1.6% of the sample of patients with AMI and coexistent T2DM (Table 10) and is accompanied by higher risk of in-hospital death for this subgroup compared with the group with AMI and coexistent T2DM overall. Similarly, morbid obesity was identified in 1.8% of the entire sample and is accompanied by higher risk of in-hospital death (Table 10). There was no significant change in death rate in either subgroup over the observation time.

Discussion

Using a nationally representative sample of more than 1.5 million patients hospitalized with AMI from 2000 to 2010, our findings support the following conclusions. First, over the past decade, there have been significant increases in the prevalence of T2DM and the prevalences of CV risk factors in AMI patients. Second, despite this increased disease burden, there has been a 40% reduction in in-hospital mortality over time. Third, the reduction in mortality risk varied by age and sex. Fourth, the adverse impact of T2DM on in-hospital mortality has not significantly changed over this time period.

Possible explanations for these observations include earlier diagnosis and aggressive management of this traditionally high-risk group, inclusion of relatively lower risk subjects compared with earlier time periods, secular trends in AMI-related incidence and mortality, or a combination of all of these. We explored the likelihood of inclusion of such potentially lower risk subjects as well as the likelihood of more aggressive ascertainment and treatment, either or both of which might contribute to an observed increase in prevalence of T2DM or improvement in in-hospital mortality over the time of this study. The serum glucose threshold for a diagnosis of DM was modified in 1997 and 1999[23] and antedate the time period of the current study. $HbA1_c$ was not recommended for use as a diagnostic test for DM until 2009–2010.[24] The present data from 2000 to 2010 would not have been affected by the changes in the serum glucose threshold for diagnosis of DM, and the widespread use of $HbA1_c$ as a diagnostic tool is not relevant to the time frame of this study. Consequently, the present observations are less subject to potential misclassification and/or spectrum bias. The present data demonstrate a decline in in-hospital mortality beginning well before 2009–2010, minimizing potential spectrum bias from the use of $HbA1_c$ criteria.

Potentially influencing the observed decrease in in-hospital mortality is the increasing prevalence of patients with non-STEMI-type AMI, a group felt to be at lower risk. Similar to other reports,[1,6,25] we observed an increase in the absolute and relative prevalence of non-STEMI from 2000 to 2010.

Table 3. Pre- and In-Hospital Patient Characteristics Among Patients With AMI and Without Diabetes Mellitus

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	*P* Value (Trend)	*P* Value (DM vs No DM)
N (sample)	120 510	116 941	117 356	115 039	104 115	96 506	97 629	87 238	90 145	85 539	81 576		
N (weighted)	588 826	584 900	567 133	550 154	504 964	472 811	476 086	43 175	442 524	430 546	248 774		
Prehospital, %													
Sex													
Male	60.3	60.0	60.2	60.4	60.3	60.6	61.6	60.9	60.9	61.7	61.8	<0.0001	<0.0001
Female	39.7	40.0	39.8	39.6	39.7	39.4	38.4	39.1	39.1	38.3	38.2		
Age group, y													
<55	21.2	21.1	21.8	22.0	21.6	22.1	23.3	23.2	22.5	23.2	22.9	<0.0001	<0.0001
55 to 64	18.5	18.4	19.0	19.6	19.5	19.5	20.7	20.7	20.9	21.5	22.1	<0.0001	
65 to 74	22.8	21.9	21.2	20.3	20.5	19.6	19.3	19.3	19.3	19.8	19.7	<0.0001	
75 to 84	24.8	24.7	24.0	23.9	23.8	23.3	22.2	21.3	21.2	20.3	19.7	<0.0001	
>84	12.8	13.9	14.0	14.3	14.5	15.5	14.6	15.5	16.1	15.3	15.5	<0.0001	
Race													
Non-Hispanic White	84.8	84.1	82.0	80.7	81.5	82.8	81.5	79.8	80.6	79.7	79.1	<0.0001	<0.0001
Black	6.8	7.0	7.6	7.9	8.3	6.4	7.6	8.9	8.0	8.1	10.1	<0.0001	
Hispanic	4.7	4.9	5.7	6.9	5.7	6.2	6.1	5.7	5.1	5.8	5.6	<0.0001	
Asian	1.4	1.3	1.6	1.8	1.8	1.5	1.7	2.0	2.0	1.9	1.9	<0.0001	
AI/NA	0.2	0.4	0.2	0.1	0.3	0.2	0.4	0.6	0.9	0.6	0.8	<0.0001	
Other	2.1	2.4	2.9	2.5	2.6	2.9	2.7	3.0	3.5	4.0	2.4	<0.0001	
Type of AMI													
STEMI	43.2	40.7	39.8	37.4	34.7	33.1	34.1	32.3	31.4	30.1	30.1	<0.0001	<0.0001
Comorbidities													
TIA	3.8	3.7	3.8	3.7	3.8	3.8	3.8	3.8	4.2	4.0	3.9	<0.0001	<0.0001
Heart failure	29.8	29.1	29.0	31.3	32.2	31.6	30.5	30.6	30.4	30.6	30.8	<0.0001	<0.0001
Prior MI	65.2	66.7	67.9	69.1	69.6	70.7	72.9	73.2	75.1	76.8	76.6	<0.0001	<0.0001
Hypertension	47.0	49.0	51.1	52.7	54.5	56.1	58.0	59.1	61.3	62.9	63.7	<0.0001	<0.0001
Renal failure	5.5	6.1	6.5	7.3	7.9	10.0	13.6	18.2	19.2	20.5	21.4	<0.0001	<0.0001
AFib	16.3	16.8	16.8	16.9	17.3	17.6	17.3	17.0	15.9	15.9	16.0	<0.0001	<0.001
Dyslipidemia	27.7	30.5	34.3	35.6	38.8	41.9	44.7	47.9	49.6	51.9	53.9	<0.0001	<0.0001
PAD	3.6	3.7	4.0	4.2	4.2	4.1	4.3	4.7	5.1	5.1	5.1	<0.0001	<0.0001
Cancer	0.7	0.7	0.8	0.7	0.9	0.9	0.9	1.0	1.0	1.0	1.0	<0.0001	<0.0001

Continued

DOI: 10.1161/JAHA.114.001090

Table 3. Continued

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	*P* Value (Trend)	*P* Value (DM vs No DM)
Dementia	1.0	0.9	0.8	0.9	0.7	0.8	0.8	0.7	0.8	0.7	0.6	<0.0001	0.9
Tobacco use	—	—	18.4	18.6	19.5	21.3	22.9	23.4	24.3	25.4	25.4	<0.0001	<0.0001
Obesity	—	—	5.0	5.3	5.3	5.7	5.9	6.7	7.9	8.8	8.5	<0.0001	<0.0001
In-hospital, %													
Shock	4.3	4.3	4.6	4.8	4.8	5.0	5.1	5.5	5.8	6.2	6.1	<0.0001	<0.0001
VFib	3.0	2.8	2.9	2.8	2.9	2.7	2.9	3.0	3.0	3.1	3.2	<0.0001	<0.0001
Revasc	58.2	60.5	61.3	62.7	63.2	65.4	68.0	67.5	67.8	70.9	71.1	<0.0001	<0.0001

AFib indicates atrial fibrillation; AI/NA, American Indian or Native American; AMI, acute myocardial infarction; MI, myocardial infarction; PAD, peripheral arterial disease; Revasc, coronary revascularization procedure; STEMI, ST-segment elevation myocardial infarction; TIA, transient ischemic attack; VFib, ventricular fibrillation.

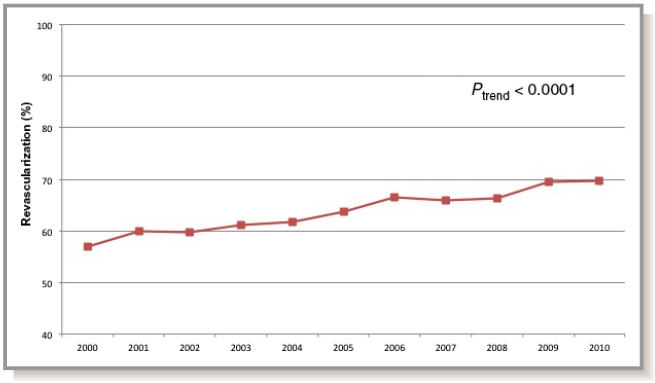

Figure 3. Frequency of coronary revascularization during hospitalization. From 2000 to 2010, there was a 23% increase in the use of coronary revascularization procedures in patients with acute myocardial infarction and type 2 diabetes mellitus. The majority (>75%) of these procedures were percutaneous coronary interventions.

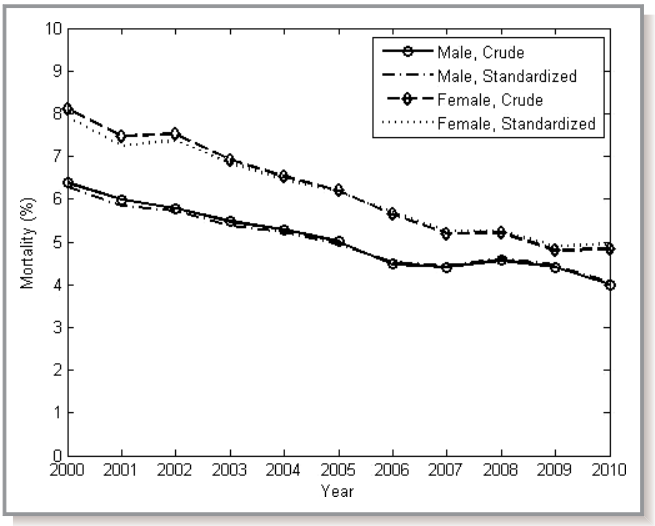

Figure 4. Decrease in crude and age-standardized mortality rates by sex. Crude and age-standardized mortality rates in both men and women decreased significantly from 2000 to 2010.

Decreasing overall mortality rates, although potentially influenced by changing biomarker criteria for AMI, antedate the current universal use of troponin as the preferred biomarker for the diagnosis of AMI. In addition, ICD-9-CM codes for AMI changed in 2005.[26] Despite higher in-hospital mortality for patients with STEMI, both before and after 2005, the difference in mortality rates between STEMI and non-STEMI was not statistically significant (2000–2005 difference, 2.17%; 2006–2010 difference, 2.26%; *P*=0.6), and mortality decreased equally over time in both STEMI and non-STEMI groups. The results of our sensitivity analysis of the STEMI-only patients (thereby obviating much of the uncertainty in diagnosis related to the increasing reliance on biomarker

Table 4. Characteristics Associated With In-Hospital Mortality in All Patients With Acute Myocardial Infarction, 2002–2010

Effect	Odds Ratio	95% CI	*P* Value
T2DM	1.069	1.051 to 1.087	<0.0001
Year	0.751	0.719 to 0.785	<0.0001
Female	1.071	1.05 to 1.093	<0.0001
Age (vs <55), y			
55 to 64	1.651	1.578 to 1.727	<0.0001
65 to 74	2.477	2.371 to 2.588	<0.0001
75 to 84	3.93	3.758 to 4.109	<0.0001
>84	5.996	5.71 to 6.297	<0.0001
Race (vs white)			
Black	1.019	0.972 to 1.069	0.4267
Hispanic	1.072	1.016 to 1.132	0.0114
Asian	1.035	0.964 to 1.111	0.3471
AI/NA	0.871	0.738 to 1.028	0.1013
Other	0.979	0.916 to 1.046	0.5301
STEMI	1.308	1.276 to 1.34	<0.0001
TIA/stroke	1.827	1.758 to 1.898	<0.0001
Heart failure	1.228	1.199 to 1.257	<0.0001
Prior MI	0.536	0.522 to 0.551	<0.0001
Hypertension	0.773	0.756 to 0.791	<0.0001
Renal failure	2.24	2.187 to 2.294	<0.0001
AFib	1.072	1.047 to 1.096	<0.0001
Dyslipidemia	0.467	0.456 to 0.479	<0.0001
PAD	1.165	1.119 to 1.213	<0.0001
Cancer	2.427	2.257 to 2.611	<0.0001
Dementia	0.989	0.914 to 1.069	0.7736
Smoke	0.658	0.632 to 0.686	<0.0001
Obesity	0.786	0.75 to 0.824	<0.0001
VFib	4.986	4.751 to 5.233	<0.0001
Shock	9.425	9.104 to 9.757	<0.0001
Revasc	0.395	0.381 to 0.409	<0.0001
Hospital size (medium vs small)	1.021	0.964 to 1.081	0.4781
Hospital size (large vs small)	0.993	0.941 to 1.049	0.8112
Hospital location (urban vs rural)	0.873	0.828 to 0.921	<0.0001

AFib indicates atrial fibrillation; AI/NA, American Indian or Native American; MI, myocardial infarction; PAD, peripheral arterial disease; Revasc, coronary revascularization procedure; STEMI, ST-segment elevation myocardial infarction; T2DM, type 2 diabetes mellitus; TIA, transient ischemic attack; VFib, ventricular fibrillation.

criteria) confirm the observed decrease in mortality in the AMI group overall and support the thesis that the diabetic condition itself confers an increased risk of mortality. Particularly high-risk diabetic patients, such as those requiring supplemental insulin or morbidly obese patients, demonstrated in-hospital mortality rates that were significantly higher than overall mortality and that did not decline. However, these latter observations must be qualified due to the small sample sizes and the possibility of undercoding or undercounting.

Secular improvements in primary and secondary prevention of CV disease and AMI treatment strategies over the study period may well have affected the continuing reduction in in-hospital mortality rates in all patients.[1,4,27,28]

Table 5. Characteristics Associated With In-Hospital Mortality in Patients With Type 2 Diabetes Mellitus, 2002–2010

Effect	Odds Ratio	95% CI	*P* Value
Year	0.774	0.722 to 0.83	<0.0001
Female	1.033	0.997 to 1.072	0.0765
Age (vs <55), y			
55 to 64	1.473	1.349 to 1.607	<0.0001
65 to 74	2.001	1.835 to 2.182	<0.0001
75 to 84	2.762	2.536 to 3.007	<0.0001
>84	3.475	3.165 to 3.816	<0.0001
Race (vs white)			
Black	0.926	0.869 to 0.986	0.0168
Hispanic	1.016	0.95 to 1.088	0.6398
Asian	0.873	0.781 to 0.976	0.0173
AI/NA	1.095	0.84 to 1.427	0.5016
Other	0.902	0.809 to 1.006	0.0636
STEMI	1.76	1.681 to 1.843	<0.0001
TIA/stroke	1.753	1.635 to 1.879	<0.0001
Heart failure	1.085	1.042 to 1.13	<0.0001
Prior MI	0.754	0.724 to 0.785	<0.0001
Hypertension	0.8	0.768 to 0.832	<0.0001
Renal failure	1.991	1.91 to 2.075	<0.0001
AFib	1.092	1.045 to 1.141	<0.0001
Dyslipidemia	0.537	0.515 to 0.56	<0.0001
PAD	1.127	1.06 to 1.199	0.0001
Cancer	1.751	1.491 to 2.056	<0.0001
Dementia	0.929	0.803 to 1.075	0.3232
Smoke	0.747	0.69 to 0.809	<0.0001
Obesity	0.825	0.771 to 0.883	<0.0001
VFib	9.508	8.653 to 10.447	<0.0001
Shock	12.086	11.409 to 12.804	<0.0001
Revasc	0.292	0.276 to 0.308	<0.0001
Hospital size (medium vs small)	1.107	1.025 to 1.195	0.0095
Hospital size (large vs small)	1.225	1.142 to 1.314	<0.0001
Hospital location (urban vs rural)	1.137	1.055 to 1.224	0.0007

AFib indicates atrial fibrillation; AI/NA, American Indian or Native American; MI, myocardial infarction; PAD, peripheral arterial disease; Revasc, coronary revascularization procedure; STEMI, ST-segment elevation myocardial infarction; TIA, transient ischemic attack; VFib, ventricular fibrillation.

A decrease in mortality rate among DM patients is suggestive of a decrease in disease incidence, a decrease in case fatality rate, or a change in disease-severity spectrum. The latter hypothesis is consistent with improved population-based risk factor management of DM[28–30] and/or sharing in overall favorable secular changes in the incidence of AMI and AMI-related mortality. We observed lower odds over time for mortality among DM patients despite increasing frequencies of a history of AMI, a history of hypertension, and a history of dyslipidemia, an observation that may reflect the extent and effectiveness of evidence-based medical therapy at the time of presentation. Similar conclusions have been reported from other large population-based registries and studies.[26–33] These latter studies and their conclusions are also consistent with the results of our rate decomposition analysis and suggest an

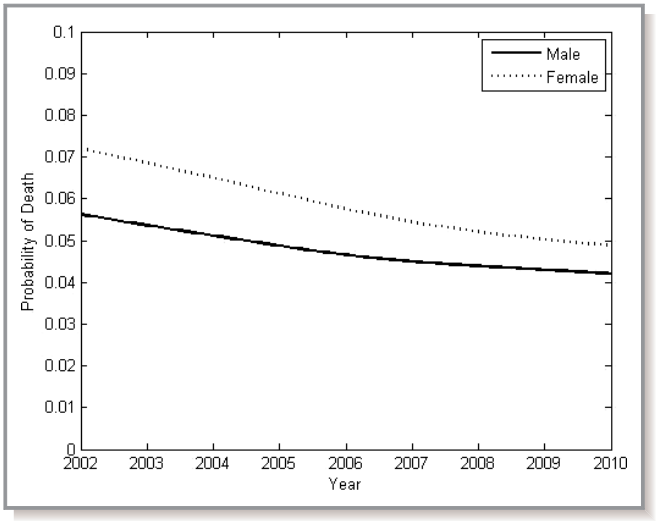

Figure 5. Effect modification of time (year) by sex. Probability of death plotted against time stratified by sex. The nonparallel nature of the plots is consistent with a statistically significant interaction between time and sex. The probability of death for each sex takes into account the variation in probability of death with age.

overall decrease in age-independent risk in patients either as a result of receiving appropriate care for risk factors identified prior to the time of AMI or a true population-based shift in the spectrum of disease severity. Consequently, the countervailing effects of an increase in disease burden, namely, prevalence of risk factors, and effective treatment of these risk factors must be kept in mind when forecasting future trends.

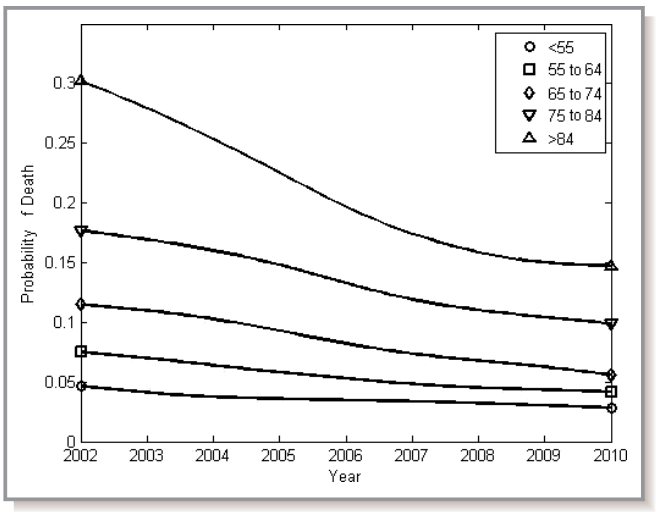

Figure 6. Effect modification of time (year) by age. Probability of death plotted against time stratified by age. The nonparallel nature of the plots is consistent with a statistically significant interaction between time and age. The probability of death within each age category takes into account the variation in probability of death with sex.

As shown in the current analysis, both sex and age continue to affect the risk of in-hospital mortality in AMI patients with DM. Older age has been known to be a risk factor for CV disease-related mortality. In the present analysis, the impact of sex on death in AMI patients with DM was dependent not only on the specific age category but also on time. When taking time into account, the odds for mortality for each subsequent year lessened, to a smaller extent among younger patients, and was dependent on sex. The impact of cohort-specific changes in mortality risk in these younger subjects cannot be determined from the present analysis; however, the increasing prevalence of obesity—a strong risk factor for T2DM—in these younger cohorts[34] may contribute to the increase in prevalence of T2DM as well as the "leveling off" of the decreasing mortality risk observed in older cohorts.[14]

Limitations

The NIS database was used for the present retrospective analysis using ICD-9-CM and Clinical Classification System codes. Miscoding cannot be completely ruled out, although the large number of patients in the database would strongly mitigate significant misclassification bias. Prior analyses have shown excellent positive and negative predictive capability of ICD-9-CM codes for CV risk factors in general[35] and, specifically, for AMI.[36,37] The analysis could be biased by "upcoding" or "Diagnosis-related group (DRG) creep," which may have resulted in overreporting of comorbidities[38]; however, the impact of such would likely have been uniform across the groups, would be unlikely to bias CMRs, and would bias the results of a comparison toward the null.

Data accuracy and comparisons to other national data sets

Data quality assessment of the NIS is performed annually and ensures the internal validity of the data.[20] Comparisons against other nationwide data sources (eg, the National Hospital Discharge Survey from the National Center for Health Statistics) provide external validation for the NIS.[39,40]

We were only able to assess in-hospital mortality and do not have data on longer term outcomes that may be more relevant, particularly for younger patients. Observational studies may not be able to fully adjust for residual or unmeasured confounding that might affect our estimates for the reported associations between in-hospital mortality and observed covariates. Finally, the absence of specific data on in-hospital medical therapy in the NIS database precludes further analysis regarding the impact of prevalent treatment on outcomes. Notwithstanding the above caveats, the NIS represents the largest publicly available

Table 6. Pre- and In-Hospital Characteristics Among Patients With ST-Segment Elevation Myocardial Infarction

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	*P* Value
N (sample)	64 918	316 871	59 433	54 960	46 332	41 405	43 559	37 249	37 556	34 200	32 900	
N (weighted)	316 871	10 744	286 615	262 937	225 706	202 291	211 620	184 115	184 442	172 006	164 297	
Prehospital												
Sex, %												
Male	63.23	63.76	64.03	64.72	65.02	65.50	66.95	66.85	67.17	68.39	68.74	<0.0001
Female	36.77	36.24	35.97	35.28	34.98	34.50	33.06	33.15	32.83	31.61	31.26	<0.0001
Age, y, %												
<55	25.81	26.13	27.19	27.84	27.31	28.11	30.00	29.99	29.40	30.46	29.96	<0.0001
55 to 64	22.08	22.25	22.68	24.08	24.38	25.01	25.70	25.90	26.68	26.90	28.15	<0.0001
65 to 74	23.24	22.72	22.03	21.11	20.99	20.15	19.62	19.27	20.18	20.09	20.04	<0.0001
75 to 84	20.47	20.12	19.31	18.58	18.88	17.83	16.53	16.29	15.51	14.75	14.33	<0.0001
>84	8.40	8.78	8.79	8.39	8.44	8.90	8.15	8.55	8.23	7.80	7.51	<0.0001
Race, %												
White	83.80	82.85	80.53	79.52	80.77	81.80	81.19	78.52	79.37	78.55	78.16	<0.0001
Black	6.16	6.32	6.87	7.28	6.99	5.56	6.51	7.78	7.06	7.21	8.07	<0.0001
Hispanic	5.55	6.05	6.91	7.85	6.64	7.42	7.04	7.37	6.28	6.85	7.36	<0.0001
Asian	1.69	1.53	2.06	2.20	2.22	1.78	1.95	2.08	2.23	2.20	2.37	<0.0001
AI/AN	0.26	0.37	0.22	0.18	0.30	0.27	0.43	0.57	0.99	0.64	0.93	<0.0001
Other	2.53	2.88	3.41	2.98	3.10	3.18	2.88	3.68	4.09	4.56	3.11	<0.0001
Comorbidities, %												
T2DM	19.73	20.42	21.26	21.71	22.29	22.68	23.34	24.29	24.56	24.74	25.42	<0.0001
TIA/stroke	3.05	3.00	3.02	2.84	2.91	2.69	2.75	2.69	2.90	2.52	2.80	<0.0001
Heart failure	25.39	24.16	24.42	25.20	25.43	24.24	23.45	24.04	23.23	23.39	22.81	<0.0001
Prior MI	66.56	68.68	70.59	72.63	74.39	76.10	78.77	80.01	82.87	84.08	84.13	<0.0001
Hypertension	46.32	48.07	50.07	51.46	53.05	54.43	56.36	57.99	59.42	60.81	61.32	<0.0001
Renal failure	4.63	5.04	5.59	5.77	6.12	7.52	9.93	12.97	13.66	14.38	14.84	<0.0001
AFib	12.73	12.85	12.99	12.26	12.80	12.53	12.16	12.00	11.25	11.19	10.95	<0.0001
Dyslipidemia	30.38	33.50	37.68	39.52	43.26	46.92	49.91	53.47	55.06	57.06	58.82	<0.0001
PAD	2.94	2.98	3.27	3.29	3.31	3.25	3.41	3.67	3.87	3.65	3.66	<0.0001
Cancer	0.57	0.61	0.58	0.57	0.60	0.71	0.60	0.73	0.71	0.65	0.69	<0.0001
Dementia	0.64	0.63	0.52	0.51	0.44	0.51	0.48	0.40	0.38	0.39	0.29	<0.0001
Tobacco use	—	—	24.00	25.39	26.93	29.08	31.12	32.07	33.86	34.73	34.69	<0.0001
Obesity	—	—	11.4075	12.4402	12.5151	14.701	14.9526	15.7799	17.9707	19.4745	19.9242	<0.0001
In-hospital, %												
Shock	6.19	6.51	7.01	7.23	7.52	8.25	8.39	9.28	9.96	10.71	10.75	<0.001
VFib	4.27	4.23	4.61	4.59	4.85	4.88	5.11	5.46	5.72	6.16	6.19	<0.0001
Revasc	70.52	72.84	74.60	76.56	77.72	81.19	83.38	84.68	86.53	89.02	89.65	<0.0001
Mortality	9.09	8.57	8.36	7.93	7.77	7.65	6.85	7.14	6.93	6.63	6.32	<0.0001

AFib indicates atrial fibrillation; AI/NA, American Indian or Native American; MI, myocardial infarction; PAD, peripheral arterial disease; Revasc, coronary revascularization procedure; T2DM, type 2 diabetes mellitus; TIA, transient ischemic attack; VFib, ventricular fibrillation.

Table 7. Pre- and In-Hospital Characteristics Among Patients With ST-Segment Elevation Myocardial Infarction and Type 2 Diabetes Mellitus

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	*P* Value
N (sample)	12 812	12 228	12 604	11 901	10 320	9393	10 161	9052	9231	8462	8355	
N (weighted)	62 539	61 147	60 933	57 118	50 340	45 901	49 407	44 722	45 303	42 561	41 762	
Prehospital, %												
Sex, %												
Male	59.27	59.49	59.69	59.57	61.00	61.73	62.70	63.73	63.35	64.36	63.95	<0.0001
Female	40.73	40.51	40.31	40.43	39.00	38.27	37.30	36.27	36.65	35.64	36.05	<0.0001
Age, y, %												
<55	19.84	20.23	21.95	21.70	21.55	23.46	25.61	25.75	24.67	26.23	25.93	<0.0001
55 to 64	23.81	24.05	24.12	25.55	26.26	27.42	27.16	27.05	27.73	27.16	29.43	<0.0001
65 to 74	27.35	26.63	25.46	25.14	24.77	22.53	23.12	22.28	23.98	23.07	22.90	<0.0001
75 to 84	21.71	21.99	20.93	20.09	20.48	19.29	17.40	18.02	16.80	16.46	15.46	<0.0001
>84	7.29	7.09	7.54	7.52	6.95	7.30	6.70	6.89	6.82	7.08	6.29	<0.0001
Race, %												
White	77.22	75.90	72.99	71.11	73.23	74.26	73.74	70.58	72.38	70.77	69.78	<0.0001
Black	8.35	8.45	9.19	9.53	9.27	7.28	8.66	10.02	9.64	9.69	10.40	<0.0001
Hispanic	8.85	9.93	10.28	12.40	10.35	11.57	10.93	11.42	9.52	10.42	11.22	<0.0001
Asian	2.23	2.00	3.04	3.05	3.11	2.53	2.60	2.99	2.87	2.96	3.39	<0.0001
AI/AN	0.43	0.34	0.43	0.28	0.45	0.42	0.68	0.88	1.12	0.68	1.26	<0.0001
Other	2.93	3.39	4.06	3.64	3.60	3.94	3.39	4.11	4.48	5.49	3.95	<0.0001
CV risk factors, %												
TIA/stroke	3.23	3.56	3.23	3.22	3.27	3.25	3.04	3.13	3.26	2.69	3.12	<0.0001
Heart failure	31.51	29.93	30.67	31.37	31.57	29.91	28.15	30.14	27.86	28.51	27.27	<0.0001
Prior MI	68.05	71.35	71.98	74.73	76.40	78.75	80.52	82.42	84.91	85.72	85.84	<0.0001
Hypertension	60.00	61.62	64.15	66.09	68.27	68.39	72.04	72.71	72.90	75.88	75.24	<0.0001
Renal failure	5.38	5.71	6.89	7.30	7.37	9.68	13.41	18.51	19.51	20.53	20.33	<0.0001
AFib	12.69	12.59	12.64	11.89	11.75	12.08	11.95	12.28	11.44	10.92	11.20	<0.0001
Dyslipidemia	33.37	36.28	42.36	45.33	49.20	53.11	57.06	60.55	62.59	63.49	65.06	<0.0001
PAD	4.29	4.62	4.47	4.78	4.74	4.70	4.58	5.32	5.65	5.17	5.01	<0.0001
Cancer	4.29	4.62	4.47	4.78	4.74	4.70	4.58	5.32	5.65	5.17	5.01	<0.0001
Dementia	0.71	0.66	0.56	0.60	0.62	0.53	0.52	0.48	0.48	0.54	0.28	<0.0001
Tobacco use	—	—	15.83	16.10	18.09	20.41	22.22	23.99	25.35	24.90	26.38	<0.0001
Obesity	—	—	11.41	12.44	12.52	14.70	14.95	15.78	17.97	19.47	19.92	<0.0001
In-hospital, %												
Shock	5.77	5.95	6.54	6.28	6.78	7.64	7.50	8.76	9.52	10.65	10.82	<0.001
VFib	2.66	2.65	2.82	2.82	2.80	3.22	3.47	3.75	3.96	4.20	4.02	<0.0001
Revasc	66.72	68.47	70.35	72.12	73.82	78.31	80.75	82.56	84.56	86.89	87.84	<0.0001
Mortality	9.6	8.48	8.65	8.27	8.16	8.02	6.78	7.41	6.99	7.24	6.43	<0.0001

AFib indicates atrial fibrillation; AI/NA, American Indian or Native American; CV, cardiovascular; MI, myocardial infarction; PAD, peripheral arterial disease; Revasc, coronary revascularization procedure; TIA, transient ischemic attack; VFib, ventricular fibrillation.

Table 8. Pre- and In-Hospital Characteristics Among Patients With ST-Segment Elevation Myocardial Infarction Without Type 2 Diabetes Mellitus

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	*P* Value
N (sample)	12 812	12 228	12 604	11 901	10 320	9393	10 161	9052	9231	8462	8355	
N (weighted)	62 539	61 147	60 933	57 118	50 340	45 901	49 407	44 722	45 303	42 561	41 762	
Prehospital, %												
Sex, %												
Male	59.27	59.49	59.69	59.57	61.00	61.73	62.70	63.73	63.35	64.36	63.95	<0.0001
Female	40.73	40.51	40.31	40.43	39.00	38.27	37.30	36.27	36.65	35.64	36.05	<0.0001
Age, y, %												
<55	19.84	20.23	21.95	21.70	21.55	23.46	25.61	25.75	24.67	26.23	25.93	<0.0001
55 to 64	23.81	24.05	24.12	25.55	26.26	27.42	27.16	27.05	27.73	27.16	29.43	<0.0001
65 to 74	27.35	26.63	25.46	25.14	24.77	22.53	23.12	22.28	23.98	23.07	22.90	<0.0001
75 to 84	21.71	21.99	20.93	20.09	20.48	19.29	17.40	18.02	16.80	16.46	15.46	<0.0001
>84	7.29	7.09	7.54	7.52	6.95	7.30	6.70	6.89	6.82	7.08	6.29	<0.0001
Race, %												
White	77.22	75.90	72.99	71.11	73.23	74.26	73.74	70.58	72.38	70.77	69.78	<0.0001
Black	8.35	8.45	9.19	9.53	9.27	7.28	8.66	10.02	9.64	9.69	10.40	<0.0001
Hispanic	8.85	9.93	10.28	12.40	10.35	11.57	10.93	11.42	9.52	10.42	11.22	<0.0001
Asian	2.23	2.00	3.04	3.05	3.11	2.53	2.60	2.99	2.87	2.96	3.39	<0.0001
AI/NA	0.43	0.34	0.43	0.28	0.45	0.42	0.68	0.88	1.12	0.68	1.26	<0.0001
Other	2.93	3.39	4.06	3.64	3.60	3.94	3.39	4.11	4.48	5.49	3.95	<0.0001
CV risk factors, %												
TIA	3.23	3.56	3.23	3.22	3.27	3.25	3.04	3.13	3.26	2.69	3.12	<0.0001
Heart failure	31.51	29.93	30.67	31.37	31.57	29.91	28.15	30.14	27.86	28.51	27.27	<0.0001
Prior MI	68.05	71.35	71.98	74.73	76.40	78.75	80.52	82.42	84.91	85.72	85.84	<0.0001
Hypertension	60.00	61.62	64.15	66.09	68.27	68.39	72.04	72.71	72.90	75.88	75.24	<0.0001
Renal failure	5.38	5.71	6.89	7.30	7.37	9.68	13.41	18.51	19.51	20.53	20.33	<0.0001
AFib	12.73	12.73	12.73	12.73	12.73	12.73	12.73	12.73	12.73	12.73	12.73	<0.0001
Dyslipidemia	33.37	36.28	42.36	45.33	49.20	53.11	57.06	60.55	62.59	63.49	65.06	<0.0001
PAD	4.29	4.62	4.47	4.78	4.74	4.70	4.58	5.32	5.65	5.17	5.01	<0.0001
Cancer	4.29	4.62	4.47	4.78	4.74	4.70	4.58	5.32	5.65	5.17	5.01	<0.0001
Dementia	0.71	0.66	0.56	0.60	0.62	0.53	0.52	0.48	0.48	0.54	0.28	<0.0001
Tobacco use	—	—	15.83	16.10	18.09	20.41	22.22	23.99	25.35	24.90	26.38	<0.0001
Obesity	—	—	11.41	12.44	12.52	14.70	14.95	15.78	17.97	19.47	19.92	<0.0001
In-hospital, %												
Shock	6.30	6.66	7.14	7.50	7.74	8.43	8.66	9.45	10.11	10.72	10.72	<0.001
VFib	4.67	4.64	5.09	5.08	5.43	5.37	5.60	6.00	6.29	6.81	6.93	<0.0001
Re-Vasc	66.72	68.47	70.35	72.12	73.82	78.31	80.75	82.56	84.56	86.89	87.84	<0.0001

AFib indicates atrial fibrillation; AI/NA, American Indian or Native American; CV, cardiovascular; MI, myocardial infarction; PAD, peripheral arterial disease; Revasc, coronary revascularization procedure; TIA, transient ischemic attack; VFib, ventricular fibrillation.

database with a statistically sound sampling design allowing for accurate identification of trends in specific diseases.

Conclusions and Clinical Relevance

Over the past decade, despite an increasing prevalence of T2DM in the general population and an increasing

Table 9. Characteristics Associated With In-Hospital Mortality in Patients With ST-Segment Elevation Myocardial Infarction, 2002–2010

Effect	OR	95% CI	*P* Value
T2DM	1.11	1.066 to 1.156	<0.0001
Year	0.869	0.819 to 0.922	<0.0001
Female	1.226	1.182 to 1.27	<0.0001
Age (vs <55), y			
55 to 64	1.519	1.425 to 1.62	<0.0001
65 to 74	2.243	2.106 to 2.39	<0.0001
75 to 84	3.445	3.23 to 3.674	<0.0001
>84	4.662	4.333 to 5.017	<0.0001
Race (vs white)			
Black	1.026	0.944 to 1.115	0.5413
Hispanic	1.069	0.992 to 1.151	0.0787
Asian	0.947	0.839 to 1.068	0.3749
AI/NA	1.037	0.799 to 1.346	0.783
Other	1.037	0.94 to 1.144	0.4689
TIA	1.982	1.833 to 2.143	<0.0001
Heart failure	0.971	0.934 to 1.01	0.146
Prior MI	0.755	0.724 to 0.787	<0.0001
Hypertension	0.864	0.833 to 0.896	<0.0001
Renal failure	2.528	2.418 to 2.642	<0.0001
AFib	1.098	1.052 to 1.145	<0.0001
VFib	3.603	3.386 to 3.834	<0.0001
Shock	8.417	8.016 to 8.839	<0.0001
Dyslipidemia	0.468	0.448 to 0.489	<0.0001
PAD	1.189	1.094 to 1.293	<0.0001
Cancer	2.177	1.891 to 2.508	<0.0001
Dementia	0.896	0.765 to 1.049	0.1708
Smoke	0.691	0.653 to 0.73	<0.0001
Obesity	0.881	0.814 to 0.953	0.0015
Revasc	0.292	0.277 to 0.309	<0.0001
Hospital size (medium vs small)	1.156	1.068 to 1.251	0.0003
Hospital size (large vs small)	1.275	1.184 to 1.373	<0.0001
Hospital location (urban vs rural)	1.261	1.172 to 1.358	<0.0001

AFib indicates atrial fibrillation; AI/NA, American Indian or Native American; MI, myocardial infarction; OR, odds ratio; PAD, peripheral arterial disease; Revasc, coronary revascularization procedure; T2DM, type 2 diabetes mellitus; TIA, transient ischemic attack; VFib, ventricular fibrillation.

prevalence of CV risk factors in AMI patients with T2DM, AMI patients with T2DM exhibited a steady and significant decline in in-hospital mortality. The impact of diabetes, expressed as the increased risk of in-hospital death for diabetic patients compared with nondiabetic patients, remained unchanged over time. Secular changes in the diagnosis and management of diabetics in the general population may have contributed to an alteration in the spectrum of disease severity in AMI patients with T2DM. Although women remain at a slightly increased risk of mortality, there was a greater reduction in mortality among women, compared with men, over time. The decline in mortality over time was nearly flat among younger patients, whereas the biggest gains in survival were observed in the elderly. Continued efforts toward recognizing and treating a growing burden of risk factors, particularly DM and obesity,

Table 10. In-Hospital Mortality in Patients With Acute Myocardial Infarction and Coexistent Type 2 Diabetes Mellitus in Additional Subgroups

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Insulin use										
—	—	—	–	10.71	11.52	11.69	11.25	11.62	11.67	10.89
Morbid obesity										
10.83	9.53	11.62	11.76	11.40	11.67	11.89	12.01	11.17	11.60	11.96

Data are shown as percentages.

in younger patients[41] should be used to improve the differential risk in in-hospital mortality.

Acknowledgments

The authors would like to express their appreciation to Ed Bedrick, PhD, and Faith Selzer, PhD, who provided critical reviews of this manuscript.

Sources of Funding

This study was supported, in part, by the Robert S. Flinn Foundation (University of New Mexico School of Medicine, Albuquerque, NM) for cardiovascular research.

Disclosures

No conflicts of interest on the part of any author exist with respect to the material presented herein.

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