Socioeconomic Status, Medicaid Coverage, Clinical Comorbidity, and Rehospitalization or Death After an Incident Heart Failure Hospitalization

Atherosclerosis Risk in Communities Cohort (1987 to 2004)

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Background—Among patients with heart failure (HF), early readmission or death and repeat hospitalizations may be indicators of poor disease management or more severe disease.

Methods and Results—We assessed the association of neighborhood median household income (nINC) and Medicaid status with rehospitalization or death in the Atherosclerosis Risk in Communities cohort study (1987 to 2004) after an incident HF hospitalization in the context of individual socioeconomic status and evaluated the relationship for modification by demographic and comorbidity factors. We used generalized linear Poisson mixed models to estimate rehospitalization rate ratios and 95% CIs and Cox regression to estimate hazard ratios (HRs) and 95% CIs of rehospitalization or death. In models controlling for race and study community, sex, age at HF diagnosis, body mass index, hypertension, educational attainment, alcohol use, and smoking, patients with a high burden of comorbidity who were living in low-nINC areas at baseline had an elevated hazard of all-cause rehospitalization (HR, 1.40; 95% CI, 1.10 to 1.77), death (HR, 1.36; 95% CI, 1.02 to 1.80), and rehospitalization or death (HR, 1.36; 95% CI, 1.08 to 1.70) as well as increased rates of hospitalization compared to those with a high burden of comorbidity living in high-nINC areas. Medicaid recipients with a low level of comorbidity had an increased hazard of all-cause rehospitalization (HR, 1.19; 95% CI, 1.05 to 1.36) and rehospitalization or death (HR, 1.21; 95% CI, 1.07 to 1.37) and a higher rate of repeat hospitalizations compared to non-Medicaid recipients.

Conclusions—Comorbidity burden appears to influence the association among nINC, Medicaid status, and rehospitalization and death in patients with HF. (Circ Heart Fail. 2011;4:308-316.)

Key Words: patient readmission • follow-up studies • socioeconomic status • heart failure • mortality • comorbidity

Hospital discharges for heart failure (HF) increased 157% from 1979 to 2002 and continue to rise. HF rehospitalizations, which often are preventable, tend to be higher among older patients, nonwhites, and patients with prior hospitalizations and multiple primary-care visits. In addition to being recognized as a major cause of serious morbidity, HF mortality is high. From 1980 to 1995, the number of deaths in the United States with an underlying cause of HF increased nearly 70%. HF is a primary or contributory cause of >300,000 deaths each year in the United States, and HF mortality rates increase sharply with age.

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Among Atherosclerosis Risk in Communities (ARIC) study (1987 to 2002) cohort members with incident HF, 30-day mortality was 10%, whereas 1- and 5-year mortality was 22% and 42%, respectively. Several studies with a combined end point of rehospitalization or mortality report a prevalence of rehospitalization or death of 31% to 35% at 60 days and 81% at 1 year.

A shorter interval of time between initial hospitalization for HF and readmission or death may be an indicator of more severe disease. Chronic conditions such as hypertension, coronary heart disease, diabetes, and obesity are risk factors for the development of HF, and clinical HF commonly is accompanied by 1 or more of these factors. In general, the burden of mortality and rehospitalization increases with increasing comorbidity. In populations, however, variations in HF morbidity and mortality are not completely explained by clinical features of the disease, suggesting the need to explore understudied domains, such as the influence of the socioeconomic context.
Low socioeconomic status is associated with higher HF incidence,22–24 rehospitalization, and mortality.25–27 Meanwhile, health insurance status is associated with care-seeking behavior20 and subsequent disease outcomes.28 Receipt of Medicaid, in particular, may exert effects on health outcomes that are independent of socioeconomic status29,30 because coverage is determined by having certain diseases and disabilities or an income below the poverty line.31 Evidence suggests that social and environmental contexts play an important role in health outcomes32–34; however, research to date has not jointly assessed the effects of neighborhood socioeconomic status and receipt of Medicaid on the risk of rehospitalization or mortality among patients with HF in the context of individual socioeconomic factors. Furthermore, no published data are available that address whether the influence of the socioeconomic context differs between patients with and without a high level of comorbidity. We hypothesized that low neighborhood socioeconomic status and receipt of Medicaid, respectively, lead to earlier readmission or death and that these factors impart a larger influence among participants with a higher burden of comorbidity.

Methods

ARIC cohort participants (N = 15,792) were enrolled from 1987 to 1989 from the following four US communities: Forsyth County, North Carolina; Washington County, Maryland; suburbs of Minneapolis, Minnesota; and Jackson, Mississippi.35 As part of annual follow-up, information regarding inpatient hospital stays is collected from cohort members, and hospitalization data are abstracted from the medical record.

All-cause hospitalizations are identified during annual follow-up or during routine ARIC community surveillance.36 For the current study, cardiovascular disease (CVD)-related hospitalizations were further identified from all-cause hospitalizations using International Classification of Diseases, Ninth Edition (ICD-9) discharge codes 402, 410 to 414, 427, 428, 430 to 436, or 518.4, whereas a HF-related hospitalization was defined as that with ICD-9 discharge codes 428.37

Participant addresses obtained at baseline were assigned to the level of the census tract by a vendor with high geocoding accuracy (Mapping Analytics).38 The 1990 US census tract-level neighborhood-level socioeconomic measure selected for study was neighborhood median household income (nINC). In previous work, the use of the single-variable nINC measure produced results of similar magnitude and precision to a more-complex composite index measure of neighborhood socioeconomic status.39 We categorized nINC into community-wide tertiles based on participants’ place of residence during the period of 1987 to 1989 as follows: low, < $24,777; medium, $24,777 to ≤ $36,071; and high, ≥ $36,071.

After excluding 245 participants with prevalent HF at baseline, 1,415 participants had an incident hospitalized HF event through 2004. An additional 70 participants were excluded because of missing data on neighborhood socioeconomic status, and 3 were excluded because of insufficient numbers for analysis because they were not white or black or were blacks living in Minnesota or Maryland, resulting in a final sample size of 1,342 participants.

Covariates included race and study community; sex; age at incident HF hospitalization; and selected socioeconomic, clinical, and behavioral characteristics. Educational attainment was assessed at baseline (<11 years, high school graduate, and greater than high school) as was health insurance status at the time of the index HF hospitalization (receipt of Medicaid, yes or no). Participants’ body mass index was assessed at baseline and classified as normal (<25 kg/m²), overweight (25 to <30 kg/m²), or obese (≥30 kg/m²). Hypertensive status at baseline was identified as systolic blood pressure ≥140 mm Hg, diastolic blood pressure ≥90 mm Hg, or taking hypertensive medication within the previous 2 weeks. Teaching status of the hospital during the index admission (teaching versus nonteaching), was based on whether the hospital had an internal medicine residency training program.

We ascertained the prevalence of common underlying conditions at the time of the index HF hospitalization using ICD-9 discharge codes. The Charlson Index, a clinical comorbidity algorithm,41 was derived from these data. The Charlson Index is a validated measure used to quantify the burden of comorbidity in several studies of mortality and adverse health outcomes.18,19 In its use with HF outcomes, a modified Charlson Index excludes chronic HF from the conditions included in the computation of the comorbidity score.40 Consistent with previous studies, we defined a high burden of comorbidity as a sum of ≥2 points on the Charlson Index scale, whereas a low burden of comorbidity was defined as a total of 0 to 1 point.

We used generalized linear Poisson mixed models to estimate all-cause, CVD-related, and HF-related rehospitalization rate ratios (RRs), comparing the rates of participants from low nINC to high nINC, medium nINC to high nINC, and Medicaid recipients to non-Medicaid recipients along with 95% CIs. This modeling strategy accounted for repeat hospitalizations among patients as well as the clustering of patients within census tracts. Time at risk for rehospitalization was the time elapsed between the incident HF hospitalization admission date and death, loss to follow-up, or the end of 2004, whichever came first. We assessed for overdispersion by consulting the deviance statistic of the Poisson model and conducted supplementary analyses using negative binomial regression when the deviance statistic exceeded 1.41

The product-limit (Kaplan-Meier) method was used to measure time to readmission, death, or readmission or death over the course of follow-up. Multivariate Cox proportional hazard models estimated the risk of death or rehospitalization or death, and rehospitalization alone using death during follow-up as the censoring variable. The model produced survival curves depicting survival free of readmission or death, and the proportional hazards assumption was assessed. All participants were censored at the end of 2004.

Crude nINC-rehospitalization/mortality relationship analyses were conducted, the influence of covariates in a full model were tested, and the effect modification (interaction P < 0.05) of the nINC-rehospitalization/mortality relationship was assessed by age, race and study community, sex, hypertension, body mass index, and comorbidity index score. Analyses were performed with SAS version 9.1 (SAS Institute Inc; Cary, NC) statistical software.

Results

Among participants with an incident HF hospitalization, 41% lived in low-nINC and 25% in high-nINC areas at baseline. Approximately half (46%) were women, 33% were black, and the average age at the time of the index event was 67 years. As shown in Table 1, a greater proportion (55%) of participants from low-nINC areas had attained ≤11 years of education compared to participants in medium- (35%) and high- (19%) nINC areas. Twenty percent of participants living in low-nINC areas were Medicaid recipients in contrast to 3% of those living in medium- and high-nINC areas (Table 2).

By the end of 2004, 89% of participants with an incident HF hospitalization had been rehospitalized at least once (mean, 3.6; range, 0 to 47), 47% died, and 91% had been rehospitalized or died. Figure 1 shows life table trends of rehospitalization, death, and rehospitalization or death by person-time elapsed since the incident hospitalized HF event. Of note, the cumulative proportion of persons experiencing rehospitalization or death is quite similar to that of rehospitalization but not death. At 1 year, 19% had died, 59% had
been rehospitalized, and 62% had been rehospitalized or had died (Figure 1).

Almost 25% of participants had a comorbidity index score of ≥2 (Table 2). The most common comorbidities identified at the index hospitalization were chronic pulmonary disease (27%), diabetes (22%), and myocardial infarction (13%). The comorbidity index score modified the nINC-rehospitalization/mortality relationship (P < 0.05) in Cox proportional hazards (time to event) and Poisson (rate) analyses. Therefore, subsequent results are stratified by level of the comorbidity score (≥2 versus <2).

Time-to-Event Analyses
Crude median rehospitalization- and mortality-free survival times varied by comorbidity index score (high versus low) among participants in each nINC tertile (low nINC, 107 versus 283 days; medium nINC, 118 versus 128 days; high nINC, 161 versus 229 days) as well as by receipt of Medicaid (recipients, 60 versus 168 days; nonrecipients, 133 versus 217 days). Figure 2 shows rehospitalization-free survival curves, 1 for each level of comorbidity burden, stratified by nINC. Among participants with a high burden of comorbidity, those living in high-nINC areas experienced the longest rehospitalization-free survival, whereas those living in low-nINC areas experienced the shortest. The observed nINC gradient did not persist among participants with a low burden of comorbidity (Figure 2).

The nINC/Medicaid-rehospitalization/mortality survival relationships are shown in Table 3. In models controlling for race and study community, sex, age at HF diagnosis, body mass index, hypertension, educational attainment, alcohol use, and smoking, participants with a high burden of comor-

### Table 1. Baseline Characteristics of Participants With Incident Hospitalized Heart Failure by Medicaid Status and nINC

<table>
<thead>
<tr>
<th></th>
<th>Medicaid Recipient</th>
<th>Median Household Income</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes (n = 135)</td>
<td>No (n = 1207)</td>
<td>Low (n = 553)</td>
<td>Medium (n = 454)</td>
<td>High (n = 335)</td>
</tr>
<tr>
<td>Median household income, USD</td>
<td>$17,897</td>
<td>$29,456</td>
<td>$16,519</td>
<td>$31,799</td>
<td>$42,979</td>
</tr>
<tr>
<td>Sex</td>
<td>Female 97 (71.9)</td>
<td>513 (42.5)</td>
<td>309 (55.9)</td>
<td>173 (38.1)</td>
<td>128 (38.2)</td>
</tr>
<tr>
<td></td>
<td>Male 38 (28.1)</td>
<td>694 (57.5)</td>
<td>244 (44.1)</td>
<td>281 (61.9)</td>
<td>207 (61.8)</td>
</tr>
<tr>
<td>Race/study community</td>
<td>Black/Forsyth, NC 5 (3.7)</td>
<td>40 (3.3)</td>
<td>26 (4.7)</td>
<td>17 (3.7)</td>
<td>2 (0.6)</td>
</tr>
<tr>
<td></td>
<td>Black/Jackson, MS 97 (71.9)</td>
<td>300 (24.8)</td>
<td>369 (66.7)</td>
<td>6 (1.3)</td>
<td>22 (6.6)</td>
</tr>
<tr>
<td></td>
<td>White/Forsyth, NC 9 (6.6)</td>
<td>264 (21.9)</td>
<td>42 (7.6)</td>
<td>141 (31.1)</td>
<td>90 (26.9)</td>
</tr>
<tr>
<td></td>
<td>White/Washington County, MD 20 (14.8)</td>
<td>363 (30.1)</td>
<td>103 (18.6)</td>
<td>232 (51.1)</td>
<td>48 (14.3)</td>
</tr>
<tr>
<td></td>
<td>White/Minneapolis, MN 4 (3.0)</td>
<td>240 (19.9)</td>
<td>13 (2.4)</td>
<td>58 (12.8)</td>
<td>173 (51.6)</td>
</tr>
<tr>
<td>Hypertensive*</td>
<td>Yes 112 (66.3)</td>
<td>598 (51.0)</td>
<td>349 (63.1)</td>
<td>200 (44.1)</td>
<td>161 (48.1)</td>
</tr>
<tr>
<td></td>
<td>No 57 (33.7)</td>
<td>564 (48.1)</td>
<td>200 (36.2)</td>
<td>251 (55.3)</td>
<td>170 (50.8)</td>
</tr>
<tr>
<td>Body mass index†</td>
<td>Obese 75 (55.6)</td>
<td>503 (41.7)</td>
<td>273 (49.4)</td>
<td>172 (37.9)</td>
<td>133 (39.7)</td>
</tr>
<tr>
<td></td>
<td>Overweight 37 (27.4)</td>
<td>447 (37.0)</td>
<td>186 (33.6)</td>
<td>173 (38.1)</td>
<td>125 (37.3)</td>
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<tr>
<td></td>
<td>Normal 23 (17.0)</td>
<td>255 (21.1)</td>
<td>92 (16.8)</td>
<td>109 (24.0)</td>
<td>76 (22.7)</td>
</tr>
<tr>
<td>Current drinker</td>
<td>Yes 32 (23.7)</td>
<td>589 (48.8)</td>
<td>168 (30.4)</td>
<td>237 (52.2)</td>
<td>216 (64.5)</td>
</tr>
<tr>
<td></td>
<td>No 103 (76.3)</td>
<td>618 (51.2)</td>
<td>385 (69.6)</td>
<td>217 (47.8)</td>
<td>119 (35.5)</td>
</tr>
<tr>
<td>Current smoker</td>
<td>Yes 56 (41.5)</td>
<td>417 (34.5)</td>
<td>204 (36.9)</td>
<td>161 (35.5)</td>
<td>108 (32.2)</td>
</tr>
<tr>
<td></td>
<td>No 79 (58.5)</td>
<td>790 (65.5)</td>
<td>349 (63.1)</td>
<td>293 (64.5)</td>
<td>227 (67.8)</td>
</tr>
<tr>
<td>Educational attainment</td>
<td>Advanced (17–21 y) 12 (8.9)</td>
<td>307 (25.4)</td>
<td>79 (14.3)</td>
<td>106 (23.4)</td>
<td>134 (40.0)</td>
</tr>
<tr>
<td></td>
<td>Intermediate (12–16 y) 26 (19.3)</td>
<td>472 (39.1)</td>
<td>169 (30.6)</td>
<td>190 (41.9)</td>
<td>139 (41.5)</td>
</tr>
<tr>
<td></td>
<td>Basic (≤11 y) 96 (71.1)</td>
<td>425 (35.2)</td>
<td>302 (54.6)</td>
<td>157 (34.5)</td>
<td>62 (18.5)</td>
</tr>
<tr>
<td></td>
<td>Missing 1 (0.7)</td>
<td>3 (0.3)</td>
<td>3 (0.5)</td>
<td>1 (0.2)</td>
<td>…</td>
</tr>
</tbody>
</table>

Data are presented as n (%), unless otherwise indicated. nINC indicates neighborhood median household income; USD, US dollars. *Systolic blood pressure ≥140 mm Hg, diastolic blood pressure ≥90 mm Hg, or blood pressure medication in the past 2 weeks. †Normal body mass index, <25 kg/m²; overweight, 25 to <30 kg/m²; and obese, ≥30 kg/m².
bidity who were living in low-nINC areas at baseline had an elevated risk for all-cause rehospitalization (hazard ratio [HR], 1.40; 95% CI, 1.10 to 1.77), death (HR, 1.36; 95% CI, 1.02 to 1.70), and rehospitalization or death (HR, 1.36; 95% CI 1.08 to 1.70) compared to those with a high burden of comorbidity living in high-nINC areas. In contrast, participants with a low burden of comorbidity who were living in low-nINC areas at baseline did not experience an increased risk of death. Medicaid recipients with a low level of comorbidity had an increased risk of all-cause rehospitalization (HR, 1.19; 95% CI, 1.05 to 1.36) and rehospitalization or death (HR, 1.21; 95% CI, 1.07 to 1.37) compared to non-Medicaid recipients with a low level of comorbidity. Restricting the model to include those in the lowest nINC tertile and combining across comorbidity categories, the risk for all-cause rehospitalization among participants with Medicaid was 1.22 (95% CI, 1.07 to 1.38) compared to those without Medicaid. A significantly lower hazard of death was seen among those with a higher burden of comorbidity living in medium-nINC areas compared to those living in high-nINC areas (HR, 0.74; 95% CI, 0.59 to 0.93).

### Rate Analyses

Of 1342 participants with an incident HF hospitalization, 148 (11%) were not rehospitalized for any cause, whereas 318 (24%) were not rehospitalized for a CVD-related cause, and 590 (44%) were not rehospitalized for HF. All-cause rehospitalization rates per 100 person-years were 71.3 (95% CI, 63.3 to 80.4) for low nINC, 71.9 (95% CI, 64.5 to 80.2) for

![Figure 1. Cumulative proportion of participants with an incident heart failure hospitalization experiencing rehospitalization, death, and rehospitalization or death.](http://circheartfailure.ahajournals.org/)
medium nINC, and 54.3 (95% CI, 47.7 to 61.7) for high nINC.

In models controlling for race and study community, sex, age at HF diagnosis, body mass index, hypertension, educational attainment, receipt of Medicaid, teaching hospital status, alcohol use, and smoking, participants with a higher burden of comorbidity living in low-nINC areas had a higher risk of all-cause (rate ratio (RR), 1.67; 95% CI, 1.01 to 2.76) and CVD-related (RR, 1.82; 95% CI, 1.08 to 3.07) hospitalizations but did not reach statistical significance for HF-related (RR, 1.65; 95% CI, 0.81 to 3.34) hospitalizations compared to those with a high burden of comorbidity living in high-nINC areas. Participants living in medium-nINC areas at baseline did not have an elevated risk compared to participants living in high-nINC areas, nor was there an nINC differential among participants with a low burden of comorbidity. Similar results were seen for CVD-related hospitalizations; however, no nINC effect in either strata of comorbidity

Figure 2. Survival after the incident heart failure hospitalization: time to rehospitalization by nINC and (A) high comorbidity burden and (B) low comorbidity burden. nINC indicates neighborhood median household income.
burden was seen for HF-related hospitalizations possibly because of relatively few events meeting the criteria for HF-related hospitalizations. Among participants with a low comorbidity burden, Medicaid recipients were at increased risk for all-cause hospitalizations. The observed results persisted for Medicaid recipients with a low comorbidity burden in analyses for CVD- and HF-related hospitalizations (Figure 3).

In our data, the Poisson models used for estimating rehospitalization RRs yielded a deviance statistic of close to 4. Thus, overdispersion was suggested. In response, we fit negative binomial models to the data. As expected, the point estimates of the RRs did not change, but the CIs widened with the application of the negative binomial model, reflecting the effect overdispersion had on these data. Although the negative binomial estimates were less precise, the analyses accounting for overdispersion did not change our interpretation of the results.

**Discussion**

In the present study, incident HF hospitalizations were more common among ARIC cohort participants living in low- and medium-nINC areas compared to those living in high-nINC areas at baseline. Further, low-nINC participants with an elevated comorbidity index score at the time of the incident hospitalized HF event were rehospitalized at a higher rate than high-nINC participants in the same comorbidity category. These findings were consistent with a review concluding that hospital admission rates increase with increased social deprivation.42 In addition, participants had an increased hazard of rehospitalization, death, and rehospitalization or death if they lived in a low-nINC area at baseline and had a higher burden of comorbidity compared to participants living in high-nINC areas at baseline with a similar level of comorbidity.

Patients with limited neighborhood socioeconomic resources may not have adequate social support or access to primary-care facilities necessary to manage HF outside the hospital. Persons living in economically deprived areas may be less likely to have a primary-care physician and, thus, may seek care in the hospital for conditions commonly managed outside the hospital. In 2004, McAlister et al23 reported that follow-up rates with primary-care physicians were lowest among patients with high neighborhood socioeconomic de-

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**Table 3. All-Cause Rehospitalization, Death, and Rehospitalization or Death After an Incident Hospitalized Heart Failure Event by nINC, Stratified by Charlson Index Score**

<table>
<thead>
<tr>
<th></th>
<th>Charlson Index Score ≥2</th>
<th>Charlson Index Score &lt;2</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Model 1* Model 2† Model 1* Model 2†</td>
<td></td>
</tr>
<tr>
<td>All-cause rehospitalization nINC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>1.23 (1.00–1.51) 1.40 (1.10–1.77) 1.13 (1.01–1.26) 1.16 (1.04–1.30)</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>1.07 (0.91–1.27) 1.14 (0.95–1.36) 1.26 (1.15–1.39) 1.28 (1.16–1.41)</td>
<td></td>
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<tr>
<td>High</td>
<td>1.00 (referent) 1.00 (referent) 1.00 (referent) 1.00 (referent)</td>
<td></td>
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<tr>
<td>Medicaid recipient</td>
<td></td>
<td></td>
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<tr>
<td>Yes</td>
<td>1.18 (0.95–1.46) 1.12 (0.89–1.40) 1.17 (1.03–1.32) 1.19 (1.05–1.36)</td>
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</tr>
<tr>
<td>No</td>
<td>1.00 (referent) 1.00 (referent) 1.00 (referent) 1.00 (referent)</td>
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</tr>
<tr>
<td>Death nINC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>1.34 (1.04–1.72) 1.36 (1.02–1.80) 1.12 (0.97–1.30) 1.09 (0.94–1.26)</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>0.75 (0.61–0.93) 0.74 (0.59–0.93) 0.91 (0.79–1.03) 0.90 (0.78–1.02)</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>1.00 (referent) 1.00 (referent) 1.00 (referent) 1.00 (referent)</td>
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<tr>
<td>Medicaid recipient</td>
<td></td>
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<tr>
<td>Yes</td>
<td>0.99 (0.76–1.30) 0.95 (0.72–1.25) 1.03 (0.87–1.23) 0.96 (0.80–1.14)</td>
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<tr>
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<td>1.00 (referent) 1.00 (referent) 1.00 (referent) 1.00 (referent)</td>
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<tr>
<td>All-cause rehospitalization or death nINC</td>
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<tr>
<td>Low</td>
<td>1.23 (1.01–1.50) 1.36 (1.08–1.70) 1.09 (0.98–1.21) 1.13 (1.02–1.26)</td>
<td></td>
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<tr>
<td>Medium</td>
<td>1.00 (0.85–1.17) 1.04 (0.87–1.23) 1.24 (1.13–1.36) 1.27 (1.15–1.39)</td>
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<td>High</td>
<td>1.00 (referent) 1.00 (referent) 1.00 (referent) 1.00 (referent)</td>
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<tr>
<td>Medicaid recipient</td>
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<tr>
<td>Yes</td>
<td>1.23 (1.00–1.51) 1.17 (0.95–1.45) 1.17 (1.04–1.32) 1.21 (1.07–1.37)</td>
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<tr>
<td>No</td>
<td>1.00 (referent) 1.00 (referent) 1.00 (referent) 1.00 (referent)</td>
<td></td>
</tr>
</tbody>
</table>

Data are presented as hazard ratio (95% CI). nINC indicates neighborhood median household income.
*Model 1* Medicaid status plus race and study community, sex, and age at index event.
†Model 1 plus hypertension, body mass index, current smoker, current drinker, and educational attainment.
privation. Fewer primary-care visits may be an indication of higher hospital utilization rates among patients of lower nINC. A limitation of our study is that we are unable to take into account out-of-hospital management of HF because outpatient records were not available for the time period under study. Future investigations in ARIC will, however, attempt to monitor the outpatient events related to HF.

A related limitation of this study is the lack of information regarding HF medication adherence after discharge. To address this limitation, we assessed whether angiotensin-converting enzyme inhibitors or β-blockers were given during the hospitalization or at discharge and controlled for these factors in models containing all potential confounders. Inclusion of the HF medication variables did not appreciably change the estimates (<5%) and did not alter our interpretation of the results.

Medicaid recipients without a high burden of comorbidity tended to have a higher hazard of first rehospitalization and were rehospitalized more often than participants not receiving Medicaid. It is possible that the Medicaid recipients in this study with greater comorbidity were more likely to seek or be referred to care for symptom management outside the hospital and as a result, did not require more frequent hospitalizations than non-Medicaid recipients with a high comorbidity burden. Conversely, the Medicaid recipients with fewer comorbidities in this study may not have been as aggressively managed inside or outside the hospital, leading to a higher hazard of first rehospitalization after the index HF hospitalization. However, these estimates should be interpreted with caution because the number of Medicaid recipients with a high comorbidity burden in these data were relatively small. Shorter median times from the index event to readmission among those living in low-nINC areas appeared to be a strong influence on the combined rehospitalization/mortality end point because low nINC was not a predictor for HF survival across levels of comorbidity in the ARIC study population. In particular, rehospitalization occurs more often and more quickly among participants living in low-nINC areas, especially among those with more comorbidities identified during the incident hospitalized event. In general, patients with more comorbidity may require a greater number of treatments because they are sicker, more susceptible to severe HF, or experience acute exacerbations of the disease. Requiring more medical attention because of a high burden of comorbidity may highlight the limited resources available in low-nINC areas for either adequate self-care or out-of-hospital management of disease.

A strength of the present study is its inclusion of a racially diverse population of men and women who were free of HF at baseline and followed from 1987 to 2004 to capture an incident HF hospitalization, subsequent hospitalizations, and fatal events. Longer follow-up more adequately depicts the survival experience and clinical course of HF progression for the majority of patients with HF. Blacks living in Jackson, Mississipp...
Mississippi, comprised the majority of patients with HF who both resided in low-nINC areas at baseline and were Medicaid recipients. This limitation highlights the difficulty of disentangling race and socioeconomic disadvantage in our society.

The index HF hospitalization was defined as the first mention of ICD-9 discharge code 428 in the medical record, a technique used in extant studies of HF.14 We acknowledge limitations inherent to this method of event identification, such as an inability to distinguish between acute and chronic HF events as well as an inability to determine the etiology of the incident hospitalized event. Although the identification of incident events through ICD-9 discharge codes does not capture outpatient events that may have occurred before the incident hospitalized event, the distribution of hospitalizations among ARIC participants with incident hospitalization for HF were similar to a recently published community-based report that ascertained incident HF cases from both outpatient and inpatient records.44

In the context of increasing hospital discharges for HF and a consistently high rate of mortality from the syndrome, it is very important to identify social and economic neighborhood forces that affect HF rehospitalization or death in the presence of individual socioeconomic, demographic, and comorbidity factors. Differences by nINC in survival free from readmission or death after an incident HF hospitalization may have important implications for the management and treatment of patients with HF.45,46 It is likely that nINC, in part, determines the availability of healthcare resources in a community, such as the proximity of neighborhood health clinics. Outpatient care is critical to the out-of-hospital monitoring of patients with HF and if less available in low-nINC areas, may adversely affect the progression of HF among patients in these communities.47 In the present study, Medicaid recipients with a low burden of comorbidity were more likely to be admitted to the hospital after an incident hospitalized HF event. Whether these patients are adequately monitored on an outpatient basis remains unclear. Regardless, comorbidity burden appears to modify the association among nINC, Medicaid status, and rehospitalization and death in patients with HF.

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Disclosures

None.

References


**CLINICAL PERSPECTIVE**

Hospital discharges for heart failure (HF) continue to rise. Chronic conditions such as hypertension, diabetes, and obesity are risk factors for the development of HF, and the burden of rehospitalization increases with increasing comorbidity. However, variations in HF morbidity are not completely explained by clinical features of the disease, suggesting the need to explore understudied domains, such as the influence of the socioeconomic context. We assessed the association of neighborhood median household income (nINC) and receipt of Medicaid with rehospitalization or death in the Atherosclerosis Risk in Communities cohort study (1987 to 2004) after an incident HF hospitalization (n=1342) in the context of individual socioeconomic status. Participants who lived in low-nINC areas at baseline and had multiple comorbidities were rehospitalized faster and more often compared with participants living in high-nINC areas with multiple comorbidities. Medicaid recipients with a low level of comorbidity were rehospitalized faster and more often compared with non-Medicaid recipients. In the context of increasing hospital discharges for HF, it is critical to identify social and economic neighborhood forces that affect HF rehospitalization. The observed differences by nINC may have important implications for the management and treatment of patients with HF. It is likely that nINC determines, in part, the availability of healthcare resources in a community, such as the proximity of neighborhood health clinics. Outpatient care is very important to the out-of-hospital monitoring of patients with HF and if less available in low-nINC areas, may adversely affect the progression of HF among patients in these communities.
Socioeconomic Status, Medicaid Coverage, Clinical Comorbidity, and Rehospitalization or Death After an Incident Heart Failure Hospitalization: Atherosclerosis Risk in Communities Cohort (1987 to 2004)

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