Incidence and Outcomes of Acute Myocardial Infarction During Motor Vehicle Accident Related Hospitalizations

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Data on Motor Vehicle Accidents (MVA) associated acute myocardial infarctions (AMI) are scares. We aimed to examine the frequency, characteristics, and outcomes of AMI among patients admitted with MVA. Patients hospitalized with Motor Vehicle Traffic Accidents (ICD-9-CM codes e810-e819) in 2003 to 2014 were identified in the national inpatient sample. The primary end point was crude and risk-adjusted in-hospital mortality in patients with and without AMI. Secondary end-points were major morbidities, and resource utilization metrics. A total of 573,717 patients were hospitalized after MVAs in 2003 to 2014, of whom 2,793 (0.5%) suffered an AMI (26% STEMI and 74% NSTEMI). Patients who suffered AMI were older, and had higher rates of hypertension, diabetes, hyperlipidemia, renal insufficiency, and vascular disease. In the AMI group, angiography was performed in 26.7%, and among those, 42.2% received percutaneous intervention and 9.2% underwent coronary artery bypass surgery during the same admission. In-hospital mortality was higher in patients with AMI compared with patients without MI (21.7% vs 2.7%, p <0.001). After adjusting for age, gender, race, co-morbidities, and hospital characteristics, AMI remained associated with significantly higher mortality (adjusted overall [OR] 6.3, 95% confidence interval [CI] 5.98 to 6.57, p< 0.001). Patients with AMI had higher incidences of cardiac arrest (11.9% vs 0.7%, p <0.001), new dialysis (2.2% vs 0.1%, p <0.001), and stroke (4.1% vs 0.5%, p <0.001). They also had longer hospitalizations (12 ± 17 vs 6 ± 10 days, p <0.001), higher cost ($48046 ± 56316 vs $20820 ± 31758, p <0.001), and higher rates of nonhome discharges (55.5% vs 15.4%, p <0.001). In conclusion: AMI in patients admitted with MVA is uncommon but is associated with substantial morbidity, mortality, and cost. © 2018 Elsevier Inc. All rights reserved. (Am J Cardiol 2019;123:725−728)

Motor Vehicle Accidents (MVA) can be associated with various cardiovascular injuries including coronary dissection, thrombotic coronary occlusion, myocardial contusion, perforation or rupture, and valvular avulsion.[1−10] These injuries are associated with substantial morbidity and mortality.[1,11] The current literature is, however, limited to care reports, and is mostly focuses on myocardial injuries related to direct penetrating or blunt chest trauma.[1−10] To our knowledge, the incidence, and outcomes of acute myocardial infarction (AMI) among victims of MVA has not been previously systematically assessed. We utilized a national representative database to examine the frequency, characteristics, and outcomes of AMI in patients admitted with MVA.

Methods

The National Inpatient Sample (NIS) was used to derive patient relevant information in January 1st 2003 and December 31st 2014. The NIS is the largest publicly available all-payer administrative claims-based database that contains clinical and resource utilization information on 5 to 8 million discharges annually, with safeguards to protect the privacy of individual patients, physicians, and hospitals. These data are stratified to represent ~20% of United States inpatient hospitalizations across different hospital and geographic regions (random sample). National estimates (NE) of the entire United States hospitalized population were calculated using the Agency for Healthcare Research and Quality weighting method. Patients who were hospitalized with a principle discharge diagnosis of Motor Vehicle Traffic Accidents were identified using International Classification of Diseases-Ninth Revision-Clinical Modification [ICD-9-CM] codes (e810-e819). Among these patients, ICD-9-codes 410.x were used to identify patients with AMI: ST-segment−elevation MI (STEMI; ICD-9-CM: 410.11 to 410.61, 410.81, and 410.91 and non−STEMI (NSTEMI; ICD−9−CM code of 410.7x). To estimate the cost of hospitalization, the NIS data were merged with cost-to-charge ratios available from the Healthcare Cost and Utilization Project. We estimated the cost of each inpatient stay by multiplying the total hospital charge with cost-to-charge ratios. The *primary endpoint* of the study was crude and adjusted in-hospital mortality in patients with AMI following MVA versus those without AMI. *Secondary endpoints* were major postoperative morbidities, length of stay, nonhome discharges, and hospital charges. The Cochran-Armitage trend test was used to investigate the

incidence and mortality of AMI overtime. Trends were calculated using the national estimates, while baseline characteristics and outcomes were calculated using the actual sample. Descriptive statistics were presented as frequencies with percentages for categorical variables. Mean and standard deviations were reported for continuous measures. Baseline characteristics were compared using a Pearson chi-squared test and Fisher's exact test for categorical variables and an independent-samples *t* test for continuous variables. A logistical regression models to calculate was used to adjust the primary endpoint (in-hospital mortality) for demographic, clinical comorbidities, and hospital characteristics. A Type-I error rate of <0.05 was considered statistically significant. All statistical analyses were performed using SPSS version 24 (IBM Corporation, Armonk, NY). To account for potential confounding factors

Results

A total of 573,717 patients (NE = 2,822,652) were hospitalized after a MVA in 2003 to 2014, of whom 2,793 (0.5%) (NE = 13,794) suffered an AMI (26% STEMI and 74% NSTEMI) during the hospitalization. The number of MVA patients suffering STEMI decreased, while the number of those suffering NSTEMI increased during the study's period (Figure 1). Patients who suffered AMI were older,

and had higher rates of key comorbidities including hypertension, diabetes, hyperlipidemia, renal insufficiency, and peripheral vascular diseases. On the other hand, patients without AMI had higher prevalence of smoking, depression, drug abuse, and alcohol-related disorders (Table 1). Among patients who suffered AMI, coronary angiography was performed in 26.7% overall but more often in patients with NSTEMI than in those with STEMI (75.8% vs 24.2%, p = 0.005). The majority of coronary angiography procedures were performed within 48 hours of the admission (65% for STEMI and 45.4% NSTEMI patients). Among patients who underwent coronary angiography, 42.2% underwent PCI (73.4% in the STEMI and 32.1% in the NSTEMI group, p <0.001) and 9.2% underwent CABG during the same admission (1.5% in the STEMI and 7.7% in the NSTEMI group, p <0.001).

In-hospital mortality was substantially higher in patients with AMI compared with patients without MI (21.7% vs 2.7%, p <0.001), and higher for patient with STEMI compared with those with NSTEMI (38.7% vs 15.7%, p <0.001). The mortality of AMI in patients following MVAs decreased slightly from 26.2% in 2003 to 22.7% in 2014 (P_{trend} < 0.001) (Figure 2). After adjusting for age, gender, race, baseline co-morbidities, and hospital characteristics, AMI remained associated with significantly higher in-hospital mortality (adjusted overall [OR] 6.3, 95% confidence interval [CI] 5.98 to 6.57, p <0.001, OR 3.85, 95%
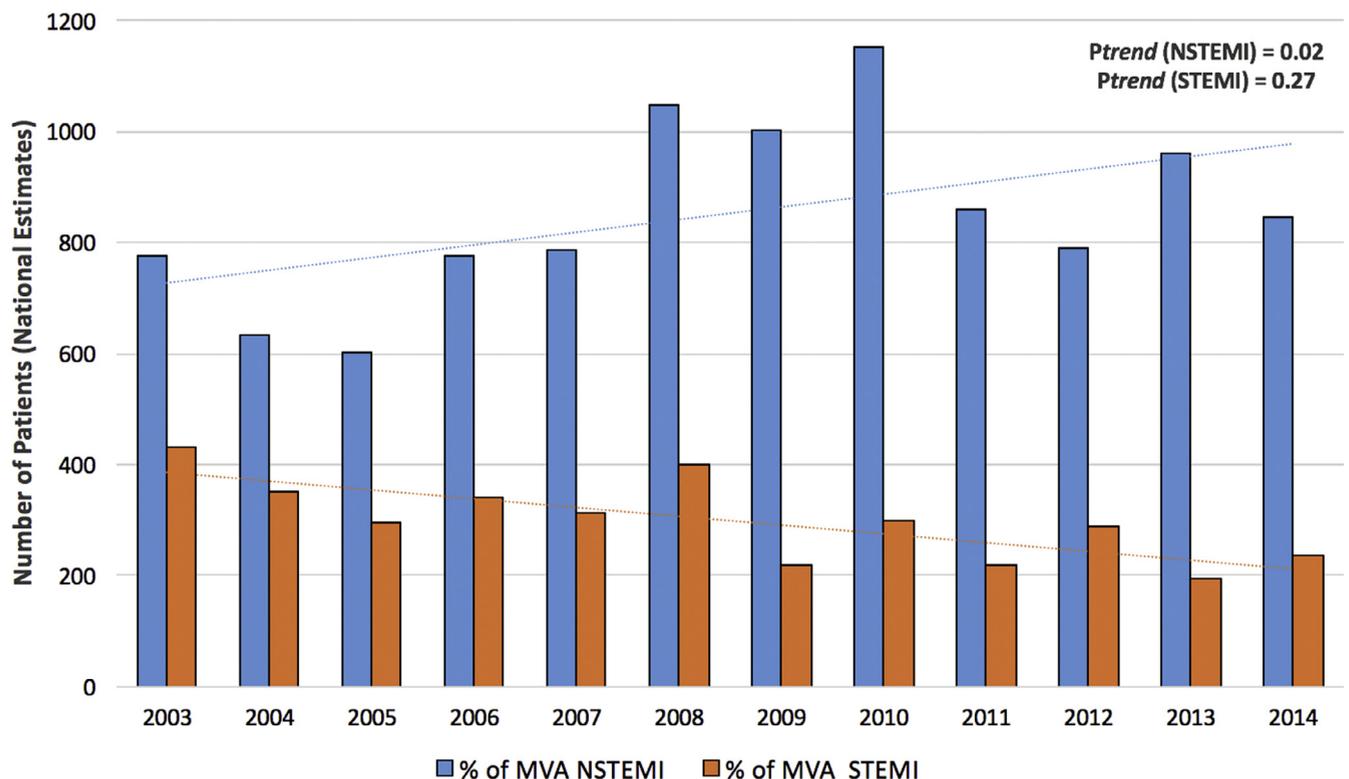

Figure 1. Temporal trends in the incidence of acute myocardial infarction among patients hospitalized following a motor vehicle accident.

Table 1
Baseline characteristics of patients admitted following motor vehicle accidents stratified by the incident of acute myocardial infarction

Baseline characteristics	Acute myocardial infarction		P Value
	No n = 570,924 (NE = 2,822,652)	Yes n = 2,793 (NE = 13,794)	
Age group (year)			
18-45	55.1%	5.4%	<0.001
45-65	28.7%	33.1%	
65-85	14.0%	50.7%	
>85	2.1%	10.9%	
Male	61.8%	63.8%	0.032
Hypertension	23.4%	52.8%	<0.001
Diabetes mellitus	9.5%	26.6%	<0.001
Dyslipidemia*	8.3%	21.1%	<0.001
Coronary artery disease	3.3%	32.9%	<0.001
Prior sternotomy	1.7%	8.8%	<0.001
Vascular disease	1.7%	8.5%	<0.001
Chronic renal failure	1.9%	12.4%	<0.001
Anemia	6.6%	15.7%	<0.001
Atrial fibrillation/flutter	3.4%	19.4%	<0.001
Depression	5.1%	3.2%	<0.001
Smoking	16.9%	10.6%	<0.001
Alcohol related disorders	13.2%	6.0%	<0.001
Drug abuse	6.4%	2.9%	<0.001
Teaching hospital	67.6%	68.7%	0.24
Rural location	7.3%	6.9%	0.53

N; number, NE; national estimates

* dyslipidemia defined as any hypercholesterolemia coded by ICD-9-CM codes

CI 3.62 to 4.08, p <0.001 for NSTEMI, and OR 14.52, 95% CI 13.47 to 15.6, p <0.001 for STEMI). Patients with AMI also had higher incidences of cardiac arrest (11.9% vs 0.7%, p <0.001), acute kidney injury requiring dialysis (2.2% vs 0.1%, p <0.001), and stroke (4.1% vs 0.5%, p <0.001). In addition, patients in the MI group had longer hospital stays, higher hospitalization cost, and higher rates of nonhome discharges (Table 2).

Discussion

The main finding of this study is that AMI complicates a small percentage of patients suffering MVAs, but those suffering an AMI after a MVA experience substantial in-hospital morbidity, mortality, prolonged, and costlier hospitalizations.

To our knowledge, this is the first nationwide study that assesses the incidence and outcomes of AMI in patients hospitalized with MVAs. The incidence of AMI among patients admitted with MVA in our study was 0.5% overall but with a temporal increase in 2003 to 2014, mostly driven by an increase in the frequency of NSTEMI. Our study demonstrated substantial clinical and economic burden of MVA associated AMI; about 1 in 5 patients who suffered an AMI after a MVA did not survive to discharge (estimated ~3000 death during the study period), and those who survived had prolonged hospitalizations, over 2-fold increase in cost, and higher rates of nonhome discharges. These findings highlight the significant burden of AMI in MVA patients, and the importance of identifying the
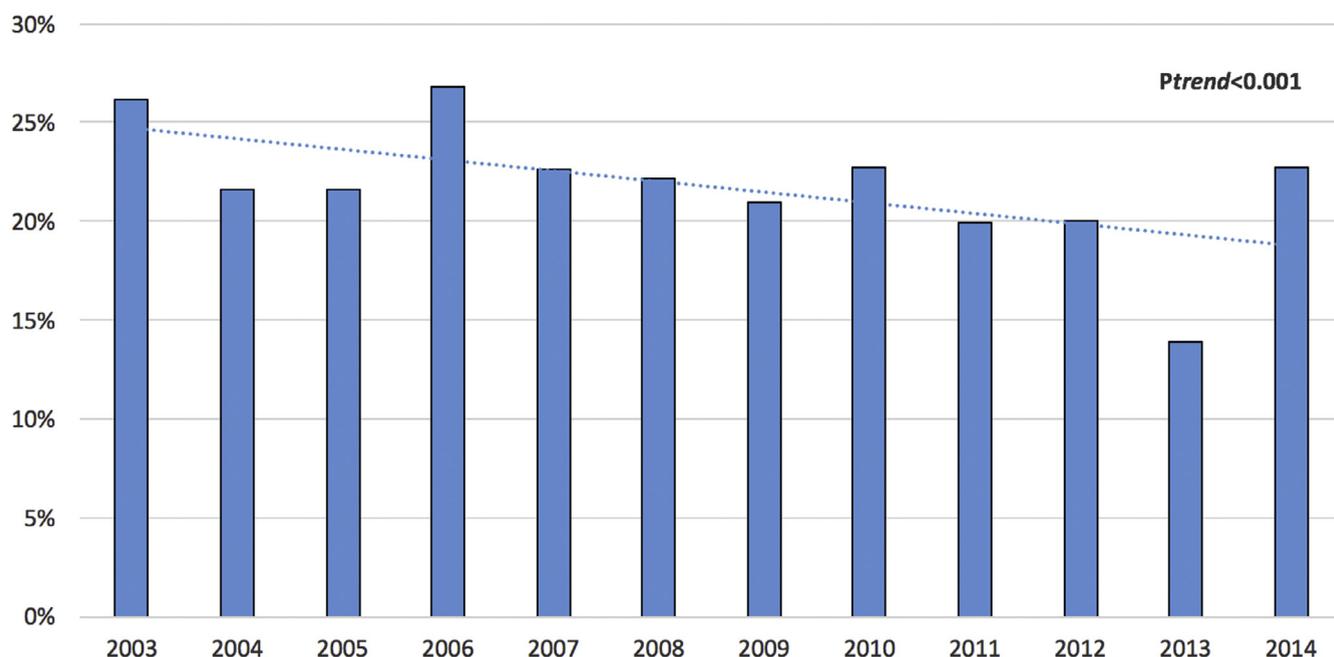

Figure 2. Temporal trend in in-hospital mortality of acute myocardial infarction among patients hospitalized following a motor vehicle accident.

Table 2

Outcomes of patients admitted following motor vehicle accidents stratified by the incident of acute myocardial infarction

In-hospital outcomes	Acute myocardial infarction		P Value
	No n = 570,924 (NE = 2,822,652)	Yes n = 2,793 (NE = 13,794)	
Coronary angiography	0.3%	26.7%	<0.001
Percutaneous coronary intervention	0.1%	11.3%	<0.001
Concomitant valve/muscle injury	0.01%	0.2%	<0.001
Coronary bypass grafting	0.0%	2.7%	<0.001
Concomitant cardiac surgery	0.01%	0.3%	<0.001
In-hospital mortality	2.7%	21.7%	<0.001
Acute kidney injury	2.2%	21.0%	<0.001
New hemodialysis	0.1%	2.2%	<0.001
Cardiac arrest	0.7%	11.9%	<0.001
Stroke	0.5%	4.1%	<0.001
Nonhome discharge	19.9%	43.5%	<0.001
Length of stay	6 ± 10	12 ± 17	<0.001
Cost ($)	20820 ± 31758	48046 ± 56316	<0.001

N; number, NE; national estimates.

underlying mechanisms and the optimal management of these AMIs.

Significant differences in the management pattern and outcomes between patients experiencing STEMI or NSTEMI following a MVA were also notable in our analysis. Compared with NSTEMI patients, those with STEMI underwent angiography much less frequently (24.2% vs 75.8%), were more likely to receive percutaneous coronary intervention (73.4% vs 32.1%), and had higher rates of in-hospital death (38.7% vs 15.7%). The differences in rates of angiography, PCI, and in-hospital mortality may be related to differences in baseline risk profile or the underlying mechanism of AMI between STEMI and NSTEMI patients. Acute myocardial infarction following a MVA can result from; (A) direct coronary trauma (e.g., coronary dissection) due to blunt chest injury,[11] (B) acute thrombotic occlusion of a coronary artery due to the stress associated with MVAs, or its subsequent squeals (e.g., trauma requiring major surgery). Also, in theory, the MVA itself could have resulted from an AMI or an associated arrhythmia in a driving patient. Albeit speculative, STEMI patients could have had worse MVA-related trauma leading to a more

significant cardiac injuries hence lower rates of invasive assessment and higher mortality rates.

This study has inherent limitations related to the design of the NIS: granular data on type and extent of MVA related injuries and their management are not available. Also, details of the AMI (coronary distribution, mechanism, and so on.) and long-term outcomes beyond hospital discharge are also not accessible with NIS. Nevertheless, to our knowledge this is the first report on the incidence and outcomes of MVA associated AMI in the United States.

Disclosures

The authors have no conflicts of interest to disclose.

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