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An Exploration of the Complex Relationship of Socioecologic Factors in the Treatment and Outcomes of Acute Myocardial Infarction in Disadvantaged Populations

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Objective. To examine the relationship of patients' socioeconomic status (SES) as measured by race, health insurance status, and median income by zip code to in-hospital mortality of acute myocardial infarction (AMI), paying special attention to patients with multiple unfavorable socioeconomic risk factors.
Data Sources/Study Setting. The data set was abstracted from patient-level hospital discharges in the Nationwide Inpatient Sample, Release 3, 1994. A total of 95,971 AMI discharges in 11 states were extracted.
Study Design. The risk adjustment methodology was adapted from the California Hospital Outcomes Project. Risk factors included demographic and clinical characteristics. Patients in double jeopardy had inferior insurance status and lived in poorer neighborhoods.
Principal Findings. Compared with patients with health care coverage under Medicare and private insurance uninsured AMI patients had the highest risk-adjusted mortality odds and Medicaid AMI patients had the second highest odds. Probably because of the modest association of median income by zip code areas with mortality odds, the double jeopardy phenomenon was not observed. However, compared to patients who had two favorable SES attributes, patients who carried two unfavorable SES attributes had much higher mortality risk, more comorbidities, longer length of stay, and higher total hospital charges, while they received fewer AMI specialized procedures. Race did not seem to be a significant factor after adjustment for other SES attributes.
Conclusions. SES is significantly related to the mortality of AMI patients. The disadvantaged patients receive fewer specialized procedures, possibly because of their higher levels of severity and financial barriers. The variation in mortality between patients who had favorable and unfavorable SES becomes wider when multiple socioeconomic risks are borne by the latter.

Key Words. Acute myocardial infarction, double jeopardy, multiple socioeconomic risks, outcome, socioeconomic status

Socioeconomic status (SES) is often used to identify those who are disadvantaged in receiving health care. SES is a powerful determinant of outcomes for disease and treatment (Moore 1997). Because access to care and the outcomes of health services for disadvantaged populations have long been issues in health care delivery (Altman, Reinhardt, and Shields 1998), a question of great interest is whether outcomes of major diseases are associated with SES of patients. This study looks at acute myocardial infarction (AMI), the principal disease in the group of coronary heart diseases that constitute the leading cause of death in the United States. In 1995 coronary heart disease was responsible for approximately 500,000 deaths (one of every five U.S. deaths). The cost of AMI and angina associated with coronary heart disease was estimated to be $96 billion in 1998, of which $51 billion is directly related to medical treatment (American Heart Association 1998; Hodgson 1998).

Low SES, commonly measured by race, education, income, and insurance status (Mueller, Patil, and Boilesen 1998; Williams and Collins 1995), often creates barriers to access to health care as well as good outcomes of care. Among socioeconomic measures race is perhaps the most studied. Race as an indicator, despite often being tied to income and insurance status, has been shown to significantly reflect cultural barriers to health care (Belgrave, Wykle, and Choi 1993; Mueller, Patil, and Boilesen 1998). Moreover, despite the assertion that African Americans have worse health care outcomes on the basis of SES than do non-Hispanic Caucasians, the literature that compares health outcomes between these populations has demonstrated mixed results (Ebell, Smith, Kruse, et al. 1995; Lillie-Blanton et al. 1996; Norris, deGuzman, Sobel, et al. 1993; Winkleby et al. 1998). A key reason for this inconsistency is the lack of control for socioeconomic factors other than race. Evidence has shown that racial differentials in outcome are minimized when data are stratified or adjusted for social class (Lillie-Blanton et al. 1996).

Education is probably the most robust indicator of SES, and a positive relationship has been demonstrated between lower education levels and worse health care outcomes (Jaglal and Goel 1994; Williams and Collins 1995). However, because information about education level is often not

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available in health care data repositories it appears less frequently as an indicator in outcome studies. Income level and insurance status both can be financial barriers to access to health services (Mueller, Patil, and Boilesen 1998). In some instances the affordability of health care may be more closely related to the treatment patients receive than clinical factors (Moore 1997). However, as with patient-level data on education, income information is often unavailable.

Another less explored area of the relationship between outcome and SES is the phenomenon recognized as "double jeopardy." This term is used to describe multidimensional vulnerability in SES such as being both impoverished and elderly. As Belgrave, Wykle, and Choi (1993) point out, the original double-jeopardy hypothesis proposed that African American elderly face more of a burden than do non-Hispanic Caucasian elderly. This explanatory framework can be generalized to examine other phenomena related to double jeopardy (Muccigrosso 1991; Rich, Rich, and Mullins 1995; Salmon 1994). Double jeopardy creates increased vulnerability for both obtaining health services and having good clinical outcomes (Belgrave, Wykle, and Choi 1993).

Differences among AMI patients in seeking emergency care and receiving diagnostic and therapeutic procedures across different socioeconomic levels have been well documented. Most empirical studies have reported that African American and uninsured AMI patients receive fewer AMI-related procedures than do, respectively, non-Hispanic Caucasian AMI patients or patients with private insurance (Bearden, Allman, McDonald, et al. 1994; Laouri, Kravitz, French, et al. 1997; Wenneker and Epstein 1989; Young and Cohen 1991).

The relationship between outcome of AMI and SES is not well understood, nor are the postulated mechanisms uniform. Young and Cohen (1991) found higher mortality among uninsured AMI patients than among those covered either by fee-for-service plans or HMOs, but they found no difference according to race or income. The limitation of that study, aside from its geographic restriction, is in the use of a risk adjustment methodology that is less robust than that presently used, which may result in not accounting adequately for patients' severity of illness. Another study, by Norris, deGuzman, Sobel, et al. (1993), found that race, which was the single SES indicator used, was significantly associated with in-hospital mortality. However, that study did not control for socioeconomic factors other than race. In the California Hospital Outcomes Project (CHOP) results were also mixed, suggesting that uninsured AMI patients have a higher risk of death than patients covered by private insurance or MediCal patients and that African American patients have lower risk than non-Hispanic Caucasian or Hispanic patients (Romano et al. 1997). Similarly, Kahn, Pearson, Harrison, et al. (1994) found that AMI patients who were African American or from poor neighborhoods were no more likely than those from wealthier neighborhoods to die during or after hospitalization.

The socioecologic perspective provides a broader view of SES. Socioecologic studies recognize the social environment as a dominant factor affecting health. For instance, outcome differences among people "could be explained largely by obvious discrepancies in sanitation, nutrition, and housing," and these elements are substantially influenced by income level (Bloomberg, Meyers, and Braverman 1994). The socioecologic perspective is profoundly important in exploring potential differences in disease burden associated with different populations at different socioeconomic strata. For example, lower SES is associated with more advanced disease at presentation (Haywood, Ell, deGuzman, et al. 1993). The observation that disadvantaged populations receive fewer diagnostic procedures and therapeutic interventions may relate to more advanced disease or multiple comorbidities, precluding the use of the procedures in question. Thus, understanding the limited use of these procedures is complex and will only occur in the context of a broader socioecologic examination.

Toward gaining insight into these relationships this study examines multiple dimensions of socioecologic advantage and disadvantage and explores the concept of double-jeopardized and doubly favored patients. This study explores how SES is associated with the outcome as well as process of treating AMI and incorporates more detailed socioeconomic information, a more sophisticated risk adjustment model, and data from a broad geographic sample of the United States.

METHODS

Data and Sample

This study used data abstracted from the National Inpatient Sample (NIS), Release 3, 1994, collected by the Healthcare Cost and Utilization Project, the Agency for Health Care Policy and Research (now the Agency for Healthcare Research and Quality). Approximately 20 percent of the total inpatient discharges were drawn as a stratified randomized sample from hospitals in 17 states. AMI discharges were then identified by two criteria: (1) a principal diagnosis of AMI, initial or unspecified episode of care; and (2) a principal diagnosis of a presumed AMI complication with a secondary diagnosis of AMI, initial or unspecified episode of care (Romano et al. 1997).

Of the total of 128,142 AMI discharges drawn from the NIS data file, 32,171 in six states (25 percent of the total) were excluded. Hospitals in Iowa did not provide reliable information about expected payers for patients' care. Arizona, Illinois, Oregon, Pennsylvania, and Washington did not require race information. The remaining 11 states were California, Colorado, Connecticut, Florida, Kansas, Massachusetts, Maryland, New Jersey, New York, South Carolina, and Wisconsin. A total of 95,971 cleaned AMI discharges were extracted as the sample for the study. The unit of analysis was hospital discharge.

Measures

Outcome of AMI was measured by in-hospital mortality adjusted according to an AMI-specific risk adjustment model developed by CHOP (Romano et al. 1997). Validated in 1996 and revised in 1997, the CHOP model is relatively reliable. As dictated by the nature of the NIS data, one of the four CHOP models applicable to absence of prior admission data was selected for this study. This model includes patient's age, sex, year of admission, 11 clinical risk factors, and nine selected main interaction terms. The 11 clinical risk factors were central nervous system disease, chronic renal failure, complicated diabetes, congestive heart failure, high-risk or secondary malignant neoplasm, hypertension, anterior wall myocardial infarction, inferior wall myocardial infarction, other infarction site, prior coronary artery bypass grafting (CABG), and thyroid disease (Romano et al. 1997). A preliminary binary analysis based on the NIS data revealed that all of the 11 clinical risk factors and the nine interaction terms were highly significantly associated with mortality except for the interaction between congestive heart failure and prior CABG, in which association with mortality was marginally significant.

In addition to mortality the use of three specialized procedures often used in conjunction with AMI was examined. Diagnostic coronary arteriography and the therapeutic interventions of angioplasty and CABG were analyzed in terms of their relationships with mortality and SES. In some studies the use of these procedures (e.g., angioplasty) has been shown to reduce AMI mortality in elderly patients (Berger, Schulman, Gersh, et al. 1999).

SES was measured using race, health insurance status, and median income by zip code of residence. Race was used as a proxy for potential cultural differences between ethnic groups (Belgrave, Wykle, and Choi 1993; Mueller, Patil, and Boilesen 1998). In this study race was categorized as non-Hispanic Caucasian, African American, and Hispanic. Insurance status, regarded as the patient's mechanism of payment for health services (Gold 1998), was categorized as Medicare, Medicaid, private insurance including HMO/prepaid health plans, and uninsured. Because of "universal" coverage Medicare patients were not included when double jeopardy was examined. Uninsured was defined as the most inferior insurance status (coded as three), private insurance as the most advantageous (coded as one), and Medicaid as in between (coded as two).

The median income was identified for each zip code of patient residence. This measure has been found to reflect the community's overall socioecologic conditions that are associated with outcome and health status (Claudio et al. 1999; Pappas et al. 1997; Smith, Wentworth, Neaton, et al. 1996). Median income by zip code ranged from less than $15,000 to more than $45,000, constituting two strata; income was also stratified at three intermediate levels.

Patients in double jeopardy in this study were defined as those who had inferior health insurance and resided in poor neighborhoods. Following Ferraro (1989), the hypotheses were framed as follows. First, uninsured patients should have higher AMI mortality than the Medicaid patients, who in turn should have higher mortality than patients in private insurance programs. Second, mortality variance inversely associated with median income by zip code should be greater for uninsured patients than for the Medicaid patients and greater for the Medicaid patients than for those in private insurance programs. In other words, both insurance status and median income by zip code as well as their interaction should be present in a multivariate analysis to empirically demonstrate the existence of double jeopardy.

To explore the magnitude of difference in outcome between those who carried two adverse SES characteristics and those who had two favorable ones, two subgroups of patients were directly compared. The "extremely unfavorable group" included those who were covered by Medicaid or were uninsured and who also resided in zip code areas having a median income lower than $20,000. The "extremely favorable group" consisted of those who were covered by private insurance and lived in zip code areas with median incomes above $40,000. The direct comparison of the two groups was conducted by defining a dummy variable (equal to one if a patient belonged to the extremely unfavorable group and zero if the patient belonged to the extremely favorable group). Between the two groups wider variations in mortality and uses of the three AMI specialized procedures, number of diagnoses, number of procedures received, length of stay, and total charges per discharge were expected.

In addition, because the NIS is a multistate data source ten dummy variables for ten states, not including California (which was used as the reference), were defined to control for geographic differences that might be related to AMI patient outcomes.

Analytic Techniques

After adding socioeconomic variables to the revised CHOP model logistic regression was conducted to predict the adjusted mortality odds for each AMI discharge and detect salient SES attributes. The odds ratio of mortality obtained from the logistic regression is close to the risk ratio when the incidence of death among AMI discharges was less than 10 percent (Zhang and Yu 1998). In addition the general linear model was used to compare the number of diagnoses, number of procedures received, length of stay, total charges per AMI discharge, and total charges per hospital day between the extremely favorable and the extremely unfavorable groups. Because of the skews of the data distributions a natural logarithm transformation was performed for all dependent variables in the general linear model.

RESULTS

Patient and Hospitalization Characteristics

Characteristics of patients and their hospitalization for all AMI patients and non-Medicare AMI patients are summarized in Table 1. While certain characteristics were conserved among all patients—coronary heart disease occurs in older patients—differences in mortality rate, length of stay, distribution of gender, and the use of two of the three specialized procedures were not. The average unadjusted hospital mortality rates were 10.2 percent for all AMI patients and 4.9 percent for non-Medicare patients. The non-Medicare patients had a higher percentage of males, 73.0 percent, and the percentage for all was about 61.8 percent. The average length of stay for all patients (7.1 days) was about one day longer than that for the non-Medicare discharges (6.2 days). Finally, non-Medicare discharges had more uses of diagnostic arteriography (51.7 percent) and interventional angioplasty (24.4 percent) compared to those of all AMI patients (41.6 percent and 17.7 percent, for the two procedures, respectively).

Table 1: Patients Demographic and Hospitalizational Characteristics

	All Patients		*Non-Medicare Patients*	
	Frequency	*%*	*Frequency*	*%*
Sex				
Male	59,312	61.8	28,126	73.0
Female	36,654	38.2	10,399	27.0
Race				
Non-Hispanic Caucasian	81,133	88.5	30,854	85.2
African American	6,147	6.7	2,991	8.3
Hispanic	4,380	4.8	2,383	6.6
Insurance status				
Medicare	57,443	59.9		
Medicaid	3,539	3.7	3,539	9.2
Private insurance	29,915	31.2	29,915	77.7
Uninsured	5,039	5.3	5,039	13.1
Median income by zip code ($)				
< 15,000	1,506	1.8	640	1.9
- 25,000	20,421	24.3	7,160	21.3
- 35,000	33,877	40.2	13,107	39.0
- 45,000	17,371	20.6	7,519	22.4
> 45,000	11,017	13.1	5,204	15.5
Discharge status				
Discharged alive	9,816	10.2	1,872	4.9
Discharged dead	86,134	89.8	36,651	95.1
Arteriography received				
Yes	39,926	41.6	19,936	51.7
No	56,045	58.4	18,592	48.3
Angioplasty received				
Yes	16,972	17.7	9,395	24.4
No	78,999	82.3	29,133	75.6
CABG received				
Yes	8,699	9.1	3,856	10.0
No	87,272	90.9	34,672	90.0
	Mean (n = 95,971)	*s.d.*	*Mean (n = 38,528)*	*s.d.*
Age	67.6	13.3	56.4	10.8
Number of diagnoses	6.0	2.9	5.1	2.7
Number of procedures	2.6	2.6	2.9	2.6
Length of stay	7.1	8.9	6.2	9.8
Total charges ($)	19,713.3	24,467.2	19,848.1	23,485.4

SES and Mortality of AMI: An Overview

Using Medicare patients as the reference group, for all AMI patients Medicaid and uninsured AMI patients showed a higher adjusted mortality odds ratio and AMI patients covered by private insurance demonstrated a lower mortality odds ratio. Table 2 shows that, compared to Medicare patients, Medicaid patients had a hospital-mortality odds ratio of 1.19 and uninsured patients had an odds ratio of 1.33. Patients with private insurance had mortality odds ratios of 0.83. In general Medicaid and uninsured AMI patients were about 20 percent and 30 percent more likely to die in hospital, respectively, than were Medicare AMI patients, but AMI patients covered by private insurance had only about 0.83 times the risk of dying as Medicare AMI patients.

The level of the median income by zip code was only marginally negatively associated with the mortality odds of AMI patients. Race did not seem to be significantly related to mortality. Compared to non-Hispanic

Table 2: Relationship Between SES and Mortality for All Patients ($n = 84{,}174$)

	Parameter Estimate	*Odds Ratio*	*95% C.I. for Odds Ratio*
Dependent Variable:† Discharged died			
African American	0.001	1.00	0.89 – 1.12
Hispanic	−0.065	0.94	0.83 – 1.05
Medicaid	0.174**	1.19	1.03 – 1.38
Private insurance	−0.182***	0.83	0.77 – 0.90
Uninsured	0.288***	1.33	1.16 – 1.53
Median income by zip code	−0.025	0.98	0.95 – 1.00
Colorado	−0.243**	0.79	0.63 – 0.97
Connecticut	0.090	1.09	0.32 – 3.72
Florida	−0.010	0.99	0.92 – 1.07
Kansas	−0.113*	0.89	0.79 – 1.01
Massachusetts	−0.073	0.93	0.83 – 1.04
Maryland	−0.097*	0.91	0.82 – 1.01
New Jersey	−0.051	0.95	0.84 – 1.08
New York	−0.062	0.94	0.86 – 1.03
South Carolina	−0.164	0.85	0.53 – 1.37
Wisconsin	−0.098**	0.91	0.82 – 1.00

*$p < .10$; **$p < .05$; ***$p < .01$.

†In Tables 2 through 6, only the results of SES variables and the geographic control variables are presented.

Note: Full tables containing the results of risk-adjustment variables can be obtained from the authors.

Caucasian patients neither African American patients nor Hispanic patients showed higher mortality odds. However, variation in mortality odds across states was observed. Some unexplained factors related to AMI mortality may exist among states.

AMI Mortality: Does the Double Jeopardy Exist?

Table 3 shows results of associations of mortality with SES obtained from four models that were based on non-Medicare AMI patients. The use of diagnostic arteriography or therapeutic angioplasty was significantly associated with lower mortality although the use of CABG was not.

Variation in mortality related to insurance status became wider regardless of inclusion of the three AMI-related specialized procedures. The mortality odds ratio was about 1.40 for the Medicaid patients over patients covered by private insurance and for uninsured patients over the Medicaid patients. For model one, where none of the three procedures were included, and model four, where use of CABG did not significantly relate to mortality, among the five levels of median income by zip code the mortality odds ratio was .89 for any income level over the level below. However, this association became insignificant in both model three and model four when uses of arteriography and angioplasty were included and showed significantly negative association with mortality.

No significant association between the double-jeopardy interaction and mortality for any of the four models was detected. Even in conjunction with lower income, race showed no significant association with mortality. Significant variations in mortality across states disappeared after Medicare discharges were excluded.

Results in Table 4 show relationships between SES and uses of the three AMI specialized procedures. Only the use of angioplasty, an interventional procedure, significantly related to insurance status and median income by zip code. The odds ratio of receiving angioplasty was .86 for uninsured patients over the Medicaid patients and for the Medicaid patients over patients covered by private insurance. Among the five levels of median income by zip code the odds ratio of using angioplasty was 1.11 for any of two neighboring levels from the lower income level to the next higher one.

Race became a very significant factor related to uses of the three cardiac procedures. Compared to non-Hispanic Caucasian patients with AMI African American patients had odds ratios for receiving arteriography, angioplasty, and CABG procedures of .89, .80, and .59, respectively, whereas Hispanic patients' odds ratio for receiving arteriography was .74. In addition a great

Table 3: Relationships Between Mortality and SES, Double Jeopardy, and Three AMI-Related Specialized Procedures: Non-Medicare AMI Patients (n=33,601)

	(1) None of the 3 Procedures Included			(2) Arteriography Included			(3) Angioplasty Included			(4) CABG Included		
	Parameter Estimate	*Odds Ratio*	*95% C.I. for Odds Ratio*	*Parameter Estimate*	*Odds Ratio*	*95% C.I. for Odds Ratio*	*Parameter Estimate*	*Odds Ratio*	*95% C.I. for Odds Ratio*	*Parameter Estimate*	*Odds Ratio*	*95% C.I. for Odds Ratio*
Dependent Variable:												
Discharged died												
One of the 3 procedures	–	–	–	−0.971***	0.38	0.34 – 0.43	−0.689***	0.50	0.42 – 0.59	−0.146	0.86	0.72 – 1.04
Inferior insurance status	0.351***	1.42	1.15 – 1.76	0.346***	1.41	1.14 – 1.76	0.340***	1.40	1.13 – 1.74	0.351***	1.42	1.15 – 1.76
Median income by zip code	−0.116**	0.89	0.79 – 1.00	−0.114*	0.89	0.79 – 1.00	−0.110*	0.90	0.80 – 1.01	−0.116**	0.89	0.79 – 1.00
Double-jeopardy interaction	−0.036	0.97	0.90 – 1.03	−0.040	0.96	0.90 – 1.03	−0.034	0.97	0.90 – 1.04	−0.036	0.96	0.90 – 1.03
African American	−0.114	0.89	0.72 – 1.10	−0.156	0.86	0.69 – 1.06	−0.131	0.88	0.71 – 1.08	−0.118	0.89	0.72 – 1.10
Hispanic	−0.095	0.91	0.74 – 1.11	−0.165	0.85	0.69 – 1.04	−0.096	0.91	0.74 – 1.11	−0.097	0.91	0.74 – 1.11
Colorado	−0.157	0.86	0.57 – 1.29	−0.198	0.82	0.54 – 1.24	−0.141	0.87	0.58 – 1.31	−0.163	0.85	0.56 – 1.28
Connecticut	0.588	1.80	0.21 – 15.68	0.333	1.40	0.16 – 12.53	0.491	1.63	0.19 – 14.25	0.572	1.77	0.20 – 15.43
Florida	−0.009	0.99	0.85 – 1.16	0.019	1.02	0.87 – 1.19	−0.015	0.99	0.85 – 1.15	−0.007	0.99	0.85 – 1.16
Kansas	−0.092	0.91	0.70 – 1.19	0.047	1.05	0.80 – 1.37	−0.029	0.97	0.75 – 1.27	−0.084	0.92	0.71 – 1.20
Massachusetts	−0.013	0.99	0.77 – 1.27	−0.097	0.91	0.70 – 1.17	−0.038	0.96	0.75 – 1.24	−0.015	0.99	0.76 – 1.27
Maryland	−0.117	0.89	0.72 – 1.10	−0.122	0.89	0.72 – 1.09	−0.156	0.86	0.69 – 1.06	−0.121	0.89	0.72 – 1.09
New Jersey	−0.158	0.85	0.65 – 1.12	−0.234*	0.79	0.60 – 1.04	−0.201	0.82	0.62 – 1.07	−0.159	0.85	0.65 – 1.12
New York	−0.137	0.87	0.72 – 1.06	−0.191*	0.83	0.68 – 1.00	−0.190*	0.83	0.68 – 1.00	−0.133	0.88	0.72 – 1.06
South Carolina	−0.277	0.76	0.27 – 2.12	−0.300	0.74	0.26 – 2.08	−0.318	0.73	0.26 – 2.03	−0.281	0.76	0.27 – 2.12
Wisconsin	−0.074	0.93	0.74 – 1.16	−0.059	0.94	0.75 – 1.18	−0.073	0.93	0.74 – 1.16	−0.069	0.93	0.75 – 1.17

*$p<.10$; **$p<.05$; ***$p<.01$.

Table 4: Relationships of SES with Uses of Three AMI-Related Specialized Procedures: Non-Medicare AMI Patients ($n = 33,601$)

	Arteriography Received			*Angioplasty Received*			*CABG Received*		
	Parameter Estimate	*Odds Ratio*	*95% C.I. for Odds Ratio*	*Parameter Estimate*	*Odds Ratio*	*95% C.I. for Odds Ratio*	*Parameter Estimate*	*Odds Ratio*	*95% C.I. for Odds Ratio*
Inferior insurance status	−0.061	0.94	0.85 – 1.04	−0.149**	0.86	0.77 – 0.97	−0.031	0.97	0.82 – 1.15
Median income by zip code	0.016	1.02	0.97 – 1.07	0.101***	1.11	1.04 – 1.17	−0.005	1.00	0.92 – 1.08
Double-jeopardy interaction	−0.017	0.98	0.95 – 1.02	0.027	1.03	0.99 – 1.07	−0.028	0.97	0.92 – 1.03
African American	−0.117**	0.89	0.81 – 0.97	−0.230***	0.80	0.71 – 0.90	−0.531***	0.59	0.49 – 0.70
Hispanic	−0.303***	0.74	0.67 – 0.81	0.005	1.01	0.90 – 1.12	−0.089	0.92	0.78 – 1.07
Colorado	−0.259***	0.77	0.65 – 0.91	0.131	1.14	0.95 – 1.37	−0.649***	0.52	0.36 – 0.76
Connecticut	−0.780	0.46	0.14 – 1.55	−0.539	0.58	0.12 – 2.75	–	–	–
Florida	0.236***	1.27	1.18 – 1.36	0.071*	1.07	0.99 – 1.17	0.214***	1.24	1.10 – 1.39
Kansas	0.776***	2.17	1.93 – 2.45	0.577	1.78	1.58 – 2.01	0.670***	1.95	1.65 – 2.31
Massachusetts	−0.397***	0.67	0.60 – 0.75	−0.220***	0.80	0.71 – 0.91	−0.144	0.87	0.72 – 1.05
Maryland	−0.029	0.97	0.89 – 1.06	−0.443***	0.64	0.58 – 0.71	−0.413***	0.66	0.56 – 0.78
New Jersey	−0.317***	0.73	0.66 – 0.81	−0.494***	0.61	0.54 – 0.70	0.049	1.05	0.88 – 1.26
New York	−0.211***	0.81	0.75 – 0.88	−0.595***	0.55	0.50 – 0.61	0.452***	1.57	1.38 – 1.79
South Carolina	0.013	1.01	0.71 – 1.45	−0.221	0.80	0.52 – 1.24	−1.134**	0.32	0.12 – 0.88
Wisconsin	0.305***	1.36	1.24 – 1.49	0.206***	1.23	1.11 – 1.36	0.473***	1.61	1.39 – 1.85

*$p < .10$; **$p < .05$; ***$p < .01$.

Note: The control variable for Connecticut was not included in the CABG model to improve the model fit.

deal of variation was observed across states in receiving the three procedures (see Table 4).

AMI Mortality: Do Multiple Risks Matter?

Comparison of discharges in the extremely unfavorable group and the extremely favorable group revealed a large variation in mortality odds among AMI patients. Patients with the extremely unfavorable factors had a mortality odds ratio 1.77 times that of those who were characterized as extremely favorable (see Table 5). Odds ratios of the extremely unfavorable patients over the extremely favorable patients for receiving arteriography, angioplasty, and CABG were .77, .74, and .69, respectively.

Still, race was an insignificant factor related to mortality but was more significantly associated with the use of the three AMI procedures. Hispanic patients had 1.45 times the odds for receiving angioplasty than both non-Hispanic Caucasian and African American patients. In comparison to non-Hispanic Caucasian patients odds ratios of receiving CABG for African Americans and Hispanics were .52 and 1.36, respectively. No state variation in AMI mortality was observed, but state variations in using the three AMI procedures were significant.

Patients in the extremely unfavorable group had a longer length of stay (6.9 days), more comorbidity diagnoses (5.5), and fewer procedures recorded (2.8) compared with the extremely favorable group, which recorded 5.9 days, 5.0 diagnoses, and 3.0 procedures. The results also show that patients in the extremely unfavorable group incurred higher average total charges per discharge ($21,028.6) than patients in the extremely favorable group ($19,332.2; see Table 6).

DISCUSSION

Among the three measures of SES evaluated in this study (race, insurance, and median income by zip code) insurance status was the most dominant in relation to in-hospital mortality following AMI. Uninsured patients and Medicaid patients, respectively, are the most disadvantaged and second-most disadvantaged groups of AMI patients in terms of adjusted hospital mortality odds compared with patients covered by Medicare or private insurance. Patients with private insurance have lower mortality odds than do Medicare patients.

The higher mortality risk demonstrated for uninsured patients over Medicaid patients may indicate financial barriers that prevent uninsured

Table 5: Variation in AMI Mortality and Uses of the Three AMI Specialized Procedures Between the Extremely Unfavorable Patients and the Extremely Favorable Patients ($n = 9346$)

	Discharged Died			*Arteriography Received*			*Angioplasty Received*			*CABG Received*		
	Parameter Estimate	*Odds Ratio*	*95% C.I. for Odds Ratio*	*Parameter Estimate*	*Odds Ratio*	*95% C.I. for Odds Ratio*	*Parameter Estimate*	*Odds Ratio*	*95% C.I. for Odds Ratio*	*Parameter Estimate*	*Odds Ratio*	*95% C.I. for Odds Ratio*
Extreme unfavor	0.571***	1.77	1.32 – 2.37	−0.262***	0.77	0.68 – 0.88	−0.298***	0.74	0.63 – 0.87	−0.366***	0.69	0.55 – 0.87
African American	0.104	1.11	0.78 – 1.58	0.023	1.02	0.87 – 1.20	−0.173	0.84	0.68 – 1.04	-0.653***	0.52	0.37 – 0.74
Hispanic	0.164	1.18	0.78 – 1.78	0.128	1.14	0.95 – 1.36	0.371***	1.45	1.19 – 1.77	0.309**	1.36	1.03 – 1.81
Colorado	−0.491	0.61	0.18 – 2.05	−0.240	0.79	0.54 – 1.15	−0.106	0.90	0.59 – 1.38	−0.642	0.53	0.21 – 1.32
Connecticut	−0.052	0.95	0.41 – 2.18	−0.113	0.89	0.58 – 1.37	0.204	1.23	0.75 – 2.01	0.113	1.12	0.50 – 2.52
Florida	−0.006	0.99	0.70 – 1.41	0.329***	1.39	1.20 – 1.61	0.103	1.11	0.94 – 1.31	0.375***	1.45	1.15 – 1.85
Kansas	0.064	1.07	0.53 – 2.13	0.797***	2.22	1.59 – 3.10	0.631***	1.88	1.33 – 2.65	0.947***	2.58	1.63 – 4.09
Massachusetts	−0.072	0.93	0.53 – 1.63	−0.440***	0.64	0.53 – 0.79	−0.260**	0.77	0.61 – 0.98	0.089	1.09	0.78 – 1.52
Maryland	0.102	1.11	0.78 – 1.57	−0.045	0.96	0.84 – 1.10	−0.812***	0.44	0.37 – 0.53	−0.4742***	0.62	0.48 – 0.81
New Jersey	0.112	1.12	0.72 – 1.73	−0.039	0.96	0.82 – 1.13	−0.444***	0.64	0.53 – 0.78	0.263*	1.30	1.00 – 1.70
New York	−0.097	0.91	0.63 – 1.31	−0.050	0.95	0.83 – 1.10	−0.330***	0.72	0.61 – 0.85	0.617***	1.85	1.450 – 2.31
South Carolina	−0.177	0.84	0.50 – 1.40	−0.013	0.99	0.79 – 1.24	−0.021	0.98	0.75 – 1.29	0.102	1.11	0.71 – 1.73
Wisconsin	−0.058	0.94	0.54 – 1.65	0.368***	1.45	1.18 – 1.77	0.370***	1.45	1.18 – 1.79	0.697***	2.01	1.51 – 2.68

*$p < .10$; **$p < .05$; ***$p < .01$.

Table 6: Variation in Hospitalization Characteristics Between the Extremely Favorable Patients and the Extremely Unfavorable Patients

	Extremely Unfavorable Group		*Extremely Favorable Group*		*Difference Between*
	n	*Mean (s.d.)*	n	*Mean (s.d.)*	*Two Groups*†
Number of diagnoses	2198	5.5 (2.8)	7148	5.0 (2.7)	0.5***
Number of procedures	2198	2.8 (2.6)	7148	3.0 (2.7)	−0.2***
Length of stay	2196	6.9 (7.3)	7147	5.9 (5.8)	1.1***
Total charges ($)	2162	21,028.6 (24,423.1)	6829	19,332.2 (23,145.7)	1,696.4***

***$p < .01$.

†The natural logarithm transformation for all variables was performed before the statistical test.

patients from receiving access to both preventive and emergency care (Berk and Schur 1998). As Medicaid patients are qualified by income, uninsured patients are excluded from Medicaid but often cannot afford health insurance. In addition to the out-of-pocket expense of preventive and primary care uninsured patients are likely unprepared to weather the costs of an AMI. It should be noted that the total charges per episode of AMI care were approximately $20,000 in this study. While some of the care may not be discretionary, foregone diagnostic procedures or therapeutic interventions in this population deserve further study. That increased risk for adverse outcome was also associated with Medicaid patients may again implicate access limitations imposed by financial barriers (Crawford, McGraw, Smith, et al. 1994; Ell, Haywood, Sobel, et al. 1994).

Being uninsured or a Medicaid participant was associated with a lower frequency of use of specialized diagnostic and therapeutic cardiac procedures, which in some studies have been shown to confer survival advantage (Berger, Schulman, Gersh, et al. 1999). This study reveals a significant negative relationship between inferior insurance status and use of angioplasty, which is consistent with results from previous studies (Mueller, Patil, and Boilesen 1998; Young and Cohen 1991). One explanation of the results is that patients with inferior insurance status may have more comorbidities or more advanced disease as a result of financial limitations on sources and access to primary, preventive, or even urgent care (Weinick, Zuvekas, and Drilea 1997). Conversely, indigence may affect procedures offered to patients, especially in an era of greater financial accountability with a concomitant reduction of the cost shifting that has been historically used to support unreimbursed care.

Median income by zip code areas, as the measure of socioecologic conditions of a community, is modestly associated with AMI mortality. For non-Medicare AMI patients, regardless of receiving AMI-related specialized procedures, those who live in zip code areas with lower median incomes tend to have higher mortality odds than do those who live in zip code areas with relatively higher median incomes irrespective of the type of health insurance.

The hypothesis that the double-jeopardy status of both inferior insurance and reduced income confers increased risk for AMI mortality did not reach statistical significance. Despite a demonstration that uninsured patients have higher mortality risk than do Medicaid patients and that the Medicaid patients have higher mortality risk than do patients covered by private insurance, results of this study provide no evidence that the increases in mortality risk as median income by zip code decreases are greater for uninsured patients than for Medicaid patients and in turn for patients in private insurance programs. If the hypothesis is correct, one reason for not detecting any significant double-jeopardy factor related to AMI mortality may be the use of median income by zip code as one of the risk factors. This community-level measure may not be sensitive enough to identify individual socioeconomic differences. Future studies should try to identify a patient-level measure to better reflect patients' SES and combine it with insurance status to further test the double-jeopardy hypothesis. A competing explanation stems from the assumption that specialized cardiac procedures uniformly confer survival advantage.

The inability to observe the double-jeopardy phenomenon from AMI patients in this study does not relieve our concerns about the outcome of those patients who carry multiple socioeconomic risks. In fact results of this study do show that multiple socioeconomic risks worsen outcomes for AMI patients. Compared with the extremely favorable AMI patients the extremely unfavorable AMI patients have much higher mortality risks, more comorbidities, longer average length of stay, and higher average total charges; yet the extremely unfavorable patients do receive significantly fewer specialized procedures such as arteriography, angioplasty, and CABG. Defined as the antithesis of the favorably biased patients who have good insurance coverage and live in wealthier neighborhoods, AMI patients who have inferior insurance status and live in poorer neighborhoods may be briefly characterized by the following circumstances: admission to the hospital with more comorbidities; fewer specialized procedures (possibly as a result of more comorbidities and possibly because of resource constraints of the hospitals); longer stays in hospital (again likely a result of multiple comorbidities and more advanced disease); and higher charges as a result and worse clinical outcomes (Kravitz 1999). In short, from the societal perspective the current dynamic of treating AMI patients with multiple socioeconomic risks appears less effective than ideal.

Having limited health insurance resources and living in a poor community may coexist with other adverse socioeconomic factors. Persons living in low-income areas tend to have worse overall health status because they are more likely by definition to be poor and by circumstance to have limited access to primary and continuity care. Financially vulnerable people tend to have less education, a factor that is associated with high AMI mortality (American Heart Association 1998). Inadequate income, limited knowledge, and stressful living conditions are strong drawbacks to organizing and maintaining such elements of a healthy lifestyle as proper diet and exercise. Such AMI risk factors as obesity and smoking are related to lifestyle and may compound other significant risks such as hypertension and diabetes. Persons having low SES or living in lower socioecologic areas tend to have more AMI, more severe AMI, and more AMI deaths (American Heart Association 1998). Obtaining a clearer understanding of the relationships of social, economic, and medical features of low SES, especially double jeopardy and multiple socioeconomic risks, requires and merits further study.

Race was not significant in predicting AMI mortality once other socioeconomic factors were accounted for. Several factors may explain this observation. First, race is correlated with such SES variables as insurance status and income. As higher relative percentages of African Americans are Medicaid beneficiaries, are uninsured, or live in low-income areas (Health Care Financing Administration 1999) the influence of race on AMI may be subordinated to stronger associations of those variables with AMI outcome. It has been theorized elsewhere that possibly greater frequency of use of urban teaching hospitals by patients who are African American may offset the worse outcomes predicted by other associated adverse socioeconomic indicators (Kahn, Pearson, Harrison, et al. 1994). Finally, because race may aggregate both biologic and cultural differences between populations of different ethnic origins if other socioeconomic factors are controlled (Belgrave, Wykle, and Choi 1993; Mueller, Patil, and Boilesen 1998), a more sophisticated risk adjustment model as employed in this study can control for a large portion of clinical factors, helping to uncover the association with more specific predictor variables. Therefore, caution should be exercised in interpreting the relationship between race and outcomes. As Jones, laVeist, and Lillie-Blanton (1991) point out, "'[R]ace' has historically served as an imprecise surrogate for socioeconomic status, culture, and genetic endowment . . ."

Several limitations are inherent in the methodology employed in this study. As noted median income by zip code area is not a sensitive measure of an individual patient's income or living standard or by extension clinical outcome. From the suggestions made by Dale et al. (1996) five criteria stipulate minimum requirements for studies addressing the relationship between SES and outcome: (1) SES measure(s) should be at the individual level; (2) other SES factors should be controlled for when making comparisons within an SES factor; (3) SES should include at least (individual-level) measures of income and education; (4) sample sizes should be sufficient for the relevant populations; and (5) specific diseases should be studied separately. Using contemporary data resources Dale et al.'s ideal criteria must be tempered by practicality. Ideally future research will employ more direct measures of individual SES.

The NIS data based on the 1992 revision of the Uniform Bill (UB-92) lack richly detailed clinical information. The risk adjustment model used in this study, although state of the art, may not fully adjust for AMI patients' severity of illness. The risk adjustment model would be improved if prior admission information were available, removing the implication that the clinical activities and outcome of the index admission are unrelated to possible prior admissions. In addition postdischarge mortality (not available in the NIS data) as another outcome measure might allow comparison of the consistency of the associations between SES and late mortality not identified in the present data set.

Exclusion of discharges in six states because of lack of necessary information reduces the generalizability of the results of this study. Further, some variation in AMI mortality across states was found in the analytic model. This variation begs further investigation.

Policy Implications

Substantial variation across SES in the outcomes for the treatment of AMI would seem to be central to the national discussion regarding access to and quality of health care, especially with growth in uninsured and underinsured populations (Weinick, Zuvekas, and Drilea 1997).

One policy strategy might be to strengthen care for those who are rendered medically indigent by being disqualified for Medicaid by virtue of income yet are without adequate resources for private insurance. Attention also should be given to optimized resource distribution that enhances access, capacity, effectiveness, and efficiency of the health delivery infrastructure. This research demonstrates that uninsured patients are at significantly greater risk for adverse outcomes for AMI than are those enrolled in Medicaid.

It is also worth noting that increased focus on improving treatment of AMI patients bearing multiple low socioeconomic attributes may be in the public interest from a cost-effectiveness perspective. These data demonstrate that disadvantaged patients experience greater lengths of hospital stay, greater charges, as well as inferior outcomes.

Identification of relationships between socioeconomic and insurance status can serve to inform dialogue regarding the most effective mechanisms for program development to reduce barriers to care and promote favorable clinical and economic outcomes. This should result in better strategies to target improvement of the care for economically vulnerable groups, in particular persons who bear complex socioeconomic risk, which predicts worse outcome.

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