

Differences in health care use and outcomes by the timing of in-hospital worsening heart failure



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Background Patients hospitalized with acute heart failure may experience worsening symptoms requiring escalation of therapy. In-hospital worsening heart failure is associated with worse in-hospital and postdischarge outcomes, but associations between the timing of worsening heart failure and outcomes are unknown.

Methods Using data from a large clinical registry linked to Medicare claims, we examined characteristics, outcomes, and costs of patients hospitalized for acute heart failure. We defined in-hospital worsening heart failure by the use of inotropes or intravenous vasodilators or initiation of mechanical circulatory support, hemodialysis, or ventilation. The study groups were early worsening heart failure (n = 1,990), late worsening heart failure (n = 4,223), complicated presentation (n = 15,361), and uncomplicated hospital course (n = 41,334).

Results Among 62,908 patients, those with late in-hospital worsening heart failure had higher in-hospital and postdischarge mortality than patients with early worsening heart failure or complicated presentation. Those with early or late worsening heart failure had more frequent all-cause and heart failure readmissions at 30 days and 1 year, with resultant higher costs, compared with patients with an uncomplicated hospital course.

Conclusion Although late worsening heart failure was associated with the highest mortality, both early and late worsening heart failures were associated with more frequent readmissions and higher health care costs compared to uncomplicated hospital course. Prevention of worsening heart failure may be an important focus in the care of hospitalized patients with acute heart failure. (*Am Heart J* 2015;170:1124-32.)

Acute heart failure is a costly public health problem that results in >1 million hospitalizations annually in the United States.¹ More patients 65 years and older are hospitalized for a primary diagnosis of heart failure than for any other condition.² Some patients admitted with acute heart failure will experience a worsening of their condition during hospitalization. Worsening heart failure is defined as persistent or worsening symptoms requiring escalation of therapy.³⁻⁷ In-hospital worsening heart failure is associated with poorer in-hospital and post-

discharge outcomes, including mortality, readmission, and higher costs.⁸ Outcomes are similar for patients who experience worsening heart failure in the first few days of hospitalization or later in the hospitalization.⁹ However, it is unknown whether there is a difference in outcomes and health care expenditures for patients who experience in-hospital worsening heart failure very early in the hospitalization (ie, during the first day) or later in the hospital course.

We sought to describe the characteristics of patients hospitalized for heart failure by the presence and timing of in-hospital worsening heart failure and examine associations between timing of worsening heart failure and mortality, readmission, and health care costs.

Methods

Data sources

The Acute Decompensated Heart Failure National Registry (ADHERE) was a multicenter registry of patients hospitalized with acute heart failure in the United States.¹⁰ All adult patients hospitalized with new-onset or decompensated heart failure were eligible for inclusion in the registry.¹⁰ Each

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participating institution had institutional review board approval for participation in the registry. More than 185,000 patients from > 300 medical centers were enrolled between January 2001 and March 2006. Data were collected via retrospective chart review.

We obtained Medicare fee-for-service standard analytic claim files from the Centers for Medicare & Medicaid Services. Medicare claims contain information about inpatient and outpatient services rendered and procedures performed and associated payment information. In addition, Medicare denominator files contain information about patient demographic characteristics, including information about eligibility and enrollment and death.

We linked the Medicare data and the registry data using a previously described method.¹¹ The institutional review board of the Duke University Health System approved the study.

Study population

The study population consisted of Medicare fee-for-service beneficiaries 65 years or older who had a hospitalization recorded in the ADHERE registry between January 1, 2001, and December 31, 2004. Registry data after 2005 did not include information about the timing of inotrope administration and were not included in this study. We required that patients be enrolled in fee-for-service Medicare for at least 6 months before the index hospitalization. We excluded patients with elective admissions. We excluded patients who died in the hospital, left against medical advice, or were discharged or transferred to another short-term hospital or hospice from the measurement of 30-day and 1-year outcomes.¹² The ADHERE registry collected information on individual hospital admissions, not individual patients; some patients had multiple enrollments in the registry. For this analysis, we selected the first admission in the registry for each patient.

Study groups

Consistent with previously published studies, we defined in-hospital worsening heart failure based on the use of intravenous inotropes or vasodilators; mechanical support including ventilator, dialysis, intra-aortic balloon pump, or left ventricular assist device; or an intensive care unit (ICU) stay during the index hospitalization.⁸ We assigned patients to 1 of 4 comparison groups: early in-hospital worsening heart failure, late in-hospital worsening heart failure, complicated presentation, and uncomplicated hospital course. To highlight decompensation that occurs early in the hospital course, we categorized worsening heart failure by whether it occurred during the first hospital day or after the first hospital day. "Early in-hospital worsening heart failure" occurred during day 1 of the hospitalization (ie, 12-24 hours after presentation). "Late in-hospital worsening heart failure" occurred after the first day of the hospitalization. As in previous analyses, we classified patients who met the worsening heart failure criteria during the first 12 hours after presentation as having a complicated presentation and

classified patients who did not meet the worsening heart failure criteria during the hospitalization as having an uncomplicated hospital course.⁸ We used the earliest time point recorded or retrievable in the medical record to determine the baseline time point. We excluded patients who were transferred to an ICU but for whom the timing of transfer was not available.

Outcomes

Postdischarge outcomes of interest were all-cause mortality, all-cause readmission, readmission for heart failure, days alive and out of the hospital, and Medicare payments. We summarized these outcomes at 30 days and 1 year after discharge. We excluded patients from calculations of all postdischarge outcomes if they died in the hospital, left against medical advice, or were transferred to another short-term hospital or hospice. Moreover, we excluded patients who enrolled in Medicare managed care during the follow-up period from calculations of the payment outcomes and of days alive and out of the hospital. We also measured all-cause mortality, length of stay, and Medicare payments associated with the index hospitalization.

We obtained information about all outcomes from the Medicare data. Death dates were available in the Medicare denominator files. Readmissions were identified from subsequent inpatient claims. Heart failure readmissions were identified by claims having a primary diagnosis of heart failure (*International Classification of Diseases, Ninth Revision, Clinical Modification*, diagnosis code 428.x, 402.x1, 404.x1, or 404.x3). Days alive and out of the hospital were calculated based on mortality and readmission dates identified above. Medicare payments were obtained from Medicare inpatient, outpatient, and professional claims. Payment information was adjusted for inflation using the Consumer Price Index medical care component and reported in 2010 US dollars.

Patient characteristics

Patient characteristics were ascertained from ADHERE registry documentation, including demographic characteristics, medical history, findings from the initial evaluation, vital signs, laboratory test results, admission and discharge medications, and the year of the index hospitalization.

Statistical analysis

We describe the baseline characteristics of the study population using frequencies and percentages for categorical variables and means with SDs or medians with interquartile ranges for continuous variables. We tested for differences between groups using χ^2 tests for categorical variables and Kruskal-Wallis test for continuous variables.

We present the observed outcomes by study group. We summarize in-hospital mortality using frequencies and percentages, and we used χ^2 tests to assess differences between groups. We summarize length of stay, days alive and out of the hospital, and Medicare payments using

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