Emergency Department Observation of Heart Failure: Preliminary Analysis of Safety and Cost

One third of patients diagnosed with heart failure (HF) receive inpatient care each year, and at least 80% of patients presenting in the emergency department (ED) with HF are hospitalized. ED patients seen, admitted, and treated in an inpatient bed account for the majority of expenditures for HF care. Up to 80% of patients discharged from the hospital with a primary diagnosis of HF come from the ED. Based on American College of Cardiology/American Heart Association or Agency for Health Care Policy Research guidelines, however, it has been suggested that up to 50% of admitted patients are low risk and would have been candidates for outpatient therapy. This conservative approach to the HF patient is a significant inefficiency in an overburdened health care system.

A novel approach for management of ED HF patients is necessary to decrease the relative burden of this disease. Even with the development of new diagnostic and prognostic tools, the high rate of admissions for HF patients has not changed in decades. Providing the emergency physician with an alternative to hospitalization that still allows for an extended evaluation and treatment would represent a significant advance. An observation-unit (OU) approach may satisfy this goal.

We hypothesized that evaluating and treating low-risk HF patients in an OU would decrease the need for admission, decrease hospital length of stay, and decrease costs as compared with direct admission. We also hypothesized that patients admitted to the OU did not have worse outcomes than those admitted to an inpatient setting. We expected costs to change more than lengths of stay since the cost per day for an observation patient is about one third of that for an admitted patient.

Methods

Model of the Problem. A schematic of our study is shown in Figure 1. The model is based on the introduction of standardized criteria to provide emergency physicians with an alternative disposition to hospital admission. These criteria identify a low-to-moderate-risk patient population who, when managed in an OU, decrease the cost and resource use associated with HF admissions, without increasing the number of adverse clinical events.

Study Design. This was an observational, sequential, cohort study. Both cohorts satisfied the same inclusion and exclusion criteria. In one cohort the OU was not operational, and in the other the OU was available to treating physicians. Our Institutional Review Board approved the study in April 2002; we enrolled a convenience sample of patients in the first cohort from April 2002.

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through April 2003, and in the second from May 2003 through September 2003. The study design follows the schematic in Figure 1, adding screening criteria at the first decision-making node. This study was conducted at an academic ED with a current annual ED census of approximately 85,000 patients, of whom approximately 550 have been discharged from an inpatient setting with a primary diagnosis of HF. The ED serves an urban, biracial (53% black and 47% white) community, including a high proportion of indigent patients.

Patients undergoing evaluation for suspected HF exacerbation, as indicated by shortness of breath, dyspnea on exertion, dependent edema, or difficulty breathing, were identified by trained research associates 16 hours a day, 7 days a week between April 2002 and September 2003. Patients were included if they satisfied two major, or one major and two minor, modified Framingham Criteria. Inclusion and exclusion criteria (Table I and II) were selected based on a review of previously derived retrospective risk data, so as to identify what current practice suggests is a low-to-moderate-risk patient. 

Patients currently believed to be at high risk and patients with new-onset HF were not included. Inclusion criteria additionally included an initial brain natriuretic peptide level >100 pg/mL, designated admission by the emergency physician, and informed consent. Patients visiting the ED more than once were included for their first visit only. All data reported in this study are based upon retrospective chart and database review and, as such, measures were obtained through normal clinical practice.

Outcome Measures. Three outcomes were considered in this study: adverse clinical events, costs, and resource burden. Adverse clinical events were: 1) repeat visits to the ED; 2) readmission with a primary complaint of HF; or 3) death, all within 30 days. We analyzed laboratory, inpatient, ED, and pharmacy charges as a surrogate for cost. The resource burden was defined as length of stay.

Data Collection and Processing. Clinical data were abstracted from the medical record by authors Storrow or Collins. Additionally, the social security death index was reviewed. Data were recorded on case report forms and subsequently entered into a customized database for crosschecking and data verification. Charge data and administrative data were provided to the investigators in spreadsheet format by the hospital data center. The datasets were merged and formatted for analysis.

Data Analysis. Continuous data are described using medians and range; costs and lengths of stay are right-skewed. Categorical data are described as frequencies and proportions with 95% confidence intervals (CIs). Comparisons between admitted patients and patients placed in the OU used the Fisher exact test for categorical data. Due to the skew of continuous data, non-parametric significance tests (Mann-Whitney U test) and p values were used for comparison purposes; graphical representations of data at the unit of analysis were also used. Analyses were conducted using SPSS v12.0 (SSPS Inc., Chicago, IL).

Results

Characteristics of Study Subjects. Overall, 64 patients were included in the study; the sample is described in Table III. The two statistically significant differences—percentage of subjects with a history of chronic obstructive pulmonary disease and presenting heart rate—were not believed to be clinically significant. Thirty-six patients were admitted directly to the inpatient setting while 28 were placed in the OU. One patient left the OU

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**Figure 1. Schematic of the study**

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**Table III. Characteristics of Study Subjects**

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**Without Observation**

- Heart failure patient presents to the emergency department
- Patient evaluated with conservative approach to disposition decision-making
- Admission (80%)
- Discharge (20%)

**With Observation**

- Heart failure patient presents to the emergency department
- Patient evaluated with standardized guidelines for admission to observation
- Observation
- Admission (60%)
- Discharge (40%)

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Clinical Outcomes. Six of the 28 observation patients (21.4%; 95% CI, 10.2–39.5) required subsequent admission. There were no deaths within 30 days. There were 10 readmissions for HF (six admitted and four observation); all but one included an HF-related ED visit. These outcome events represented 16.7% (95% CI, 7.9–31.9) of the admitted group and 14.3% (95% CI, 5.7–31.5) of the observation group.

Table I. Inclusion Criteria Used to Identify Low-to-Moderate-Risk Heart Failure Patients*

| TWO FROM THE LEFT COLUMN OR ONE FROM THE LEFT COLUMN PLUS TWO FROM THE RIGHT COLUMN* | Extremity edema | Night cough | Dyspnea on exertion | Hepatomegaly | Pleural effusion | Tachycardia (≥130 bpm) |
| Paroxysmal nocturnal dyspnea | Neck vein distention | Pulmonary edema (on chest X-ray) | Rales | Cardiomegaly | S3 gallop | Jugular venous distention | Positive hepatojugular reflex | B-type natriuretic peptide level >100 pg/mL | Designated for admission by the emergency physician | Provided informed consent

*Adapted for emergency department use from the Framingham criteria6,12–21

Table II. Exclusion Criteria Used to Identify Low-to-Moderate-Risk Heart Failure Patients*

| Alternative diagnosis explaining acute clinical presentation | Hypoxia (oxygen saturation <90% on room air) | Severe respiratory distress | Hypotension (systolic blood pressure <90 mm Hg) | Temperature >100.0°F | Syncope | Requirement of IV infusion to treat hypotension | Electrocardiogram with ischemic changes not known to be old | Serum markers indicative of myocardial necrosis | New-onset heart failure | Severe electrolyte imbalances | Currently receiving dialysis | Failure to provide informed consent | ≤18 years of age
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Resource Burden. OU patients were discharged without hospitalization in 75% of cases; one patient left the OU against medical advice and 6 (21.4%; 95% CI, 10.2–39.5) were admitted. Median time from triage to discharge for observation patients, including both patients discharged from observation and those admitted to the hospital and subsequently discharged, was 25.7 hours (range 9.5–108.6 hours). Patients admitted directly from the ED had a median length of stay of 58.5 hours (range 11.5–173.0 hours).

A histogram showing the distribution of total lengths of stay for admitted vs. OU patients is presented in Figure 2. For OU patients who eventually required hospitalization, the length of hospital stay was shorter than for directly admitted patients (Table II, Figure 3). The mean number of bed hours saved through OU use was 43.2 hours (95% CI, 25.6–60.8 hours).

Financial Outcomes. Data for two admitted and one OU patient could not be matched to hospital accounting data; these patients were excluded from cost analyses. Figure 3 shows the source of charges for admitted and OU patients (outliers not shown). The total charge was lower for the OU patients (Table III). Inpatient charges and pharmacy charges were greater for admitted than OU patients, while charges for emergency services were higher for OU than for admitted patients (Figure 3).

Discussion

The results of this pilot study suggest OU management of the low-to-moderate-risk HF patient results in a safe and cost-effective alternative to direct admission to the inpatient setting. There were no deaths experienced during follow-up, and recidivism was not different between the two patient groups. Further, cost savings in the 28 patients admitted to the OU were estimated to amount to more than $100,000 or approximately $3600 per patient.

One of the primary criticisms of OU care is that low-risk patients are placed in the unit when they would otherwise have been discharged. While direct discharge home is another option for the decompensated HF patient, selecting those patients that may be safely discharged...
Table III. Characteristics of Study Subjects*

<table>
<thead>
<tr>
<th>Demographics</th>
<th>All (N=64)</th>
<th>Admitted (N=36)</th>
<th>Observation Unit (N=28)</th>
<th>p-Value**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>58 (23–101)</td>
<td>61 (23–101)</td>
<td>56 (30–81)</td>
<td>0.461</td>
</tr>
<tr>
<td>Female</td>
<td>29 (45.3)</td>
<td>17 (47.2)</td>
<td>12 (42.9)</td>
<td>0.463</td>
</tr>
<tr>
<td>Male</td>
<td>35 (54.7)</td>
<td>19 (52.8)</td>
<td>16 (57.1)</td>
<td></td>
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<tr>
<td>Black</td>
<td>49 (76.6)</td>
<td>27 (75.0)</td>
<td>22 (78.6)</td>
<td>0.488</td>
</tr>
<tr>
<td>White</td>
<td>15 (23.4)</td>
<td>9 (25.0)</td>
<td>6 (21.4)</td>
<td></td>
</tr>
<tr>
<td>History</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>30 (46.9)</td>
<td>17 (47.2)</td>
<td>13 (46.4)</td>
<td>0.575</td>
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<tr>
<td>Hypertension</td>
<td>53 (82.8)</td>
<td>28 (77.8)</td>
<td>25 (89.3)</td>
<td>0.192</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>19 (29.7)</td>
<td>14 (38.9)</td>
<td>5 (17.9)</td>
<td>0.059</td>
</tr>
<tr>
<td>COPD</td>
<td>17 (26.6)</td>
<td>14 (38.9)</td>
<td>3 (10.7)</td>
<td>0.011</td>
</tr>
<tr>
<td>Presenting vital signs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiration rate (BPM)</td>
<td>22 (16–40)</td>
<td>20 (16–40)</td>
<td>22 (16–40)</td>
<td>0.171</td>
</tr>
<tr>
<td>Oxygen saturation (%)</td>
<td>97 (87–100)</td>
<td>98 (89–100)</td>
<td>97 (87–100)</td>
<td>0.660</td>
</tr>
<tr>
<td>Systolic blood pressure (mm Hg)</td>
<td>144 (98–218)</td>
<td>142 (98–218)</td>
<td>145 (100–214)</td>
<td>0.903</td>
</tr>
<tr>
<td>Diastolic blood pressure (mm Hg)</td>
<td>89 (58–143)</td>
<td>88 (58–143)</td>
<td>90 (66–121)</td>
<td>0.607</td>
</tr>
<tr>
<td>Heart rate (bpm)</td>
<td>90 (56–136)</td>
<td>99 (56–129)</td>
<td>83 (63–136)</td>
<td>0.023</td>
</tr>
<tr>
<td>Temperature (°F)</td>
<td>97.5 (96.1–100.6)</td>
<td>97.5 (96.2–99.5)</td>
<td>97.4 (96.1–100.6)</td>
<td>0.924</td>
</tr>
<tr>
<td>Outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical events</td>
<td>10 (15.6)</td>
<td>6 (16.7)</td>
<td>4 (14.3)</td>
<td>0.538</td>
</tr>
<tr>
<td>Total length of stay (h)</td>
<td>46 (9–173)</td>
<td>59 (12–173)</td>
<td>26 (9–109)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Total cost ($)</td>
<td>5893 (2518–34,604)</td>
<td>7824 (3730–34,604)</td>
<td>4203 (2518–17,485)</td>
<td>0.001</td>
</tr>
</tbody>
</table>

COPD=chronic obstructive pulmonary disease; BPM=breaths per minute; bpm=beats per minute; *continuous data are presented as median and (range); categorical data are presented as count and (percent); **Differences between groups were tested using the Mann-Whitney U test for continuous data and the Fisher exact test for categorical data.

home remains difficult; risk-stratification studies have not accurately defined appropriate decision-making criteria. Indeed, a study evaluating HF patients discharged directly from the ED reported a 61% 90-day event rate (death and recidivism). Without a prospectively derived HF “risk-score,” emergency physicians must risk-stratify, based on the patient’s acute presentation, and social situation, and the physician’s previous clinical experience with similar patients. As a result, the majority of patients with HF are admitted.

In our OU, the emergency physician is provided with further opportunity for risk-stratification through testing such as serial cardiac markers, echocardiography, and rest cardiac perfusion imaging. They may also begin aggressive treatment, including the use of IV/p.o. vasodilators and diuretics, and the opportunity they have to provide patient education. These benefits of OU management potentially negate the necessity to make a conservative disposition decision based on limited information.

Another area of HF management that needs further investigation is OU treatment end points. Currently, patients are discharged based essentially on two broad criteria: 1) symptomatic improvement; and 2) not fulfilling obvious high-risk features such as positive cardiac markers, electrocardiogram changes, severe electrolyte disturbances, or vital sign abnormalities. However, what have not been delineated are specific treatment goals (e.g., urinary output, jugular venous distention changes, disappearance of an S3, changes in brain natriuretic peptide levels) that could be used to facilitate safe discharge. Other disease processes such as sepsis have been investigated in this manner, and such goal-directed therapy has proven to reduce morbidity and mortality while simultaneously being cost-effective.

Preliminary studies in HF patients have identified surrogate markers of tissue perfusion (lactate) and ventricular stretch (brain natriuretic peptide) as two potential targets for goal-directed therapy. However, rigorous, prospective studies,
especially of patients in the OU, have not been performed to date.

There are a number of limitations to our study. Though patients were enrolled prospectively, data were collected retrospectively. While this does not affect measurements such as vital signs and laboratory values, it does affect elements pertaining to history taking and patient follow-up. However, patients in our indigent population frequently receive the majority of their care at our institution and history and follow-up for these patients are relatively complete.

The ultimate decision for admission to the OU was left to the treating physician, potentially creating enrollment bias by placing patients in the OU that would normally have been sent home. However, the strong inclination toward conservative disposition (>80% of HF patients are admitted at our institution) of this cohort of patients minimizes the potential for enrollment bias. A formal cost-effectiveness analysis was not performed, and using charges to approximate costs has significant limitations.

Finally, while the two groups were enrolled during different time periods, HF diagnostics and treatment did not change to such a degree during this period as to significantly impact care.

Our results are consistent with other studies. Albert reported that the use of the OU to manage HF decreased overall hospital costs. Peacock and Craig, using chart review methodology, found that 50% of low-to-moderate-risk HF patients managed in an OU were discharged home with only a 12% readmission rate at 1 month report, that 90-day ED recidivism and hospital readmission decreased by 56% and 64%, respectively, in OU patients. Two methods similar to the OU approach to managing HF have also shown success. For example, Chapman and Torpy reported a 30% decrease in hospital admissions for HF after they opened an outpatient HF center operating along guidelines similar to those used in the OU.

While the results from our preliminary analysis are promising, a prospective study randomizing low-to-moderate-risk HF patients to either the inpatient setting or an OU is necessary. This would maximize the likelihood of successful risk matching between groups, and minimize the chance of enrollment bias. This would also allow for more rigorous data collection and follow-up, including more thorough quantification of economic and quality-of-life costs.


References


ED observation of HF

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