Regional Variation in Mortality, Length of Stay, Cost, and Discharge Disposition Among Patients Admitted for Heart Failure in the United States

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The objective of the study was to provide contemporary evidence on regional variation in hospitalization outcomes in patients with heart failure (HF) in the United States. Using the National Inpatient Sample, we compared hospitalization outcomes among primary HF admissions (2013 to 2014) among the 4 Census regions of the United States. Overall, an estimated 1.9 million HF hospitalizations occurred in the United States over the study period. Mortality rate was 3%, the mean length of stay was 5.3 days, the median cost of hospitalization was US$7,248, and the rate of routine home discharge was 51%. There was a significant regional variation for all end points (p <0.001); for example, compared with other regions of the country, the risk-adjusted rate of in-hospital mortality was highest in the Northeast (3.2%) and lowest in the Midwest (2.7%); and within each region, these mortalities were higher in the rural locations (range: 3.0% to 3.8%) than in the urban locations (range: 2.7% to 3.1%). In addition, the Northeast region had the longest length of stay (mean: 5.9 days) and the lowest risk-adjusted rate of routine home discharge (42%). However, the cost of hospitalization was highest in the West (median: US$8,898) and lowest in the South (US$6,366). A similar pattern of variation was found in subgroup analysis except that the risk-adjusted rate of in-hospital mortality was highest in the West among patients <65 years (1.7% vs 1.2% [lowest] in the Midwest), male gender (3.2% vs 2.8% in the Midwest), and rural location (3.8% vs 3% in the Midwest). In conclusion, HF hospitalization outcomes tend to be worse in the Northeast compared with other regions of the country. In addition, the in-hospital mortality rate was higher in rural locations than in urban locations. **(Am J Cardiol 2017;120:817–824)**

Heart failure (HF) constitutes a significant health burden as one of the leading causes of hospital admission in the United States.[1–3] Although accumulating evidence suggests a regional variation in health-care practices and expenditures,[4–7] there is a lack of information on how these translate to hospitalization outcomes in patients with HF. There was a suggestion of geographical variation in 30-day and 1-year mortalities in hospitalized patients with HF aged ≥65 years in 2008 in the United States.[8,9] However, the trends in HF hospitalization outcomes have been changing over time, thereby necessitating an updated analysis of contemporary data to inform the current view of regional differences in HF hospitalization outcomes.[10–12] Understanding the regional variations in hospitalization outcomes as well as the determinants of this variation provides a potential opportunity for policy makers and health-care givers to improve quality of care and outcomes in patients with HF. We therefore sought out to provide an in-depth analysis of the regional variation in HF hospitalization outcomes using a nationally representative database.

Methods

This study was conducted using the National Inpatient Sample (NIS) of the Healthcare Utilization Project sponsored by the Agency for Healthcare Research and Quality (AHRQ). Details of the design and description of the NIS are available online.[13] Briefly, this nationally representative database, which represents the largest all-payer inpatient care database in the United States, contains encounter-level information of hospital stays compiled in a uniform format with a privacy protection of individual patients. Each year, over 7 million hospital stays are sampled nationwide, which, when weighted, estimates more than 35 million hospitalizations annually. NIS therefore approximates a 20% stratified sample of discharges from US nonfederal hospitals, excluding rehabilitation and long-term acute care hospitals.

The patient population evaluated in this study includes all adult patients (age ≥18 years) with a primary diagnosis of

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HF in the NIS database in 2008 to 2014. These were identified through the following International Classification of Diseases-Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis codes as recommended by the American College of Cardiology/American Heart Association Task Force on Performance Measures: 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, and 428.[14] HF was classified as a primary diagnosis if any of the codes appear as the first diagnosis in the NIS database.

Data on patient- and hospital-level characteristics were provided for each patient in the NIS. However, identity variables were not included to preserve both patient and hospital privacies. Patient-level factors, including demographics, diagnoses, co-morbidities, in-hospital procedures, cost of hospitalization, length of stay, disposition, and so on, as well as hospital-level factors, including bed size, location (i.e., rural vs urban), geographical region, and so on, were available through the NIS database. Cost information was obtained from the hospital accounting reports collected by the Centers for Medicare and Medicaid Services.

For the purpose of this study, geographical region was classified based on Census region as defined by the US Census Bureau, namely, Northeast, Midwest, West, and South. This information was obtained by AHRQ for each hospital from the American Heart Association Annual Survey of Hospitals. The main end points in this study were the risk-adjusted rates of in-hospital mortality in patients with a primary diagnosis of HF. In-hospital mortality was available in the NIS data as a categorical variable (Y/N). In addition, we evaluated the variations in the length of stay, the cost of hospitalization, and the disposition of patients who survived to hospital discharge as secondary outcomes. Disposition was classified into routine home discharge vs others (including home with home health care, transfer to a short-term hospital, and transfer to an extended care facility [i.e., skilled nursing facility and intermediate care facility]).

National estimates, including sum, rate, average, proportion, and their standard error or deviation, were calculated using the hospital-level trend weights provided for the NIS by AHRQ. Risk-adjusted rates of in-hospital mortality as well as routine home discharge were calculated by first fitting logistic regression models that adjusted for patient-level covariates, including age, race, gender, median household income, type of insurance, Elixhauser co-morbidity index, and weekend vs weekday admission, as well as hospital-level covariates, including hospital bed size, hospital location or teaching status, and year of data collection. Standard errors were clustered at the hospital level to account for the potential correlation of observations within the same hospital. Thereafter, risk-adjusted rates were calculated using the marginal standardization form of predictive margins.[15] To assess the potential progress made with respect to in-hospital mortality in the last few years, we initially assessed the trend in risk-adjusted in-hospital mortality within each region from 2008 to 2014. Subsequent analyses of regional variation were, however, restricted to the last 2 years of NIS that are available at this time (i.e., 2013 and 2014) to provide a more contemporary assessment of the regional variation in outcomes. We quantified co-morbidity burden per hospitalization using the Elixhauser co-morbidity index.[16] Patient- and hospital-level characteristics were compared among the regions using chi-square test for categorical variables, analysis of variance for normally distributed continuous variables, and the Kruskal-Wallis test for continuous variables with skewed distribution. Given the nested observations in the NIS database, we used the mixed-effect logistic model to assess for differences in in-hospital mortality between regions. This model enabled us to account for the potential correlation of observations within each hospital. As patient-level factors are nested within hospital-level factors, we built a hierarchical model with a unique hospital identification number as a random effect in the model. Patient- and hospital-level covariates as well as the year of data collection (as previously mentioned) were adjusted for in a multivariable analysis. Similarly, the regional variation in the dispositions of the patients (i.e., rates of routine home discharge) was evaluated through a mixed-effect logistic model, whereas the length of stay and the cost of hospitalization were evaluated through a linear mixed model. Lastly, a subgroup analysis within the categories of age (<65 and ≥65 years), gender, and location (i.e., rural vs urban) was considered for each end point. All analyses were performed using STATA 14 (StataCorp, College Station, Texas), with a 2-tailed level of significance set at 0.05.

Results

An estimated 1.9 million HF hospitalizations occurred in the United States in 2013 to 2014 in patients aged ≥18 years. Most of the hospitalizations were from the South (41%), followed by the Midwest (23%), the Northeast (20%), and the West (16%). Patient- and hospital-level characteristics tended to vary among the 4 regions (Table 1). For example, the mean age at hospitalization was highest in the Northeast (75 years) and lowest in the South (71 years). Hospitalization was predominant in whites in each region but was most pronounced in whites in the Midwest (75%) compared with the other regions. In contrast, hospitalization for blacks was most pronounced in the South (26%), whereas hospitalization for Hispanics and Asians was most pronounced in the West (17% and 7.9%, respectively). Also, there existed regional variations in co-morbidities at admission (Table 2). Notably, cardiovascular co-morbidities, including acute myocardial infarction, cardiac dysrhythmia, and valvular heart disease, were more common in the Northeast, whereas coronary atherosclerosis and hypertension were more common in the Midwest. As regards respiratory complications, pulmonary circulation disorder, chronic obstructive pulmonary disease, pneumonia, and asthma were more common in the Northeast, Midwest, South, and West, respectively.

When we evaluated the trend in risk-adjusted in-hospital mortality within each region from 2008 to 2014, in-hospital mortality was persistently highest in the Northeast except in 2008, when it was highest in the West (Figure 1). There were declining trends in all 4 regions from 2008 to 2014, although some crossing over in the trends occurred during the study period. Notably, in-hospital mortality in the West was highest in 2008 but decreased faster than that in other regions of the country during the early part of the trend analysis to become the lowest in 2011 and 2012. Thereafter, there was a spike in in-hospital mortality in this region and it again became the second highest in the last 2 years (2013 and 2014). Compared with 2008, the relative change in the rate of