Socioeconomic Status as an Independent Risk Factor for Hospital Readmission for Heart Failure

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The management of heart failure is characterized by high rates of hospital admission as well as rehospitalization after inpatient treatment of this disorder, whereas skillful medical care may reduce the risk of hospital admission. The purpose of this study was to examine the relation between income (as a measure of socioeconomic status) and the frequency of hospital readmission among a large and diverse group of persons treated for heart failure. We analyzed administrative discharge data from 236 nonfederal acute-care hospitals in New York State, involving 41,776 African-American or Caucasian hospital survivors with International Classification of Diseases, Ninth Revision, Clinical Modification codes for heart failure in the principal diagnosis position between January 1 and December 31, 1995. Household income was derived from postal ZIP codes and census data. We found that patients residing in lower income neighborhoods were more often women or African-Americans, had more comorbid illness, had higher use of Medicaid insurance, and were more often admitted to rural hospitals. There was a stepwise decrease in the crude frequency of readmission from the lowest quartile of income (23.2%) to the highest (20.0%) ($p < 0.0001$ for Mantel-Haenszel chi-square test for trend across all quartiles; $p < 0.0001$ for comparison between quartiles 1 and 4). After adjustment for baseline differences and process of care, income remained a significant predictor, with an increase in the risk of readmission noted in association with lower levels of income (adjusted odds ratio for quartile 1:4 comparison, 1.18; 95% confidence interval, 1.10 to 1.26, $p < 0.0001$). We conclude that lower income patients hospitalized for treatment of heart failure in New York differ from higher income patients in important clinical and demographic comparisons. Even after adjustment for these fundamental differences and other potential confounding factors, lower income is a positive predictor of readmission risk.
(Am J Cardiol 2001;87:1367–1371)

The frequency of heart failure–related hospital readmission is approximately 25% within the first 6 months after hospital discharge.[1–3] Both patient characteristics and process of care are related to the risk of hospital admission for heart failure,[1,4–8] although skillful medical care may reduce this risk.[8] People of lower socioeconomic status may receive a different style or quality of medical care for various conditions, including cardiovascular disease.[9–16] Accordingly, we hypothesized that lower socioeconomic status increases the risk of hospital readmission among patients with heart failure. We examined the relation between household income as a measure of socioeconomic status and frequency of hospital readmission among a large and diverse group of patients treated for heart failure.

METHODS

Patients: This study was approved by the institutional review board of the Massachusetts General Hospital. This was a retrospective analysis of hospital administrative discharge data collected prospectively by New York State Department of Health's Statewide Planning and Research Cooperative System. This organization systematically archives information on all patients admitted to all nonfederal acute-care hospitals in New York. We included all patients who were discharged ≥1 times during the period from January 1 to December 31,1995 from an eligible hospital with an International Classification of Diseases, Ninth Revision, Clinical Modification code indicative of heart failure in the principal diagnosis position on the discharge abstract. The codes used were 428.0, 402.91, 404.93, 428.1, 402.11, 398.91, 404.91, 404.13, 402.01, 404.03, 404.11, 404.01, and 428.9. This method of case selection defined a group of patients whose primary diagnosis was heart failure irrespective of procedures performed. Patients dying during their first eligible hospital admission were excluded because they were not at risk for hospital readmission. Because race is an important predictor of readmission for heart failure, we restricted this analysis to African-American and Caucasian patients. A quantitative estimate of income was derived by assigning to each patient the value equivalent to median household income among residents of his or her home postal ZIP code. Income data were derived from the 1990 United States census. Patients were separated into 4 groups

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0002-9149/01/$–see front matter
PII S0002-9149(01)01554-5

based on quartiles of income. Hospital readmission for heart failure was defined as present or absent by searching the same data set for subsequent admissions after the index discharge for all patients. Other definitions used in this study have been previously published.[6]

To account for baseline differences that are relevant to the risk of hospital readmission, we used a published prediction rule.[6] The predictors of higher risk of hospital readmission include African-Americans, Medicare insurance, Medicaid insurance, ischemic heart disease, valvular heart disease, idiopathic cardiomyopathy, diabetes, renal disease, chronic lung disease, history of prior cardiac surgery, referral to home health services upon hospital discharge, and the use of telemetry monitoring during the index admission. Four factors predict a lower risk of hospital readmission including treatment in a rural hospital, discharge to a skilled nursing facility at the time of the index discharge, the performance of echocardiography during the index admission, and the performance of diagnostic cardiac catheterization during the index admission. To determine an overall readmission risk score, one adds the number of predictors of higher risk that are present for an individual and subtracts the number of negative predictors of readmission that are present. To avoid negative numbers, 4 is added to this sum. Patients with the lowest scores, 0 to 3, have a 10% rate of hospital readmission, whereas those with the highest scores, $\geq$11, have a rate in excess of 45%.

Data analyses: Statistical analyses were performed using SAS software (SAS Institute, Cary, North Carolina). Results are displayed as mean $\pm$ SD, binomial proportions, median with interquartile range, or adjusted odds ratios (ORs) with 95% confidence intervals (CIs) as appropriate. Comparisons of crude data were made across all income quartiles using the Mantel-Haenszel chi-square test for trend (dichotomous variables) and PROC GLM (continuous variables). We also compared the lowest quartile of income (quartile 1) with the highest (quartile 4) using chi-square tables and Student's *t* test. The significance of income as an independent predictor of readmission was determined using multiple logistic regression analysis (PROC LOGISTIC). In this process, each patient's readmission risk score was entered along with income quartile into a logistic regression model that contained readmission as the dependent variable.

RESULTS

Patients: A total of 52,010 eligible patients were identified. Of these, 6,116 (11.8%) were excluded because their race was neither African-American nor white, including "unknown" race (2,196 patients), "other" race (3,330), Asian or Pacific Islander (518), and Native American (102). In addition, 3,163 patients (6.1%) were excluded because they died during the index admission. Finally, 955 (1.8%) were excluded because of missing data regarding income. Thus, this study comprised 41,776 African-American or Caucasian hospital survivors. All data elements were complete for these patients. The patients in this study were drawn from a total of 236 hospitals.

Demographics, clinical characteristics, and outcomes: The Table shows descriptive information for the sample of 41,776 evaluable patients. Age averaged 74 $\pm$ 13 years. Eighteen percent were African-Americans and 57% were female. Seventy-four percent had Medicare as their primary insurance, and 9% had Medicaid. Ten percent were treated in rural hospitals. The mean Charlson Comorbidity Index score for the group was 2.5 $\pm$ 1.6. Readmission risk score for the group averaged 6.5 $\pm$ 1.4. Hospital length of stay during the index admission averaged 9.2 $\pm$ 13.6 days (median 7, interquartile range 4 to 10) and hospital charges averaged \$11,016 $\pm$ \$14,522, (median \$7,469, interquartile range \$4,615 to \$12,516). Household income averaged \$33,573 $\pm$ \$13,152 (median \$31,041, interquartile range \$25,097 to \$41,476). A total of 8,976 patients (21.5%) experienced at least 1 readmission for recurrent heart failure.

The table also displays the characteristics of the cohort stratified by income. Patients in the lowest quartile of income were younger than others, and were more often women or African-American. This group more often had Medicaid insurance, but less often Medicare. They had a higher prevalence of hypertension, diabetes, and chronic lung disease, but a lower prevalence of valvular heart disease, coronary artery disease, and prior cardiac surgery. Patients in the lowest quartile had the highest mean Charlson Comorbidity Index score and highest mean readmission risk score, although the absolute differences were small and of unclear clinical significance. This group most often received their care in rural hospitals (teaching and nonteaching). Among urban patients, low-income patients were more likely to receive their care in teaching rather than nonteaching hospitals.

Length of stay during the index hospitalization was similar among the quartiles ($p = 0.76$ for comparison across all quartiles; $p = 0.30$ for comparison between quartiles 1 and 4). Mean hospital charges during the index hospitalization were \$11,552 for quartile 1, \$10,172 for quartile 2, \$10,638 for quartile 3, and \$11,709 for quartile 4 ($p < 0.0001$ for comparison across all quartiles; $p = 0.44$ for comparison between quartiles 1 and 4).

Hospital readmission for heart failure: The crude frequency of hospital readmission for heart failure stratified by income quartile is shown in Figure 1. There was a stepwise decrease in the frequency of readmission from the lowest quartile of income (23.2%) to the highest (20.0%) ($p < 0.0001$ for Mantel-Haenszel chi-square test for trend; $p < 0.0001$ for comparison between quartiles 1 and 4). The OR and 95% CI for hospital readmission derived from the logistic regression analysis are shown in Figure 2. As expected, higher risk score, previously validated and shown to account for relevant baseline differences between patients, was associated with a significantly higher risk of readmission. Each 1-unit increment in score was associated with a 25% increase in the relative risk of readmission. In addition, income was a

TABLE 1 Clinical and Demographic Characteristics Stratified by Quartiles of Income*

Clinical or Demographic Feature	Group (n = 41,776)	Quartile 1 (n = 10,331)	Quartile 2 (n = 10,481)	Quartile 3 (n = 10,451)	Quartile 4 (n = 10,513)
Age (yrs)†	74 ± 13	71 ± 14	74 ± 13	74 ± 13	75 ± 13‡
Women†	41,776 (57%)	6,049 (59%)	6,034 (58%)	5,858 (56%)	5,687 (54%)‡
African-American†	7,662 (18%)	4,023 (39%)	1,239 (12%)	1,583 (15%)	817 (8%)‡
Nursing home residents	3,236 (8%)	750 (7%)	832 (8%)	813 (8%)	841 (8%)
Household income ($)†	33,573 ± 13,152	19,351 ± 3,974	27,812 ± 1,818	35,267 ± 2,843	51,609 ± 10,036‡
Medical Insurance					
Medicare†	30,738 (74%)	6,903 (67%)	7,960 (76%)	7,801 (75%)	8,074 (77%)‡
Medicaid†	3,744 (9%)	1,701 (16%)	895 (9%)	776 (7%)	372 (4%)‡
Indemnity†	4,026 (10%)	850 (8%)	868 (8%)	989 (9%)	1,319 (13%)‡
Health maintenance organization†	1,253 (3%)	269 (3%)	243 (2%)	365 (3%)	376 (4%)†
Coexistent medical conditions					
Coronary artery disease†	20,595 (49%)	4,447 (43%)	5,428 (52%)	5,248 (50%)	5,472 (52%)‡
Hypertension†	18,790 (45%)	5,225 (51%)	4,552 (43%)	4,671 (45%)	4,342 (41%)‡
Cardiomyopathy	5,330 (13%)	1,467 (14%)	1,186 (11%)	1,328 (13%)	1,349 (13%)‡
Valvular heart disease†	8,458 (20%)	1,796 (17%)	2,121 (20%)	2,091 (20%)	2,450 (23%)‡
Prior cardiac surgery†	4,365 (10%)	794 (8%)	1,033 (10%)	1,141 (11%)	1,397 (13%)‡
Peripheral vascular disease	3,582 (9%)	820 (8%)	993 (9%)	922 (9%)	847 (8%)
Chronic lung disease†	11,829 (28%)	3,084 (30%)	3,070 (29%)	2,993 (29%)	2,682 (26%)‡
Renal disease†	8,237 (20%)	2,161 (21%)	1,994 (19%)	2,029 (19%)	2,053 (20%)‡
Diabetes mellitus†	13,603 (33%)	3,592 (35%)	3,505 (33%)	3,362 (32%)	3,144 (30%)‡
Charlson Comorbidity Index†	2.5 ± 1.6	2.6 ± 1.7	2.5 ± 1.6	2.5 ± 1.6	2.4 ± 1.6‡
Attending physician					
Cardiologist†	8,532 (20%)	1,950 (19%)	1,980 (19%)	2,249 (22%)	2,353 (22%)‡
Hospital characteristics					
Urban teaching hospital†	21,175 (51%)	6,395 (62%)	4,456 (43%)	5,381 (51%)	4,943 (47%)‡
Urban nonteaching hospital†	16,431 (39%)	2,022 (20%)	4,328 (41%)	4,569 (44%)	5,512 (52%)‡
Rural teaching hospital†	596 (1%)	260 (3%)	110 (1%)	199 (2%)	27 (0.2%)‡
Rural nonteaching hospital†	3,574 (9%)	1,654 (16%)	1,587 (15%)	302 (3%)	31 (0.3%)‡
Readmission risk score†	6.5 ± 1.4	6.6 ± 1.5	6.5 ± 1.4	6.5 ± 1.5	6.4 ± 1.4‡

*Continuous variables are reported as mean ± SD; categorical variables are reported as number of patients (percentage of the group or quartile in parentheses).
†Indicates $p < 0.05$ for difference across all quartiles.
‡Indicates $p < 0.05$ for difference between quartiles 1 and 4.

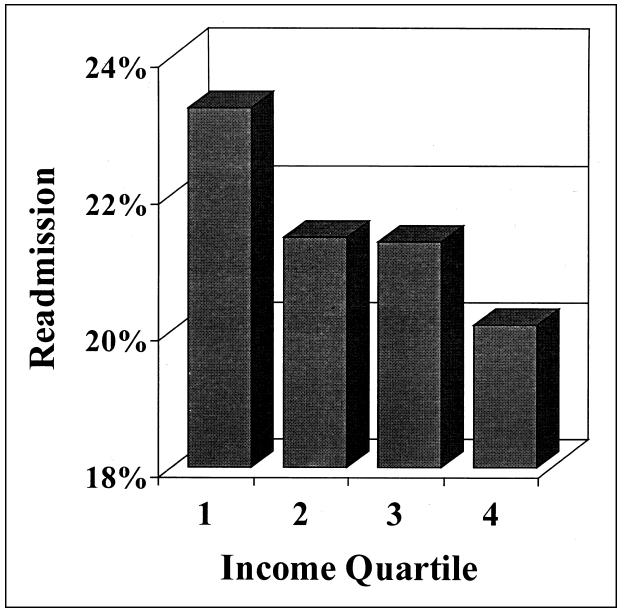

FIGURE 1. Crude frequency of heart failure-related hospital readmission among quartiles of income ($p < 0.0001$ for chi-square test for trend across all quartiles; $p < 0.0001$ for difference between quartiles 1 and 4).

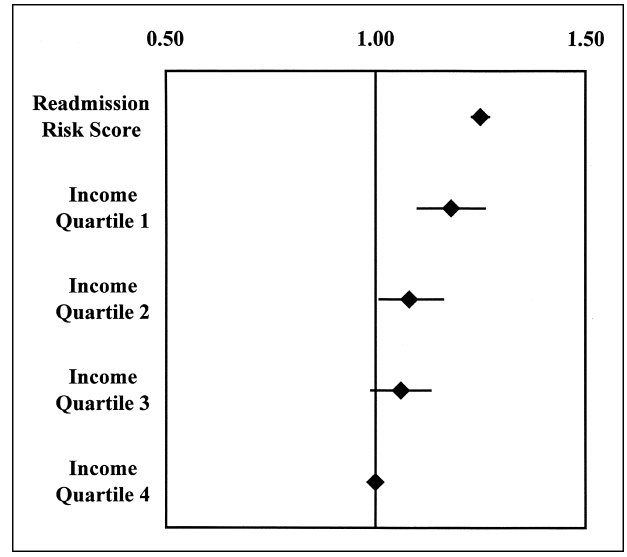

FIGURE 2. Adjusted ORs and 95% CIs for heart failure–related hospital readmission (reference quartile is quartile 4).

significant predictor, with a stepwise decrease in the risk of readmission noted in association with higher levels of income (quartile 1, adjusted OR 1.18, 95% CI 1.10 to 1.26, $p < 0.0001$; quartile 2, OR 1.08, 95% CI 1.01 to 1.16, $p = 0.02$; quartile 3, OR 1.06, 95% CI 0.99 to 1.13, $p = 0.11$; quartile 4, reference group).

DISCUSSION

In this study, we examined the influence of income and other sociodemographic and clinical variables on

the risk of hospital readmission after inpatient treatment of heart failure. To our knowledge, no previous study of heart failure readmission has attempted to address the multiple and intertwined issues of age-, sex-, race-, insurance-, socioeconomic status-, and geographic-based risk in a single comprehensive analysis. The additional strength of our study was its inclusion of a large number of consecutive patients from a wide spectrum of hospital types and health care settings. The principal findings of this study were: (1) Among patients hospitalized for heart failure, those residing in lower income neighborhoods were more often women or African-American, had more comorbid illness, had higher use of Medicaid insurance, and were more often admitted to rural hospitals. (2) The crude frequency of hospital readmission is greater in lower income than higher income patients. (3) After adjustment for baseline differences, income remained a significant predictor, with a stepwise increase in the risk of readmission noted in association with lower levels of income. These findings suggest that differences in age, sex, race, insurance, coexistent illness, and location of care do not fully explain the higher frequency of readmission among low-income patients, but rather imply that other causes may exist.

Explaining the increased risk of readmission among low-income patients: Because the data set that we used is relatively lacking in disease-specific clinical detail and does not contain information regarding postdischarge process of care, this study cannot fully explain the cause(s) of higher readmission among poorer patients. However, a discussion of possible causes is worthwhile. Access to skillful medical care appears to influence the risk of hospital admission among patients with heart failure.[8] At least 2 pieces of evidence in our study suggest that low-income patients may have diminished access to such care. First, 19% of patients in the lowest quartile of income (as opposed to 0.5% of patients in the highest quartile) were treated in rural hospitals and, presumably, lived in rural areas. Rural hospitals may be less likely to offer comprehensive programs for management of heart failure, whereas potentially longer distances from patients' homes to a rural hospital or doctor's office may prohibit optimal postdischarge care. Second, patients in the lowest income quartile were 4 times more likely to have Medicaid insurance than those in the highest quartile. Evidence suggests that Medicaid patients with coronary artery disease[11,13,15] and heart failure[14] receive a different or lower quality of medical care than those with other forms of insurance. However, our risk-adjustment process accounted for both rural location and Medicaid insurance, suggesting that these factors alone do not explain the higher readmission risk among low income patients.

Certain therapies such as the use of angiotensin-converting enzyme inhibitors,[17] digoxin,[18] and β-adrenergic receptor blockers[19] reduce the risk of hospital admission for heart failure. Because the data set that we used does not contain physicians' recommendations at hospital discharge, we cannot exclude the possibility that differences in drug prescriptions or other physicians' orders contributed to the higher frequency of readmission among low-income patients. Moreover, financial constraints and educational limitations, more common among low-income persons, could compromise compliance with treatment recommendations and lead to a higher rate of hospitalization.[4] Related factors such as substance abuse and cigarette smoking, more common among minorities with heart failure than Caucasians with heart failure,[20] could also play an important role. Finally, underlying disease substrate, which varies by income and race among patients with heart failure,[3,20] may be an important factor. Although our risk score accounts for most important medical comorbidites, we cannot exclude the possibility that it does not include $\geq$1 subtle but relevant biologic risk factor.

Study limitations: The limitations inherent in the use of administrative discharge data for research purposes deserve comment. Disease severity is not adequately captured in such sources of information, given the lack of data regarding disease-specific severity, functional status, and well being.[21] Further, ideal assessments of appropriateness and quality of care are not possible from these sources of data.[10,21,22] Our data were limited to hospital-based information, so that other equally important end points such as mortality could not be studied. Although quantification of socioeconomic status based on ZIP code–derived household income has validity, it may be less robust than measurement based on individual income or other factors.[12] Finally, the use of very large sample sizes may yield differences among groups that are statistically but not clinically significant. To address this, we have focused our attention on differences whose magnitude, in our opinion, has probable or definite clinical relevance.

Implications: The possible implications of these data as we observed them deserve comment. Heart failure disease management programs, which have proliferated during the past decade, appear to maximize their ability to reduce hospital admissions and attendant health care costs when they target patients at higher risk. Thus, managers of such programs should take note that low-income—or perhaps characteristics that are more common among low-income patients—are markers of increased risk. From the research perspective, our results should be considered hypothesis-generating and lead to further investigation of the association between socioeconomic status, access to care, process of care, treatment compliance, and risk of hospital admission.

1. Krumholz HM, Parent EM, Tu N, Vaccarino V, Wang Y, Radford MJ, Hennen J. Readmission after hospitalization for congestive heart failure among Medicare beneficiaries. *Arch Intern Med* 1997;157:99–104.
2. Philbin EF, Rocco TA, Lindenmuth NW, Ulrich K, Jenkins PL. Clinical outcomes in heart failure: report from a community hospital-based registry. *Am J Med* 1999;107:549–555.
3. Philbin EF, DiSalvo TG. The influence of race and gender on process of care, resource utilization, and hospital-based outcomes in congestive heart failure. *Am J Cardiol* 1998;82:76–81.
4. Ghali JK, Kadakia S, Cooper R, Ferlinz J. Precipitating factors leading to decompensation of heart failure: traits among urban blacks. *Arch Intern Med* 1988;148:2013–2016.

5. Vinson JM, Rich MW, Sperry JC, Shah AS, McNamara T. Early readmission of elderly patients with congestive heart failure. *J Am Geriatr Soc* 1990;38:1290–1295.
6. Philbin EF, DiSalvo TG. Prediction of hospital readmission for heart failure: development of a simple risk score based on administrative data. *J Am Coll Cardiol* 1999;33:1560–1566.
7. Chin MH, Goldman L. Correlates of early hospital readmission or death in patients with congestive heart failure. *Am J Cardiol* 1997;79:1640–1644.
8. Philbin EF. Comprehensive multidisciplinary programs for management of patients with congestive heart failure. *J Gen Intern Med* 1999;14:130–135.
9. Alter DA, Naylor CD, Austin P, Tu JV. Effects of socioeconomic status on access to invasive cardiac procedures and on mortality after acute myocardial infarction. *N Engl J Med* 1999;341:1359–1367.
10. Leape LL, Hilborne LH, Bell R, Kamberg C, Brook RH. Underuse of cardiac procedures: do women, ethnic minorities and the uninsured fail to receive needed revascularization? *Ann Intern Med* 1999;130:183–192.
11. Carlisle DM, Leake BD, Shapiro MF. Racial and ethnic disparities in the use of cardiovascular procedures: associations with type of health insurance. *Am J Public Health* 1997;87:263–267.
12. Gornick ME, Eggers PW, Reilly TW, Mentnech RM, Fitterman LK, Kucken LE, Vladeck BC. Effects of race and income on mortality and use of services among Medicare beneficiaries. *N Engl J Med* 1996;335:791–799.
13. Sada MJ, French WJ, Carlisle DM, Chandra NC, Gore JM, Rogers WJ. Influence of payor on use of invasive cardiac procedures and patient outcome after myocardial infarction in the United States. *J Am Coll Cardiol* 1998;31:1474–1480.
14. Retchin SM, Brown B. Elderly patients with congestive heart failure under prepaid care. *Am J Med* 1991;90:236–242.
15. Philbin EF, McCullough PA, DiSalvo TG, Dec GW, Jenkins PL, Weaver WD. Socioeconomic status is an important determinant of utilization of invasive procedures after acute myocardial infarction in New York State. *Circulation* 2000;102(suppl III):III-107–III-115.
16. Kahn KL, Pearson ML, Harrison ER, Desmond KA, Rogers WH, Rubenstein LV, Brook RH, Keeler EB. Health care for black and poor hospitalized Medicare patients. *JAMA* 1994;271:1169–1174.
17. The SOLVD Investigators. Effect of enalapril on survival in patients with reduced left ventricular ejection fractions and congestive heart failure. *N Engl J Med* 1991;325:293–302.
18. The Digitalis Investigation Group. The effect of digoxin on mortality and morbidity in patients with heart failure. *N Engl J Med* 1997;336:525–533.
19. Packer M, Bristow MR, Cohn JN, Colucci WS, Fowler MB, Gilbert EM, Shusterman NH. The effect of carvedilol on morbidity and mortality in patients with chronic heart failure. *N Engl J Med* 1996;334:1349–1355.
20. Philbin EF, Weil HFC, Francis CA, Marx HJ, Jenkins PL, Pearson TA, Reed RG. Race-related differences among patients with left ventricular dysfunction: observations from a large biracial angiographic cohort. *J Cardiac Failure* 2000;6:187–193.
21. Iezzoni LI. How much are we willing to pay for information about quality of care? *Ann Intern Med* 1997;126:391–393.
22. Laouri M, Kravitz RL, French WJ, Yang I, Milliken JC, Hilborne L, Wachsner R, Brook RH. Underuse of coronary revascularization procedures: application of a clinical method. *J Am Coll Cardiol* 1997;29:891–897.