

## Research Letter

### Changing Heart Failure Coding Practices and Hospital Risk-Standardized Mortality Rates

#### Introduction

As the most common reason for hospitalization among the elderly, admissions for acute heart failure (HF) are a frequent target for quality measurement and improvement activities. Large scale performance improvement initiatives such as the Centers for Medicare and Medicaid Services (CMS) Value Based Purchasing program use hospital HF mortality measures to determine hospital reimbursement rates.<sup>1,2</sup> To identify patients with a hospitalization for HF, programs use *International Classification of Diseases 9<sup>th</sup> or 10<sup>th</sup> Edition* codes limited to the principal diagnosis position.

However, studies in other conditions suggest that there may be limitations to an approach that focuses only on a principal diagnosis to identify hospitalizations tracked for performance measurement. For example, diagnostic coding in pneumonia gradually shifted more severe conditions (e.g., sepsis) that were not targeted for outcome measurement into the principal diagnosis position in place of pneumonia. Hospitals that were more likely to shift the most severely ill patients with pneumonia out of performance surveillance (e.g., by using a principal diagnosis of sepsis) showed lower risk adjusted mortality rates than hospitals that were more likely to code pneumonia as a principal diagnosis, biasing hospital pneumonia mortality performance measures.<sup>3–5</sup>

Although hospitalizations for acute HF may plausibly also be coded with alternative principal diagnoses (e.g., acute respiratory failure), it is unknown whether the kind of coding trends observed in pneumonia have carried over to HF, or whether shifts to alternative principal diagnoses have biased estimates of HF outcome performance measures. Among patients hospitalized for acute HF, we evaluated trends in the position of HF diagnosis codes and the association between use of alternative principal diagnosis codes and risk-standardized HF mortality rates.

#### Methods and Results

##### Data source

We used de-identified, administrative claims data from Premier, Inc., a hospital benchmarking database, using hospitalizations from years 2006–2014. Premier data represent

a non-random, approximate 20% sample of hospitalizations in the United States, and include hospital characteristics, patient demographics, *International Classification of Diseases, 9<sup>th</sup> Edition, Clinical Modification (ICD-9-CM)* codes for diagnoses and procedures, and patient hospital discharge status (i.e., hospital mortality). Characteristics of Premier hospitals are similar to American Hospital Association hospitals, with the exception of relatively more small hospitals and more Southern hospitals within Premier data.

##### Heart Failure Cohorts

HF hospitalizations were identified using two methods. First, we replicated CMS algorithms used to create a cohort of heart failure hospitalizations for inclusion in performance measurement by searching the principal diagnosis position for CMS HF *ICD-9-CM* codes (principal diagnosis HF).<sup>6</sup> Second, we identified the most common principal diagnoses associated with hospitalizations with a secondary diagnosis *ICD-9-CM* code specifying acute HF (*ICD-9-CM* 428.21, 428.23, 428.31, 428.33, 428.41, 428.43) that was not already included in other performance measures (i.e., not pneumonia or myocardial infarction): acute respiratory failure (ARF, *ICD-9-CM* 518.81). We then created a second, alternative cohort of acute HF hospitalizations identified through a secondary diagnosis of acute HF with a principal diagnosis of acute respiratory failure (HF with principal diagnosis ARF). All cohorts excluded patients who were under age 18, transferred from another hospital, were admitted to hospitals with fewer than 25 annual HF hospitalizations, or had unrecorded gender or vital status.<sup>6</sup>

##### Statistical Analysis

In order to evaluate secular trends in HF coding practices, we evaluated the proportion of all HF cases identified with either a principal diagnosis of HF or as HF with principal diagnosis ARF each year. In order to identify effects of HF coding practice on performance measurement, we calculated risk-standardized HF hospital mortality rates (RSMR) for each hospital for years 2006–2014, and Spearman coefficients for correlations between RSMR and the percentage of HF hospitalizations with principal diagnosis HF. RSMRs were calculated as previously described using multivariable-adjusted hierarchical logistic regression models (SAS proc GLIMMIX).<sup>6–8</sup> All models included patient age, sex, and 26 Elixhauser comorbid conditions present on hospital admission,<sup>9,10</sup> with a random intercept calculated for each

hospital. We used joinpoint models to assess and compare trends in hospital mortality over time for different coding strategies.<sup>11</sup> SAS version 9.4 (Cary, NC, USA) and Joinpoint 4.6 (Statistical Research and Applications Branch, National Cancer Institute) were used for all statistical analyses. Study procedures were deemed not to be human subjects research by the Institutional Review Board of Baystate Medical Center.

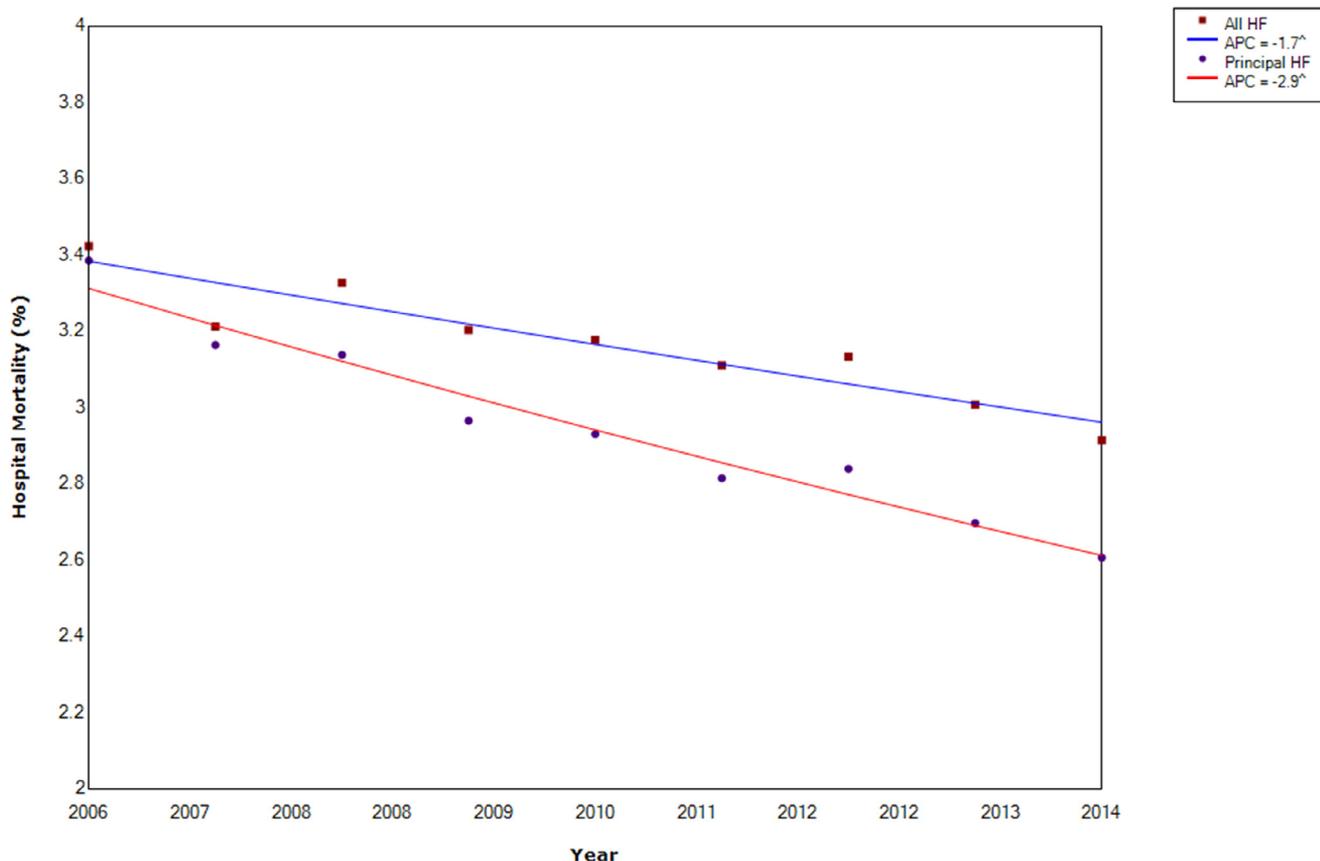
### Results

We identified 1,368,816 hospitalizations for acute HF across 646 hospitals during the years 2006-2014, including 1,336,395 (97.6%) hospitalizations with a HF code in the principal diagnosis position and 32,421 (2.4%) identified with a principal diagnosis ARF and a secondary diagnosis of HF. The rate of HF hospitalizations with a principal diagnosis of ARF increased 8.5-fold over time, from 0.4% of all acute HF hospitalizations in 2006 to 3.4% in 2014. Compared to patients with a principal diagnosis of heart failure, those coded with a principal diagnosis of ARF and secondary diagnosis of HF were younger, more likely to be female, had more comorbidities, were more likely to require mechanical ventilator support, were more likely to have

acute respiratory failure present on admission (see data from 2014 in Supplementary Table), and had higher hospital mortality rates (11.7% vs 2.6%  $p < 0.001$ ). **Figure 1** shows the trends in hospital mortality for hospitalizations identified by a principal diagnosis of HF (annual % change: -2.9% [95% CI -2.4, -3.4%]) and HF hospitalizations identified by a principal diagnosis of HF or ARF (annual % change: -1.7% [95% CI -1.1, -2.2%]),  $p = 0.01$  for difference in estimated annual % change in mortality based upon the method used to identify HF hospitalization. Hospital HF RSMR did not strongly correlate with proportion of HF hospitalizations with a principal diagnosis of HF (N = 359, Spearman rho = 0.09,  $p = 0.09$  in 2006; N = 530, Spearman rho = 0.05,  $p = 0.24$  in 2014). Similarly, changes in hospital rates of heart failure hospitalizations defined by a principal diagnosis of heart failure did not correlate with changes in hospital RSMR from 2006 to 2014 (N = 276 hospitals, Spearman rho = 0.04,  $p = 0.47$ ).

### Discussion

We identified secular trends in acute HF claims that increasingly shifted HF out of the principal diagnosis position in favor of ARF codes as the principal diagnosis for



^ Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level. Final Selected Model: All HF - 0 Joinpoints, Principal HF - 0 Joinpoints. Rejected Parallelism.

**Figure 1.** Trends in heart failure mortality 2006-2014. Trends in heart failure mortality differed when heart failure hospitalizations were identified by principal diagnosis codes alone (“Principal HF”, red line), as compared with heart failure hospitalizations identified by either a principal diagnosis of HF or a principal diagnosis of acute respiratory failure with a secondary diagnosis of acute heart failure (“All HF”, blue line),  $p = 0.01$ .

more severely ill patients with HF. Patients with acute HF and a principal diagnosis of ARF had nearly five times higher hospital mortality rates than patients with a principal diagnosis of HF. Our results suggest that studies and performance measures that do not account for shifting coding practices may underestimate HF mortality rates and mischaracterize temporal trends in HF mortality.

We did not find evidence that hospitals coding a larger proportion of HF admissions as ARF (and shifting more severe patients out of surveillance) had lower HF RSMR. Our findings of poor correlation between RSMR and hospital HF diagnosis coding practices are likely explained by the low absolute percentage of HF hospitalizations (i.e., 3.4% in 2014) shifted into secondary diagnoses. Conditions such as pneumonia – which have previously been found susceptible to changing hospital RSMR through shifts in the position of diagnostic coding – had more than 30% of hospitalizations identified through alternative principal diagnoses.<sup>4</sup> Whereas pneumonia performance measures now seek to mitigate bias through expansion of the cohort definitions to allow alternative principal diagnoses such as sepsis and aspiration pneumonia, our findings suggest that expanding HF cohorts to include alternative principal diagnoses are unlikely to significantly alter RSMR at the present time. However, the increasing use of principal diagnoses such as ARF among patients with acute HF raises concerns that future measures may be affected by secular trends in coding and warrant surveillance for shifting coding trends in HF among stakeholders in performance measurement.

Our study is subject to limitations. Premier data are a non-random sample; thus, our results may not generalize if hospitals included within premier data used different heart failure coding strategies than other US hospitals. Our methods differed from mortality performance measures used by CMS: we did not have data for post-hospitalization mortality available to calculate generally higher 30-day mortality rates used by CMS and we did not use comorbid conditions identified via the CMS hierarchical condition category approach. It is possible that higher 30-day mortality rates may be more susceptible to shifts in diagnostic coding than hospital mortality. Additionally, we did not use an approach that comprehensively captures other potential principal diagnoses for HF hospitalizations (e.g., acute renal failure, arrhythmia). We chose to focus on ARF given its clinical plausibility in association with HF, common use, and high mortality rates, which make it particularly susceptible to use in potential measure gaming.<sup>4,5</sup> Lastly, we did not have access to readmission data, and were therefore unable to examine the association between changes in coding and readmission outcomes.

In conclusion, we identified trends in diagnostic coding of acute HF hospitalizations that shifted HF increasingly out of the principal diagnosis position in favor of acute respiratory failure. Trends in HF coding position altered estimates of temporal trends in HF mortality and should be monitored for future effects on hospital performance measures.

## Supplementary Materials

Supplementary material associated with this article can be found in the online version at [doi:10.1016/j.cardfail.2019.01.003](https://doi.org/10.1016/j.cardfail.2019.01.003).

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