Early Deaths in Patients With Heart Failure Discharged From the Emergency Department

A Population-Based Analysis

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Background—Although approximately one third of patients with heart failure (HF) visiting the emergency department (ED) are discharged home, little is known about their care and outcomes.

Methods and Results—We examined the acute care and early outcomes of patients with HF who visited an ED and were discharged without hospital admission in Ontario, Canada, from April 2004 to March 2007. Among 50 816 patients (age, 76.4±11.6 years; 49.4% men) visiting an ED for HF, 16 094 (31.7%) were discharged without hospital admission. A total of 4.0% died within 30 days from admission, and 1.3% died within 7 days of discharge from the ED. Although multiple (≥2) previous HF admissions (odds ratio [OR], 1.64; 95% CI, 1.14 to 2.31), valvular heart disease (OR, 1.37; 95% CI, 1.00 to 1.84), peripheral vascular disease (OR, 1.41; 95% CI, 1.00 to 1.93), and respiratory disease (OR, 1.33; 95% CI, 1.08 to 1.63) increased the risk of 30-day death among those discharged from the ED, presence of these conditions did not increase the likelihood of admission. Patients were more likely to be admitted if they were older (OR, 1.08; 95% CI, 1.06 to 1.10 per decade), arrived by ambulance (OR, 2.02; 95% CI, 1.93 to 2.12), had a higher triage acuity score (OR, 4.12; 95% CI, 3.84 to 4.42), or received resuscitation in the ED (OR, 2.85; 95% CI, 2.68 to 3.04). In those with comparable predicted risks of death, subsequent 90-day mortality rates were higher among discharged than admitted patients (11.9% versus 9.5%; log-rank $P=0.016$).

Conclusions—Patients with HF who are discharged from the ED have substantial risks of early death, which, in some cases, may exceed that of hospitalized patients. **(*Circ Heart Fail*. 2010;3:228-235.)**

Key Words: heart failure ■ emergency department ■ mortality ■ prognosis ■ hospitalization ■ outcomes research

Heart failure (HF) is a leading reason for hospitalization, physician visits, and healthcare costs,[1] with a large proportion of resource utilization attributable to emergent care and hospitalizations.[2,3] The global implications of HF are underscored by the high lifetime risk of the condition in North America[4] and the rising HF incidence around the world attributable, in part, to increasing economic globalization.[5,6] Approximately 2.5% of the total healthcare budget in Europe is attributable to HF, and hospital-based care continues to be a major component, comprising ≈70% of this amount.[5,7] The emergency department (ED) is the point of first contact for patients with acute HF, and in North America, there are >1 million visits to the ED for HF annually, representing a 20% increase during the past decade.[8]

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Acute decompensated HF has been increasingly recognized as a distinct entity from that of chronic stable HF, yet relatively little is known about the presentation and outcomes of this condition.[9] Patients with acute decompensated HF funnel toward clinical presentation in the ED with the possible need for hospital admission.[9] Although many previous studies have examined disease epidemiology and outcomes after hospitalization,[10–12] there has been little study of the totality of patients presenting to the ED with an acute decompensation of HF. There is escalating interest in the emergent care of patients with HF because of the increasingly important role of care provided in this setting, stemming from high rates of utilization, overcrowding, and growing pressure to discharge patients from the ED to home. Thus, much of the current literature portrays only a partial view of HF care because the large group of patients who are assessed in the ED and discharged home have been largely excluded from previous studies.

In this study, we describe the characteristics of a population sample of patients with HF in the ED setting and compare the lethal outcomes and predictors of mortality

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among those who were admitted to the hospital or discharged from the ED. We hypothesized that even among patients discharged from the ED, and thus considered "safe" for discharge, a significant number of adverse outcomes would occur within days of discharge from the ED.

Methods

Data Sources

ED information was obtained using the National Ambulatory Care Reporting System database, which contains information on all ED visits. Hospitalizations were evaluated using the Canadian Institute for Health Information Discharge Abstract Database (CIHI-DAD). Both the National Ambulatory Care Reporting System and CIHI-DAD used the International Classification of Diseases, 10th Revision, Canadian Enhancement (ICD-10-CA) or 9th Revision, Clinical Modification (ICD-9-CM) coding systems. Procedures were determined using both the CIHI-DAD and Ontario Health Insurance Plan physician billing database. We used the 2006 Canadian Census to determine the socioeconomic status quintile based on forward sortation address of the postal code. All data were linked using the patients' unique, encrypted health card numbers.

Patients

We examined patients aged ≥20 years who visited an ED in Ontario from April 1, 2004, to March 30, 2007, with a primary diagnosed condition of HF. Both those patients who were discharged from the ED and those who were admitted to the hospital from the ED were evaluated. In those with multiple ED visits during the study period, the first episode was selected as the index HF visit.

Determination of Cardiac and Noncardiac Conditions

We determined the presence of cardiac conditions (eg, HF and myocardial infarction) and noncardiac comorbidities by examining all diagnoses in the CIHI-DAD and the same-day surgery database in the 3 years before the index ED visit (see the online-only Data Supplement Appendix 1 for ICD-9-CM and ICD-10-CA codes). Previous procedures (eg, coronary artery bypass graft surgery, percutaneous coronary intervention, and implantable cardioverter defibrillator) were determined using the Canadian Classification of Interventions, Canadian Classification of Procedures, and Ontario Health Insurance Plan codes (supplemental Appendix 1). Noncardiac comorbid conditions were classified using the Charlson comorbidity classification system.[13]

Presentation Features and Care

We examined the mode (eg, ambulance versus ambulatory) and time of presentation (eg, daytime, 0801 to 1600 hours; evening, 1601 to 2400 hours; and night, 0001 to 0800 hours) and the Canadian Triage Acuity Scale, which signified the perceived acuity of the ED patient. Patients with Canadian Triage Acuity Scale scores 1 (resuscitation) or 2 (emergent) were considered high acuity; score 3 (urgent), medium acuity; and scores 4 (less urgent) and 5 (nonurgent) were low acuity.[14] The impact of resuscitation provided in the ED was assessed using Ontario Health Insurance Plan fee codes for critical care delivery, cardiorespiratory resuscitation, or endotracheal intubation for cardiopulmonary arrest or prearrest situations. The length of stay in the ED also was examined and calculated as the time from presentation to the time of disposition from the ED (eg, time of discharge or admission).

Outcomes

The main outcome of this study was mortality, which was determined using the Registered Persons Database for all deaths and the CIHI-DAD for in-hospital deaths. Time to death was determined starting from the time of discharge from the ED to either the patient's residence (nonadmitted) or to the hospital (admitted).

Statistical Analyses

Clinical and demographic characteristics were compared between discharged and admitted patients. Continuous variables are reported as mean±SD, unless otherwise stated. Student t test and the χ^2 test were used to compare continuous and categorical variables, respectively. We examined factors associated with the decision to admit or discharge patients from the ED, using multiple logistic regression analysis. Because our intent was to examine the joint effects of these predictors, we adjusted for all covariates in the multivariable model.

We determined the predicted probabilities of death in discharged and admitted patients and determined the degree of overlap of predicted death probabilities using multiple logistic regression analysis. We constructed predictive models for death within 7 and 30 days of discharge from the ED using multiple logistic regression. These models included demographic variables (age, sex, and socioeconomic status quintile) and cardiovascular history of previous HF, myocardial infarction, peripheral vascular disease, cerebrovascular disease, coronary artery bypass graft surgery, percutaneous coronary intervention, implantable defibrillator, or permanent pacemaker. We also included presenting features (eg, paramedic versus ambulatory, Canadian Triage Acuity Scale, and registration time), ED features (eg, length of stay and resuscitation status), and all noncardiac comorbidities in the mortality prediction models. The cardiac and noncardiac conditions and procedures included in the predictive models for death are shown in supplemental Appendix 1. One-way interactions of all covariates with age and sex also were included. Discrimination of the logistic regression models were assessed using the C statistic, and we examined model fit using the Hosmer-Lemeshow goodness-of-fit statistic.

We compared mortality rates in patients with predicted probabilities of death within the same range, defined empirically by the 75th percentile of risk for discharged patients and the 25th percentile for admitted patients. Thus, we compared the highest risk quartile of discharged patients and the lowest risk quartile of admitted patients, an overlapping cohort in whom there may have been equipoise in the decision to admit to the hospital or discharge from the ED based on predicted risks of death. These ranges were considered to represent plausible thresholds that defined overlapping predicted probabilities of death. We used Kaplan-Meier analysis to determine cumulative mortality among discharged and admitted patients with overlapping predicted probabilities of death and compared the survival curves using the log-rank statistic. Sensitivity analyses were conducted by varying the thresholds of predicted risk probabilities and thus allowing for inclusion of larger numbers in the discharged and admitted cohorts. We used Cox regression analysis with time-varying covariates to estimate the mortality effect of ED visits or hospitalizations for HF occurring over time, and we censored our time-to-event analyses at 90 days or on the last follow-up date of March 31, 2008 (whichever occurred earlier). A 2-sided $P<0.05$ was considered statistically significant. All analyses were performed using SAS version 9.1.3.

Results

Patients

A total of 78 642 ED visits for HF were examined. Of the 50 816 unique first patient visits to the ED (mean age, 76.4±11.6 years; 49.4% men), 16 094 (31.7%) were discharged home without hospital admission and 34 722 (68.3%) were admitted to the hospital directly from the ED. The status of all study patients at 30 days was determined, with a total of 48 570 person-months of follow-up examined. Baseline characteristics of discharged and admitted study patients are shown in Table 1, and features at ED presentation are shown in Table 2. The majority of patients discharged from the ED (99.2%) were discharged by the physician, and only a few were discharged against medical advice (0.7%) or left without being seen (0.1%). A small proportion of those

Table 1. Characteristics of Patients Discharged From the ED Versus Admitted to the Hospital

Demographic Characteristics, Comorbidities,* and Previous Cardiac Procedures†	Discharged From ED	Admitted to Hospital From ED	*P*
n	16 094	34 722	
Age, mean±SD, y	75.3±11.9	76.9±11.5	<0.001
Male sex	8268 (51.4)	16 856 (48.5)	<0.001
Socioeconomic status			0.20
Quintile 1 (lowest income)	3909 (24.3)	8260 (23.8)	
Quintile 2	3689 (22.9)	7902 (22.8)	
Quintile 3	3131 (19.5)	6895 (19.9)	
Quintile 4	2858 (17.8)	6159 (17.7)	
Quintile 5 (highest income)	2507 (15.6)	5506 (15.9)	
Myocardial infarction	2581 (16.0)	6163 (17.7)	<0.001
HF	4632 (28.8)	10 918 (31.4)	<0.001
Coronary artery bypass graft surgery	654 (4.1)	1012 (2.9)	<0.001
Percutaneous coronary intervention	687 (4.3)	1369 (3.9)	0.08
Coronary heart disease‡	3091 (19.2)	7003 (20.2)	0.01
Implantable cardioverter defibrillator	267 (1.7)	387 (1.1)	<0.001
Permanent pacemaker	704 (4.4)	1344 (3.9)	0.007
Peripheral vascular disease	827 (5.1)	1885 (5.4)	0.18
Cerebrovascular disease	1111 (6.9)	2461 (7.1)	0.45
Dementia	543 (3.4)	1484 (4.3)	<0.001
Respiratory disease	2508 (15.6)	6001 (17.3)	<0.001
Rheumatologic disease	208 (1.3)	534 (1.5)	0.03
Peptic ulcer disease	331 (2.1)	757 (2.2)	0.37
Mild liver disease	63 (0.4)	126 (0.4)	0.62
Diabetes	2393 (14.9)	5556 (16.0)	0.001
Complicated diabetes	1158 (7.2)	2914 (8.4)	<0.001
Hemi- or paraplegia	157 (1.0)	438 (1.3)	0.005
Renal disease	1813 (11.3)	4513 (13.0)	<0.001
Nonmetastatic cancer	815 (5.1)	2019 (5.8)	<0.001
Moderate to severe liver disease	75 (0.5)	148 (0.4)	0.53
Metastatic cancer	176 (1.1)	442 (1.3)	0.09

Data are presented as n (%) unless otherwise indicated.

*Charlson comorbidities present within 3 years before ED visit, from CIHI-DAD and same-day surgery data.

†Previous procedure occurring within 3 years before ED visit, from CIHI-DAD, same-day surgery data, Ontario Health Insurance Plan data.

‡Myocardial infarction, coronary artery bypass graft surgery, or percutaneous coronary intervention within past 3 years.

discharged from the ED were referred for palliative care (0.3% within 7 days and 0.8% of 7-day survivors within 30 days).

Multivariable Predictors of Admission Versus Discharge

The significant multivariable predictors of admission to the hospital are shown in Table 3 (all model covariates, including both significant and nonsignificant, are shown in supplemental Appendix 2). Although arrival by ambulance, evening or nighttime presentation, acuity, and receipt of resuscitation were all associated with hospital admission, a history of myocardial infarction or HF and most noncardiac comorbidities had little influence on disposition from the ED.

Mortality

The 7-day mortality rate of patients discharged from the ED was 1.3% (n=203), with 108 (53.2%) deaths occurring out of hospital and 95 (46.8%) occurring in hospital. The 30-day mortality rate among patients discharged from the ED was 4.0% (n=649), with 275 (42.4%) deaths occurring out of hospital and 374 (57.6%) occurring in hospital. Among patients initially admitted to the hospital directly from the index ED visit, the mortality rate was 5.7% at 7 days and 12.3% at 30 days.

Predicted Death in Discharged and Admitted Patients With HF

The predicted probability of death was 1.2±1.9% at 7 days and 4.0±4.3% at 30 days among patients discharged from the

Table 2. ED Presentation Features of Patients Discharged From the ED Versus Those Admitted to the Hospital

Presentation and ED Features	Discharged From ED	Admitted to Hospital From ED	*P*
n	16 094	34 722	
Mode of arrival			<0.001
Ambulance	4402 (27.4)	17 446 (50.2)	
Ambulatory	11 692 (72.6)	17 276 (49.8)	
Triage acuity			<0.001
High acuity (code 1 or 2)	4699 (29.4)	18 300 (52.7)	
Medium acuity (code 3)	8450 (52.9)	14 509 (41.8)	
Low acuity (code 4 or 5)	2832 (17.7)	1907 (5.5)	
Registration time			<0.001
Day	9239 (57.4)	16 849 (48.5)	
Evening	4401 (27.3)	10 366 (29.9)	
Night	2454 (15.2)	7507 (21.6)	
Length of stay, mean±SD, h	6.55±6.92	6.43±5.14	0.03
Resuscitation in ED	1338 (8.3)	9409 (27.1)	<0.001

Data are presented as n (%) unless otherwise indicated.

Table 3. Multivariable Predictors of Hospital Admission Versus Discharge From the ED

Predictor Variable*	Adjusted OR (95% CI)	*P*
Age, per 10 y	1.08 (1.06–1.10)	<0.001
Male sex	1.02 (0.98–1.06)	0.34
Mode of arrival		
Ambulatory	Referent	
Ambulance	2.02 (1.93–2.12)	<0.001
Triage acuity		
Low acuity (code 4 or 5)	Referent	
Medium acuity (code 3)	2.24 (2.09–2.39)	<0.001
High acuity (code 1 or 2)	4.12 (3.84–4.42)	<0.001
Registration time		
Day	Referent	
Evening	1.14 (1.09–1.20)	<0.001
Night	1.13 (1.07–1.20)	<0.001
Myocardial infarction	0.98 (0.92–1.04)	0.47
HF	1.03 (0.98–1.09)	0.18
Coronary artery bypass graft surgery	0.76 (0.68–0.85)	<0.001
Percutaneous coronary intervention	0.88 (0.80–0.98)	0.02
Implantable cardioverter defibrillator	0.74 (0.62–0.87)	0.001
Permanent pacemaker	0.88 (0.80–0.98)	0.02
Cerebrovascular disease	0.89 (0.82–0.97)	0.007
Rheumatologic disease	1.19 (1.00–1.42)	0.05
Diabetes	1.09 (1.03–1.16)	0.003
Complicated diabetes	1.19 (1.10–1.30)	<0.001
Nonmetastatic cancer	1.17 (1.07–1.28)	0.001
Length of stay in ED, per 5 h	0.92 (0.91–0.94)	<0.001
Resuscitation in ED	2.85 (2.68–3.04)	<0.001

*Socioeconomic status quintile, peripheral vascular disease, dementia, respiratory disease, peptic ulcer disease, liver disease (mild or severe), hemi- or paraplegia, renal disease, and metastatic cancer were not significant predictors.

ED. Predicted probabilities of death in admitted patients were 5.7±4.5% at 7 days and 12.3±7.8% at 30 days. All covariates were included in the multivariable models for mortality, and there was no lack of model fit (Hosmer-Lemeshow, $P>0.30$).

Observed Mortality Rates

Histograms of predicted probabilities of 7-day and 30-day death are shown in Figures 1 and 2, respectively. There was a significant overlap in the predicted probabilities of death, with a large proportion of discharged patients having predicted probabilities that were similar to that of admitted patients. Mortality rates in admitted and discharged patients with overlapping predicted probabilities of 7-day and 30-day death are shown in Figures 3 and 4. Mortality comparisons were performed for patients discharged from the ED or admitted to the hospital with overlapping predicted probabilities of 7-day death between 1.3% and 2.5% and between 4.8% and 6.5% for 30-day death. A total of 7549 (14.9%) patients of whom 1696 were discharged and 5853 were admitted had predicted risks of 7-day death that overlapped in the range of 1.3% to 2.5%. A total of 4893 (9.6%) patients of whom 1189 were discharged and 3704 were admitted had predicted risks of 30-day death that overlapped in the range of 4.8% to 6.5%.

For the 7-day cohort, mortality was significantly higher in patients who were discharged from the ED, with 90-day mortality rates of 12.4% for discharged and 9.4% for admitted patients (log-rank $P<0.001$) (Figure 3). Similar findings were observed for the 30-day cohort (Figure 4), with mortality rates of 11.9% for discharged and 9.5% for admitted patients at 90 days (log-rank $P=0.016$). The rates of repeated ED visits or hospitalizations for HF were significantly higher in those who were discharged directly from the ED. Event rates at 30 days were 14.0% (discharged from the ED) and 7.5% (discharged from the hospital) among patients who survived the first 7 days after HF onset ($P<0.001$). Event rates at 90 days were 20.3% (ED) and 16.6% (hospitalized)

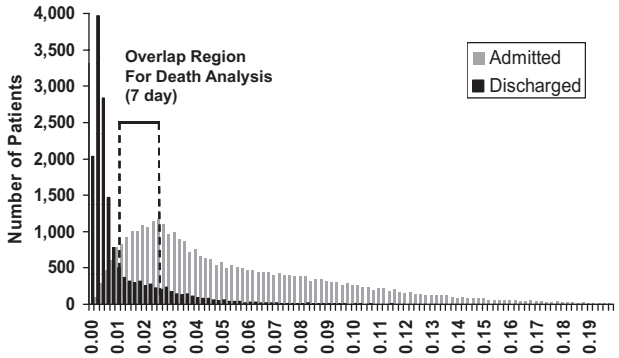

Figure 1. Distribution of predicted probabilities of 7-day death (x-axis) in patients discharged from the ED or admitted to the hospital. Overlap region shows patients compared in time-to-event analysis.

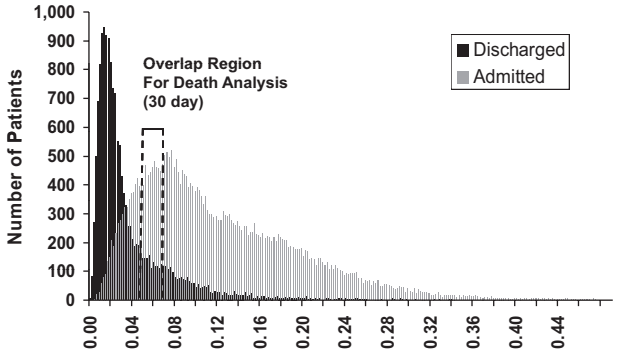

Figure 2. Distribution of predicted probabilities of 30-day death (x-axis) in patients discharged from the ED or admitted to the hospital. Overlap region shows patients compared in time-to-event analysis.

among patients who survived the first 30 days after HF onset ($P<0.001$). In a time-varying Cox model adjusted for age, sex, and Charlson comorbidity score, the hazard ratio for death was 3.65 (95% CI, 3.46 to 3.84) for each additional ED visit or hospitalization that occurred within the first 90 days after discharge from the ED ($P<0.001$).

In sensitivity analyses, we examined greater numbers of patients by including discharged patients with ≥65th percentile (n=3944) and admitted patients with ≤35th percentile (n=11 320) of risk, with predicted 7-day mortality rates between 0.79% and 3.12%. Mortality rates remained higher in patients discharged from the ED than in those admitted to the hospital at 90 days (12.2% versus 9.1%, $P<0.001$). Similarly, expanding to discharged patients with ≥65th percentile (n=3605) and admitted patients with ≤35th percentile (n=9746) of risk, with predicted 30-day mortality rates between 3.43% to 7.88%, mortality rates at 90 days remained higher in patients who were discharged from the ED than in those admitted to the hospital (12.2% versus 9.7%, $P<0.001$).

Predictors of Death

Mortality rates according to patient characteristics are shown in Table 4. Mortality increased with the number of previous HF admissions, mode and time of presentation, and receipt of

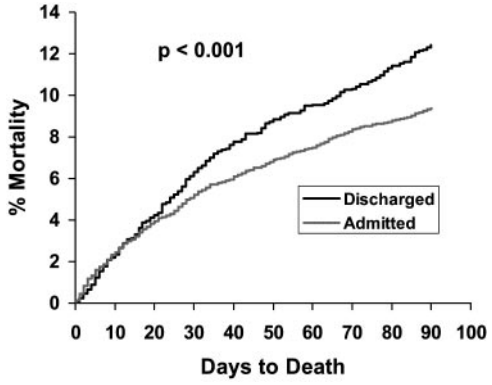

Figure 3. Time-to-death for patients discharged from the ED or admitted to the hospital with comparable predicted risks of 7-day death. Discharged patients had significantly higher rates of death (log-rank $P<0.001$).

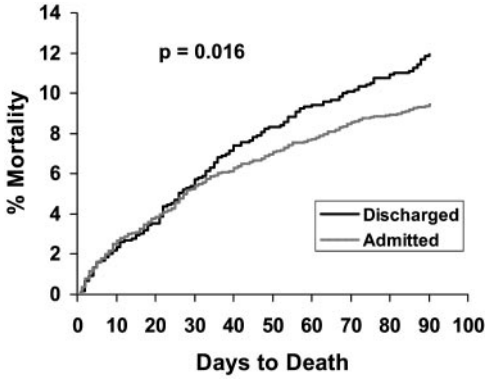

Figure 4. Time-to-death for patients discharged from the ED or admitted to the hospital with comparable predicted risks of 30-day death. Discharged patients had significantly higher rates of death (log-rank $P=0.016$).

resuscitation in the ED. Significant multivariable predictors of 30-day mortality are presented in Table 5, which are age, male sex, arrival by ambulance, ≥2 previous HF admissions, valvular heart disease, peripheral vascular disease, respiratory disease, and longer ED length of stay. Higher initial triage acuity was associated with lower 30-day death. A subset of the 30-day covariates (Table 5) also predicted increased 7-day mortality, including older age (odds ratio [OR], 1.55 per 10 years; 95% CI, 1.31 to 1.84; $P<0.001$), male sex (OR, 1.63; 95% CI, 1.20 to 2.20; $P=0.002$), arrival by ambulance (OR, 5.07; 95% CI, 3.58 to 7.24; $P<0.001$), ≥2 previous HF admissions (OR, 2.26; 95% CI, 1.25 to 3.90; $P=0.005$), dementia (OR, 2.27; 95% CI, 1.44 to 3.46; $P<0.001$), metastatic cancer (OR, 3.27; 95% CI, 1.22 to 7.25; $P=0.008$), and longer ED length of stay (OR, 1.07 per 5 hours; 95% CI, 1.00 to 1.13; $P=0.022$). The C statistics for the 7-day and 30-day models were 0.806 and 0.755, respectively.

Discussion

Previous studies pertaining to the hospital-based care of patients with HF have largely included those who were hospitalized. Relatively little is known about the outcomes of those who are discharged home from the ED. In this study, we examined population-based data from a large cohort of patients presenting to the ED with symptoms of acute decompensated HF, and we found that 4.0% of nonadmitted patients with HF died within 30 days of discharge from the ED. There was a wide variation in the predicted risks of death among discharged patients with HF, suggesting that clinicians currently lack tools to determine the anticipated risk of adverse outcomes in the ED. Indeed, a substantial proportion of discharged patients had risks of death that were comparable with their counterparts who were admitted to the hospital. They also had high rates of repeated ED visits and hospitalizations for HF occurring within 90 days, and the postdischarge events conferred increased mortality risk as we had observed in a previous evaluation.[15]

Previous studies have examined almost exclusively patients with HF who have been admitted to the hospital.[10,12,16,17] Therefore, most of the previous studies portray a partial view of HF care because patients who are assessed in the ED and discharged home often have been excluded. There

Table 4. Number of Deaths (and Percent Death) Within 30 Days Among Patients Discharged From the ED or Admitted to the Hospital

	Discharged From ED			Admitted to Hospital		
	<65 y	65–79 y	≥80 y	<65 y	65–79 y	≥80 y
n	2881	6552	6661	4987	13 348	16 387
No. previous HF admissions*						
0	47 (1.9)	143 (2.6)	329 (5.8)	231 (5.4)	1082 (9.8)	2212 (16.2)
1	9 (3.1)	19 (2.6)	55 (7.1)	30 (6.1)	169 (10.4)	342 (17.3)
≥2	…‡ (4.1)	19 (7.0)	23 (9.7)	17 (8.7)	67 (10.3)	110 (15.3)
Coronary heart disease†						
No coronary heart disease	48 (2.1)	133 (2.6)	334 (6.0)	232 (5.7)	1036 (10.1)	2218 (16.6)
Coronary heart disease	13 (2.3)	48 (3.4)	73 (6.7)	46 (4.9)	282 (9.2)	446 (14.8)
Mode of arrival						
Ambulatory	42 (1.7)	93 (1.8)	132 (3.2)	122 (3.6)	454 (6.2)	682 (10.3)
Ambulance	19 (4.4)	88 (6.3)	275 (10.7)	156 (9.7)	864 (14.3)	1982 (20.2)
Registration time						
Day	31 (2.1)	104 (2.7)	229 (5.8)	122 (5.5)	649 (10.1)	1315 (16.0)
Evening or night	30 (2.2)	77 (2.8)	178 (6.5)	156 (5.6)	669 (9.7)	1349 (16.5)
Resuscitation in ED						
Yes	6 (2.4)	23 (4.2)	52 (9.5)	105 (7.5)	424 (11.3)	878 (20.7)
No	55 (2.1)	158 (2.6)	355 (5.8)	173 (4.8)	894 (9.3)	1786 (14.7)
Length of stay in ED						
<5 h	26 (1.7)	87 (2.6)	134 (4.3)	147 (6.1)	741 (11.1)	1344 (17.4)
5–10 h	23 (2.4)	56 (2.4)	152 (6.3)	92 (5.2)	421 (9.1)	930 (15.6)
>10 h	10 (2.9)	33 (3.9)	105 (10.2)	39 (4.9)	156 (7.6)	390 (14.4)

Data are presented as n (%).
*Admissions for primary diagnosis of HF within 3 years before ED visit.
†Myocardial infarction, coronary artery bypass graft surgery, or percutaneous coronary intervention within past 3 years.
‡Small cell size, unable to report.

have been few previous studies of patients with HF discharged directly from the ED. The Acute Decompensated Heart Failure National Registry Emergency Medicine study reported characteristics of patients presenting to the ED with acute HF.[18] Others have reported that approximately one third of patients with HF are discharged from the ED, with 30-day mortality rates that were similar to our observations.[19] Our study adds to the current HF literature that many patients who are discharged from the ED exhibited high-risk features, with a substantial early mortality rate. Indeed, higher rates of death were observed in patients discharged from the ED than in patients admitted with comparable short-term predicted probabilities of death.

Several factors influenced the decision to admit patients with HF to the hospital. Some of these factors were related to disease severity, but variations in care were observed. Although the majority of patients who received resuscitation, arrived by ambulance, and had higher triage acuity scores were admitted, a significant proportion of these patients were discharged from the ED. Longer durations of ED stay conferred higher risk in the discharged group, suggesting that the empirical strategy of observation of patients with HF in the ED to ensure that it is safe to discharge the patient does not necessarily discriminate well those who are at low risk of subsequent death. In patients discharged from the ED, the mode of arrival and longer ED stay were multivariate predictors of mortality; however, higher initial triage acuity was associated with improved survival. The seemingly paradoxical effects of higher triage acuity could be related to the intensity of initial investigations and postdischarge follow-up care, which may have been provided preferentially to those who were perceived to be sicker at the time of presentation. Previous HF admissions directly reflect HF severity,[15] whereas other conditions, such as valvular heart disease, peripheral vascular disease, and respiratory disease, may contribute to mortality through multiple mechanisms. However, these conditions did not increase the likelihood of admission to the hospital, illustrating the need for further study of patients with HF in the emergency setting. Finally, our findings could not be explained by an intention for palliation because only a small percentage of patients who were discharged from the ED received palliative care.

Because the crude mortality rate was lower among patients discharged from the ED than those who were admitted, some may argue that current empirical decision making is effective. However, the mortality rate of patients with HF is high compared with the parallel context of patients with chest pain who visit the ED and are discharged, in whom the 30-day mortality rate is <1%.[20,21] Despite the substantially lower rate of death in ED patients with chest pain, great efforts are

Table 5. Multivariable Predictors of Mortality Among Discharged ED Patients

30-Day Mortality Predictors	Wald χ^2	Adjusted OR (95% CI)	*P*
Age, per 10 y*	63.2	1.45 (1.32–1.59)	<0.001
Male sex*	15.3	1.41 (1.19–1.67)	<0.001
Mode of arrival			
Paramedic vs ambulatory*	151.1	3.17 (2.64–3.81)	<0.001
Triage code			
High vs low acuity	11.4	0.63 (0.49–0.83)	<0.001
Medium vs low acuity	5.0	0.77 (0.61–0.97)	0.025
No. previous HF admissions			
1 vs 0	0.2	1.06 (0.82–1.37)	0.632
≥2 vs 0*	7.7	1.64 (1.14–2.31)	0.006
Valvular and rheumatic heart disease	4.2	1.37 (1.00–1.84)	0.041
Peripheral vascular disease	4.2	1.41 (1.00–1.93)	0.041
Dementia*	21.6	1.96 (1.47–2.60)	<0.001
Respiratory disease	7.3	1.33 (1.08–1.63)	0.007
Renal disease	3.5	1.27 (0.99–1.63)	0.060
Metastatic cancer*	40.6	4.60 (2.81–7.23)	<0.001
Length of stay in ED, per 5 h*	20.9	1.10 (1.05–1.14)	<0.001

*Also a predictor of 7-day mortality.

being applied to further reduce this risk with the use of clinical prediction rules,[22] biomarkers,[23] and imaging.[21,24] In contrast, for patients with HF who have higher rates of death, there is little evidence to guide decision making in the ED.

From the public health perspective, the implications are large. For every 25 discharged patients, 1 died within 30 days, and for every 80 discharged patients, >1 died within 7 days; thus, we estimate that thousands of early deaths occur after discharge from the ED in North America annually. From a clinical standpoint, our study suggests that although management for the ED is influenced somewhat by the acuity of presentation, the decision to admit or discharge is based largely on clinical judgment. There is a need for validated tools to assist physicians to better determine the mortality risk of patients with HF who present to the ED and to guide decision making regarding the safety of discharge from the ED. Potentially, predictive tools might be used to identify high-risk patients who could benefit from early interventions, including expeditious referral to an HF clinic or specialist care, home visits by nurses, and cardiac investigations.

Our study had some notable limitations. We used large administrative databases that did not include clinical variables such as blood pressure or echocardiographic information. Despite this limitation, our broad, population-based analysis identified a gap in HF care for which future clinical research is needed to improve decision making. We did not examine the uptake or impact of brain natriuretic peptide in the ED setting; however, emerging data suggest that brain natriuretic peptide is of untested value for outcomes assessment in the ED at the broad population level[25,26] or for guiding therapeutic decisions.[27] The contribution of acute HF drug therapy was beyond the scope of this study, but conversely, the relative benefits of emergent use of pharmacological agents for acute decompensated HF have not been fully delineated. Finally, although we examined the contribution of multiple patient characteristics, presentation features, and facets of the treatments received, as yet unmeasured pre- and post-ED factors also may have influenced the results.

In conclusion, patients with HF who are discharged from the ED have an appreciable early mortality risk beginning as soon as 7 days postdischarge. Indeed, some patients who were discharged from the ED had predicted and observed mortality risks that were comparable with or exceeded those of hospitalized patients. These early findings suggest that there is a need for further clinical evidence to guide risk stratification in the ED and to assist in decision making with regard to the safety of direct discharge of patients with HF from the ED.

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Disclosures

None.

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CLINICAL PERSPECTIVE

Patients with acute heart failure (HF) often present to the emergency department (ED) for care, and approximately one third are discharged home without hospital admission. In this study of 50 816 patients with HF, we found that death occurred in 1.3% within 7 days and 4.0% at 30 days after discharge from the ED. There was overlap in predicted probabilities of death among those who were discharged from the ED and those admitted to the hospital, suggesting that equipoise exists in the decision to admit or discharge the patients with HF from the ED. Among those with similar predicted probabilities of death, observed 90-day mortality was significantly higher among patients who were discharged from the ED compared with those who were admitted to the hospital ($P<0.001$ and $P=0.016$ for 7-day and 30-day predicted probability cohorts, respectively). Repeat ED visits or hospitalization for HF within 90 days occurred in 20.3% of those initially discharged and 16.6% of those initially hospitalized ($P<0.001$). Recurrent ED visits or hospitalizations after initial discharge conferred a 3.6-fold increase in risk of death. Older age, male sex, arrival by ambulance, ≥2 previous HF hospitalizations, valvular heart disease, peripheral vascular disease, respiratory disease, and longer length of ED stay were predictors of death after discharge from the ED. These early findings suggest that there is a need for further clinical evidence to guide risk stratification in the ED and to assist in decision making regarding the safety of direct discharge of patients with HF from the ED.

Early Deaths in Patients With Heart Failure Discharged From the Emergency Department: A Population-Based Analysis

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SUPPLEMENTAL MATERIAL

Expanded methods

Biochemical analysis

Human Adiponectin Quantikine ELISA: minimal detection limit of 0.246 ng/L, intra-assay precision of 2.5% for mean 19.8 mg/L, SD 0.50 (n=20) and inter-assay precision of 3.2% for mean 12.5 mg/L, SD 0.41 (n=40); Human TNFα/TNFSF1A Quantikine HS ELISA: minimal detection limit of 0.106 pg/mL, intra-assay precision of 4.3% for mean 11.5 pg/mL, SD 0.49 (n=20) and inter-assay precision of 7.3% for mean 10.5 pg/mL, SD 0.76 (n=41); Human IL-6 Quantine HS ELISA; minimal detection limit of 0.039 pg/mL, intra-assay precision of 7.8% for mean 2.45 mg/L, SD 0.19 (n=20) and inter-assay precision of 7.2% for mean 2.78 mg/L, SD 0.20 (n=36).

The coefficient of variation for NT-proBNP was 1.3% (n=10) at a level of 221 pg/mL and 1.2% (n=10) at a level of 4091 pg/mL.

Immunohistochemistry (IHC)

The 5 µm paraffin tissue sections were deparaffinized and hydrated. A dextran-based method (Dako REAL EnVision Detection System; DakoCytomation A/S, Glostrup, Denmark) was used to detect the antigen. The primary antibody used was the mouse anti-human adiponectin [19F1] (1:100; Abcam, Cambridge, UK). Horseradish peroxidase activity was visualized with 3,3'- diaminobenzidine tetrahydrochloride, and hematoxylin was used for nuclear staining. Negative controls were performed by replacing the primary antibody with normal mouse serum at the same concentration of the primary antibody. Negative controls displayed an absence of signal. The images were analyzed using a color image analysis system (Image-Pro Plus 4.1; Media Cybernetics, Inc., Silver Spring, MD).

Western blot

Protein extracts (50 µg) of vastus lateralis muscles from CHF patients and healthy subjects were loaded onto SDS-polyacrylamide gels and separated for 120 min at 120 V. After electrophoresis, the proteins

were transferred to Hybond nitrocellulose membranes (Amersham) using a Bio-Rad blot system for 90 min at 150 V. Thereafter, the blots were blocked with 5% milk in PBS for 60 min at room temperature, followed by incubation with a primary antibody at 4°C overnight. Specific antibodies were used to measure the protein content of phospho- and total αAMPK (#2535 and #2532, Cell Signaling, Ozyme France). After washing, the membranes were incubated with horseradish peroxidase secondary antibody (#7074 Cell Signaling) for 60 min and revealed with enhanced chemiluminescent substrate (PIERCE dura, Fischer, France). Light emission was detected by autoradiography and quantified using an image-analysis system (Chemidoc XRS, Biorad).