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Socioeconomic Status, Medicaid Coverage, Clinical Comorbidity and Rehospitalization or Death following an Incident Heart Failure Hospitalization: ARIC Cohort (1987–2004)

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Abstract

Background—Among heart failure (HF) patients, 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 (1987–2004) following an incident HF hospitalization in the context of individual socioeconomic status, and evaluated the relationship for modification by demographic and comorbid factors. We used generalized linear Poisson mixed models to estimate rehospitalization rate ratios and 95% confidence intervals (RR, 95% CI) and Cox regression to estimate hazard ratios (HR, 95% CI) of rehospitalization or death. In models controlling for race/study community, gender, age at HF diagnosis, body mass index, hypertension, educational attainment, alcohol use and smoking, persons with a high burden of comorbidity who were living in low nINC areas at baseline had an elevated hazard of all-cause rehospitalization (1.40, 1.10–1.77), death (1.36, 1.02–1.80), and rehospitalization or death (1.36, 1.08–1.70)—as well as increased rates of hospitalizations—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 (1.19, 1.05–1.36) and rehospitalization or death (1.21, 1.07–1.37), and a higher rate of repeat hospitalizations compared to non-Medicaid recipients.

Conclusions—Comorbidity burden appears to influence the association between nINC, Medicaid status and rehospitalization and death among HF patients.

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Disclosures
None.

Keywords

hospital readmission follow-up studies; socioeconomic position heart failure; mortality; comorbidities heart failure

Hospital discharges for heart failure (HF) increased 157% from 1979 to 2002[1], and continue to rise[2]. HF rehospitalizations, which are often preventable[3], tend to be higher among older patients, non-whites, and patients with prior hospitalizations and multiple primary care visits[4–6]. In addition to being recognized as a major cause of serious morbidity[7–9], HF mortality is high[10,11]. From 1980 to 1995, the number of deaths in the US with an underlying cause of HF increased nearly 70%[12]. HF is a primary or contributory cause of more than 300,000 deaths each year in the US[13], and HF mortality rates increase sharply with age.

Among Atherosclerosis Risk in Communities (ARIC) study (1987–2002) cohort members with incident HF, 30-day mortality was 10%, while one- and five-year mortality was 22% and 42%, respectively[14]. Several studies with a combined endpoint of rehospitalization or mortality report a prevalence of rehospitalization or death of 31–35% at 60 days[15], and 81%[16] at one 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 (CHD), diabetes and obesity are risk factors for the development of HF[4], and clinical HF is commonly accompanied by one or more of these factors[17]. In general, the burden of mortality[10,18,19] and rehospitalization[20] increases with increasing comorbidity. However, in populations, variations in HF morbidity and mortality are not completely explained by clinical features of the disease[21], 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 survival[25–27]. Meanwhile, health insurance status is associated with care-seeking behavior[20] and subsequent disease outcomes[28]. Receipt of Medicaid, in particular, may exert effects on health outcomes which are independent of socioeconomic status[29,30], as 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 outcomes[32–34], 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 HF patients in the context of individual socioeconomic factors. Furthermore, no published data are available which 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, would lead to earlier readmission or death, and that these factors would impart a larger influence among participants with a higher burden of comorbidity.

Methods

ARIC cohort participants (N=15,792) were enrolled from 1987–1989 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, Version 9 (ICD-9) discharge codes *402*, *410–414*, *427*, *428*, *430–436* or *518.4*; while a HF-related hospitalization was defined as that with an ICD-9 discharge code *428*[37].

Participants' 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 median household income (nINC). In previous work, the use of the single-variable nINC measure produced results of similar magnitude and precision when compared to a more complex composite index measure of neighborhood SES[39]. We categorized nINC into community-wide tertiles based upon participants' place of residence at baseline, during the period 1987–1989: low (< $24,777), medium ($24,777≤–<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 due to missing data on neighborhood socioeconomic status, and 3 were excluded due to 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/study community, gender, age at incident HF hospitalization and selected socioeconomic, clinical and behavioral characteristics. Educational attainment was assessed at baseline (less than 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/no). Participants' body mass index (BMI) was assessed at baseline and classified as normal (<25 kg/m^2), overweight (25–<30 kg/m^2) or obese (≥30 kg/m^2). Hypertensive status at baseline was identified as systolic blood pressure ≥140 mmHg, diastolic blood pressure ≥90 mmHg, or taking hypertensive medication within the previous two weeks. Teaching status of the hospital during the index admission (teaching vs. non-teaching), was based upon whether or not 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[19], 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 two or more points on the Charlson Index scale, whereas a low burden of comorbidity was defined with a total of zero to one points.

We used generalized linear Poisson mixed models to estimate all-cause, CVD-related and HF-related rehospitalization rate ratios, 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% confidence intervals (RR, 95% CI). This modelling 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 over-dispersion by consulting the deviance statistic of

the Poisson model, and conducted supplementary analyses using negative binomial regression when the deviance statistic exceeded one[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 analyses were conducted, the influence of covariates in a full model were tested, and effect modification ($p_{interaction}<0.05$) of the nINC-rehospitalization/mortality relationship was assessed by age, race/study community, gender, hypertension, BMI and comorbidity index score. Analyses were performed by using SAS Version 9.1 (SAS Institute, Inc., Cary, NC).

Results

Among participants with an incident HF hospitalization, 41% lived in low nINC, and one-quarter resided in high nINC, areas at baseline. Approximately half (46%) were female, one-third (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 or fewer years of education, as 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: 0–47), 47% died, and 91% had been rehospitalized or had 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 one year, 19% had died, 59% had been rehospitalized, and 62% had been rehospitalized or had died (Figure 1).

Almost one-quarter of participants had a comorbidity index score of two or greater (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 presented stratified by level of the comorbidity score (≥2 vs. <2).

Time-to-event analyses

Crude median rehospitalization- and mortality-free survival times, in days, varied by comorbidity index score (high vs. low) among participants in each nINC tertile [low nINC (107 vs. 283), medium nINC (118 vs. 128) and high nINC (161 vs. 229)] as well as by receipt of Medicaid [recipients (60 vs. 168), those not receiving Medicaid (133 vs. 217)]. Figure 2 shows rehospitalization-free survival curves, one 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, while 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 (HR, 95% CI) are shown in Table 3. In models controlling for race/study community, gender, age at HF diagnosis, body mass index, hypertension, educational attainment, alcohol use and smoking, persons with a high burden of comorbidity who were living in low nINC areas at baseline had an elevated risk for all-cause rehospitalization (1.40, 1.10–1.77), death (1.36, 1.02–1.80) and rehospitalization or death (1.36, 1.08–1.70) 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 for death. Medicaid recipients with a low level of comorbidity had an increased risk of all-cause rehospitalization (1.19, 1.05–1.36) and rehospitalization or death (1.21, 1.07–1.37) 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 (1.07, 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 (0.74, 0.59–0.93).

Rate analyses

Of 1,342 participants with an incident HF hospitalization, 148 (11%) were not rehospitalized for any cause, while 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 (95% CI) were 71.3 (63.3–80.4) for low nINC, 71.9 (64.5–80.2) for medium nINC, and 54.3 (47.7–61.7) for high nINC.

In models controlling for race/study community, gender, age at HF diagnosis, BMI, 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 (1.67, 1.01–2.76) and CVD-related (1.82, 1.08–3.07) – but did not reach statistical significance for HF-related (1.65, 0.81–3.34) – 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 burden was seen for HF-related hospitalizations, possibly due to 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 rate ratios yielded a deviance statistic of close to four. Thus, over-dispersion was suggested. In response, we fit negative binomial models to the data. As expected, the point estimates of the rate ratios did not change, however, the confidence intervals widened with the application of the negative binomial model, reflecting the effect over-dispersion had on these data. Although the negative binomial estimates were less precise, the analyses accounting for over-dispersion did not change our interpretation of the results.

Discussion

In this study, incident HF hospitalizations were more common among ARIC cohort participants of low and medium nINC 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 out-of-hospital. Persons living in economically deprived areas may be less likely to have a primary care physician, and thus may seek care in-hospital for conditions commonly managed out-of-hospital. McAlister (2004) reported follow-up rates with primary care physicians were lowest among patients with high neighborhood socioeconomic deprivation[23]. 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, as 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 post-discharge. To address this limitation, we assessed whether angiotensin-converting enzyme inhibitors or beta-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 managment out-of-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 in- or out-of- hospital, leading to a higher hazard of first rehospitalization following the index HF hospitalization. However, these estimates should be interpreted with caution, as the number of Medicaid recipients with a high comorbidity burden in these data was 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 endpoint, as 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 due to a high burden of comorbidity may serve to highlight the limited resources available in low nINC areas, either for adequate self-care[43] or out-of-hospital management of disease.

A strength of this 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 in order 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 HF patients. Blacks living in Jackson, Mississippi constituted the majority of HF patients 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 a *428* ICD-9 discharge code 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 not being able to determine the etiology of the incident hospitalized event. Although the identification of incident events via ICD-9 discharge codes does not capture outpatient events that may have occurred prior the incident hospitalized event, the distribution of hospitalizations among ARIC participants with incident hospitalized HF were similar to a recently published community-based report which 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 critical to identify social and economic neighborhood forces which impact HF rehospitalization or death in the presence of individual socioeconomic, demographic and comorbid factors. Differences by nINC in survival free from readmission or death post-incident HF hospitalization may have important implications for the management and treatment of HF patients[45,46]. It is likely that nINC in part determines the availability of health care resources in a community, such as the proximity of neighborhood health clinics. Outpatient care is critical to the out-of-hospital monitoring of HF patients, and if less available in low nINC areas, may adversely affect the progression of HF among patients in these communities[47]. In this study, Medicaid recipients with a low burden of comorbidity were more likely to be admitted to the hospital following 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 between nINC, Medicaid status and rehospitalization and death among HF patients.

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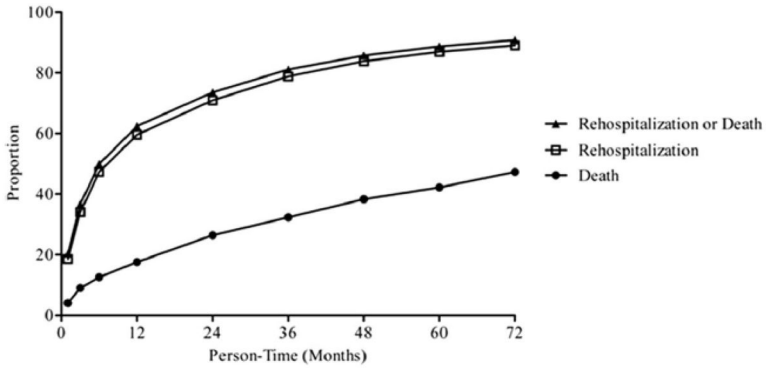

Figure 1.
Cumulative proportion of participants with an incident heart failure hospitalization experiencing rehospitalization, death and rehospitalization or death, The ARIC study (1987–2004)

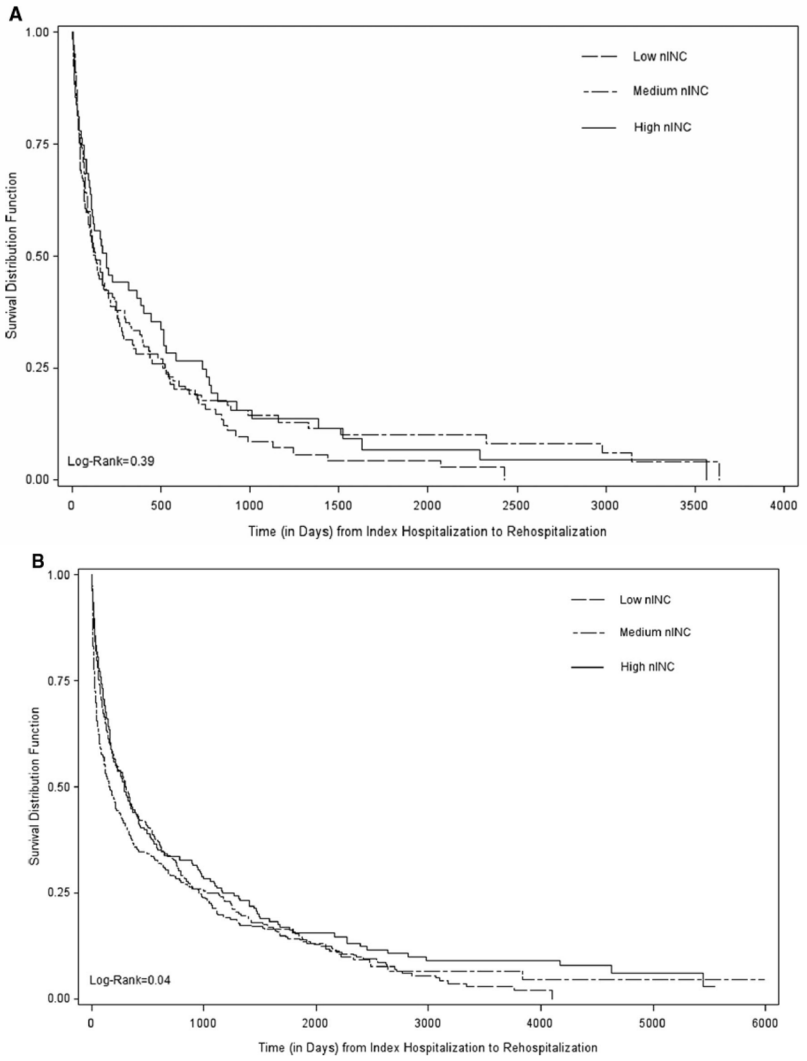

Figure 2.

Survival after the Incident HF Hospitalization: Time to Rehospitalization by Comorbidity Burden and nINC: The ARIC study (1987–2004).

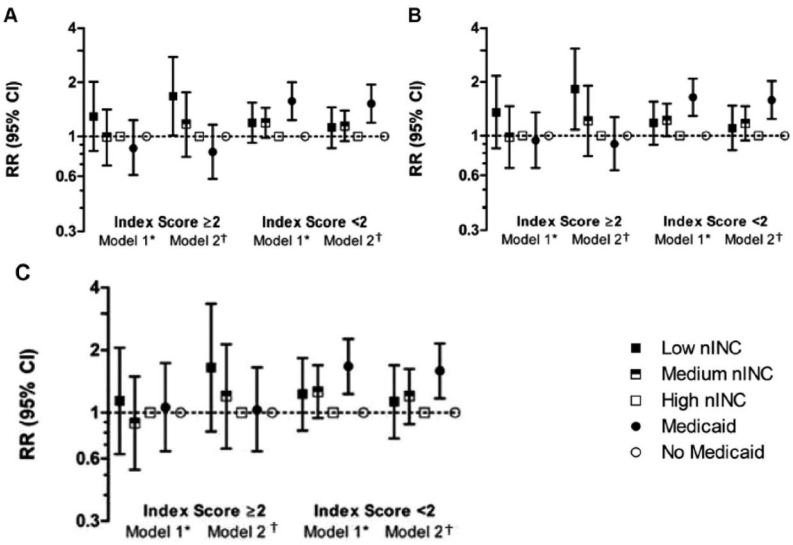

Figure 3.

Rate Ratios (and 95% CI) for All-cause, CVD- and HF-related Rehospitalizations among Participants with Incident Hospitalized HF: The ARIC study (1987–2004).

*nINC and Medicaid status plus race/study community, gender and age at index event

†Model 1 plus hypertension, body mass index, current smoker, current drinker and educational attainment

Table 1

Baseline Characteristics of Participants with Incident Hospitalized Heart Failure, by Medicaid Status and nINC: The ARIC study, 1987–2004.

	Medicaid Recipient				Median Household Income (nINC)					
	Yes N=135		No N=1,207		Low N=553		Medium N=454		High N=335	
	N	%	N	%	N	%	N	%	N	%
Median Household Income (USD), mean	17,897		29,456		16,519		31,799		42,979	
Gender										
Female	97	71.9	513	42.5	309	55.9	173	38.1	128	38.2
Male	38	28.1	694	57.5	244	44.1	281	61.9	207	61.8
Race/Study Community										
Black/Forsyth	5	3.7	40	3.3	26	4.7	17	3.7	2	0.6
Black/Jackson	97	71.9	300	24.8	369	66.7	6	1.3	22	6.6
White/Forsyth County	9	6.6	264	21.9	42	7.6	141	31.1	90	26.9
White/Washington County	20	14.8	363	30.1	103	18.6	232	51.1	48	14.3
White/Minneapolis	4	3.0	240	19.9	13	2.4	58	12.8	173	51.6
Hypertensive*										
Yes	112	66.3	598	51.0	349	63.1	200	44.1	161	48.1
No	57	33.7	564	48.1	200	36.2	251	55.3	170	50.8
Missing	-	-	11	0.9	4	0.7	3	0.7	4	1.1
Body Mass Index (BMI)†										
Obese	75	55.6	503	41.7	273	49.4	172	37.9	133	39.7
Overweight	37	27.4	447	37.0	186	33.6	173	38.1	125	37.3
Normal	23	17.0	255	21.1	93	16.8	109	24.0	76	22.7
Missing	-	-	2	0.2	1	0.2	-	-	1	0.3
Current Drinker										
Yes	32	23.7	589	48.8	168	30.4	237	52.2	216	64.5
No	103	76.3	618	51.2	385	69.6	217	47.8	119	35.5
Current Smoker										
Yes	56	41.5	417	34.5	204	36.9	161	35.5	108	32.2

	Medicaid Recipient				Median Household Income (nINC)					
	Yes N=135		No N=1,207		Low N=553		Medium N=454		High N=335	
	N	%	N	%	N	%	N	%	N	%
No	79	58.5	790	65.5	349	63.1	293	64.5	227	67.8
Educational Attainment (years)										
Advanced (17–21)	12	8.9	307	25.4	79	14.3	106	23.4	134	40.0
Intermediate (12–16)	26	19.3	472	39.1	169	30.6	190	41.9	139	41.5
Basic (≤11)	96	71.1	425	35.2	302	54.6	157	34.5	62	18.5
Missing	1	0.7	3	0.3	3	0.5	1	0.2	-	-

* Systolic blood pressure ≥140mmHg or diastolic blood pressure ≥90mmHg, or blood pressure medication in the last two weeks.

† Normal BMI: <25kg/m^2; overweight: 25–<30kg/m^2; and obese: ≥30kg/m^2

Table 2

Characteristics of Participants During the Index Heart Failure Admission, by Medicaid Status and nINC: The ARIC study, 1987–2004.

	Medicaid Recipient				Median Household Income (nINC)					
	Yes N=135		No N=1,207		Low N=553		Medium N=454		High N=335	
	N	%	N	%	N	%	N	%	N	%
Age, mean (SD)	67.5 (6.1)		66.9 (6.9)		66.0 (6.8)		67.9 (6.6)		67.5 (6.9)	
Medicaid Recipient*	-		-		111	20.1	15	3.3	9	2.7
Prevalence of Comorbidities†										
Myocardial Infarction	15	11.1	155	12.8	57	10.3	74	16.3	39	11.6
Peripheral Vascular Disease	11	8.2	94	7.8	38	6.9	36	7.9	31	9.3
Cerebrovascular Disease	9	6.7	38	3.2	55	10.0	38	8.4	28	8.4
Dementia	1	0.7	7	0.6	0	-	5	1.1	3	0.9
Chronic Pulmonary Disease	40	29.6	328	27.2	124	22.4	153	33.7	91	27.2
Rheumatologic Disease	2	1.5	31	2.6	11	2.0	13	2.9	9	2.7
Mild Liver Disease	0	-	11	0.9	4	0.7	4	0.9	3	0.9
Moderate or Severe Liver Disease	0	-	6	0.5	4	0.7	0	-	2	0.6
Diabetes Mellitus	38	28.2	248	20.6	137	24.7	91	20.1	65	19.5
Diabetes with Chronic Complications	9	6.7	53	4.4	20	3.6	16	3.5	19	5.7
Hemiplegia or Paraplegia	3	2.2	17	1.4	9	1.6	11	2.4	0	-
Renal Disease	4	3.0	33	2.7	22	4.0	8	1.8	7	2.1
Charlson Comorbidity Index Score‡										
≥ 2	37	27.4	277	23.0	126	22.8	118	26.0	70	20.9
<2	98	72.6	930	77.0	427	77.2	336	74.0	265	79.1

*As indicated in medical record

†Charlson Index Score Components

‡Adapted for use with ICD-9 discharge codes

Table 3

Hazard Ratios (HR) and 95% Confidence Intervals (95% CI) for all-cause rehospitalization, death, and rehospitalization or death following an Incident Hospitalized Heart Failure Event by nINC, Stratified by Charlson Index Score: The ARIC study, 1987–2004.

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

*nINC and Medicaid status plus race/study community, gender and age at index event

†Model 1 plus hypertension, body mass index, current smoker, current drinker and educational attainment