Comparison of Length of Stay, 30-Day Mortality, and 30-Day Readmission Rates in Medicare Patients With Heart Failure and With Reduced Versus Preserved Ejection Fraction

Matthew Shane Loop, PhD[a,*], Melissa K. Van Dyke, PhD[b], Ligong Chen, PhD[a], Todd M. Brown, MD, MSPH[c], Raegan W. Durant, MD, MPH[d], Monika M. Safford, MD[e], and Emily B. Levitan, ScD[a]

Length of stay (LOS), 30-day mortality, and 30-day readmission rates have not been compared between Medicare beneficiaries with heart failure (HF) with reduced ejection fraction (HFrEF) and beneficiaries with heart failure with preserved ejection fraction (HFpEF), although HFpEF is common in patients with HF. To determine whether type of HF (HFrEF or HFpEF) was associated with LOS, 30-day mortality, and 30-day readmission, we used a cohort of 19,477 Medicare beneficiaries admitted to the hospital and discharged alive with a primary discharge diagnosis of HF between 2007 and 2011. Gamma regression, Poisson regression, and Cox proportional hazards with a competing risk for death were used to model LOS, 30-day mortality, and 30-day readmission rate, respectively. All models were adjusted for HF severity, co-morbidities, demographics, nursing home residence, and calendar year of admission. Beneficiaries with HFpEF had an LOS 0.02 days shorter than beneficiaries with HFrEF and a nearly identical 30-day readmission rate. Thirty-day mortality was 10% lower in beneficiaries with HFpEF versus HFrEF. In conclusion, readmission rates were as high in those with HFpEF as they are in those with HFrEF, with comparable LOS in the hospital. **(Am J Cardiol 2016;■:■−■)**

Although patients with heart failure (HF) with preserved ejection fraction (HFpEF) make up half of HF hospitalizations,[1] treatment is limited.[2] In contrast, several therapeutic treatment strategies that reduce mortality and rehospitalizations exist for patients with HF with reduced ejection fraction (HFrEF).[2] Length of stay (LOS), 30-day mortality, and 30-day readmission are important outcomes for beneficiaries and can affect rates at which Medicare reimburses providers. Previous studies comparing outcomes between patients with HFrEF versus HFpEF have been restricted to patients admitted to hospitals participating in registries with no adjustment for potential confounders[3,4] or those participating in regional Healthcare Maintenance Organizations.[5] Recent increases in the use of *International Classification of Diseases, Ninth Revision*, codes that specify HF type allow the investigation of differences in LOS, 30-day mortality, and 30-day readmission rates between those with HFrEF and HFpEF among Medicare beneficiaries.

Methods

Our study sample consisted of Medicare beneficiaries in a 5% national random sample who (1) had an inpatient claim for an overnight hospital stay with a primary discharge *International Classification of Diseases, Ninth Revision,* code for HF between 2007 and 2011; (2) lived in the United States for at least 1 year before index claim admission date; (3) had continuous fee-for-service coverage for inpatient, outpatient, and pharmacy services for at least 1 year before index claim admission date (Medicare parts A, B, and D coverage); (4) were <110 years old on the index claim admission date; and (5) were discharged alive. Follow-up data for this study were available through December 31, 2011. Heart failure type was determined to be either HFpEF (428.30 diastolic HF, unspecified; 428.31 diastolic HF, acute; 428.32 diastolic HF, chronic; and 428.33 diastolic HF, acute or chronic) or HFrEF (428.20 systolic HF, unspecified; 428.21 systolic HF, acute; 428.22 systolic HF, chronic; 428.23 systolic HF, acute or chronic; 428.40 combined systolic and diastolic HF, unspecified; 428.41 combined systolic and diastolic HF, acute; 428.42 combined systolic and diastolic HF, chronic; and 428.23 combined systolic and diastolic HF, acute or chronic). In a

[a]Department of Epidemiology, School of Public Health and [c]Division of Cardiovascular Disease and [d]Division of Preventive Medicine, School of Medicine, University of Alabama at Birmingham, Birmingham, Alabama; [b]Center for Observational Research, Amgen Inc., Thousand Oaks, California; and [e]Division of General Internal Medicine, Weill Department of Medicine, Weill Cornell Medical College, New York, New York. Manuscript received January 21, 2016; revised manuscript received and accepted April 11, 2016.

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See page 6 for disclosure information.

*Corresponding author: Tel: (205) 934-5304; fax: (205) 975-3329.

E-mail address: loop2@uab.edu (M.S. Loop).

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validation study of Medicare beneficiaries, 77% of beneficiaries with an *International Classification of Diseases, Ninth Revision*, code for systolic HF (428.2x or 428.4x) had an EF <45% based on medical record review.[6]

Hospital admissions that occurred on the day of a hospital discharge, or the day after hospital discharge with a hospital transfer code, were considered as 1 episode of care. Only the first HF hospitalization for each beneficiary was used to determine study eligibility. This hospitalization was not necessarily the beneficiary's first episode of HF treatment. Only hospitalizations that documented whether the HF was systolic, diastolic, or both (428.2x, 428.3x, and 428.4x) were included.

LOS was defined as the difference between the first day after discharge and admission date. Thirty-day mortality was determined by whether death by any cause occurred within 30 days of hospital discharge. Thirty-day hospital readmission was determined by whether hospitalization for any cause occurred within 30 days of hospital discharge.

Beneficiary characteristics were assessed using the beneficiary summary files, inpatient claims, and outpatient claims. Several potential confounders of the relation between HF type (HFrEF vs HFpEF) and LOS, 30-day mortality, and 30-day readmission were included as covariates in the statistical models. An intensive care unit stay during hospitalization served as an indicator of disease severity. Therapies for HF included β-blocker use, angiotensin-converting enzyme inhibitor use, loop diuretics use, and treatment by implanted cardiac devices (cardiac resynchronization therapy−defibrillator, cardiac resynchronization therapy−pacemaker, defibrillator, pacemaker, or no device), determined by claims in the year before admission. Indicators of co-morbidity burden based on claims in the year before admission were hypertension, chronic kidney disease, stroke, coronary heart disease, malnutrition, diabetes, atrial fibrillation, anemia, chronic obstructive pulmonary disease, and the Charlson co-morbidity index (0, 1 to 3, or ≥4). Age (years), race (black, white, or other), gender, and US Census region of residence (East North Central, East South Central, Middle Atlantic, Mountain, New England, Pacific, South Atlantic, West North Central, and West South Central) were included as demographic variables. Claims indicating nursing home residence during the year before admission were used as an indicator of frailty, as described previously.[7] Calendar year of admission was also included in the models.

Summary statistics were calculated for potential confounders and for LOS (median [interquartile range]), 30-day mortality, and 30-day readmission for the total sample and by HF type (HFrEF or HFpEF). We estimated the cumulative incidence functions for 30-day mortality and 30-day readmission by HF type. LOS was modeled using a gamma distribution with a log-link function, following the precedence set by a previous study.[8] We used Poisson regression with a log-link function and robust standard errors to calculate risk ratios for 30-day mortality because the algorithm for performing binomial regression with a log-link function did not converge. We used a Fine-Gray model to estimate the risk ratios of 30-day readmission, while accounting for the competing risk of death,[9] which took into account that some beneficiaries died before we could observe their readmission. All model parameter estimates for HF type were adjusted for all potential confounders described earlier. Likelihood ratio tests or score tests were used to determine the statistical significance of variables with multiple categories, with a type 1 error rate of 0.05. Forest plots of the parameter estimates and 95% confidence intervals for all model variables were created for each of the LOS, 30-day mortality, and 30-day hospital readmission models. All statistical analyses were performed using SAS 9.4 (Cary, North Carolina). Plot creation was performed in R v. 3.1.3[10] using the dyplyr[11] and ggplot2[12] packages in the RStudio Integrated Development Environment.[13]

This study was determined not to be Human Subjects Research by the Institutional Review Board at the University of Alabama at Birmingham. The Centers for Medicare and Medicaid Services Privacy Board approved this study.

Results

We initially identified 76,555 HF hospitalization episodes that met the inclusion criteria. After excluding HF rehospitalizations (30,971) and hospitalizations with an undocumented type of HF (26,107), we included a cohort of 19,477 beneficiaries for the current analysis (see Supplementary Figure 1). Table 1 provides summary statistics for LOS, 30-day mortality, 30-day readmission, and model covariates for the total cohort and by HF type. Beneficiaries with a diagnosis of HFpEF were slightly older, more likely to be female, hypertensive, anemic, have chronic obstructive pulmonary disease, and be living in a nursing home than beneficiaries with a diagnosis of HFrEF. Beneficiaries with a diagnosis of HFpEF were less likely to have been taking a β-blocker or angiotensin-converting enzyme inhibitor, less likely to have a defibrillator (with or without cardiac resynchronization), and were less likely to have had coronary heart disease than beneficiaries with a diagnosis of HFrEF. Based on univariate comparisons, median LOS did not appear to be different between those with HFpEF and those with HFrEF. Crude 30-day mortality and readmission rates were similar between beneficiaries with HFpEF and beneficiaries with HFrEF. There were fewer hospitalizations in 2007 compared with later years because of the increasing trend in use of *International Classification of Diseases, Ninth Revision,* codes that specified HF type since 2008. Figure 1 shows a histogram of LOS by HF type for those with LOS <30 days, and Figure 2 shows the cumulative incidence functions for 30-day mortality and 30-day readmission by HF type.

Figure 3 shows the ratio of LOS for those with HFpEF compared with those with HFrEF and also the ratios of LOS for each other covariate. Important covariates in the model for LOS were intensive care unit stay, malnutrition, and chronic kidney disease.

Figure 4 shows the risk ratios for 30-day mortality for those with HFpEF compared with those with HFrEF and also the risk ratios for 30-day mortality for each covariate. Important covariates for 30-day mortality were intensive care unit stay, hypertension, chronic kidney disease, malnutrition, chronic obstructive pulmonary disease, age, and gender.