Trends in Length of Stay and Short-term Outcomes Among Medicare Patients Hospitalized for Heart Failure, 1993-2006

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During the last decade, the most prominent change in the acute care of patients with heart failure (HF) was a decreasing length of stay in hospitals. Advances in the care of patients with HF, including drugs such as angiotensin-converting enzyme inhibitors, β-blockers or aldosterone antagonists, and cardiac device-related therapies such as implantable defibrillators or resynchronization, accrue benefits to patients after months or years of therapy. No parallel progress in the acute drug or procedural treatment of patients with HF has occurred.

The reduction in hospital length of stay could have reduced the risk of hospital-associated adverse events. Conversely, shortening the time in the hospital could have led to more adverse events in the period early after discharge. Whether decreases in the length of stay during the past decade for patients with heart failure (HF) may be associated with changes in outcomes is unknown.

Objective To describe the temporal changes in length of stay, discharge disposition, and short-term outcomes among older patients hospitalized for HF.

Design, Setting, and Participants An observational study of 6,955,461 Medicare fee-for-service hospitalizations for HF between 1993 and 2006, with a 30-day follow-up.

Main Outcome Measures Length of hospital stay, in-patient and 30-day mortality, and 30-day readmission rates.

Results Between 1993 and 2006, mean length of stay decreased from 8.81 days (95% confidence interval [CI], 8.79-8.83 days) to 6.33 days (95% CI, 6.32-6.34 days). In-hospital mortality decreased from 8.5% (95% CI, 8.4%-8.6%) in 1993 to 4.3% (95% CI, 4.2%-4.4%) in 2006, whereas 30-day mortality decreased from 12.8% (95% CI, 12.8%-12.9%) to 10.7% (95% CI, 10.7%-10.8%). Discharges to home or under home care service decreased from 74.0% to 66.9% and discharges to skilled nursing facilities increased from 13.0% to 19.9%. Thirty-day readmission rates increased from 17.2% (95% CI, 17.1%-17.3%) to 20.1% (95% CI, 20.0%-20.2%; all P < .001). Consistent with the unadjusted analyses, the 2005-2006 risk-adjusted 30-day mortality risk ratio was 0.92 (95% CI, 0.91-0.93) compared with 1993-1994, and the 30-day readmission risk ratio was 1.11 (95% CI, 1.10-1.11).

Conclusion For patients admitted with HF during the past 14 years, reductions in length of stay and in-hospital mortality, less marked reductions in 30-day mortality, and changes in discharge disposition accompanied by increases in 30-day readmission rates were observed.
charge. Without a national surveillance system, the dramatic change in hospital care occurred without a systematic assessment of the effect. Therefore, it is unknown if decreases in the length of stay during the past decade for patients with HF may have been associated with changes in outcomes. To characterize the trends in length of stay, patient disposition, and patient outcomes, we used Medicare data between 1993 and 2006. We specifically determined if, during a period of decreasing length of stay, there were changes in short-term mortality, readmission, and discharge to skilled nursing facilities. We also evaluated changes in in-hospital mortality with trends in 30-day mortality.

**METHODS**

**Study Sample**

The Medicare Provider Analysis and Review (MEDPAR) files and the denominator file from the Centers for Medicare & Medicaid Services (CMS) were obtained for the years between 1993 and 2006. The denominator file includes Medicare beneficiary enrollment and mortality information from administrative enrollment records. It is an abbreviated version of the enrollment database that contains detailed data on all beneficiaries entitled to Medicare. The MEDPAR data contain hospital discharge abstracts for the acute care hospitalizations of all Medicare recipients covered by the hospital care program (Part A). Only patients covered by fee-for-service arrangements are included in the MEDPAR file.

The study population included fee-for-service Medicare patients aged 65 years or older hospitalized with HF, defined by a principal discharge diagnosis using International Classification of Diseases, Ninth Revision, Clinical Modification codes 402.01, 402.11, 402.91, 404.01, 404.11, 404.91, 428, 404.03, 404.13, and 404.93. We excluded patients with incomplete information in their Medicare denominator file (eg, health claim identification). For patients with multiple hospitalizations within a calendar year, only 1 randomly selected hospitalization was included in the sample. Hospitalizations in subsequent years were considered as potential index admissions.

**Patient Characteristics**

We identified 6,955,461 hospitalizations fulfilling the inclusion criteria. Patient characteristics included demographics (age as a continuous variable, male sex, and white, black, and other [Asian, Hispanic, North American Native, or other not specified] races) and history of cardiovascular and comorbid disease variables. The majority of these variables were used in the validated CMS HF 30-day all-cause hospital-specific mortality and readmission measures, and were used to develop a model that was clinically sensible and statistically sound built upon previous work.

In addition, we examined inhospital mortality (defined as death during the index hospitalization) and post-discharge mortality (calculated as the difference between 30-day and in-hospital mortality). Patients who were transferred from the admitting hospital to another acute care hospital and those who died during the index hospitalization were excluded from the readmission analyses. Information on readmission and in-hospital mortality was obtained from MEDPAR data, and post-discharge mortality information was obtained from the denominator file by linking unique patient identifiers.

**Outcome Measures**

Outcome measures included length of stay (defined as the difference between discharge and admission dates plus 1; patients with a length of stay >1 year were excluded), all-cause 30-day readmission (defined as any rehospitalization to any acute care hospital within 30 days from index discharge), and all-cause 30-day mortality (defined as death from any cause 30 days following the index admission date). We chose 30-day mortality and readmission rates because they were more likely to reflect variations related to changes in length of stay compared with outcomes measured at longer follow-up periods, and because they are standard measurements of quality of care.10

Statistical Analyses

We conducted bivariate analyses to quantify changes in patient characteristics and observed outcomes by biannual years using the Mantel-Haenszel χ² test for categorical variables and Cuzick nonparametric test for continuous variables.12 We used 2-year periods to facilitate data presentation and a survival life table to calculate 30-day readmission; patients who neither died nor were readmitted within 30 days after discharge were right-censored. Cox proportional hazards regression models were constructed to evaluate the changes in 30-day all-cause mortality and readmission rates over time, adjusted for age, sex, and comorbidities. Dummy variables were created for each 2-year period, using the 1993-1994 period as the reference. Kaplan-Meier curves were plotted to test the assumption of Cox proportional hazards regression models, and the curves were roughly parallel. To account for within-hospital correlation of patient outcomes, the Lin and Wei sandwich estimation of standard errors was used to calculate robust estimates of standard errors.13 All statistical tests were 2-sided P < .05 and were performed using SAS version 9.2 (SAS Institute Inc, Cary, North Carolina) and STATA version 9.0 (STATA Corp, College Station, Texas).

The Centers for Medicare & Medicaid Services reviewed and approved the submission of the manuscript, based on data use only. The Human Investiga-
tion Committee at Yale University determined that institutional review board approval was not required for this analysis.

RESULTS

Between 1993 and 2006, we identified 6 955 461 hospitalizations based on the selection criteria. The changes in baseline characteristics throughout the study period are shown in Table 1. Secular trends for length of stay and short-term outcomes in 2-year intervals are shown in Table 2. In 1993, 498 300 hospitalizations for HF were studied with a mean length of stay of 8.81 days (95% confidence interval [CI], 8.79-8.83 days) and an in-hospital mortality rate of 8.5% (95% CI, 8.4%-8.6%). A total of 74.0% (95% CI, 73.8%-74.1%) were discharged to home or under home care service, and 13.0% (95% CI, 12.9%-13.1%) were discharged to skilled nursing facilities. In contrast, during 2006 in which 493 554 hospitalizations for HF were analyzed, mean length of stay was 6.33 days (95% CI, 6.32-6.34 days) and the in-hospital mortality rate was 4.3% (95% CI, 4.2%-4.4%). A total of 66.9% (95% CI, 66.9%-70.0%) were discharged to home or under home care service, and 19.9% (95% CI, 19.8%-20.0%) were discharged to skilled nursing facilities.

During the 14-year study period, the mean length of stay decreased by 2.5 days (28% relative reduction, P < .001) (Figure 1), and the discharge disposition changed significantly (P < .001), with a 53% relative increase in the proportion of discharges to skilled nursing facilities and a 10% relative reduction in the proportion of discharges to home (Figure 1).

### Table 1. Secular Trends for Clinical Characteristics of Fee-for-Service Medicare Beneficiaries Hospitalized for Heart Failure by Year

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<td>No. of hospitalizations</td>
<td>993 467</td>
<td>990 283</td>
<td>980 571</td>
<td>983 770</td>
<td>964 060</td>
<td>1 027 230</td>
<td>1 016 080</td>
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<td>Age, mean (SD), y</td>
<td>79.5 (8.2)</td>
<td>79.6 (8.2)</td>
<td>79.5 (8.0)</td>
<td>79.5 (7.9)</td>
<td>79.6 (8.0)</td>
<td>79.7 (8.0)</td>
<td>80.0 (8.0)</td>
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<tr>
<td>Male sex</td>
<td>416 632 (41.9)</td>
<td>410 411 (41.4)</td>
<td>404 113 (41.2)</td>
<td>403 632 (41.0)</td>
<td>398 238 (41.3)</td>
<td>435 995 (42.4)</td>
<td>442 911 (43.6)</td>
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### Abbreviations

- AMI: acute myocardial infarction
- CHF: congestive heart failure
- COPD: chronic obstructive pulmonary disease
- aData are presented as No. (%) unless otherwise specified.

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The unadjusted in-hospital mortality rate decreased by 4.2%, yielding a 49% relative reduction between 1993 and 2006 (Figure 1). The unadjusted 30-day mortality rate decreased by 2.1% (from 12.8% [95% CI, 12.8%-12.9%] in 1993 to 10.7% [95% CI, 10.7%-10.8%] in 2006, a 16.4% relative reduction, \( P < .001 \)). In contrast, postdischarge mortality (from discharge to the 30th day after admission) increased by 2.1% (from 4.3% in

| Table 2. Secular Trends for Length of Stay and Short-term Outcomes of Fee-for-Service Medicare Beneficiaries Hospitalized for Heart Failure by Year* |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Length of stay, d              | 8.6 (6.1)       | 7.5 (6.8)       | 7.0 (6.0)       | 6.8 (5.9)       | 6.8 (5.9)       | 6.6 (5.4)       | 6.4 (5.1)       |
| Mean (SD)                      | 7 (4-10)        | 6 (4-9)         | 5 (4-8)         | 5 (4-8)         | 5 (4-8)         | 5 (4-8)         | 5 (4-8)         |
| Major discharge disposition    | Home            | Home            | Home            | Home            | Home            | Home            | Home            |
| Home                           | 60.5 (60.4-60.6)| 58.2 (58.1-58.3)| 57.6 (57.5-57.7)| 56.6 (56.5-56.7)| 55.8 (55.7-55.9)| 51.2 (51.1-51.3)| 48.9 (48.8-49.0)|
| Skilled nursing or intermediate care facility | 13.2 (13.2-13.3) | 15.1 (15.0-15.2) | 16.8 (16.7-16.9) | 17.3 (17.3-17.4) | 17.6 (17.5-17.7) | 18.4 (18.3-18.4) | 19.6 (19.5-19.6) |
| Transfer to other acute care hospital | 2.6 (2.5-2.6) | 2.9 (2.8-2.9) | 3.0 (3.0-3.1) | 3.1 (3.1-3.2) | 3.2 (3.1-3.2) | 2.9 (2.9-3.0) | 2.6 (2.6-2.7) |
| Hospice                        | 0.0 (0.0-0.0)   | 0.0 (0.0-0.0)   | 0.0 (0.0-0.0)   | 0.2 (0.1-0.2)   | 0.5 (0.5-0.6)   | 1.4 (1.4-1.4)   | 2.1 (2.1-2.1)   |
| All-cause mortality            | Home            | Home            | Home            | Home            | Home            | Home            | Home            |
| In-hospital                     | 8.2 (8.1-8.2)   | 7.0 (7.0-7.1)   | 6.1 (6.0-6.1)   | 6.1 (6.1-6.2)   | 5.9 (5.8-5.9)   | 5.2 (5.1-5.2)   | 4.5 (4.5-4.6)   |
| Postdischarge                   | 4.4 (4.3-4.5)   | 5.2 (5.1-5.3)   | 5.3 (5.2-5.4)   | 5.6 (5.5-5.7)   | 5.7 (5.6-5.8)   | 5.9 (5.8-5.9)   | 6.3 (6.2-6.4)   |
| 30 d                            | 12.6 (12.6-12.7)| 12.2 (12.2-12.3)| 11.3 (11.2-11.3)| 11.7 (11.6-11.7)| 11.5 (11.5-11.6)| 11.1 (11.0-11.1)| 10.8 (10.8-10.9)|
| All-cause readmission rates     | 17.3 (17.2-17.4)| 18.2 (18.1-18.3)| 18.4 (18.3-18.5)| 19.2 (19.1-19.3)| 19.6 (19.5-19.7)| 19.6 (19.5-19.7)| 20.1 (20.0-20.2)|
| Abbreviation: IQR, interquartile range. |

Data are presented as % (95% confidence interval) unless otherwise specified. \( P < .001 \) for all comparisons.
1993 to 6.4% in 2006, a 49% relative increase, \( P < .001 \). Due to this steady increase, postdischarge mortality exceeded in-hospital mortality from 2003 to the end of the study period.

There were 6,327,796 patients who were discharged alive and not transferred to an acute care hospital during the study period. The number of patients readmitted for all causes during the 30 days after discharge increased from 74,578 in 1993 to 89,560 in 2006, such that the unadjusted 30-day all-cause readmission rate increased by 2.9% (from 17.2% [95% CI, 17.1%-17.3%] in 1993 to 20.1% [95% CI, 20.0%-20.2%] in 2006, a 17% relative increase, \( P < .001 \)) (Figure 1).

During the study period, the risk-adjusted 30-day mortality and readmission risks changed progressively and inversely (Figure 2). Compared with 1993-1994, the 30-day mortality risk ratio for 2005-2006 was 0.92 (95% CI, 0.91-0.93), and the 30-day readmission risk ratio was 1.11 (95% CI, 1.10-1.11).

**COMMENT**

In this large observational study, we found that during a 14-year period of reduction in hospital length of stay and increased use of skilled nursing facilities after discharge for Medicare patients with HF, 30-day mortality decreased but posthospital readmission and mortality risk increased. From the patient perspective, it is not clear that care in 2006 was markedly better than it was in 1993. The outcome of patients hospitalized for HF measured by short-term mortality has improved, which may be a result of better quality of care. However, because length of stay has substantially decreased, improvement is less than what might be suggested by in-hospital mortality. In contrast with that improvement, rates of readmission and discharge to skilled nursing facilities have increased, suggesting that patient outcomes, although better, have not improved in all areas.

The Medicare fee-for-service system has provided an incentive for shortening length of stay without penalty for potential unfavorable later outcomes, such as increased readmission or mortality rates. This policy has been considered responsible for the progressive reduction in length of stay observed in patients with HF in the United States. However, despite the main goal of reducing hospital costs, it is possible that when the hospital and short-term nonhospital postdischarge costs are considered, this policy failed to reduce health care expenses. It is unknown whether the increased use of nonacute settings or the increase in short-term readmission risk are the best options for the system, or whether they have been aligned with patient preferences and resulted in increased patient satisfaction.

Several studies have addressed the secular trends of various aspects related to the care and outcomes of patients with HF in the United States, such as incidence, hospitalization rate, hospital stay, therapy, mortality, discharge destination, and readmission risk. To our knowledge, our study is the most comprehensive examination of this issue.

Our study also indicates the importance of examining an episode of acute care during a standardized period of assessment rather than merely focusing on the hospitalization. The approach of using a standardized period of assessment was endorsed for outcomes performance measures by the American College of Cardiology and the American Heart Association. Current payment structures are recognized as a major limitation of the Medicare fee-for-service payment system contributing to poor coordination of care across settings, and the Medicare Payment Advisory Commission has recommended that Medicare adopt episode-based payments including care provided during and after hospitalization. In our study, had we focused solely on the period of hospitalization, we would have reached different conclusions, perhaps finding that hospital stay could be shortened and that there was a remarkable reduction in mortality. Only with the study of the peri-hospitalization...
period are we able to appreciate the full change in outcomes for patients. Hospital deaths were found, to some extent, to be shifting to outside the hospital. The marked reduction in in-hospital deaths was accompanied by an increase in early postdischarge deaths. We cannot determine if these deaths were expected or whether the place of death imposed a burden on patients and their families or was consistent with their preferences. We also cannot determine if the shorter hospital stay contributed to some of the deaths. Nevertheless, we found that the period did not have the magnitude of improvement in mortality that was suggested by the in-hospital experience alone.

The most striking finding is that the period was associated with an increase in 30-day readmission rate. Although we cannot demonstrate that the shortened hospital stay caused these changes, it is certainly plausible that the effort to discharge patients quickly has led to transfers to nonacute institutional settings and occasionally sent patients out of the hospital before they were fully treated. Moreover, there is a paucity of studies that test criteria for readiness for discharge, adding to uncertainty about what constitutes appropriate hospital treatment for the condition. It is also possible that shorter lengths of stay in a system that supports the transition to outpatient status might not be associated with a higher readmission rate.

Our findings are consistent with those of most studies and at odds with some other studies. Our findings concur with previous studies regarding reduction in the length of stay and in the proportion of patients discharged to home, as well as an improvement in in-hospital and 30-day mortality rates. During the 1990s, a progressive increase in 30-day readmission rates for patients with HF was reported in the United States and Canada, although more recent studies did not find such an increase during the current decade in the Medicare population. Our study demonstrates that during an observation period of 14 years, spanning most of the time that the previous studies were performed, there has been a slow but steady increase in 30-day all-cause readmissions.

Our study has several limitations. First, the use of administrative data precludes the consideration of some clinically relevant prognostic factors as well as the evaluation of the quality of care. For example, there is no information about changes in treatment during the study period. However, the reported trends toward an increase in the use of angiotensin-converting enzyme inhibitors and beta-adrenergic blockers, and a decrease in the use of inotropic agents in the United States, as well as the modest effect of these therapies on short-term outcomes make it unlikely that therapeutic changes accounted for the increase in postdischarge outcomes. The inability to evaluate the quality of hospital care precludes the evaluation of the rate of premature discharge, as well as the demonstration that length of stay reduction is a causal factor in the increase in early postdischarge adverse outcomes.

Another limitation is that our study focused on length of stay, discharge status, readmission, and mortality and could not consider other important dimensions of patient outcomes such as functional status or quality of life. Also, we were limited in our ability to determine if patients were in fee-for-service Medicare for the entire year before the index hospitalization, a period when we ascertained comorbidities. However, the short-term and adjusted analyses were similar and it is unlikely that this limitation substantively affected the results. In addition, our study may not reflect the changes over time in the managed care population, which tends to be a healthier population overall.

In conclusion, the pattern of care during hospitalization and immediately after for older patients with HF has changed substantially in the United States during the last 14 years. Although the 30-day mortality rate has decreased, the increase in the readmission rates that paralleled the decrease in length of stay does raise concerns—as does the increase in the rates of discharge to nursing home facilities. The current model of care for older patients with HF in the United States may benefit from more attention to the care and outcomes in the early transition period after hospital discharge and routine surveillance of how changes in practice affect patient outcomes.
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vices reviewed and approved the use of its data for this work and approved submission of the manuscript. This approval is based on data use only and does not represent a Centers for Medicare & Medicaid Services endorsement of or comment on the manuscript content.

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REFERENCES