Brief Report

# Accuracy of Administrative Coding to Identify Reduced and Preserved Left Ventricular Ejection Fraction

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**ABSTRACT**

**Background:** Coding of systolic function in heart failure is important, but the accuracy is uncertain.
**Methods and Results:** We used data from a chart review of VA heart failure hospitalizations from 2006 to 2013. Trained abstractors determined the documented diagnosis of heart failure and the left ventricular ejection fraction (LVEF). We compared this LVEF with the primary and secondary International Classification of Disease, 9th edition, codes for heart failure for the same hospitalization. Among 43,044 hospitalizations for heart failure, the primary discharge diagnosis was coded as systolic heart failure in 18%, diastolic heart failure in 17%, and other heart failure codes in 65%. For an LVEF <40%, a systolic heart failure code had a sensitivity of 29% and a positive predictive value of 76%. The code for systolic heart failure was used more frequently over time, with sensitivity increasing from 16% to 37% but at the expense of the positive predictive value, which decreased from 80% to 74%. The overall area under the receiver operating characteristic curve for the relationship between LVEF and the systolic heart failure code was 0.71. Using LVEF >50% to define diastolic heart failure led to a sensitivity of 29% for a diastolic heart failure code, with a positive predictive value of 78%. In multivariate analysis, a systolic heart failure code had an odds ratio for 1-year mortality of 1.1 (95% confidence interval 1.03−1.17) compared to not having a systolic heart failure code.
**Conclusions:** Coding for systolic and diastolic heart failure is associated with LVEF, but the accuracy is too poor to substitute for the documented LVEF in performance measurement. (*J Cardiac Fail 2019;25:486−489*)
**Key Words:** Heart failure, ejection fraction, coding, mortality, sensitivity.

Identification of low left ventricular ejection fraction (systolic) heart failure is important for quantifying risk and providing evidence-based management.[1] Patients with systolic heart failure (typically left ventricular ejection fraction [LVEF] <40%) are known to benefit from several life-prolonging therapies.[2] Administrative codes exist for systolic and diastolic heart failure. Although there is a relationship between these codes and the LVEF,[3] the accuracy of coding for LVEF is uncertain. If accurate, codes could be used to screen clinical databases to identify patients with systolic heart failure who may be undertreated, and at the same time estimate the quality of heart failure care provided. However, if accuracy of codes is poor, using them to identify patients may waste resources, and if used as a measure of performance would give a false estimate of the quality of care provided.

## Methods

### Patient Population

We used data from 114 Veterans Affairs hospitals that underwent an annual chart review of heart failure hospitalizations from 2006 to 2013 (external peer review program). Trained abstractors confirmed that heart failure was the documented reason for admission (principal discharge

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diagnosis) and recorded any documented LVEF. We compared this abstracted LVEF to the International Classification of Disease, 9th edition (ICD-9), codes (primary and secondary) for heart failure for the same hospitalization. Heart failure can be specified as systolic (428.2x), diastolic (428.3x), or both (428.4x). The abstractors were instructed to take the numeric LVEF closest to discharge (regardless of modality) if more than 1 was present. These LVEFs had to be documented by the physician. If a range was provided, the midpoint was used.

### Statistics

Sensitivity and positive predictive value were calculated for different thresholds of LVEF. Pearson chi-square tests were used to evaluate categoric variables and *t* tests to evaluate continuous variables. In separate linear regression models we evaluated the relationship between the dependent variables of sensitivity and positive predictive value for low and preserved LVEF with independent variables of patient characteristics, including demographics (age, sex, race, year of admission), comorbid diagnoses in the preceding 2 years (hypertension, diabetes, ischemic heart disease, malignancy, cerebrovascular disease, chronic obstructive pulmonary disease), region of the country, laboratory findings (creatinine, B-type natriuretic peptide [BNP], hemoglobin, sodium), and use of medications at baseline (angiotensin-converting enzyme inhibitor, angiotensin receptor blocker, beta-blocker). We also controlled for academic status of the hospital according to Council of Teaching Hospital (COTH) membership.

We determined the association between a heart failure code and 1-year mortality with the use of a logistic regression model that included both systolic and diastolic codes, patient characteristics (listed above), and hospital data (COTH membership). The hospital was treated as a random variable. We then added LVEF and repeated the analysis to determine if this explained any association between LV function codes and mortality.

A 2-sided P value of <.05 was considered to be statistically significant. All analyses were conducted with the use of SAS 9.2 (Cary, North Carolina).

### Ethical Approval

The research was approved by the Human Subjects' Research Committee of the Stanford University School of Medicine.

## Results

This study included 43,044 hospitalized patients with a primary diagnosis of heart failure from 2006 to 2013. Characteristics of the study population are presented in Table 1. The mean (±SD) age of the patients was 73 ± 12 years, 98% were male, and 65% were white. The mean LVEF was 40 ± 17%, the mean Charlson comorbidity score was 4.5 ± 2.2. Among 30,217 with a BNP value during admission, the mean value was 1,733 ± 4,639 pg/mL.

**Table 1.** Patient Characteristics by Left Ventricular Ejection Fraction group

| Characteristic | LVEF <40% | LVEF ≥40% | *P* Value |
|---|---|---|---|
| Age (y) | 71 ± 12 | 74 ± 11 | <.001 |
| Female | 1.4 | 2.2 | <.001 |
| Race | | | <.001 |
| Asian | 0.5 | 0.5 | |
| Black | 24 | 17 | |
| Hispanic | 5.8 | 5.5 | |
| Native American | 1.0 | 0.8 | |
| Pacific Islander | 2.0 | 2.3 | |
| White | 64 | 71 | |
| Missing | 3 | 2 | |
| Diabetes | 52 | 60 | <.001 |
| Ischemic HD | 77 | 69 | <.001 |
| Hypertension | 92 | 96 | <.001 |
| Malignancy | 16 | 19 | <.001 |
| Renal disease | 44 | 50 | <.001 |
| COPD | 47 | 56 | <.001 |
| LVEF (%) | 25 ± 8 | 54 ± 9 | <.001 |
| BNP group | | | <.001 |
| <100 pg/mL | 2 | 7 | |
| 100–499 pg/mL | 17 | 35 | |
| 500–749 pg/mL | 12 | 15 | |
| 750–999 pg/mL | 11 | 10 | |
| 1000–4999 pg/mL | 53 | 29 | |
| > = 5000 pg/mL | 5 | 3 | |

Values are presented as mean ± SD or %. LVEF, left ventricular ejection fraction; HD, heart disease; COPD, chronic obstructive lung disease; BNP, B-type natriuretic peptide.

Among this cohort with physician-documented heart failure, systolic heart failure alone was coded in 7,871 (18%), diastolic heart failure alone coded in 7,259 (17%), both diastolic and systolic were used in 37 (0.1%), and unspecified other heart failure codes in 27,877 (65%).

### Systolic Heart Failure

Among the 20,603 patients (47.9%) with LVEF <40%, 5,993 had a systolic heart failure code, for a sensitivity (true positive rate) of 29%. The positive predictive value of a systolic heart failure code (for LVEF <40%) was 76%. The sensitivity and positive predictive value of a systolic HF code for different LVEF thresholds are shown in Fig. 1. The overall area under the receiver operating characteristic curve for the relationship between LVEF and the systolic heart failure code was 0.71.

### Diastolic Heart Failure

Fig. 2 shows the accuracy of a diastolic heart failure code for different LVEF thresholds. Among patients with LVEF >50%, 29% were coded as diastolic heart failure. Among those coded as diastolic heart failure, 78% had an LVEF >50%.

### Time Trends

Coding sensitivity and positive predictive value changed over time from 2009 to 2013 (Fig. 3). Use of codes specific to LV function increased over time for systolic (10%–23%) and

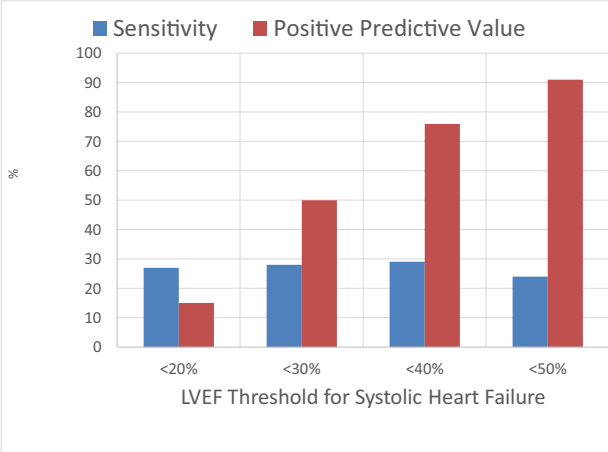


**Fig. 1.** Sensitivity and positive predictive value of a systolic heart failure code for different LVEF thresholds.

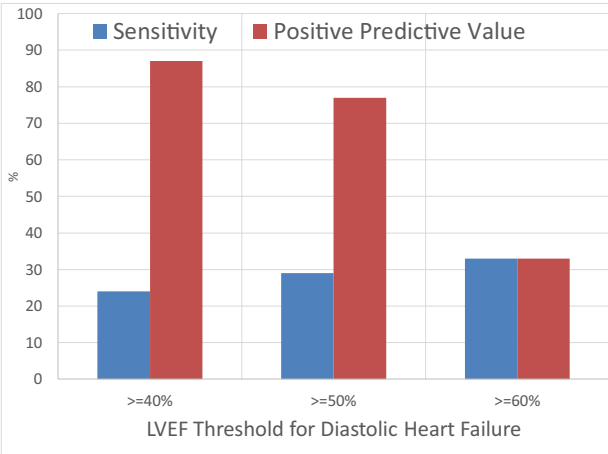


**Fig. 2.** Sensitivity and positive predictive value of a diastolic heart failure code for different LVEF thresholds.

diastolic HF (10%−19%). The sensitivity of a systolic HF code improved (16% to 37%; $P < .001$), but the positive predictive value has worsened (80 to 74%; $P < .001$). In contrast, the coding for diastolic heart failure improved for both sensitivity (20% to 38%) and positive predictive value (70% to 80%; $P < .001$).

When the hospitals were analyzed individually, the use of the systolic heart failure code ranged markedly from <1% to 56% of hospitalizations. The interquartile range for sensitivity was 8%−36% with a range of 0%−81%. Sensitivity of the systolic heart failure code was higher for COTH hospitals (32% vs 20%; $P < .001$) although the positive predictive value of a low LVEF code was slightly lower (75% vs 77%; $P = .04$).

### Mortality

Unadjusted all-cause mortality at 1 year was 26% (5,366/20,603) if the LVEF was <40% compared with 23.4% (5,251/22,441) if the LVEF was ≥40% ($P < .001$)

In multivariate analysis that did not include LVEF, a systolic heart failure code was associated with increased 1-year all-cause mortality (adjusted odds ratio [aOR] 1.10, 95% confidence interval [CI] 1.04−1.17, compared with neither systolic or diastolic code), whereas a diastolic heart failure code was associated with lower 1-year mortality (aOR 0.86, 95% CI 0.81−0.92). After adjustment for LVEF, the prognostic values of the codes for 1-year mortality were attenuated and no longer significant: systolic heart failure code: aOR 1.02, 95% CI 0.96−1.09; diastolic heart failure code: aOR 0.96, 95% CI 0.89−1.03.

## Discussion

Administrative data are increasingly used to measure quality of care. In the case of heart failure, the American

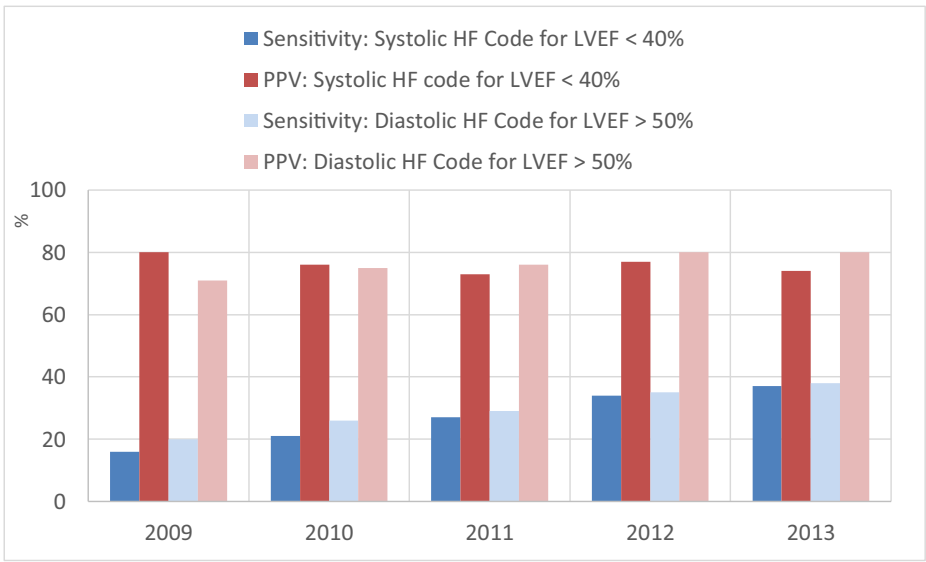


**Fig. 3.** Trends over time for systolic and diastolic heart failure coding accuracy (criterion standard: LVEF <40% for systolic dysfunction, LVEF >50% for diastolic dysfunction; $P < .001$ for all trends). Sensitivity and positive predictive value (PPV) are shown. LVEF, left ventricular ejection fraction.

College of Cardiology, American Heart Association, and Heart Failure Society of America have defined performance measures for treatment.[1] Most of these measures are limited to patients with an LVEF <40%. The ICD-9 (and now ICD-10) coding system can be used to specify systolic function.[3] The validity of such quality measurement with the use of administrative data depends on the accuracy of coding, and our study demonstrates that the current accuracy for determining systolic dysfunction for heart failure is limited. The coding of systolic function, even if not ready for measuring quality of care, may still be useful in research settings. For example, the administrative data can be used to screen for potential clinical trial participants.

Previous studies have found limited positive predictive value of heart failure diagnostic codes[4–8] unless the codes are the primary discharge diagnosis.[9] A high positive predictive value is important if the goal is accountability, such as for public reporting or pay-for-performance. Unfortunately, we found a positive predictive value of only 75% for LVEF <40%. Thus, using coding to determine performance could falsely label 25% of heart failure providers as providing poor care.

There is hope that eventually, coding can be useful for measuring quality. The use of LVEF-related codes are increasing, and accuracy may also be improving. Furthermore, some VA hospitals demonstrated high accuracy in the use of the codes. Although our study did not determine why these few hospitals were more accurate than others, this finding suggests that best practices exist and have the potential to be spread. Our finding of a large variation in coding accuracy suggests that coding from a particular hospital can not be assumed to have the same coding accuracy as the national average.

## Study Limitations

This study included those with known heart failure at discharge as determined by chart review. Thus, it is applicable to those patients hospitalized with heart failure. If one were to include patients without suspected heart failure it is likely that a few would be coded as systolic or diastolic heart failure, further lowering the positive predictive value. We examined principle diagnoses of heart failure, and accuracy may differ for those where heart failure is not the primary diagnosis. Finally, the study was conducted in the VA health system, whose patients are predominately male, and where most reimbursement is not based on diagnosis-related group (DRG) coding. Therefore, the motivation to accurately code may be lower than in non-VA settings.

In summary, coding for systolic and diastolic heart failure is associated with LVEF, but the accuracy is limited and likely too poor to substitute for the documented LVEF in performance measurement.

## Disclosures

None.

## Supplementary materials

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.cardfail.2019.01.019.

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