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Sex and Racial Differences in the Management of Acute Myocardial Infarction, 1994 through 2002

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Abstract

BACKGROUND—Although increased attention has been paid to sex and racial differences in the management of myocardial infarction, it is unknown whether these differences have narrowed over time.

METHODS—With the use of data from the National Registry of Myocardial Infarction, we examined sex and racial differences in the treatment of patients who were deemed to be "ideal candidates" for particular treatments and in deaths among 598,911 patients hospitalized with myocardial infarction between 1994 and 2002.

RESULTS—In the unadjusted analysis, sex and racial differences were observed for rates of reperfusion therapy (for white men, white women, black men, and black women: 86.5, 83.3, 80.4, and 77.8 percent, respectively; P<0.001), use of aspirin (84.4, 78.7, 83.7, and 78.4 percent, respectively; P<0.001), use of beta-blockers (66.6, 62.9, 67.8, and 64.5 percent; P<0.001), and coronary angiography (69.1, 55.9, 64.0, and 55.0 percent; P<0.001). After multivariable adjustment, racial and sex differences persisted for rates of reperfusion therapy (risk ratio for white women, black men, and black women: 0.97, 0.91, and 0.89, respectively, as compared with white men) and coronary angiography (relative risk, 0.91, 0.82, and 0.76) but were attenuated for the use of aspirin (risk ratio, 0.97, 0.98, and 0.94) and beta-blockers (risk ratio, 0.98, 1.00, and 0.96); all risks were unchanged over time. Adjusted in-hospital mortality was similar among white women (risk ratio, 1.05; 95 percent confidence interval, 1.03 to 1.07) and black men (risk ratio, 0.95; 95 percent confidence interval, 0.89 to 1.00), as compared with white men, but was higher among black women (risk ratio, 1.11; 95 percent confidence interval, 1.06 to 1.16) and was unchanged over time.

CONCLUSIONS—Rates of reperfusion therapy, coronary angiography, and in-hospital death after myocardial infarction, but not the use of aspirin and beta-blockers, vary according to race and sex, with no evidence that the differences have narrowed in recent years.

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In recent years, attention has been focused on variations in the treatment of coronary heart disease that are related to the sex and race of the patient. Landmark studies in the late 1980s and early 1990s reported differences in treatment according to sex and race.[1–4] In the past decade, other investigations have described a generally consistent pattern of less intensive treatment of acute myocardial infarction in women, as compared with men,[5–11] and in blacks, as compared with whites,[8,9,12–17] across a variety of settings. Efforts to remedy racial and sex differences in health care use have received prominent attention, including a recent Institute of Medicine report[18] and the Public Health Service's Healthy People 2010 initiative.[19]

Although sex and racial differences in the treatment of coronary heart disease have been documented for more than a decade, little is known about whether these differences have persisted in more recent years. We assessed temporal trends in sex and racial differences in the use of guideline-based management for patients hospitalized with acute myocardial infarction.

METHODS

PATIENTS

Since July 1, 1990, hospitals participating in the National Registry of Myocardial Infarction (NRMI) have enrolled consecutive patients with myocardial infarction, as previously described.[20] Because NRMI-1 (July 1990 through May 1994) collected little information on patients' characteristics, we restricted our analysis to the 1,724,984 patients from 1917 hospitals who were enrolled in NRMI-2 (June 1994 through March 1998), NRMI-3 (April 1998 through June 2000), and NRMI-4 (July 2000 through May 2002). We excluded 12,132 patients with erroneous discharge dates and 381,018 patients who were transferred from another acute care hospital because their early treatments were not documented. We also excluded 131,474 patients who survived less than 24 hours because of insufficient time to begin treatments; 40,881 patients of unknown age, sex, race, or survival status; 60,689 patients whose race was not recorded as white or black; and 55,316 patients with missing data for model covariables. We restricted our analysis to 658 hospitals (out of 1917 hospitals) participating in NRMI for the full study period, resulting in a final sample of 598,911 patients. NRMI data collection has previously been validated by comparison with the Cooperative Cardiovascular Project.21 This protocol was deemed exempt from review by the institutional review board at Emory University.

TREATMENT OF MYOCARDIAL INFARCTION

Patients were evaluated for the use of treatments recommended by the American College of Cardiology–American Heart Association (ACC–AHA) guidelines for the treatment of myocardial infarction since 1990.22–24 These included acute reperfusion therapy for patients with ST-segment elevation within 24 hours of admission, the administration of aspirin and beta-blockers within 24 hours of admission, and coronary angiography during hospitalization. As secondary treatment end points, we examined the frequency of coronary-artery bypass graft (CABG) surgery and percutaneous transluminal coronary angioplasty (PTCA) (except for primary PTCA, which was included in our definition of reperfusion therapy) during hospitalization.

To exclude racial or sex variations in treatment that may reflect differences in the proportion of patients for whom treatment is considered appropriate, we identified subgroups of patients who were ideally suited for each management strategy — in other words, patients with the strongest indications for treatment (ACC–AHA class I) and without major contraindications, according to guidelines published in 1990,[22] 1996,23 and 1999.24 When variations were present in the three sets of guidelines, the 1996 guidelines were followed, since they are similar to the 1999 guidelines and were published closest to the beginning of our observation period.

To avoid bias in regard to the availability of services, rates of coronary angiography were calculated among patients admitted to facilities with full capability of performing invasive cardiovascular procedures. Rates of use of CABG and PTCA were calculated among patients admitted to these facilities who were "ideal candidates" for coronary angiography and who underwent angiography. Because information was lacking on angiographic findings, we were not able to define further patient eligibility for revascularization. The only contraindication to the use of aspirin in the initial management of myocardial infarction is true allergy to salicylates, which is uncommon and was not recorded in NRMI. Therefore, no ideal-candidate subgroup was created for aspirin.

IN-HOSPITAL MORTALITY

We examined trends in hospital mortality according to sex and race. This analysis was restricted to patients who were not transferred to another acute care hospital, since the survival status of transferred patients in the second hospital was unknown.

STATISTICAL ANALYSIS

We categorized patients into four groups according to race and sex: white men, white women, black men, and black women. Sex and racial differences in demographic and clinical factors and in the characteristics of hospitals were assessed over the full study period and stratified according to year of treatment (with a year defined as the period from June through May). We calculated crude rates of treatment and in-hospital mortality for the selected subgroups of ideal-candidate patients in the four groups.

We used logistic-regression models to derive the likelihood of treatment and death for the four groups.[25] We tested whether differences in the use of treatments according to sex and race changed over time by including a three-way interaction term reflecting the sex and race of patients and the year. Three consecutive models were constructed for each end point. Model 1 included sex, race, year, and all two-way and three-way interaction terms among sex, race, and year; model 2 expanded the data in model 1 to include other demographic and clinical factors; and model 3 expanded the data in model 2 to include characteristics of the hospitals. To assess whether the clustering of patients within hospitals affected our results, analyses were repeated with the use of generalized-estimating-equation models. The results were similar and are not reported. All analyses were performed using SAS software (version 8.2).

RESULTS

CHARACTERISTICS OF PATIENTS AND HOSPITALS

The mean age of patients did not change substantially over time, but the prevalence of most coronary risk factors increased in all subgroups (Table 1), whereas there was a decline in the proportion of patients with ST-segment elevation or Q waves on initial electrocardiography. The four subgroups showed similar time trends in most factors, as shown by the nonsignificant interaction among sex, race, and year. In all years combined, there were substantial differences in many factors according to sex and race. For example, women in both racial groups were older than men, whereas blacks in both sex groups were younger than whites. As compared with white men, fewer female and black patients had ST-segment elevation or Q waves on initial electrocardiography, but women and blacks had more risk factors, a higher Killip class, and a longer delay to reach the hospital. As compared with whites, black patients tended to be hospitalized more often in facilities that were used for teaching, were affiliated with medical schools, were located in urban areas, and had equipment for performing cardiovascular procedures.

IDEAL CANDIDATES FOR TREATMENTS AND PROCEDURES

The proportion of patients qualifying as ideal candidates for reperfusion and the administration of beta-blockers was 50 percent or less and declined over time in all groups. At each time point, women and blacks were less likely than white men to be ideal candidates (Fig. 1). Approximately 10 percent of patients were classified as ideal candidates for coronary angiography. This percentage was similar in all sex and racial groups and fairly constant over time.

TREATMENTS AND PROCEDURES AMONG IDEAL CANDIDATES

In the unadjusted analysis, treatment rates differed according to sex and race, with rates highest in white men and lowest in black women (Table 2). Differences were larger for rates of reperfusion therapy and coronary angiography, particularly for black women, but smaller for the use of aspirin and beta-blockers. The use of aspirin and beta-blockers increased over time, whereas rates of reperfusion therapy remained stable and those of coronary angiography decreased slightly, with similar time trends in the four demographic groups. As a result, there was no significant variation over time in treatment differences according to sex or race.

Results that were adjusted for the characteristics of patients and hospitals were similar (Table 3). Because models 2 and 3 provided almost identical results, only the results of model 3 (adjusted for both patient and hospital characteristics) are presented. The interaction among the factors of sex, race, and year, as well as all other pairwise interactions, were not significant, indicating that racial and sex differences in treatment did not change over time. In absolute terms, black women remained the group with the lowest rate of use of interventions. As compared with white men, the adjusted risk ratio for the use of reperfusion therapy in all years combined was 0.97 for white women, 0.91 for black men, and 0.89 for black women ($P<0.001$ for all comparisons). For coronary angiography, corresponding estimates were 0.91, 0.82, and 0.76 ($P<0.001$ for all comparisons). Adjusted differences for the use of aspirin and beta-blockers were small. For the use of aspirin, the risk ratio during the entire period was 0.97 for white women, 0.98 for black men, and 0.94 for black women, as compared with white men ($P<0.001$ for all comparisons). For the use of beta-blockers, corresponding figures were 0.98 ($P<0.001$), 1.00 ($P=0.55$), and 0.96 ($P<0.001$). Preferences of patients with respect to reperfusion therapy were recorded starting in 1998. These data show few refusals for reperfusion therapy (less than 0.5 percent) in each sex-and-race subgroup.

Analysis of secondary treatment end points indicated lower rates of use of CABG as compared with white men, with an adjusted risk ratio of treatment for white women, black men, and black women of 0.73, 0.74, and 0.63, respectively ($P<0.001$ for all comparisons). Adjusted differences in rates of PTCA according to sex and race were small, except for black women (risk ratio, 0.89; 95 percent confidence interval, 0.83 to 0.95); white women had slightly higher rates of PTCA than did white men (risk ratio, 1.06; 95 percent confidence interval, 1.04 to 1.08). Data on the use of stents were available starting in 1998. There was a steady increase in stent use over time, from 73.1 percent in 1998 to 87.3 percent in 2000 through 2002. Similar proportions of patients undergoing PTCA received stents regardless of sex or race, with similar time trends. Racial and sex differences in the use of CABG and PTCA did not change over the study period.

MORTALITY

Overall, 21.7 percent of patients were transferred to other hospitals and excluded from assessment of in-hospital mortality. The proportion of patients who were transferred varied among groups according to race and sex: 23.2 percent for white men, 18.0 percent for white women, 18.3 percent for black men, and 14.4 percent for black women ($P<0.001$). Among patients who remained in the same hospital, overall unadjusted mortality was 10.2 percent,

ranging from 7.3 percent among black men to 12.3 percent among white women (Table 2). After adjustment for differences in age and other characteristics of patients and hospitals, the death rate in hospitals was similar among black men (risk ratio as compared with white men, 0.95; 95 percent confidence interval, 0.89 to 1.00) and white women (risk ratio, 1.05; 95 percent confidence interval, 1.03 to 1.07), but higher among black women (risk ratio, 1.11; 95 percent confidence interval, 1.06 to 1.16). Racial and sex differences did not change over time.

DISCUSSION

There were notable differences and similarities in the treatment and outcome of myocardial infarction according to race and sex from 1994 through 2002. As compared with white men, fewer black men and black women received reperfusion therapy and coronary angiography, whereas black women had the highest adjusted mortality rate among all sex and racial groups. In contrast, differences in treatment and mortality between white women and white men were generally small, as were differences between any of the four racial and sex groups in the use of aspirin and beta-blockers. Racial and sex differences were essentially unchanged between 1994 and 2002.

Management differences were greater when patients were compared according to race within each sex (black men vs. white men and black women vs. white women) than when they were compared according to sex within each race (black men vs. black women or white men vs. white women), suggesting that disparities according to race may be more important than disparities according to sex. Black women had the highest risk of not receiving reperfusion therapy and coronary angiography. Several previous studies also documented less aggressive management of coronary disease in both women[5–11] and blacks.[8,9,12,14,15] The few studies that examined subgroups classified according to both sex and race also found the lowest rates among black women.[13,26,27]

Treatment differences according to sex and race persisted without much variation between 1994 and 2002. Although several studies investigated time trends in management of acute myocardial infarction,[28–30] none examined such trends with respect to patients' sex or race. Studies of patients who were referred for cardiovascular evaluation[31,32] found little difference in management according to sex, with little variation over time. One study that was based on administrative Medicare databases found smaller differences between blacks and whites in the use of coronary angiography and revascularization procedures in 1997 than in 1986.[33] Since results were adjusted only for sex and age, variations over time may reflect variations in the characteristics of patients or in their diagnoses, rather than in patterns of use in health care.

Despite considerable debate, reasons for these differences are largely unknown. Potential explanations are sex and racial differences in eligibility for treatment, clinical contraindications, and confounding by other clinical factors.[34] We mostly excluded these possibilities by focusing on ideal candidates and by adjusting for characteristics of patients and hospitals, although some misclassification is possible. It seems unlikely that misclassification affected our conclusions, because such errors should not have occurred differentially according to sex, race, or study year.

The preferences of patients regarding therapy may play some role in the treatment differences that were observed. Data on patients' preferences in NRMI were limited to reperfusion therapy in the latest years; therefore, we could not account for the preferences of patients in our analysis. However, available data indicated very low rates of refusal (less than 0.5 percent) in all sex and racial subgroups. Incomplete information regarding the time of the onset of symptoms could also contribute to differences in reperfusion therapy. These data were more often missing for white women, black men, and black women than they were for white men. To minimize

potential bias, only patients with complete information regarding this factor were considered ideal candidates for reperfusion.

Probably, persistent differences in treatments and procedures according to sex and race reflect some unmeasured characteristic of patients or a health care factor that has not changed over time. There may be differences according to sex and race in the early presentation of myocardial infarction that lead to a delayed diagnosis in black women, white women, and black men. This may affect early treatment in these groups, particularly the use of reperfusion. Similarly, unmeasured health care factors may lead to inequalities in the delivery of care among demographic groups. A recent study found that black patients tend to be treated by primary care physicians with lower qualifications and to have less access to subspecialist care, diagnostic imaging, and nonemergency hospital admissions.[35] Although these results cannot be extrapolated to acute inpatient care, provider-level differences according to race may exist during an admission for myocardial infarction — for example, the likelihood or timing of referral to a specialist. Hospital-specific effects may also account for a large portion of racial and ethnic disparities in the time to reperfusion therapy,[36] suggesting important unmeasured hospital-level factors — perhaps poorer-quality centers treating a disproportionate number of minority-group patients. This, however, is not consistent with our observation of larger treatment disparities, in comparison with white men, for black women than for black men, two groups who presumably have similar rates of use of hospitals that serve members of racial minorities.

The lack of narrowing in some differences in treatment according to sex and race in recent years is a cause for concern. Differences in treatment paralleled to some extent differences in mortality in our study, since black women were also the group with the highest adjusted in-hospital mortality rate. A full understanding of the reasons underlying such differences requires further study.

Although clinical guidelines for the treatment of acute myocardial infarction changed somewhat during the study period, that change should not affect our results, since we focused on patients who, at each time point, were ideal candidates for each intervention and since the definition was the same for each sex and racial subgroup. We lacked information on whether a history of asthma, chronic obstructive pulmonary disease, dementia, or conduction disorders may have limited the use of beta-blockers or whether a history of hypersensitivity to salicylates or active ulcer disease may have discouraged the use of aspirin. There is no reason to expect that these contraindications differed according to sex or race over time. We also lacked data on socioeconomic factors, such as education and employment status, and were unable to separate the role of sex or race from these factors. Information regarding the time of the onset of symptoms was not available for all patients. The quantity of these missing data increased over time in all sex and racial subgroups with similar trends, making it unlikely that missing values introduced bias. Finally, we did not have access to angiographic data, so we cannot exclude the possibility that observed differences in rates of revascularization after coronary angiography reflected overuse of procedures in white men, rather than underuse in other groups of patients. For this reason, rates of revascularization procedures were considered secondary end points.

Differences in some treatments and procedures, particularly reperfusion therapy and coronary angiography, according to sex and race persist after myocardial infarction, with no substantial changes from 1994 to 2002. Black women, the group with the lowest rate of use of interventions, have higher mortality rates than do other groups. Although the reasons for these differences are unknown, their persistence emphasizes the need for a continued search for explanations so that inequities in clinical care may be eliminated.

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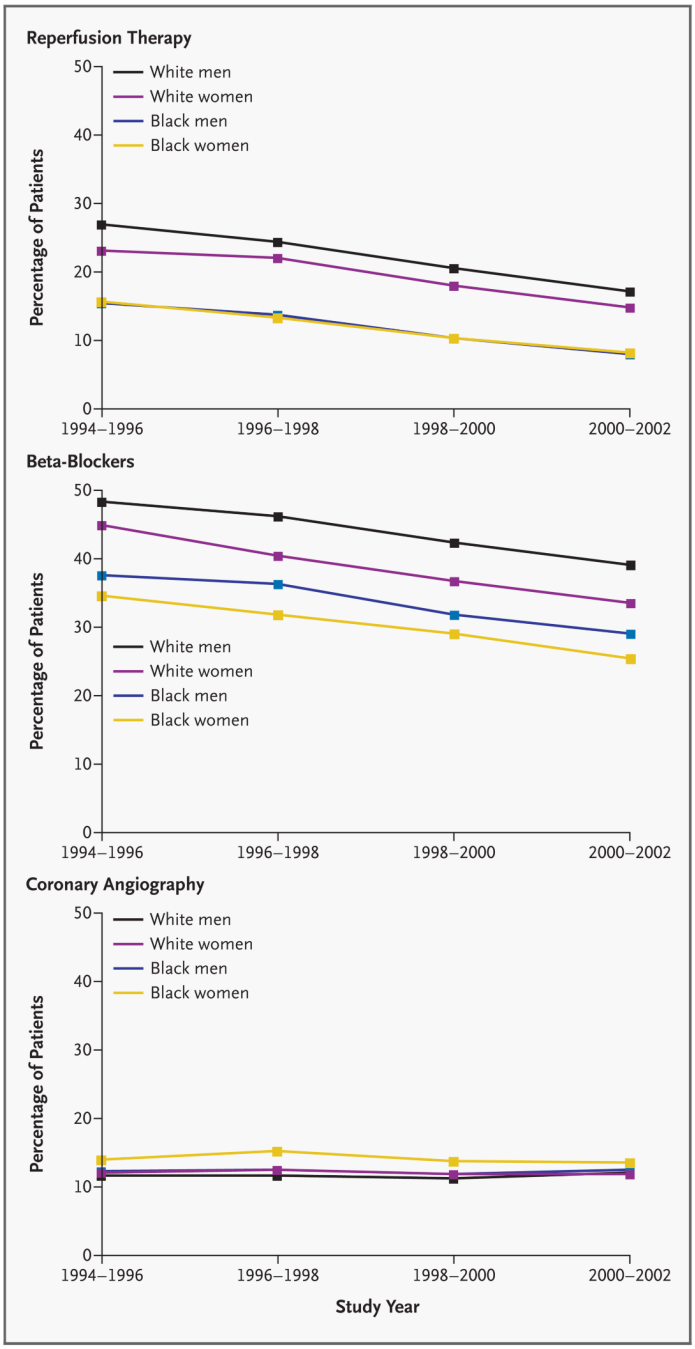

Figure 1. Proportions of Patients Considered Ideally Suited for Treatments and Procedures after Acute Myocardial Infarction, According to Sex and Race by Study Year

A year was defined in this study as the period from June through May.

Table 1

Characteristics of Hospitalized Patients According to Sex, Race, and Study Year.*

White Men					White Women					Black Men					Black Women					P Value‡
1994–1996	1996–1998	1998–2000	2000–2002	All Years†	1994–1996	1996–1998	1998–2000	2000–2002	All Years†	1994–1996	1996–1998	1998–2000	2000–2002	All Years†	1994–1996	1996–1998	1998–2000	2000–2002	All Years†	
65.1	65.9	66.9	67.4	66.4	72.9	73.4	74.4	75.0	74.0	60.5	60.8	61.4	62.0	61.3	66.6	66.8	67.6	67.9	67.3	0.96
																				0.46
24.2	21.7	21.8	21.0	22.1	10.9	9.8	9.7	9.5	9.9	21.0	18.1	19.2	18.2	19.0	13.1	10.6	10.5	11.0	11.2	
6.8	8.7	9.6	8.9	8.6	3.2	4.1	4.5	4.2	4.0	8.6	10.9	12.4	11.6	11.0	6.6	6.8	8.2	7.9	7.5	
1.5	1.4	1.3	1.4	1.4	2.0	1.8	1.7	1.7	1.8	4.7	4.3	4.3	5.0	4.6	7.1	6.9	6.4	5.9	6.5	
10.8	9.5	7.0	6.7	8.4	5.5	4.8	3.4	3.1	4.1	17.7	17.8	14.1	13.1	15.5	10.1	10.7	8.3	7.0	8.8	
56.7	58.7	60.3	62.0	59.6	78.5	79.4	80.6	81.5	80.1	48.1	48.9	50.1	52.1	49.9	63.0	65.0	66.5	68.2	66.0	
27.5	27.9	27.5	27.6	27.6	23.6	23.9	23.7	24.0	23.8	24.9	26.5	24.9	26.1	25.6	25.2	25.6	23.0	24.1	24.3	0.04
18.5	17.7	14.0	12.5	15.5	19.9	18.8	14.1	12.4	15.9	14.2	13.9	11.5	9.2	12.0	16.8	16.6	12.0	9.5	13.2	0.25
10.9	12.1	14.2	15.8	13.4	19.2	20.2	23.3	24.7	22.1	12.5	15.1	18.1	18.7	16.4	21.4	23.0	24.8	27.4	24.5	0.64
8.9	10.3	12.3	14.5	11.6	5.6	6.9	8.3	9.6	7.8	6.6	8.0	10.1	11.9	9.5	6.0	6.6	7.7	10.1	7.8	0.54
14.6	15.8	17.5	18.8	16.8	8.2	9.5	10.2	10.9	9.8	6.6	7.7	9.1	10.2	8.5	5.8	6.4	7.3	8.4	7.2	0.63
7.1	8.0	9.3	9.2	8.5	9.8	10.6	12.6	12.4	11.5	9.5	10.2	12.5	12.3	11.3	12.2	14.1	15.4	14.8	14.3	0.17
22.3	23.8	26.4	28.0	25.3	29.8	30.2	32.0	32.2	31.2	31.2	31.0	34.6	34.4	33.0	45.8	47.1	45.4	47.5	46.5	0.36
44.6	47.6	51.3	55.3	49.9	56.5	59.8	63.5	66.8	62.1	62.9	65.9	68.1	70.8	67.3	74.3	77.0	78.5	81.5	78.3	0.61
30.4	29.3	27.3	27.1	28.4	20.1	19.5	18.0	17.6	18.7	39.5	38.6	36.2	36.2	37.5	22.5	22.9	21.9	22.0	22.3	0.04
25.8	29.3	32.6	36.4	31.3	24.1	27.0	28.1	30.7	27.7	18.7	22.7	23.4	27.4	23.3	20.4	22.7	23.7	27.2	23.9	0.32
arrival at hospital																				
5.3	5.2	5.2	5.1	5.2	6.3	5.9	5.9	5.6	5.9	6.2	5.7	5.9	5.2	5.8	6.5	6.6	6.6	5.9	6.4	0.03
21.8	25.0	32.1	38.1	29.6	28.7	32.6	40.7	47.4	38.2	26.9	31.9	39.3	46.0	36.8	33.7	39.3	46.4	52.7	44.3	0.26
76.5	73.7	68.3	66.2	70.9	67.0	64.0	56.5	53.8	59.7	71.8	69.7	65.0	62.8	66.9	64.4	61.6	55.2	54.5	58.2	0.30

White Men					White Women					Black Men					Black Women					P Value‡
1994–1996	1996–1998	1998–2000	2000–2002	All Years†	1994–1996	1996–1998	1998–2000	2000–2002	All Years†	1994–1996	1996–1998	1998–2000	2000–2002	All Years†	1994–1996	1996–1998	1998–2000	2000–2002	All Years†	
n (%)																				
44.8	40.7	33.6	28.3	36.4	40.2	35.6	27.6	22.5	30.7	41.0	38.4	30.5	25.1	33.1	33.6	31.1	23.7	19.2	25.9	0.17
28.3	29.4	28.4	27.3	28.3	28.3	29.1	27.6	25.8	27.6	24.6	25.5	23.3	21.8	23.7	23.6	24.7	23.1	20.8	22.9	0.34
12.0	10.2	8.7	7.8	9.6	10.8	9.0	7.0	6.5	8.1	9.7	9.1	7.3	6.4	8.0	7.9	7.9	5.4	5.6	6.5	0.32
5.3	5.6	5.4	3.6	5.0	7.5	7.9	7.6	4.8	6.9	3.5	4.4	3.9	3.0	3.7	6.2	6.0	5.6	3.4	5.1	0.03
																				0.72
78.9	78.6	78.1	78.1	78.4	67.9	68.3	68.0	68.6	68.2	75.9	76.2	74.2	75.2	75.3	67.1	66.5	68.1	67.6	67.4	
14.2	14.4	14.7	15.0	14.6	20.9	20.8	21.0	21.3	21.0	16.0	15.7	17.3	17.1	16.6	20.2	20.8	19.4	20.8	20.3	
6.1	6.3	6.4	6.1	6.2	10.2	10.0	10.2	9.3	9.9	7.7	7.3	7.8	7.2	7.5	12.0	11.9	11.8	10.9	11.6	
0.8	0.7	0.8	0.8	0.8	1.0	0.9	0.7	0.8	0.8	0.5	0.7	0.7	0.6	0.6	0.7	0.9	0.7	0.7	0.8	
144.9	145.1	144.3	143.7	144.5	145.5	146.3	145.6	145.1	145.6	149.9	148.4	147.7	147.6	148.3	150.5	150.9	151.1	151.2	151.0	0.008
84.2	84.9	86.1	86.4	85.5	89.0	89.8	91.0	91.4	90.4	86.4	87.0	88.9	88.8	87.9	90.0	91.5	92.1	92.2	91.6	0.16
85.6	86.0	80.3	76.2	81.9	82.1	82.3	74.3	69.2	76.5	85.6	85.4	79.5	76.5	81.4	82.7	82.7	75.0	70.4	76.9	0.96
																				0.32
42.1	45.4	47.3	52.2	46.9	38.5	42.9	45.6	50.4	44.8	42.0	43.6	46.4	49.7	45.8	41.7	42.5	46.9	50.3	46.0	
15.3	17.5	19.4	22.4	18.8	14.7	16.8	18.4	21.6	18.2	17.4	19.9	23.9	26.4	22.3	16.1	19.0	20.0	23.9	20.2	
42.6	37.2	33.3	25.4	34.3	46.8	40.3	36.0	28.0	37.0	40.6	36.5	29.8	23.8	31.9	42.2	38.5	33.0	25.8	33.8	
72.9	72.7	73.1	73.7	73.1	71.7	72.4	71.8	72.3	72.1	84.4	85.2	86.5	86.6	85.8	85.6	85.4	86.9	86.8	86.3	0.47
42.5	43.3	45.3	44.6	44.0	42.4	43.6	44.7	43.6	43.7	55.8	56.6	58.2	58.6	57.4	58.2	59.3	59.9	60.4	59.6	0.95
8.5	9.7	8.4	8.7	8.8	7.7	9.2	8.1	8.6	8.4	18.0	20.5	17.5	18.7	18.6	19.1	22.6	18.8	18.6	19.7	0.01
83.0	82.6	83.7	84.4	83.5	81.9	81.8	82.5	83.3	82.4	88.5	88.4	89.8	91.1	89.6	90.2	88.5	89.8	91.0	89.9	0.08
edures (%)																				0.31
17.1	15.7	13.8	11.7	14.5	19.0	17.1	15.5	13.8	16.1	9.8	7.9	8.7	7.9	8.5	8.8	7.1	7.9	7.4	7.7	
27.3	27.3	24.2	20.1	24.6	29.0	28.8	26.4	23.0	26.5	25.9	25.8	23.7	19.4	23.4	25.9	25.9	24.7	20.6	24.0	
7.1	6.3	5.9	7.3	6.6	7.3	6.4	6.1	7.5	6.8	8.7	6.9	6.2	9.7	7.9	8.4	6.9	7.3	10.5	8.4	

	White Men					White Women					Black Men					Black Women					P Value‡
	1994–1996	1996–1998	1998–2000	2000–2002	All Years†	1994–1996	1996–1998	1998–2000	2000–2002	All Years†	1994–1996	1996–1998	1998–2000	2000–2002	All Years†	1994–1996	1996–1998	1998–2000	2000–2002	All Years†	
	48.5	50.7	56.1	60.8	54.3	44.7	47.7	52.0	55.6	50.5	55.5	59.4	61.4	63.0	60.2	57.0	60.0	60.1	61.4	59.9	
volume (%)§																					0.15
	5.5	4.8	4.0	3.4	4.4	6.0	4.9	4.5	3.9	4.7	3.0	3.0	2.8	2.4	2.8	3.5	2.8	3.6	2.5	3.1	
	14.3	13.5	12.2	11.9	12.9	14.7	14.1	13.3	13.4	13.8	14.8	13.9	13.3	11.5	13.2	14.8	12.7	13.4	12.1	13.1	
	26.6	25.1	24.8	24.4	25.2	28.1	26.3	25.6	26.0	26.4	32.1	29.4	29.6	28.9	29.9	30.3	31.4	31.7	30.8	31.1	
	53.6	56.6	58.9	60.2	57.5	51.2	54.7	56.5	56.8	55.1	50.1	53.7	54.2	57.2	54.1	51.5	53.1	51.3	54.6	52.7	
																					0.77
	12.6	12.9	11.6	11.0	12.0	12.3	12.4	11.3	10.6	11.6	16.4	19.1	18.6	15.9	17.5	16.6	20.3	17.2	16.8	17.7	
	82.5	81.9	82.7	83.5	82.7	83.3	83.0	83.6	84.5	83.6	79.7	75.2	76.7	79.8	77.9	79.3	75.3	78.3	79.6	78.2	
	4.8	5.2	5.7	5.5	5.3	4.4	4.6	5.1	4.9	4.8	3.9	5.7	4.6	4.3	4.6	4.1	4.4	4.6	3.6	4.2	

so there is overlap in years. HMO denotes health maintenance organization, PPO preferred provider organization, PTCA percutaneous transluminal coronary angioplasty, rafting. Because of rounding, not all percentages total 100.

men with white women, black men, and black women for all years combined, except for P values for creatinine kinase levels, which were two or more times the normal

significant difference in the trend over time for factors among the four subgroups defined by sex and race.

ents admitted with myocardial infarction per year.

Table 2

Unadjusted Rates of Treatments, Procedures, and Outcomes among Hospitalized Patients, According to Sex, Race, and Study Year.*

Characteristic	White Men					White Women					Black Men					Black Women				
	1994–1996	1996–1998	1998–2000	2000–2002	All Years	1994–1996	1996–1998	1998–2000	2000–2002	All Years	1994–1996	1996–1998	1998–2000	2000–2002	All Years	1994–1996	1996–1998	1998–2000	2000–2002	All Years
	percent																			
Primary treatment end points																				
Reperfusion therapy in first 24 hr for ideal candidates†	87.4	87.4	84.1	86.8	86.5	84.9	83.8	81.6	82.6	83.3	80.4	80.8	79.8	80.7	80.4	79.6	78.4	74.5	78.8	77.8
Aspirin in first 24 hr, all patients	80.7	85.4	86.8	84.2	84.4	73.5	80.1	81.3	78.8	78.7	79.5	84.1	85.1	84.5	83.7	72.2	79.8	80.4	79.3	78.4
Beta-blockers in first 24 hr for ideal candidates‡	54.7	63.2	69.3	79.7	66.6	49.7	59.7	65.6	76.0	62.9	57.1	62.9	71.2	80.0	67.8	49.8	60.7	69.1	75.6	64.5
Coronary angiography for ideal can didates§	72.3	72.3	67.0	65.4	69.1	58.0	59.7	54.5	52.7	55.9	68.5	65.6	62.0	61.1	64.0	59.5	56.4	54.8	51.1	55.0
Secondary treatment end points																				
CABG (excluding immediate CABG) for catheterized patients¶	25.5	26.6	26.4	28.1	26.7	22.4	22.3	23.1	23.3	22.8	19.5	21.6	20.5	22.7	21.1	15.9	18.2	23.7	20.4	19.8
PTCA (excluding primary procedure) for catheterized patients¶	44.5	45.0	48.2	46.7	46.1	43.6	45.1	46.6	44.5	45.0	39.6	44.7	48.5	43.0	44.0	39.8	33.4	37.8	41.5	38.1
In-hospital mortality for all patients	8.8	8.5	9.1	8.8	8.8	13.7	12.3	12.2	11.4	12.3	6.8	6.8	7.5	7.8	7.3	10.5	10.5	11.3	10.5	10.7

[*] The study period was June to May, so there is overlap in years. CABG denotes coronary-artery bypass grafting and PTCA percutaneous transluminal coronary angioplasty.

[†] Patients were considered ideal candidates for reperfusion therapy if they were less than 75 years of age, had ST-segment elevation on the first echocardiogram, presented within 12 hours after the onset of symptoms, did not have documented contraindications to fibrinolytic therapy (i.e., active internal bleeding or known bleeding diathesis; a history of stroke, recent surgery, or trauma; intracranial neoplasm; severe uncontrolled hypertension; or other documented contraindication), and did not decline to receive treatment.

[‡] Patients were considered ideal candidates for beta-blocker therapy if they had a pulse of at least 60 beats per minute; did not have evidence of heart failure, shock, or hypotension (i.e., systolic blood pressure <100 mm Hg); and presented within 12 hours after the onset of symptoms.

[§] Patients were considered ideal candidates for coronary angiography if they were admitted to hospitals fully able to perform invasive procedures and if they had had any of the following conditions: hypotension requiring intervention, recurrent angina, ischemia or infarction, cardiogenic shock, and hemodynamic instability.

[¶] Patients were considered ideal candidates for coronary angiography and had undergone the procedure.

Table 3

Unadjusted and Adjusted Risk Ratios for Treatments, Procedures, and Outcomes among Hospitalized Patients Classified According to Sex, Race, and Study Year.*

Characteristic	White Women					Black Men					Black Women					P Value†	P Value‡
	1994–1996	1996–1998	1998–2000	2000–2002	All Years§	1994–1996	1996–1998	1998–2000	2000–2002	All Years§	1994–1996	1996–1998	1998–2000	2000–2002	All Years§		
	risk ratio																
Primary treatment end points																	
Reperfusion therapy in first 24 hr for ideal candidates																	
Unadjusted	0.97	0.96	0.97	0.95	0.96	0.92	0.92	0.95	0.93	0.93	0.91	0.90	0.89	0.91	0.90	0.34	0.68
Adjusted¶	0.98	0.97	0.98	0.95	0.97	0.90	0.91	0.94	0.90	0.91	0.91	0.90	0.87	0.89	0.89	0.26	0.67
Aspirin in first 24 hr for all patients																	
Unadjusted	0.91	0.94	0.94	0.94	0.93	0.98	0.98	0.99	1.00	0.99	0.90	0.93	0.93	0.94	0.93	0.30	0.56
Adjusted¶	0.96	0.97	0.97	0.97	0.97	0.97	0.97	0.98	1.00	0.98	0.90	0.94	0.93	0.96	0.94	0.55	0.38
Beta-blockers in first 24 hr for ideal candidates																	
Unadjusted	0.91	0.94	0.95	0.95	0.94	1.04	0.99	1.03	1.00	1.02	0.91	0.96	1.00	0.95	0.97	0.80	0.78
Adjusted¶	0.96	0.98	0.98	0.98	0.98	1.00	0.96	1.00	1.00	1.00	0.88	0.95	0.98	0.96	0.96	0.38	0.75
Coronary angiography for ideal candidates																	
Unadjusted	0.80	0.83	0.81	0.81	0.81	0.95	0.91	0.92	0.93	0.93	0.82	0.78	0.82	0.78	0.80	0.07	0.62
Adjusted ‖	0.91	0.93	0.93	0.89	0.91	0.82	0.78	0.84	0.86	0.82	0.82	0.73	0.77	0.77	0.76	0.055	0.25
Secondary management end points																	
CABG (excluding immediate CABG) among catheterized patients																	
Unadjusted	0.88	0.84	0.88	0.83	0.85	0.76	0.81	0.78	0.81	0.79	0.62	0.68	0.90	0.73	0.74	0.89	0.42
Adjusted ‖	0.76	0.71	0.77	0.71	0.73	0.69	0.78	0.73	0.77	0.74	0.50	0.57	0.78	0.63	0.63	0.88	0.41
PTCA (excluding primary procedure) among catheterized patients																	
Unadjusted	0.98	1.00	0.97	0.95	0.98	0.89	0.99	1.01	0.92	0.95	0.89	0.74	0.78	0.89	0.83	0.08	0.52
Adjusted ‖	1.06	1.10	1.04	1.04	1.06	0.92	0.99	1.02	0.92	0.97	0.98	0.79	0.81	0.94	0.89	0.049	0.48
In-hospital mortality for all patients																	

Characteristic	White Women					Black Men					Black Women					P Value†	P Value‡
	1994–1996	1996–1998	1998–2000	2000–2002	All Years§	1994–1996	1996–1998	1998–2000	2000–2002	All Years§	1994–1996	1996–1998	1998–2000	2000–2002	All Years§		
	risk ratio																
Unadjusted	1.52	1.42	1.33	1.29	1.38	0.77	0.81	0.82	0.88	0.82	1.19	1.23	1.24	1.19	1.21	0.80	0.72
Adjusted ¶	1.10	1.10	1.01	0.99	1.05	0.92	0.94	0.92	0.99	0.95	1.03	1.11	1.14	1.11	1.11	0.73	0.31

* Patients were considered ideal candidates for reperfusion if they were less than 75 years of age, had ST-segment elevation on the first echocardiogram, presented within 12 hours after the onset of symptoms, did not have documented contraindications to fibrinolytic therapy (i.e., active internal bleeding or known bleeding diathesis; history of stroke, recent surgery, or trauma; intracranial neoplasm; severe uncontrolled hypertension; or other documented contraindication), and did not decline to receive treatment. The study period was June to May, so there is overlap in years. CABG denotes coronary-artery bypass grafting, and PTCA percutaneous transluminal coronary angioplasty.

† P values are for the interaction between sex and race.

‡ This P value indicates whether there is a significant difference in the trend over time for treatments or procedures among the four subgroups defined by race and sex.

§ P<0.01 for the comparison of white men with white women, black men, and black women, for all years combined, except for beta-blockers in black men (unadjusted P=0.05; adjusted P=0.55), PTCA in black men (unadjusted P=0.09; adjusted P=0.26), PTCA in white women (unadjusted P=0.02), and mortality in black men (adjusted P=0.06).

¶ Risk ratios were adjusted for age, insurance status, medical history (a history of myocardial infarction, angina, heart failure, stroke, diabetes, hypertension, or hypercholesterolemia; current smoking status; and previous CABG or PTCA), severity characteristics on admission (Killip class, systolic blood pressure, pulse, chest pain, left bundle-branch block, creatine kinase levels, location of anterior or septal infarct, and left ventricular ejection fraction [classified as <40 percent, ≥40 percent, or missing]), time from the onset of symptoms to hospital arrival (<3 hours, 3 to 6 hours, >6 to 12 hours, >12 hours, or not available), and hospital characteristics (number of beds; medical-school affiliation or teaching status; urban location; availability of invasive procedures, including catheterization, CABG, and PTCA; annual quartiles for the volume of myocardial infarction, and hospital ownership [including public, private not-for-profit, and private for-profit]).

‖ Risk ratios were adjusted for the same factors as those listed above, except that availability of invasive procedures was not included among hospital characteristics, since only patients admitted to hospitals fully able to perform invasive procedures were examined for the use of cardiovascular procedures.

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