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# It takes a village: Exploring the impact of social determinants on delivery system outcomes for heart failure patients

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## ABSTRACT

*Background:* Local social determinants may act as effect modifiers for the impact of neighborhood material deprivation on patient-level healthcare outcomes. The objective of this study was to understand the mediating effect of local social determinants on neighborhood material deprivation and delivery outcomes in heart failure (HF) patients.

*Material and methods:* A retrospective cohort study was conducted using 4737 HF patients receiving inpatient care (n = 6065 encounters) from an integrated healthcare delivery system from 2010 to 2014. Outcomes included post-discharge mortality, readmission risk and length of stay. Deprivation was measured using an area deprivation index by address of residence. Effect modifications measured included urban-rural residency and faith identification using generalized linear regression models. Patient-level data was drawn from the delivery system data warehouse.

*Results:* Faith identification had a significant protective effect on HF patients from deprived areas, lowering 30-day mortality odds by one-third over patients who did not identify with a faith (OR 0.35 95%CI:0.12–0.98;p = 0.05). Significant effects persisted at the 90 and 180-day timeframes. In rural areas, lack of faith identification had a multiplicative effect on 30-day mortality for deprived patients (OR 14.0 95%CI:1.47–132.7;p = 0.02). No significant effects were noted for other healthcare outcomes.

*Conclusions:* The lack of expected association between area deprivation and healthcare outcomes in some communities may be explained by the presence of effect modifiers.

*Implications:* Understanding existing effect modifiers for area deprivation in local communities that delivery systems serve can inform targeted quality improvement. These factors should also be considered when comparing delivery system performance for reimbursement and in population health management.

## 1. Background

Heart failure (HF) patients at high risk for poor health outcomes including 30-day readmissions and mortality are a national concern. Cardiovascular health and health delivery outcomes are linked to social risk factors, including socioeconomic disadvantage.[1,2] Such factors can lead to reduced access to specialty cardiac services, lower utilization of non-invasive cardiac investigations, revascularization procedures, and rehabilitation.[3,4]

Useful measurements of patient social risk factors are not well defined and difficult to capture at the point of care. Medicaid payer status is a common, readily available measure of material deprivation.[1] However, the use of Medicaid coverage as a proxy for material deprivation status is problematic in adult populations, many of whom do not qualify for Medicaid.

To address this gap, the healthcare delivery system implemented an area deprivation index (ADI) based upon work by Singh [5] to provide a composite measure of material deprivation based upon a patient's small area or neighborhood of residence.[6] Several studies have linked measures of neighborhood deprivation to inequities in patient-level healthcare outcomes, including increased mortality and higher readmissions in HF patients.[7–10] ADI is primarily focused on the measurement of economic characteristics of a neighborhood, though there are social components. The terms “deprivation” and “material deprivation”

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[1] Deprivation is the “disadvantaged position of an individual, family or group relative to the society to which they belong”. Material deprivation includes the lack of basic resources for living [32].

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describe neighborhood composite characteristics being measured using the ADI and equate generally to socio-economic position.[11]

Research has identified social isolation as a risk factor associated with both poverty and poor health generally, including higher mortality.[12,13] Given this, social determinants that may mediate social isolation such as urban residency and faith identification, could protect against the negative effects that neighborhood deprivation has on healthcare outcomes. The purpose of this study was to examine the potential effect modification of faith identification and urban/rural residency on the relationship between area deprivation and healthcare outcomes for heart failure patients. Understanding the significance of these effect modifiers is important in efforts to compare delivery system performance for quality improvement, population health management, and for reimbursement purposes. The results of this study can also guide efforts to identify at-risk HF patients for additional post-discharge support.

## 2. Methods

A retrospective cohort study was conducted using a population of 5831 HF patients who received inpatient care between 2010 and 2014 (n = 7393 inpatient encounters) from one of 19 hospitals (11 urban/8 rural) within the healthcare delivery system of a single state. Ninety-six percent (96%) of patient encounters were treated in hospitals situated in urban areas. Eighteen percent (18%) of patient encounters were excluded for patients that did not provide a valid and complete address of residence (n = 984 patients), were missing faith identification data (n = 72 patients), or had poor quality geo-code matches (n = 38 patients) resulting in a final study population of 4737 patients (n = 6065 encounters) as noted in Fig. 1.

Primary outcome variables included 30-day all-cause readmission risk and post-discharge death within 30, 90, 180, and 365 days. Index encounter length of stay (LOS) was also examined. Death data was obtained from the delivery system's electronic medical record and the state Department of Health death certificate data. Thirty-day, all-cause readmission risk was calculated based upon the presence of a subsequent hospitalization within 30 days of the index encounter using the Centers for Medicare and Medicaid (CMS) criteria for identifying planned and unplanned readmissions. [14] LOS was measured as the difference between the discharge date and admission date. All patient data were drawn from the delivery system's electronic data warehouse (EDW).

The primary explanatory variable used as the measure of neighborhood deprivation was a binary comparison at the U.S. Census block group level of patients living in neighborhoods scoring in the top decile (most deprived) versus all other (top decile = 1) using an ADI score initially developed by Singh [5] and adapted for use by the delivery system.[6] The Singh ADI is a normalized composite measure of 17 US Census variables identified using factor analysis and selected for their theoretical relevance and on the basis of empirical research linking U.S. Census variables with mortality. Factor score coefficients were used to weight each of the 17 Census variables comprising the ADI.[5] Patients were associated with an ADI score based upon their most recent reported address of residence. Methods used for cleaning and geo-coding patient self-reported addresses are noted elsewhere.[6]

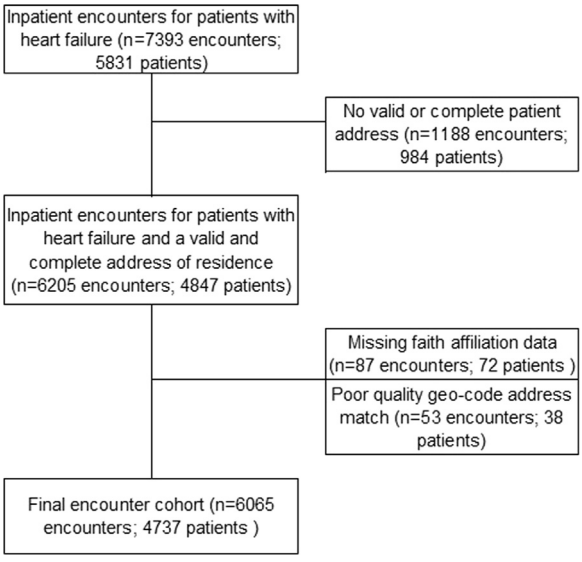


**Fig. 1.** Final encounter study cohort selection.

Other known patient risk factors used for adjustment included patient demographics (age in years, sex, race, ethnicity, marital status), delivery system access (payer type), severity of illness (using the APR-DRG classification [15]), and index length of stay in days.

Urban/rural residency was defined as a binary variable using the urban-rural county classification scheme developed by the Centers for Disease Control based upon the Office of Management and Budget delineation of metropolitan statistical areas. Rural residence included those patients living in micropolitan and non-core counties including a small group of patients (n = 42) that live on the urban fringe.[16] Urban hospitals (11) were identified as those receiving HF patients primarily from predominantly urban areas (serving between 89% and 100% urban patients). Rural hospitals (8) were identified as those receiving HF patients primarily from rural areas (serving between 88% and 100% rural patients).

Patient self-reported faith identification was also introduced as an explanatory variable recorded at the time of admission and was modeled as a binary variable (patient self-reports no faith identification – 0). The delivery system is unaffiliated with any religious institution. Patient self-reported faith identification is captured routinely at the delivery system as part of the admission survey completed by the patient. The purpose for capturing this data is to increase awareness and to promote respect for patient religious customs or practices during the course of care. Individual responses to the faith identification question have not been independently verified. However, the proportion of patients who identify with a faith is consistent with other evidence reported on the general local population.[16]

Descriptive statistical methods were used to characterize the population. Generalized linear models were employed using multiple regression methods, including logistic and negative binomial, to conduct multivariate analysis including effect modifications. To adjust for between-hospital facility level effects, a cluster-robust estimator of variance was used to report standard errors for correlated data. Significance thresholds were set at $\alpha = 0.05$ for the overall comparison and for individual effect modification comparisons. A Bonferroni correction was applied ($\alpha = 0.025$) for combined effect modification tests. Effect modification results were presented consistent with Strengthening the Reporting and Observational Studies in Epidemiology (STROBE) requirements and include measures of both additive and multiplicative effects.[17,18] All analyses were conducted using Stata 13 (StataCorp LP, College Station, TX).

## 3. Results

Baseline patient characteristics of the final study population are noted in Table 1. Mean patient age was 71.8 years (standard deviation: 14.7 years). Observed HF outcome measures overall and by area deprivation status are included in Table 2. Patient-reported faith identification did not vary significantly across urban (80%) and rural (79%) residences. Faith identification was also consistent across neighborhood deprivation levels and consistent with the general population within the service area. Urban residence was associated with area deprivation status (12% urban in top deprivation decile vs 16% in rural areas; $p = 0.004$). No significant variations in healthcare outcomes were noted