

Rate of Acute ST-Elevation Myocardial Infarction in the United States from 1988 to 2004 (from the Nationwide Inpatient Sample)

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Advances in the management of atherosclerosis risk factors have been dramatic in the previous 10 years. The goal of this study was to evaluate any decrease in age-adjusted incidence of acute ST-elevation myocardial infarction (STEMI) in a very large database of inpatient admissions from 1988 to 2004. The Nationwide Inpatient Sample database was used to calculate the age-adjusted rate for STEMI from 1988 to 2004 retrospectively. Specific International Classification of Diseases, Ninth Revision, codes for MIs consistent with STEMI were used. Patient demographic data were also analyzed and adjusted for age. The Nationwide Inpatient Sample database contained 1,352,574 patients >40 years of age who had a diagnosis of STEMI from 1988 to 2004. Mean age for these patients was 66.06 ± 13.69 years. Men had almost 2 times the age-adjusted STEMI rate as women (men 62.4%, women 37.6%). From 1988 the age-adjusted rate for all acute STEMIs remained steady for 8 years (108.3 per 100,000, 95% confidence interval [CI] 99.0 to 117.5, in 1988 and 102.5 per 100,000, 95% CI 94.7 to 110.4, in 1996). However, from 1996 onward, the age-adjusted incidence of STEMI steadily decreased to 1/2 the incidence of the previous 8 years (50.0 per 100,000, 95% CI 46.5 to 53.5, by 2004, $p < 0.01$). This decrease was similar across various races and genders. In conclusion, the incidence of STEMI was stable from 1988 to 1996, with a steady linear decrease to 1/2 by 2004. The cause of the steady decrease in STEMI rate most likely reflects the advancement in management of patients with atherosclerosis. Published by Elsevier Inc. (Am J Cardiol 2009;104:5–8)

Approximately 865,000 acute myocardial infarctions (AMIs) occur in the United States every year.¹ A substantial proportion of this population, with an estimated annual incidence of 500,000, has ST-segment elevation MI (STEMI).² Over the previous 2 decades, mortality in patients with STEMI has decreased substantially in developed countries.^{3,4} This may be attributed to major improvements achieved in management of patients with AMI and to advances in prevention and treatment of atherosclerosis risk factors. Despite advances and developments in treating AMI, MI remains a major cause of morbidity and mortality. The goal of this study is to evaluate the trend in age-adjusted incidence of documented inpatient acute STEMI using the Nationwide Inpatient Sample (NIS) database from 1988 to 2004 retrospectively. Furthermore, we evaluated this incidence across various races and genders. Specific International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM), codes that were consistent with STEMI were used to compile the data.

Methods

The NIS is a set of longitudinal hospital inpatient databases included in the Healthcare Cost and Utilization Project. These databases are created by the Agency for Healthcare Research and Quality through a federal–state–industry partnership. Healthcare Cost and Utilization Project data inform decision-making at the national, state, and community levels. Researchers and policymakers use the NIS to identify, track, and analyze national trends in health care use, access, charges, quality, and outcomes. The NIS is a national hospital database containing charge information on all patients, regardless of payer, including those covered by Medicare, Medicaid, private insurance, and the uninsured, making it the largest all-payer inpatient-care database in the United States. The NIS contains clinical and resource use information included in a typical discharge abstract, with safeguards to protect the privacy of individual patients, physicians, and hospitals. It contains data from approximately 8 million hospital stays each year. NIS data are available from 1988 to 2006, allowing analysis of trends over time. The number of states in the NIS has grown from 8 in the first year to 38 in 2009.

In this study we used ICD-9-CM primary codes for STEMI in patients discharged from hospitals in the NIS database, specifically those for AMIs of the anterolateral wall (410.01), anterior wall (410.11), inferolateral wall (410.21), inferoposterior wall (410.31), inferior wall (410.41), and lateral wall (410.51). Other codes used were

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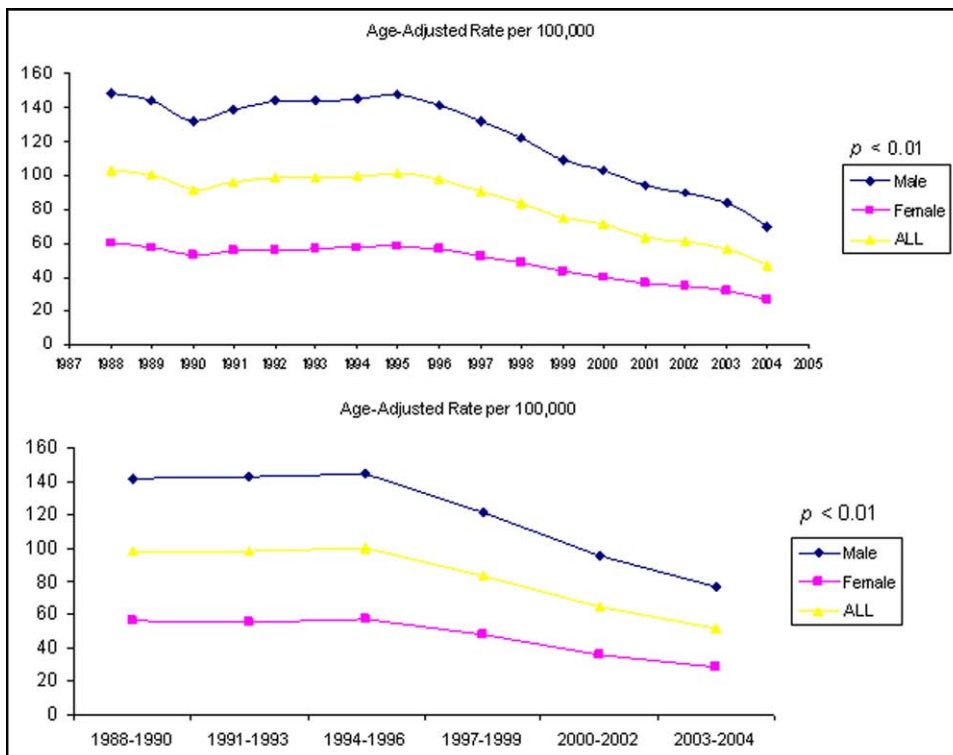


Figure 1. Age-adjusted STEMI rate per 100,000 based on total and gender.

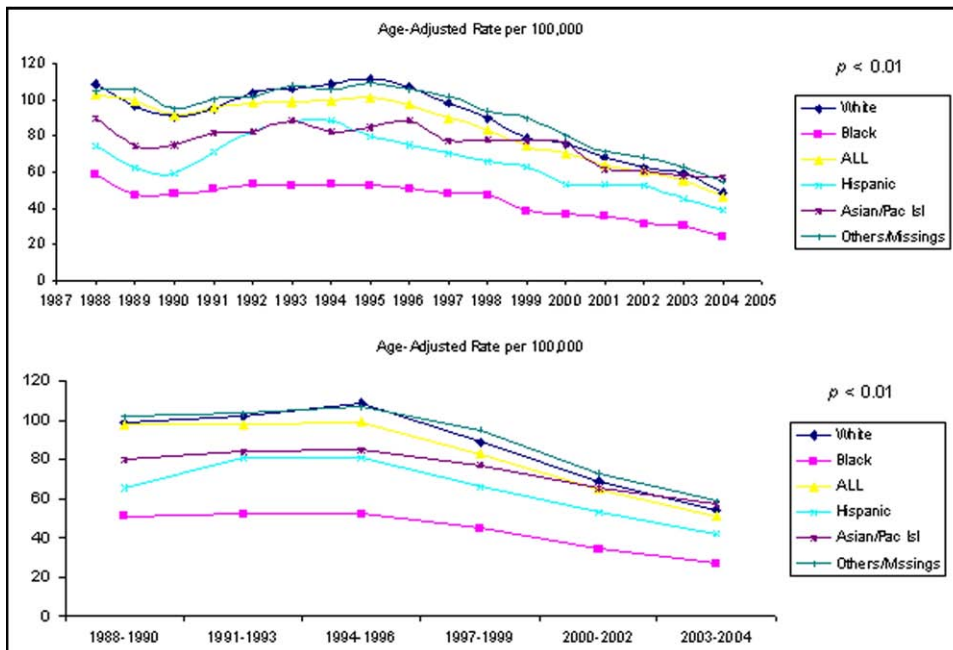


Figure 2. Age-adjusted STEMI rate per 100,000 based on race.

for true posterior wall infarction (410.61) and other specified sites including infarction of the atrium, papillary muscle, septum alone, or STEMI of other specified sites (410.81). Using the NIS database we obtained demographic information such as age and gender and thus calculated the age-adjusted occurrence of STEMI per 100,000 from 1988 to 2004.

Average annual age-adjusted rates for STEMI and

95% confidence intervals (95% CI) were calculated by multiplying age-specific rates of STEMI by age-specific weights. To decrease the number of STEMIs not related to atherosclerosis, we included only patients >40 years of age in our analysis. Weights used in age adjustment of the data were the calculated standard for the U.S. population within each age group for 2000. Weighted rates were then summed across age groups to obtain the age-

adjusted rate for each year from 1988 to 2004. Calculations were performed using SPSS 13 (SPSS, Inc., Chicago, Illinois). Quantitative variables were expressed as mean \pm SD. Analysis of variance was used to determine statistical significance when performing comparisons. A p value <0.05 was accepted as statistically significant.

Results

The NIS database contained information on 1,352,574 patients who had a diagnosis of STEMI from 1988 to 2004 and were 40 years of age. Mean age for these patients was 66.06 ± 13.69 years. Men had almost 2 times the age-adjusted STEMI rate as women (men 62.4%, women 37.6%). From 1988 the age-adjusted rate for all acute STEMIs remained steady for 8 years (108.32 per 100,000, 95% CI 99.0 to 117.5, in 1988 and 102.5 per 100,000, 95% CI 94.7 to 110.4, in 1996). However, from 1996 onward, the age-adjusted incidence of STEMI steadily decreased to 1/2 the incidence of the previous 8 years (50.0 per 100,000, 95% CI 46.5 to 53.5, by 2004, $p < 0.01$). The rate of STEMI in women was 1/2 the rate of STEMI in men and this ratio persisted throughout the study period. However, this overall decrease from 1996 occurred regardless of race or gender, which is evident in Figures 1 and 2.

Discussion

A recent report from the National Center for Health Statistics showed that there were 1,565,000 hospitalizations due to an acute coronary syndrome in 2004. Among them, 669,000 were admitted for unstable angina pectoris and 896,000 for MI.¹ Cardiovascular disease is 1 of the major reasons for visits to the emergency department; in 2003 this accounted for approximately 4,497,000 visits.¹ Our study included 1,352,574 patients who had a diagnosis of STEMI from 1988 to 2004 in the NIS database. There were significant gender differences in the average age of a patient with a first MI. This has been demonstrated in the INTERHEART study showing that women develop their first MI on average 9 years later than men despite similar risk factors.⁵ This is consistent with our results showing that men had almost 2 times the incidence of age-adjusted STEMI rate as women.

Based on our study, from 1988 the age-adjusted rate for all acute STEMIs remained steady for 8 years. However, from 1997, the age-adjusted incidence of STEMI steadily decreased to 1/2 the incidence in the previous 8 years regardless of race or gender. The cause of this steady decrease in STEMI most likely reflects advancement in the prevention and treatment of atherosclerosis risk factors and advancement in percutaneous coronary intervention. During the previous 2 decades, there has been increasing evidence to support the effects of pharmacologic therapy in decreasing the risk for coronary heart disease and associated events. The first major study investigating the treatment of hyperlipidemia was the Scandinavian Simvastatin Survival Study (4S).⁵ A year later, the West of Scotland Coronary Prevention Study

(WOSCOPS)⁶ demonstrated a decrease of nonfatal MI by 31% ($p < 0.001$) using pravastatin. After these studies there was increased usage of statins in primary and secondary prevention, which could be one of the reasons for a decrease in the incidence of STEMI since 1997. Another drug that has been studied for primary prevention of coronary heart disease is the β blocker. A randomized clinical trial evaluating the effect of low-dose metoprolol showed a decrease in the progression of intima-media thickness in the carotid bulb at 18 and 36 months. There was also a trend toward a decrease in nonfatal and fatal MIs ($p = 0.055$).⁷ Since 1997, percutaneous transluminal coronary angioplasty has become one of the commonest interventions in cardiology, which was boosted by the development of stents.⁸ This led to the significant decrease in in-hospital mortality rates.^{9,10}

Our data fit and are in concordance with the most recent American Heart Association statistical report from 2008 for MI rate.¹¹ For the 2004 age-adjusted STEMI rate, we found a rate of 50.06 per 100,000. Using the U.S. Census 2004 population of 296,056,000, there would be a 2004 STEMI incidence of 148,205. Previously, STEMI was found to be responsible for 1/3 of all MIs. However, we have shown that the rate of STEMI decreased gradually to 1/2 of the original rate despite a persistent unchanged rate of non-STEMI since 2000. Therefore, approximately 15% of all MIs should be STEMIs. Using 15% of the total MI rate reported in the American Heart Association 2008 statistics of 920,000, the rate of STEMI would be 130,000 in 2008, which is lower than our reported 2004 statistic rate of 148,205. This lower rate confirms our finding of a steady decrease in the rate of STEMI in the United States in recent years.

Our study used administrative database and ICD-9 coding, which can lead to diagnostic inaccuracy. We used primary diagnosis for STEMI. However, it cannot be ruled out that some true STEMI was coded as the secondary diagnosis, thus not capturing all STEMI events. Changes in diagnostic coding over the years studied may have influenced the accuracy of our data.

1. Rosamond W, Flegal K, Friday G, Furie K, Go A, Greenlund K, Haase N, Ho M, Howard V, Kissela B, Kittner S, Lloyd-Jones D, McDermott M, Meigs J, Moy C, Nichol G, O'Donnell CJ, Roger V, Rumsfeld J, Sorlie P, Steinberger J, Thom T, Wasserthiel-Smoller S, Hong Y. Heart disease and stroke statistics—2007 update: a report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. *Circulation* 2007;115(suppl): e69–e171.
2. Antman EM, Anbe DT, Armstrong PW, Bates ER, Green LA, Hand M, Hochman JS, Krumholz HM, Kushner FG, Lamas GA, Mullany CJ, Ornato JP, Pearle DL, Sloan MA, Smith SC Jr, Alpert JS, Anderson JL, Faxon DP, Fuster V, Gibbons RJ, Gregoratos G, Halperin JL, Hiratzka LF, Hunt SA, Jacobs AK. ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction—executive summary: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (writing committee to revise the 1999 guidelines for the management of patients with acute myocardial infarction). *Circulation* 2004;110:588–636.
3. Boersma E, Mercado N, Poldermans D, Gardien M, Vos J, Simoons ML. Acute myocardial infarction. *Lancet* 2003;361:847–858.
4. Kesteloot H, Sans S, Kromhout D. Evolution of all-causes and cardiovascular mortality in the age-group 75–84 years in Europe during

- the period 1970–1996: a comparison with worldwide changes. *Eur Heart J* 2002;23:384–398.
5. Randomized trial of cholesterol lowering in 4444 patients with coronary heart disease: the Scandinavian Simvastatin Survival Study (4S). *Lancet* 1994;344:1383–1389.
 6. Shepherd J, Cobbe SM, Ford I, Isles CG, Lorimer AR, MacFarlane PW, McKillop JH, Packard CJ. Prevention of coronary heart disease with pravastatin in men with hypercholesterolemia. West of Scotland Coronary Prevention Study Group. *N Engl J Med* 1995;333:1301–1307.
 7. Hedblad B, Wikstrand J, Janzon L, Wedel H, Berglund G. Low-dose metoprolol CR/XL and fluvastatin slow progression of carotid intima-media thickness: main results from the Beta-Blocker Cholesterol-Lowering Asymptomatic plaque Study (BCAPS). *Circulation* 2001;103:1721–1726.
 8. Mehta NJ, Khan IA. Cardiology's 10 greatest discoveries of the 20th century. *Tex Heart Inst J* 2002;29:164–171.
 9. Julian DG. The evolution of the coronary care unit. *Cardiovasc Res* 2001;51:621–624.
 10. Braunwald E. Shattuck lecture—cardiovascular medicine at the turn of the millennium: triumphs, concerns, and opportunities. *N Engl J Med* 1997;337:1360–1369.
 11. Rosamond W, Flegal K, Furie K, Go A, Greenlund K, Haase N, Hailpern SM, Ho M, Howard V, Kissela B, Kittner S, Lloyd-Jones D, McDermott M, Meigs J, Moy C, Nichol G, O'Donnell C, Roger V, Sorlie P, Steinberger J, Thom T, Wilson M, Hong Y. Heart disease and stroke statistics—2008 update: a report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. *Circulation* 2008; 117(suppl):e25–e146.