Severity of Illness, Treatment Environments, and Outcomes of Treating Acute Myocardial Infarction for Hispanic Americans

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Objective: To examine associations of ethnicity with severity of illness, treatment environments, outcomes, as well as their interactions among acute myocardial infarction (AMI) patients.

Design, Setting, and Participants: 182,374 Hispanic and non-Hispanic White AMI discharges in the 1998–1999 National Inpatient Sample.

Main Outcome Measures: In addition to measuring severity of illness and the treatment environments defined as care-seeking characteristics and process of care, the principal outcome measure was hospital mortality.

Results: Compared to non-Hispanic White patients, Hispanic patients were associated with a greater comorbidity index, less likely to be treated in small (odds ratios [OR], 0.67), rural (OR, 0.39), or low-volume hospitals (OR, 0.90), but more likely to be treated in teaching hospitals (OR, 1.74). Further, Hispanic patients were less likely to receive arteriography, PTCA, and CABG, but positively associated with more resource use; also, Hispanic patients were less likely to be discharged to non-acute health facilities (OR, 0.80) or to die in hospital (OR, 0.78). Finally, comorbidities and the receiving of PTCA interacted with ethnicity, respectively, to affect mortality.

Conclusions: Substantial differences in the hospital care for AMI existed between Hispanic and non-Hispanic White patients. While the treatment environments were less favorable for Hispanics, their survival advantage over non-Hispanic Whites remains to be unexplained. Biological or other social or clinical factors need to be identified to better explain the lower mortality rates of Hispanics. Enhancing access to specialized services should improve health outcomes for non-Hispanic Whites. (*Ethn Dis.* 2002;12:488–498)

Key Words: Hispanics, Acute Myocardial Infarction (AMI), Severity of Illness, Outcome, Interactive Effect

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Introduction

It has been widely reported that Hispanics are socioeconomically disadvantaged with regard to income, health insurance coverage, education, and behavioral risk factors.[1–4] Nevertheless, relatively limited knowledge has existed for this sub-population about medical care of major diseases, such as acute myocardial infarction (AMI). More specifically, based on our literature search from 1990 forward, only several studies have compared outcomes of treating AMI (the leading cause of death in the nation) of Hispanics against that of treating non-Hispanic Whites. Although most of those studies did not observe salient differences in outcomes between the 2 ethnic groups, they did conclude that Hispanic AMI patients were less likely to use specialized clinical procedures than non-Hispanic patients were.[5–8] No study has reported higher hospital mortality among Hispanic patients than among non-Hispanic White patients. Two studies, using data from the 1980s and published nearly 10 years ago, reported that the hospital mortality of Hispanic AMI patients was lower than that of non-Hispanic White patients under certain conditions. One of these studies found lower mortality rates only among male Hispanics compared to non-Hispanic White males.[9] The other study detected the mortality difference between the 2 ethnic groups when controlling for age and sex; however, the difference disappeared when a few comorbidities were further taken into account.[10] A more recent study found that Hispanics had lower rates of cardiovascular disease (including AMI) mortality than African Americans even after adjusting demographic variables and several comorbidities; the authors suggested possible interactions between gene environments and other factors on mortality.[11] However, the absence of non-Hispanic Whites made their results less clear because the conventional approach has used the non-Hispanic White population as the reference in comparison with minorities who are often socioeconomically disadvantaged.

Not only have the prior studies been limited in quantity, but also far from being able to provide a clear picture about outcomes of treating AMI of Hispanics as opposed to that of non-Hispanic Whites. Most published AMI studies on Hispanics have only examined age or age-sex adjusted mortality, although a few included several comorbidities such as hypertension, diabetes, and congestive heart failure.[9,10] Omission of other important patient comorbidities or lack of identifying a comprehensive comorbidity set for AMI could blur effects of socioeconomic or behavioral risk factors, effects of severity of illness, and effects of treatment environments on outcomes. For example, if racial disparities are more associated with socioeconomic status and lifestyles, possible policy interventions should focus on prevention, sources of regular care, and health education. If racial disparities, on the other hand, are associated with treatment environments, then, the improvement of the acute care delivery to unfavorable populations needs to be addressed. Second, although few studies have observed interactions between ethnicity and other sociodemographic factors,[8,9] none has explored the interactive effects between ethnicity and severity of illness, as well

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as interactive effects between ethnicity and treatment environments in relation to outcomes of AMI.

Finally, most studies on the AMI treatment of Hispanics are either outdated or lack national representation in their samples. Given the decline in the AMI hospital mortality rate during the last 10 years,[9] current AMI outcome differences between Hispanics and non-Hispanic Whites remain to be known. Hispanic Americans have become the largest minority population and they will continue to outpace the growth of other ethnic groups in years to come.[12] In order to realize the *Healthy People 2010* goals to eliminate racial disparities in health and health services,[13] it becomes urgent that we improve the understanding of outcomes of treating major diseases among Hispanic Americans.

To address these issues, we selected AMI as the tracer disease and examined associations of ethnicity with severity of patient illness, treatment environments, and outcomes. Developing an AMI-specific risk-adjustment approach and using current national data, we explored interactions between ethnicity and other sociodemographic factors, between ethnicity and severity of illness, and between ethnicity and the treatment environments, on outcomes of treating acute myocardial infarction. We believe that our findings are useful in prioritizing areas for policy intervention to eliminate racial disparities and improve the health and health care of the nation at large.

METHODS

Disease Selection

We selected acute myocardial infarction because it is the principal disease in the group of coronary heart diseases (CHD). CHD, the leading cause of death in the United States, is responsible for about half a million deaths (one out of every 5 US deaths) every year. There were approximately 2.2 million hospital discharges of CHD in 1999. The cost of AMI and angina associated with CHD was estimated to be $111.8 billion in 2001, of which $58.2 billion were directly related to medical treatment.[1]

Data

We abstracted data from the 1998 and 1999 National Inpatient Sample (NIS), maintained by the Healthcare Cost and Utilization Project (HCUP) of the Agency for Healthcare Research and Quality. The NIS contained discharges from approximately 1,000 hospitals located in 24 states, approximating a 20% stratified sample of US community hospitals. Due to lack of information about patients' ethnic background, we excluded discharges in 5 states: Georgia, Illinois, Maine, Oregon, and Washington. The 19 states remaining were: Arizona, California, Colorado, Connecticut, Florida, Hawaii, Iowa, Kansas, Massachusetts, Maryland, Missouri, New Jersey, New York, Pennsylvania, South Carolina, Tennessee, Utah, Virginia, and Wisconsin. AMI discharges were identified by 2 criteria: 1) a principal diagnosis of AMI, initial or unspecified episode of care (ICD-9 codes: 410.x0 or 410.x1); and 2) a principal diagnosis of a presumed AMI complication with a secondary diagnosis of AMI.[14] After data cleaning, we identified a total of 185,778 discharges. We excluded 3,404 discharges (1.9%) whose length of stay equaled zero, because those cases were more likely to be either transferred to another hospital or died when arriving or shortly after arriving at hospital. Among the 3,404 discharges, 2% were Hispanics and 98% were non-Hispanic Whites. A total of 182,374 AMI discharges were included in analysis.

Severity of Illness and Risk Adjustment

We developed an AMI-specific comorbidity index that reflected the severity of illness and risk of death caused by the principal diagnosis.[15] We used this index for 2 purposes. First, we used it to compare severity of illness of patients across ethnic groups; and second, we used it as risk-adjustment in assessing care-seeking characteristics, process, and outcome of care.

We developed the AMI specific comorbidity index in 5 steps. First, we identified a total of 36 AMI relevant comorbidity conditions by incorporating results of studies conducted by Romano and colleagues[14] and Elixhauser and colleagues.[16] Second, controlling for age, sex, race, insurance status, median income by zip code of residence, and admission type,[16] we conducted a multiple logistic regression analysis on the relationship between each of the 36 comorbidities and in-hospital mortality, respectively. The purpose of this regression analysis was to identify statistically significant comorbidities and their odds ratios in regard to hospital mortality. We identified 31 comorbidities that were statistically significant in predicting mortality (Appendix 1). Among them, 6 were negatively associated with mortality (ie, odds ratios less than one) and the rest were positively associated with mortality (ie, odds ratios greater than one). Third, we used the 1995–1997 NIS data to validate the results obtained from the 1998–1999 data. All of the odds ratios from the 1998–1999 data and 1995–1997 data were consistent except 2. Infarction site on the inferior wall and deficiency anemia were not significant when using 1998–1999 data (odds ratios [ORs], 0.87, 1.05) but were significant when using 1995–1997 data (ORs, 0.87, 0.83). Therefore, these 2 conditions were not included in analysis.

The fourth step was to calculate the sum of the significant odds ratios for each patient. For odds ratios that were greater than one, we simply added them together. For odds ratios that were less than one, we inversed the number to make it greater than one and then assigned a negative value to it (eg, for the odds ratio of chronic pulmonary disease: 0.58, the inverse value equaled 1.72, the final value was −1.72). In the fifth and last step, we collapsed those values based on frequency distributions and then made the values to an integer scale. The final AMI comorbidity scale consisted of 11 values ranging from −2 to 8, including 0 (Appendix 2). Each patient was assigned one of the 11 values; the higher the value a patient had, the higher the mortality risk he or she had. A zero value meant that the patient did not have any comorbidity or the sum of his/her comorbidities' odds ratios equaled zero. A negative value meant that the patient's comorbidity status was associated with a lower mortality risk than those who had no comorbidities; the lower the value, the lower the mortality risk. A positive value meant that the patient's comorbidity status was associated with a higher mortality risk than those who were absent from comorbidities; the higher the value, the higher the mortality risk. Based on our data, we found that this AMI comorbidity index performed better in predicting hospital mortality (c-Statistic,[17] 0.87) than an AMI specific comorbidity list developed by the California Hospital Outcome Project (c-Statistic, 0.79),[14] the comprehensive comorbidity list developed by Elixhauser and colleagues (c-Statistic, 0.79),[16] and the Charlson morbidity list (c-Statistic, 0.74).[18,19]

Measures

In addition to measuring severity of illness by the AMI-comorbidity index, we measured aspects of the treatment environments (defined as structure and process) as well as outcome.[20] Structure is the setting in which health care takes place and the instrumentalities of which the process is the product. From a patient's perspective, structure (ie, admission and hospital characteristics) can be viewed as their care-seeking characteristics that were measured by 5 variables in our study. They were: 1) admission through a transfer from another acute hospital; 2) admission in a small-size hospital; 3) admission in a teaching hospital; 4) admission in a rural hospital; and 5) admission in a low AMI-volume hospital. Definitions of a hospital's size, teaching status, and urban-rural setting were based on the American Hospital Association's annual survey classification.[21] Hospital volume was expressed as the average number of AMI patients discharged per year. The hospitals were ranked in order of increasing total AMI volume, and low-volume hospitals were defined by the selection of a whole-number cutoff point for annual volume that most closely sorted the patients at the bottom quintile (ie, 25%) and at the bottom 10th percentile.[22] In general, small, non-teaching, rural, or low-volume hospitals are less experienced in providing sophisticated and specialized services compared to their large, teaching, urban, and high-volume counterparts.[22,23] Admission transferred from another hospital, in general, indicates severe clinical conditions that cannot be handled by the first hospital or lack of geographic access to sophisticated hospitals at the first stop.[23,24] Admission in either teaching hospitals or urban-rural hospitals is also associated with geographic locations since most teaching hospitals are located in urban areas.[25] We did not include ownership characteristics of hospitals because, for 57% of patients, the hospitals in which they stayed were collapsed in ownership category in the NIS data.

Process of care was measured by 3 specialized procedures often used in conjunction with AMI: coronary arteriography (diagnostic); PTCA (therapeutic); and coronary artery bypass graft (CABG) (therapeutic).[8,26]

We divided outcome into economic outcomes and clinical outcomes. To measure economic outcomes, we used 3 variables: 1) length of stay (LOS); 2) the amount of total charges; and 3) average charges per hospital day. The first 2, highly correlated with each other, often approximate the total amount of resources used,[27] while the third indicates the average intensity of resource use during hospitalization.

We used in-hospital mortality as the primary clinical outcome measure because AMI has relatively high in-hospital mortality. Hospital mortality has been one of the most frequently used clinical outcome measures.[28] In addition, we used another variable, being discharged to a non-home-care and non-acute-care health facility (eg, skilled nursing facility [SNF]), to measure the clinical outcomes, assuming a routine discharge or discharged with home-care as an ideal clinical outcome.

We categorized self-reported ethnic background, the primary explanatory variable, as Hispanic and non-Hispanic White with the latter group being the reference in comparison. For the focus of the paper and the sake of simplicity, we did not include African-American and other ethnic groups in our analysis.

To control for potential confounding factors, we included patients' socioeconomic and demographic characteristics such as age, sex, health insurance status, and median income by zip code of the patient's residence. The median income by zip code has been shown to be associated with healthcare outcomes.[29,30] We also controlled for the year of patients being discharged and for geographic variations in policy and regulation among the 19 states.[31,32]

Analytical Techniques

We conducted logistic regression for dichotomous response variables to examine relations of ethnicity with structure, process, and clinical outcomes of the treatments. Meanwhile, we used the least square regression for continuous response variables to examine relations of ethnicity with severity of illness and economic outcomes. When the response variable was LOS, results of survival analysis with the right-censored data were also obtained to compare with results from the least square regression.[33] Since both results were similar, only those from the least square regression are presented in this paper. In addition, a natural logarithm transformation was performed for continuous response variables due to skewness of the data distributions. When the response variable of multivariate analysis (ie, least square regression or survival analysis) was continuous, we used age as a continuous exploratory variable. When the responsive variable (ie, logistic regression) was dichotomous, for the purpose of expanding the age to a meaningful interval, we formed an ordinal variable, age-group, that divided into 6 age-groups: younger than 40, 40–49, 50–59, 60–69, 70–79, and 80 or older.

We established a series logic relations among variables in multivariate analysis. When severity of illness was the response variable, ethnicity and control variables were included as exploratory variables in the multivariate model. When structure was the response variable, severity of illness, ethnicity, and control variables were included. When process was the response variable, structure, severity of illness, ethnicity, and control variables were included. Finally, when (either economic or clinical) outcome was the response variable, process, structure, ethnicity, and control variables were all included in the multivariate model.

We added interaction terms between ethnicity and other exploratory variables to examine the hospital mortality. According to Hosmer and Lemeshow,[34] we analyzed interactive effects on mortality risk in 4 steps: 1) running the mortality model that only included main effects of the exploratory variables (see Model C in Table 3 in the Results section); 2) adding interaction terms between ethnicity and those exploratory variables that were statistically significant main factors ($P<.05$) into the main effect model, to form an interactive model including both main effects and interactive effects (see Model D in Table 3); 3) based on results of the interactive model, recalculating the odds ratios for those variables whose interactions with ethnicity were statistically significant (Table 4); and 4) interpreting the interactive effects, if any.

For the logistic regression model we used the c-statistic and the Hosmer-Lemeshow statistic to examine the model fit.[17,34,35] In the least square regression, we checked the multicollinearity problem by examining the value of the variance inflation factor (VIF) for each exploratory variable.[36] For both logistic regression and least square regression, we used the forward stepwise selection to avoid the multicollinearity problem.

RESULTS

Sociodemographic and Hospitalization Characteristics

Unadjusted sociodemographic and hospitalization characteristics are shown in Table 1. Hispanic patients, on average, were 2 years younger than non-Hispanic White patients. Seven percent and 12.2% of Hispanic patients were uninsured and covered by Medicaid, respectively, while the 2 percentages for non-Hispanic patients were 3.6% and 3.1%, respectively. A higher proportion of Hispanic patients (16.5%) than that of non-Hispanic White patients (4.1%) lived in areas where the median income by zip code was less than $25,000, as a lower proportion of Hispanic patients (19.7%) than non-Hispanic White patients (29.0%) resided in areas where the median income by zip code was $45,000 or higher.

Hispanic patients had a slightly higher average comorbidity index (1.5) than that of non-Hispanic White patients (1.4). About 8% and 66% of Hispanic patients went to small and large hospitals, respectively, while 12.4% and 59.7% of non-Hispanic White patients went to small and large hospitals, respectively. Among Hispanic patients, 39.5% went to teaching hospitals, 4.4% went to rural hospitals, and 22.4% went to low-volume hospitals; and use of hospitals for non-Hispanic White patients were 42.2%, 15.3%, and 25.2%, respectively. On average, Hispanic patients stayed 6.0 days in hospital while non-Hispanic White patients stayed 5.6 days; and Hispanic patients had the total charges of $29,332 with an average hospital charge per day of $5,951, while non-Hispanic White patients had $24,255 and $5,168, respectively. Compared to 11.8% of non-Hispanic White patients, only 8.7% of Hispanic patients were discharged to other non-acute health facilities. Finally, the crude hospital mortality rates for non-Hispanic White patients and Hispanic patients were 9.3% and 8.0%, respectively; while the age- and sex-adjusted mortality rates were 9.2% and 8.4% for non-Hispanic White patients and Hispanic patients, respectively.

Relationships of Ethnicity with Severity of Illness and Treatment Environments

Results of the multivariate analysis are shown in Table 2. Hispanic patients had a higher comorbidity index than that of non-Hispanic White patients (regression coefficient [RC], 0.015). Compared to non-Hispanic White patients, Hispanic patients were less likely to seek acute care in small hospitals (OR, 0.67), rural hospitals (OR, 0.39), or low-volume hospitals (OR, 0.90), but more likely to seek care in teaching hospitals (OR, 1.74). The likelihood of receiving specialized procedures for Hispanic patients, compared with non-Hispanic White patients, was also lower for arteriography (OR, 0.74), PTCA (OR, 0.83), and CABG (OR, 0.85). In spite

Table 1. Patients' sociodemographic and hospitalization characteristics*

	All Patients (*N*=182374)	Non-Hispanic White (*N*=172520)	Hispanic American (*N*=9854)
Socio-demographic characteristics			
Age, mean (SD), y	69.2 (13.7)	69.3 (13.7)	67.3 (13.5)
Female	73623 (40.4)	69706 (40.4)	3916 (39.7)
Health insurance			
Medicare	112226 (61.5)	107184 (62.1)	5042 (51.2)
Medicaid	6590 (3.6)	5393 (3.1)	1197 (12.2)
Private insurance	56753 (31.1)	53849 (31.2)	2914 (29.6)
Uninsured	6795 (3.8)	6094 (3.6)	701 (7.0)
Median income by zip code of residence			
≤$25,000	8708 (4.8)	7070 (4.1)	1629 (16.5)
$25,000–$34,999	63728 (34.9)	60260 (34.9)	3468 (35.2)
$35,000–$44,999	57938 (31.8)	55117 (32.0)	2821 (28.6)
≥$45,000	52000 (28.51)	50064 (29.0)	1936 (19.7)
Severity of illness			
Comorbidity index, mean (SD)	1.43 (2.31)	1.43 (2.30)	1.50 (2.39)
Structure			
Admission through a transfer	24504 (13.4)		1312 (13.3)
Hospital size		23192 (13.4)	
Small	22179 (12.2)	21403 (12.4)	776 (7.9)
Median	50769 (27.8)	48196 (27.9)	2573 (26.1)
Large	109426 (60.0)	102921 (59.7)	6505 (66.0)
Admission in teaching hospital	76637 (42.0)	72748 (42.2)	3889 (39.5)
Admission in rural hospital	26820 (14.7)	26388 (15.3)	432 (4.4)
Admission in a low volume hospital	45652 (25.0)	43450 (25.2)	2203 (22.4)
Process			
Receiving arteriography	85469 (46.9)	81344 (47.2)	4125 (41.9)
Receiving PTCA	41749 (22.9)	39785 (23.1)	1964 (19.9)
Receiving CABG	18511 (10.2)	17664 (10.2)	847 (8.6)
Outcome			
Economic outcome			
Length of stay, mean (SD), d	5.6 (5.1)	5.6 (5.1)	6.0 (5.5)
Total charges, mean (SD), $	24528.3 (28308.0)	24254.5 (28034.4)	29322.0 (32358.8)
Charges per hospital day, mean (SD), $	5210.1 (4839.1)	5167.8 (4819.60	5950.7 (5112.1)
Clinical outcome			
Discharged to SNF or other health facility	21141 (11.6)	20282 (11.8)	859 (8.7)
Discharge status equals death	16714 (9.2)	15924 (9.3)	790 (8.0)
Age- and sex-adjusted hospital mortality, %	9.2	9.2	8.4

* Data are expressed as number and percentage unless otherwise indicated.

of having both a longer average LOS (RC, 0.091) and higher average total charges (RC, 0.061), Hispanic patients incurred lower average charges per hospital day than that of non-Hispanic White patients (RC, −0.032), which was opposite to the result shown in Table 1 in which Hispanic patients had higher unadjusted average charges per hospital day. Finally, Hispanic patients were less likely to be discharged to other non-acute care health facilities than were non-Hispanic White patients.

Factors Associated with Hospital Mortality

Table 3 lists results from 4 models that compared the hospital mortality of Hispanic patients and non-Hispanic White patients. Results from Model A, which only included ethnicity and other sociodemographic factors as exploratory variables, indicate a marginal association between ethnicity and hospital mortality (OR, 0.92, $P<.1$). Once taking into account the severity of illness (Model B), however, we found that Hispanic patients were significantly less likely to die in hospitals than non-Hispanic White patients (OR, 0.83). Furthermore, after controlling for sociodemographic factors, as well as severity of illness, structure, and process (Model C), we still observed the mortality odds ratio (0.78) favoring Hispanic patients.

Based on the results from the Model C in Table 3, 14 interaction terms were formed between Hispanic American (HA) and the 14 significant main effect variables in the Model C; then, among

Table 2. Relationships between ethnicity and the five dimensions of hospital and care (*N*=182374)†

	Hispanic American		
Response Variable	Odds Ratio	95% of C.I. for Odds Ratio	c-Statistic
Severity of illness			
Comorbidity index, parameter estimate, SE, adjusted R-square‡	0.015***	0.005	0.06
Structure			
Admission through a transfer	1.01	0.95–1.08	0.63
Admission in a small hospital	0.67***	0.62–0.73	0.68
Admission in a teaching hospital	1.74***	1.65–1.83	0.71
Admission in a rural hospital	0.39***	0.35–0.44	0.79
Admission in a low volume hospital			
Hospital volume within the bottom quantile (25th percentile)	0.90***	0.84–0.95	0.66
Hospital volume within the bottom 10th percentile	0.92*	0.84–1.01	0.72
Process			
Receiving arteriography	0.74***	0.70–0.78	0.81
Receiving PTCA	0.83***	0.78–0.88	0.81
Receiving CABG	0.85***	0.79–0.91	0.77
Outcome			
Clinical outcome			
Length of stay, parameter estimate, SE, adjusted R-square‡	0.091***	0.007	0.26
Total charges, parameter estimate, SE, adjusted R-square‡	0.061***	0.007	0.56
Charges per hospital day, parameter estimate, SE, adjusted R-square‡	−0.032***	0.005	0.46
Clinical outcome§			
Discharged to SNF or other health facility	0.80***	0.73–0.86	0.78

* $P<0.10$, ** $P<0.05$, *** $P<0.01$.
† Results are expressed as odds ratio, 95% confidence interval, and c-statistic unless otherwise indicated. The full-table results containing all variables are available upon request to the corresponding author.
‡ Results of the least square regression, dependent variables transformed by the natural logarithm during regression.
§ Results of hospital mortality are shown in Table 3.

them, 2 were selected by the stepwise regression because of their statistical significance (Model D). In addition to the main effect variables, interactions between HA and the comorbidity index (COMI), as well as receiving PTCA, respectively, were also associated with hospital mortality. Table 4 shows interactive odds ratios, from which we can see that both the observed and the predicated odds ratios were consistent for the interactions between Hispanic ethnicity and receiving PTCA, but only partly consistent for interactions between Hispanic ethnicity and the comorbidity index. The lower mortality of Hispanic patients over non-Hispanic White patients was only detected among those who did not receive PTCA (ORs, 0.82 for observed, 0.63 for predicted). For patients who received PTCA, there were comparable mortality risks between the 2 ethnic groups (CIs, 0.76–1.24 for observed, 0.67–1.24 for predicted).

For the interaction between Hispanic ethnicity and the comorbidity index, the observed and predicated odds ratios were fairly consistent when the comorbidity index was equal to or greater than zero. As the comorbidity conditions became more severe, the mortality difference between the Hispanic and non-Hispanic White patients gradually disappeared (ie, from the CIs not including 1 eventually to the CIs including 1). Among patients with a negative comorbidity index (ie, −1, −2), the observed odds ratios were not significant (CIs, 0.24–2.42, 0.50–1.29) while the predicated odds ratios were (ORs, 0.58, 0.60). It seems that the series of the observed odds ratios indicated some U-shape interactive relationships between race and the comorbidity index in terms of the effect on mortality, as the series of the predicted odds ratios showed monotonous interactions. Overall, although Hispanics still had the lower mortality risk, the differences in the mortality odds between Hispanic patients and non-Hispanic White patients tended to get smaller (ie, odds ratios increased towards to one) as the comorbidity index became greater values.

DISCUSSION

Based on national, comprehensive, and recent data, we found marked variations in a wide range of aspects of hospital care between Hispanic and non-Hispanic White AMI patients. These variations are, in part, associated with sociodemographic, socioeconomic, or cultural factors, as well as severity of illness and the treatment environments. Hispanic patients had more severe comorbidity conditions than non-Hispanic White patients did when arriving at hospitals; and, among these comorbidities, some were lifestyle or behavior re-

Table 3. Factors associated with in-hospital mortality (*N*=182374)†

	Model A: Generic Model (1) (c-Statistic = 0.69)		Model B: Generic Model (2) (c-Statistic = 0.86)		Model C: Without Interactions (c-Statistic = 0.87)		Model D: With Interactions (c-Statistic = 0.87)	
Explantory Variables	Odds Ratio	95% C.I. for Odds Ratio	Odds Ratio	95% C.I. for Odds Ratio	Odds Ratio	95% C.I. for Odds Ratio	Odds Ratio	95% C.I. for Odds Ratio
Hispanic American (HA)	0.92*	0.84–1.01	0.83***	0.77–0.90	0.78***	0.71–0.85	0.63***	0.53–0.75
Socio-demographic characteristics								
Age group	1.72***	1.68–1.75	1.52***	1.49–1.55	1.38***	1.35–1.41	1.38***	1.35–1.41
Sex, female	1.11***	1.07–1.15	1.18***	1.13–1.22	1.14***	1.10–1.18	1.14***	1.10–1.18
Medicaid	1.17**	1.03–1.33	‡	‡	‡	‡	‡	‡
Private insurance	0.74***	0.70–0.79	0.85***	0.80–0.90	0.87***	0.82–0.92	0.87***	0.82–0.92
Uninsured	‡	‡	1.18**	1.03–1.35	1.14*	0.99–1.30	1.14*	1.00–1.30
Median income by zip code	‡	‡	0.97**	0.95–1.00	0.97**	0.95–1.00	0.97**	0.95–0.99
Severity of illness								
Comorbidity index (COMI)			1.68***	1.67–1.69	1.67***	1.66–1.69	1.67***	1.66–1.68
Structure								
Admission through a transfer					0.92**	0.86–0.99	0.92**	0.86–0.99
Hospital bedsize					1.11***	1.08–1.15	1.11***	1.08–1.15
Admission in a teaching hospital					1.19***	1.14–1.24	1.19***	1.14–1.24
Admission in a rural hospital					0.84***	0.79–0.89	0.84	0.79–0.89
Admission in a low volume hospital					0.92**	0.86–0.99	0.92**	0.86–0.99
Process								
Receiving arteriography					0.47***	0.45–0.50	0.47***	0.45–0.50
Receiving PTCA					0.77***	0.72–0.83	0.76***	0.71–0.82
Receiving CABG					0.82***	0.76–0.89	0.82***	0.76–0.88
Interactions								
HA*COMI							1.04**	1.01–1.08
HA*PTCA							1.45**	1.09–1.93

* $P<0.10$, ** $P<0.05$, *** $P<0.01$.
† The full-table results containing all variables are available upon request to the corresponding author.
‡ Variable not selected by the stepwise regression model at the significant level of $P<0.1$.

Table 4. Interactive effects of ethnicity and other factors on mortality risk (*N*=182374)

	Hispanic American			
Interactive Factors	Observed Odds Ratio	95% C.I. for Odds Ratio	Predicted Odds Ratio	95% C.I. for Odds Ratio
Comorbidity index				
−2	0.76	0.24–2.42	0.58	0.45–0.74
−1	0.80	0.50–1.29	0.60	0.49–0.75
0	0.69	0.50–0.96	0.63	0.53–0.75
1	0.60	0.45–0.81	0.66	0.56–0.77
2	0.62	0.46–0.84	0.68	0.60–0.78
3	0.70	0.56–0.88	0.71	0.64–0.79
4	0.80	0.64–0.99	0.74	0.68–0.82
5	0.76	0.62–0.94	0.78	0.71–0.85
6	0.89	0.69–1.16	0.81	0.73–0.90
7	0.86	0.66–1.13	0.85	0.74–0.97
8	0.90	0.69–1.18	0.88	0.75–1.03
Receiving PTCA				
Yes	0.98	0.76–1.24	0.91	0.67–1.24
No	0.82	0.76–0.89	0.63	0.53–0.75

lated. As shown in Figure 1, relatively more Hispanic patients than non-Hispanic White patients had diabetes (both complicated and uncomplicated diabetes collapsed), hypertension, and substance abuse (all P values $<.01$), although the obesity rates of the 2 ethnic groups were the same. These lifestyle comorbidities are risk factors for AMI.[1] They are deeply rooted into one's socioeconomic status (eg, health insurance, income, education, or occupation) and cultural factors (language, communication skills, or cultural isolation). Further, the higher incidence of having these behavioral risk factors among Hispanic patients might also be explained by lack of regular primary care sources, which has been well documented.[37] However, the relatively lack of regular care sources of Hispanic Americans, again, could link back to their relatively

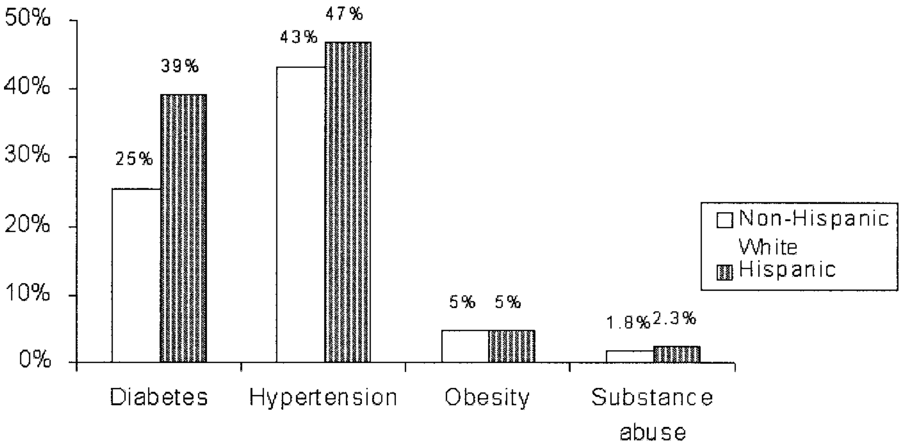

Fig 1. Life-style risk factors by ethnicity (*N*=182374)

lower socioeconomic status and higher cultural barriers to health care.[38]

It seemed that patient hospital selection or the care-seeking characteristics were more or less determined by geographic factors associated with ethnicity. Hispanic Americans disproportionally living in urban or metropolitan areas[39] might, in part, explain why they were less likely to seek care in small, rural, or low-volume hospitals, but meantime more likely to seek care in teaching hospitals, in comparison with non-Hispanic Whites. Since most large and teaching hospitals were located in non-rural areas and these hospitals had greater resources and were more experienced in providing specialized clinical procedures and dealing with severe and complicated conditions such as AMI, Hispanic patients, compared to non-Hispanic White patients, had better geographic access to more sophisticated hospitals and had less hospital transfers. It was also possible that relatively more Hispanic patients went to teaching hospitals simply because many teaching hospitals were public hospitals in which most underserved minorities were served.

Although we, in accord with other literature, found that Hispanic patients used fewer specialized procedures, explanations of why might not be simple. More comorbidity conditions might prevent Hispanic patients from receiving some complicated clinical procedures. As our results indicated, the higher incidence of diabetes among Hispanic patients made them less clinically appropriate for receiving CABG. The second explanation could be the bias of health delivery system against minority patients. Although our data did not allow us to examine the existence of this bias, other studies found that both non-Hispanic White and African-American physicians were biased against African-American patients in providing specialized procedures.[40] Future research efforts can examine whether physicians intentionally or unintentionally provide fewer specialized services to Hispanic patients without clinical justification. It is also worthy to mention that the physicians' bias might be related to financial incentives as well. Since Hispanic and other minority patients were disproportionally poor or uninsured (Table 1),[41] it might be less attractive to providers to offer expensive services to these groups. Finally, when detecting racial differences in using clinical procedures, one may question 2 situations: under-use of minority patients or over-use of non-Hispanic White patients, which might be the case. Our findings seem to have the same puzzle. On one hand, we did not see the under-use of Hispanic patients because they had a lower mortality. On the other hand, we did not seem to see the over-use of non-Hispanic White patients either because, as shown in results of the interaction analysis (Table 4), higher mortality of non-Hispanic White patients, as opposed to Hispanic patients, disappeared among those who received PTCA but persisted among those without PTCA.

Hispanic patients simultaneously having longer LOS and higher charges were reasonable because the 2 are usually highly correlated. Although the total charges might not be a perfect indicator of efficiency, it more or less approximated the resource use in hospital care.[8,42] Using the LOS to indicate efficiency might also be arguable because the LOS could be regarded as an outcome indicator. For example, more severe patients might stay in hospitals longer. Regardless of being an efficiency or outcome indicator, however, our results about the LOS seemed interpretable and consistent. Possible explanations why Hispanic patients had longer length of stay were due to the facts that: 1) more severe comorbidity conditions that required longer hospital stay; 2) since non-Hispanic White patients used more specialized procedures that have been proven clinically effective, they would be discharged faster; 3) relatively more Hispanic patients are treated in teaching hospitals where care could be more expensive and longer,[21] in part, due to their practice patterns related to medical education and research; and 4) relatively more non-Hispanic White patients were discharged to other non-acute health facilities, which shortened their stay in hospitals. Combining the findings that Hispanic patients received fewer specialized procedures, stayed in hospital longer with lower intensity of care (ie, lower average charges per hospital day), had higher total charges, and fewer were discharged to non-acute health facilities, one might ask whether we could have more Hispanic patients discharged to non-acute health facilities to shorten the LOS. Theoretically, if we could achieve this, we may reduce the total charges of hospital care to increase efficiency. Practically, however, it may be difficult because of possible lack of discharging channels among Hispanic patients. Since most non-acute facilities (eg, SNF) are private, among which many are for-profit, it would be more difficult for Hispanic patients to access non-acute facilities because of their relatively lower socioeconomic status and weaker financial accountability (eg, disproportionally uninsured). On the other hand, not-for-profit private hospitals and public hospitals, subsidized by government or private sources, provide a large amount of indigent care to socioeconomically vulnerable populations. If patients could not be discharged to non-acute facilities but were not ready to be sent to home yet, they stayed longer in hospital.

The most surprising result, perhaps, was the persistent lower hospital mortality risk among Hispanic patients than that among non-Hispanic White patients, regardless of the treatment environments (except receiving PTCA). In fact, our findings might not be surprising at all because they were consistent with results of previous studies (according to our literature review) in that no study has found a higher AMI hospital mortality among Hispanic patients than among non-Hispanic White patients.

What surprised us even more was that the mortality odds ratios, in favor of Hispanic patients, became smaller (ie, Hispanics had a lower and lower mortality risk) when more and more variables were controlled (Table 3). It indicated that some important variables and relevant interactions were of absence in our analysis. In particular, as the results of the treatment environments were less favorable to Hispanic patients than to non-Hispanic White patients, the survival advantage of the former seemed to be more unexplainable. As compared to non-Hispanic White patients, Hispanic patients who had greater comorbidity indices were: 1) less likely to go to rural or low-volume hospitals that were negatively associated with mortality; 2) more likely to go to large or teaching hospitals, which were positively associated with mortality; and 3) less likely to receive specialized procedures, which were negatively associated with mortality, but still had a lower mortality risk. The interesting results of larger or teaching hospitals associated with a higher mortality and rural hospitals associated with a lower mortality were also contradictory to findings of most previous studies.[22,23,25] One possible explanation could be that the large or teaching hospitals treat more severe AMI patients whose severity of illness were not fully represented by our comorbidity index based on the administrative data set. Nonetheless, the combination of these findings with 2 interaction effects (ie, the survival advantage of Hispanic patients over non-Hispanic White patients) became smaller when severity of illness became greater, the mortality difference between the 2 ethnic groups disappeared among patients who received PTCA), thus highlighting the complex nature of ethnicity and its effects on outcomes of care in healthcare delivery. In other words, ethnicity incorporates biological, socioeconomic, and cultural characteristics of patients and refers to both genetic and behavioral traits that interact with healthcare delivery environments to affect outcomes.[8,40,43–46]

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Future research may pursue new contributions in further understanding the hospital care of Hispanic patients in several aspects. First, researchers should obtain more detailed clinical information (eg, vital signs, results of lab tests and specialized procedures) to examine etiologic characteristics of AMI between Hispanic and non-Hispanic White patients. We think that using other clinical process indicators (eg, aspirin, beta-block, or ACI inhibitor administration) might not be particularly helpful in explaining the lower mortality of Hispanic patients, because studies have found that Hispanic patients were more likely to have poorer process indicators than non-Hispanic White patients.[6,47] Second, since literature has reported lack of regular physician care and more frequent preventable hospitalization among minorities,[37,48] one may think the more frequent use of hospital care, including emergent care as the usual source of care among Hispanics, could give them a survival advantage in the case of AMI. Since AMI is an emergent condition that often causes patients to immediately rush to a hospital, we do not believe that the physician referral is a major factor to delay the hospital care for non-Hispanic White patients. However, we do think that future studies should also focus on times and travel distances from onset of AMI symptoms to receiving treatment among different ethnic patients, as a few studies have reported a longer time to care for non-Black patients than for non-Hispanic White patients.[47] Given that Hispanics disproportionally live in city or metropolitan areas, as compared to non-Hispanic Whites, we estimate that the traveling time to hospitals for AMI might be shorter among Hispanic patients than among non-Hispanic White patients. Third, researchers may start exploring biological or genetic factors that, if exist, may influence outcomes for Hispanics because combining sociodemograpic and socioeconomic factors, severity of illness, and treatment environments could not remove mortality differences between the 2 ethnic groups.[11,49] Before studying the biological attributes, it will be helpful if we could have information to further divide the Hispanic population into sub-ethnic groups such as Hispanic White, Hispanic Black, or the mix. Then, the Hispanic sub-groups can be respectively compared with non-Hispanic Whites to see whether we can obtain any new explanations. Finally, future studies may select other major diseases (eg, heart failure, stroke, diabetes, or cancer) to determine whether similar results can be obtained across diseases.

Our analysis has other limitations. The NIS data did not allow us to examine post-discharge outcomes, such as 30-day or 180-day post-discharge mortality and readmission, from which long-term outcomes can be assessed and multiple admissions can be identified. Studies have found that Hispanic and non-Hispanic AMI patients had a comparable 30-day post-discharge mortality.[6] Also, available information on individual patient education and income may also enhance the measurement of socioeconomic status. Finally, exclusion of the 5 states reduced the generalizability of our findings.

In conclusion, given the fact that Hispanic Americans are a sub-population bearing high behavioral risk factors for acute myocardial infarction and that they do have a high rate of AMI hospitalization,[49] behavioral medicine-oriented prevention strategies, public health measures to encourage healthy lifestyles, and public policies to reduce financial and cultural barriers to regular care are undoubtedly important to reduce these risk factors among the Hispanic population. At the same time, however, the unexpected survival advantages of Hispanic patients over non-Hispanic White patients in hospital care remain to be explained. More resources should be provided to target generic attributes in relation to diseases among different ethnic populations, through which the AMI survival advantage of Hispanics over non-Hispanic Whites will be better explained. In addition, other social factors or clinical factors missing from our data may be identified to explain racial disparities in outcome. Finally, perhaps counter-intuitively, public attention should also be given to those non-Hispanic Whites (especially living in rural areas) who are traditionally believed to have better care and outcomes, but who may, in fact, be disadvantaged in the case of AMI. Enhancing access to specialized services (eg, PTCA) should improve their outcome.

REFERENCES

1. American Heart Association. *2002 Heart and Stroke Statistical Update.* Dallas, Tex: American Heart Association; 2001.
2. Agency for Healthcare Research and Quality. *Addressing Racial and Ethnic Disparities in Health Care. Fact Sheet, February 2000.* Rockville, Md: Agency for Healthcare Research and Quality. AHRQ Publication No. 00-PO41. Available at: http://www.ahrq.gov/research/disparit.htm.
3. Brown ER, Ojeda VD, Wyn R, Levan R. *Racial and Ethnic Disparities in Access to Health Insurance and Health Care.* The Henry J. Kaiser Family Foundation. 2000.
4. Goff DC Jr, Sellers DE, McGovern PG, et al. Knowledge of heart attack symptoms in a population survey in the United States: The REACT Trial. Rapid Early Action for Coronary Treatment. *Arch Intern Med.* 1998; 158(21):2329–2338.
5. Andrews RM, Elixhauser A. Use of major therapeutic procedures: are Hispanics treated differently than non-Hispanic Whites? *Ethn Dis.* 2000;10:384–394.
6. Cohen MG, Granger CB, Ohman EM, et al. Outcome of Hispanic patients treated with thrombolytic therapy for acute myocardial infarction: results from the GUSTO-I and III trials. Global Utilization of Streptokinase and TPA for Occluded Coronary Arteries. *J Am Coll Cardiol.* 1999;34(6):1729–1737.
7. Ford E, Newman J, Deosaransingh K. Racial and ethnic differences in the use of cardiovascular procedures: findings from the California Cooperative Cardiovascular Project. *Am J Public Health.* 2000;90(7):1128–1134.
8. Shen JJ, Wan TTH, Perlin JB. An exploration of the complex relationship of socioecological factors in the treatment and outcomes of acute myocardial infarction in disadvantaged populations. *Health Serv Res.* 2001;36:563–583.
9. Goff DC Jr, Ramsey DJ, Labarthe DR, Nichaman MZ. Acute myocardial infarction and coronary heart disease mortality among Mexican Americans and non-Hispanic Whites in Texas, 1980 through 1989. *Ethn Dis.* 1993; 3(1):64–69.
10. Norris SL, deGuzman M, Sobel E, Brooks S, Haywood LJ. Risk factors and mortality among Black, Caucasian, and Latina women with acute myocardial infarction. *Am Heart J.* 1993;126(6):1312–1319.
11. Henderson SO, Bretsky P, Henderson BE, Stram DO. Risk factors for cardiovascular and cerebrovascular death among African Americans and Hispanics in Los Angeles, California. *Acad Emerg Med.* 2001;8(12):1163–1172.
12. Bureau of the Census. *Census Brief: Overview of Race and Hispanic Origin.* 2000. Available at: http://www.census.gov/prod/2001pubs/c2kbr01–1.pdf.
13. Department of Health and Human Services. *Healthy People: What Are Its Goals?* 2002. Available at: http://www.health.gov/healthypeople/about/goals.htm.
14. Romano PS, Luft HS, Rainwater JA, Zach AP. *Report on Heart Attack 1991–1993, Volume 2: Technical Guide.* Sacramento, Calif: California Office of Statewide Health Planning and Development; 1997.
15. Iezzoni LI, ed. *Risk Adjustment for Measuring Healthcare Outcomes.* 2nd ed. Chicago, Ill: Health Administration Press; 1997.
16. Elixhauser A, Steiner C, Harris DR, Coffey RM. Comorbidity measures for use with administrative data. *Med Care.* 1998;36:8–27.
17. Hanley JA, McNeil BJ. The meaning and use of the area under a receiver operating characteristic (ROC) curve. *Radiology.* 1982;143:29–36.
18. Charlson ME, Pompei P, Ales KL, MacKenziek CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chron Dis.* 1987;40:373–383.
19. Deyo RA, Cherkin DC, Clol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. *J Clin Epidemiol.* 1992;45:613–619.
20. Donabidian A. Evaluating the quality of medical care. *Milbank Mem Fund Q.* 1966;44:166–206.
21. Agency for Healthcare Research and Quality. *National Statistics: Results-Outcomes by Patient and Hospital Characteristics for All Discharges.* 2001. Available at: http://hcup.ahrq.gov/hcupnet.asp.
22. Birkmeyer JD, Siewers AE, Finlayson EV, et al. Hospital volume and surgical mortality in the United States. *N Engl J Med.* 2002; 346(15):1128–1137.
23. Blustein J, Weitzman BC. Access to hospitals with high-technology cardiac services: how is race important? *Am J Public Health.* 1995;85:345–351.
24. Basu J. Access to primary care: the role of race

and income. *J Health Soc Policy.* 2001;13(4): 57–73.
25. Kahn KL, Pearson ML, Harrison ER, et al. Health care for Black and poor hospitalized Medicare patients. *JAMA.* 1994;271:1169–1174.
26. Iezzoni LI, Ash AS, Shwartz M, Mackiernan YD. Differences in procedure use, in-hospital mortality, and illness severity by gender for acute myocardial infarction patients: are answers affected by data source and severity measure? *Med Care.* 1997;35:158–171.
27. Rosenthal GE, Harper DL, Quinn LM, Cooper GS. Severity-adjusted mortality and length of stay in teaching and nonteaching hospitals. Results of a regional study. *JAMA.* 1997;278(6):485–490.
28. Rosenthal GE, Baker DW, Norris DG, Way LE, Harper DL, Snow RJ. Relationships between in-hospital and 30-day standardized hospital mortality: implications for profiling hospitals. *Health Serv Res.* Mar 2000;34(7): 1449–1468.
29. Claudio L, Tulton L, Doucette J, Landrigan PJ. Socioeconomic factors and asthma hospitalization rates in New York City. *J Asthma.* 1999;36(4):343–350.
30. Pappas G, Hadden WC, Kozak LJ, Fisher GF. Potentially avoidable hospitalizations: inequalities in rates between US socioeconomic groups. *Am J Public Health.* 1997;87(5):811–816.
31. Guadagnoli E, Landrum MB, Normand SL, et al. Impact of underuse, overuse, and discretionary use on geographic variation in the use of coronary angiography after acute myocardial infarction. *Med Care.* 2001;39(5): 446–458.
32. Morris RD, Munasinghe RL. Geographic variability in hospital admission rates for respiratory disease among the elderly in the United States. *Chest.* 1994;106(4):1172–1181.
33. Lawless JF. *Statistical Models and Methods for Lifetime Data.* New York, NY: John Wiley & Sons; 1982.
34. Hosmer DW, Lemeshow S. *Applied Logistic Regression.* New York, NY: John Wiley & Sons; 1989.
35. SAS Institute Inc. *SAS/STAT User's Guide, Volumes 1, 2, and 3, Version 8.* Cary, NC: SAS Institute Inc; 1999.
36. Stevens J. *Applied Multivariate Statistics for the Social Sciences.* 3rd ed. Mahwah, NJ: Lawrence Erlbaum Associates; 1996.
37. Weinick RM, Zuvekas SH, Cohen JW. Racial and ethnic differences in access to and use of healthcare services, 1977 to 1996. *Med Care Res Rev.* 2000;57:36–54.
38. Brach C, Fraser I. Can cultural competency reduce racial and ethnic health disparities? A review and conceptual model. *Med Care Res Rev.* 2000;57(suppl 1):181–217.
39. Bureau of the Census. *1990 Census of Population and Housing—Supplementary Reports: Metropolitan Areas as Defined by the Office of Management and Budget.* June 30, 1993:56. Available at: http://www.census.gov/prod/cen1990/cph-s/cph-s-1-1.pdf.
40. Chen J, Rathore SS, Radford MJ, Wang Y, Krumholz HM. Racial differences in the use of cardiac catheterization after acute myocardial infarction. *N Engl J Med.* 2001;344: 1443–1449.
41. Agency for Healthcare Research and Quality. *National Statistics: Results-Outcomes by Patient and Hospital Characteristics for All Discharges.* 2002. Available at: http://www.meps.ahrq.gov/compendiumtables/00ch1/t1_a00.pdf.
42. Philbin EF, DeSalvo TG. Influence of race and gender on care process, resource use, and hospital-based outcomes in congestive heart failure. *Am J Cardiol.* 1998;82:76–81.
43. Jones CP, LaVeist TA, Lillie-Blanton M. "Race" in the epidemiologic literature: an examination of the American Journal of Epidemiology, 1921–1990. *Am J Epidemiol.* 1991;134:1079–1084.
44. Nickens HW. The role of race/ethnicity and social class in minority health status. *Health Serv Res.* 1995;30:151–162.
45. Schulman KA, Rubenstein LE, Chesley FD, Eisenburg JM. The roles of race and socioeconomic factors in health services research. *Health Serv Res.* 1995;30:179–195.
46. Williams DR, Collins C. US socioeconomic and racial differences in health: patterns and explanations. *Ann Rev Sociol.* 1995;21:349–386.
47. Canto JG, Taylor HA Jr, Rogers WJ, Sanderson B, Hilbe J, Barron HV. Presenting characteristics, treatment patterns, and clinical outcomes of non-Black minorities in the National Registry of Myocardial Infarction 2. *Am J Cardiol.* 1998;82(9):1013–1018.
48. Shen JJ, Perlin JB, Xu YH, Wan TTH. Care-seeking patterns and outcome of hospitalized pneumonia patients who are socioeconomically disadvantaged. *Res Sociol Health Care.* 2000;18:97–120.
49. Goff DC, Nichaman MZ, Chan W, Ramsey DJ, Labarthe DR, Ortiz C. Greater incidence of hospitalized myocardial infarction among Mexican Americans than non-Hispanic Whites. The Corpus Christi Heart Project, 1988–1992. *Circulation.* 1997;95(6):1433–1440.

AUTHOR CONTRIBUTIONS

Design and concept of study: Shen
Acquisition of data: Shen
Data analysis and interpretation: Shen
Manuscript draft: Shen
Statistical expertise: Shen
Administrative, technical, or material assistance: Shen

Appendix 1. AMI Comorbidities and Their Relations with Hospital Mortality

Comorbidity Condition	Association with Mortality
Acute or unspecified renal failure	+
Aspiration pneumonia	+
Cardiac arrhythmias	+
Catastrophic sequelae fo AMI	+
Central nervous system disease	+
Chronic renal failure	+
Coagulopathy	+
Coma	+
Complete atrioventricular block	+
Complicated diabetes	+
Congestive heart failure	+
Depression	−
Fluid electrolyte disorders	+
High-risk or secondary malignant neoplasm	+
Hypertension	−
Hypothyroidism	−
Infarction site on anterior wall	+
Ischemic bowel or liver	+
Liver disease	+
Metastatic cancer	+
Obesity	−
Other cerebrovascular disease	+
Other infarction site	+
Paralysis	+
Paroxysmal ventricular tachycardia	+
Peptic ulcer disease excluding bleeding	−
Pulmonary edema	+
Seizure disorder	+
Shock	+
Thyroid disease	−
Weight loss	+

Appendix 2. Frequency Distribution of AMI Comorbidity Index Scores (*N*=182,374)

Comorbidity Index Score	Frequency	Percent
−2	6151	3.37
−1	29245	16.04
0	44744	24.53
1	31154	17.08
2	19798	10.86
3	20090	11.02
4	11475	6.29
5	8181	4.49
6	4344	2.38
7	4117	2.26
8	3075	1.69