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

Emergency-department (ED)-based observation-unit treatment has been shown to reduce inpatient admissions, hospital bed-hours, and costs without adversely affecting outcomes for several conditions. A sequential group design study compared risk-matched, acute decompensated heart failure patients admitted directly to the inpatient setting with those admitted to an ED observation unit for up to 23 hours before ED disposition. Outcomes were 30-day readmissions or repeat ED visits for heart failure or 30-day mortality. Estimates of bed-hours and charges between the groups were compared. Sixty-four patients were enrolled with 36 inpatient admissions and 28 observation unit patients. No patients died within 30 days. Observation unit patients had no significant difference in outcomes, a decrease in time from ED triage to discharge, a saving in mean bed-hours, and less total charges. This pilot trial provides preliminary data that suggest admitted, low-risk heart failure patients may be safely and cost-effectively managed in an ED-based observation unit. These findings need to be further evaluated in a randomized clinical trial. (CHF. 2005;11:68–72) ©2005 CHF, Inc.

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.[1,2] ED patients seen, admitted, and treated in an inpatient bed account for the majority of expenditures for HF care.[3] Up to 80% of patients discharged from the hospital with a primary diagnosis of HF come from the ED.[2,4,5] 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.[2,6] 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.[7–11]

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

Alan B. Storrow, MD;[1] Sean P. Collins, MD;[1] Michael S. Lyons, MD;[1] Lynne E. Wagoner, MD;[2] W. Brian Gibler, MD;[2] Christopher J. Lindsell, PhD[1,3]

From the Department of Emergency Medicine;[1] Department of Internal Medicine, Division of Cardiology;[2] and Institute for Health Policy and Health Services Research;[3] University of Cincinnati, Cincinnati, OH

Address for correspondence: Alan B. Storrow, MD, Department of Emergency Medicine, 231 Albert Sabin Way, MSB # 6109, Cincinnati, OH 45267-0769

E-mail: alan.storrow@uc.edu

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.[6,12–21]

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.[22] 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
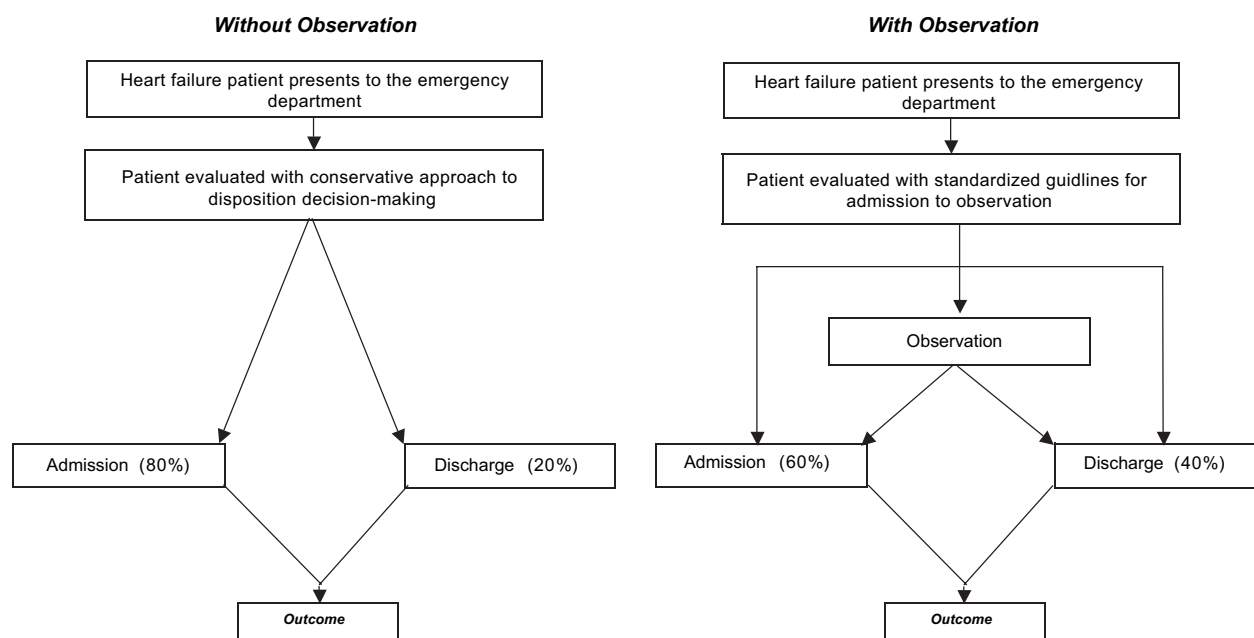

Without Observation

Heart failure patient presents to the emergency department

↓

Patient evaluated with conservative approach to disposition decision-making

Admission (80%)   Discharge (20%)

Outcome

With Observation

Heart failure patient presents to the emergency department

↓

Patient evaluated with standardized guidlines for admission to observation

Observation

Admission (60%)   Discharge (40%)

Outcome
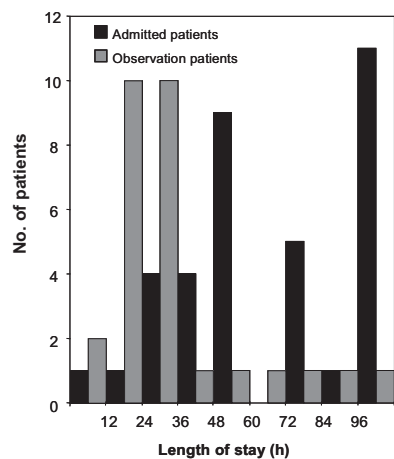
Figure 1. Schematic of the study

Figure 2. Histogram showing the distribution of total lengths of stay for admitted patients and patients in the observation unit.

against medical advice and two patients left the inpatient setting against medical advice. Clinical outcomes data have been analyzed on an intent-to-treat basis. Financial and resource outcomes are analyzed excluding these patients.

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.

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 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*	
Paroxysmal nocturnal dyspnea	Extremity edema
Neck vein distention	Night cough
Pulmonary edema (on chest x-ray)	Dyspnea on exertion
Rales	Hepatomegaly
Cardiomegaly	Pleural effusion
S_3 gallop	Tachycardia (≥130 bpm)
Jugular venous distention	
Positive hepatojugular reflex	
AND	
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 criteria[6,12–21]

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 hypo/hypertension
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

*Adapted for emergency department use from the Framingham criteria[6,12–21]

Table III. Characteristics of Study Subjects*

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

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.[6,12–21] Indeed, a study evaluating HF patients discharged directly from the ED reported a 61% 90-day event rate (death and recidivism).[13] 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.[2,23]

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 par-

tially 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 S_3, 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.[24]
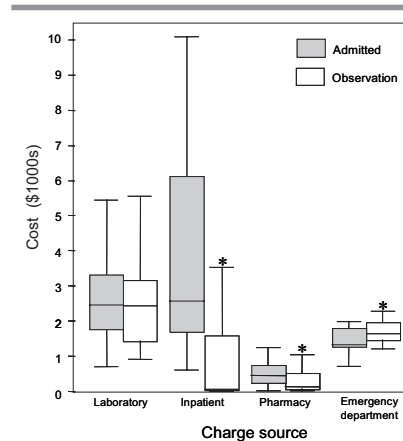

Figure 3. Charges for observation unit patients and patients admitted directly from the emergency department. *Indicates significant difference (p<0.05)

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.[25,26] 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[27] reported that the use of the OU to manage HF decreased overall hospital costs. Peacock and Craig,[28] 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.[7,29] Methods similar to the OU approach to managing HF have also shown success. For example, Chapman and Torpy[30] 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 minimizes 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

1 American Heart Association. *Heart and Stroke Statistical Update.* Dallas, TX: American Heart Association; 2005;3.
2 Graff L, Orledge J, Radford MJ, et al. Correlation of the Agency for Health Care Policy and Research congestive heart failure admission guideline with mortality: peer review organization voluntary hospital association initiative to decrease events (PROVIDE) for congestive heart failure. *Ann Emerg Med.* 1999;34(4 pt 1):429–437.
3 National Heart, Lung, and Blood Institute. *Morbidity and Mortality: 2002 Chart Book on Cardiovascular, Lung, and Blood Diseases.* Bethesda, MD: National Institutes of Health; 2002.
4 Polanczyk CA, Rohde LE, Philbin EA, et al. A new casemix adjustment index for hospital mortality among patients with congestive heart failure. *Med Care.* 1998;36:1489–1499.
5 Smith WR, Poses RM, McClish DK, et al. Prognostic judgments and triage decisions for patients with acute congestive heart failure. *Chest.* 2002;121:1610–1617.
6 Butler J, Hanumanthu S, Chomsky D, et al. Frequency of low-risk hospital admissions for heart failure. *Am J Cardiol.* 1998;81:41–44.
7 Peacock WF, Emerman CL. Emergency department observation unit heart failure treatment protocol decreases adverse outcome rates. *J Card Fail.* 1999;5(3 suppl 1):77.
8 Peacock WF. Acute emergency department management of heart failure. *Heart Fail Rev.* 2003;8:335–338.
9 Peacock WF, Allegra J, Ander D, et al. Management of acute decompensated heart failure in the emergency department. *Congest Heart Fail.* 2003;(suppl 1):3–18.
10 Peacock WF 4th, Albert NM. Observation unit management of heart failure. *Emerg Med Clin North Am.* 2001;19:209–232.
11 Peacock WF 4th, Remer EE, Aponte J, et al. Effective observation unit treatment of decompensated heart failure. *Congest Heart Fail.* 2002;8:68–73.
12 Harjai KJ, Thompson HW, Turgut T, et al. Simple clinical variables are markers of the propensity for readmission in patients hospitalized with heart failure. *Am J Cardiol.* 2001;87:234–237, A9.
13 Rame JE, Sheffield MA, Dries DL, et al. Outcomes after emergency department discharge with a primary diagnosis of heart failure. *Am Heart J.* 2001;142:714–719.
14 Cowie MR, Wood DA, Coats AJ, et al. Survival of patients with a new diagnosis of heart failure: a population-based study. *Heart.* 2000;83:505–510.
15 Villacorta H, Rocha N, Cardoso R, et al. Hospital outcome and short-term follow-up of elderly patients presenting to the emergency unit with congestive heart failure. *Arq Bras Cardiol.* 1998;70:167–171.
16 Chin MH, Goldman L. Correlates of early hospital readmission or death in patients with congestive heart failure. *Am J Cardiol.* 1997;79:1640–1644.
17 Chin MH, Goldman L. Correlates of major complications or death in patients admitted to the hospital with congestive heart failure. *Arch Intern Med.* 1996;156:1814–1820.
18 Selker HP, Griffith JL, D'Agostino RB. A time-insensitive predictive instrument for acute hospital mortality due to congestive heart failure: development, testing, and use for comparing hospitals: a multicenter study. *Med Care.* 1994;32:1040–1052.
19 Esdaile JM, Horwitz RI, Levinton C, et al. Response to initial therapy and new onset as predictors of prognosis in patients hospitalized with congestive heart failure. *Clin Invest Med.* 1992;15:122–131.
20 Katz MH, Nicholson BW, Singer DE, et al. The triage decision in pulmonary edema. *J Gen Intern Med.* 1988;3:533–539.
21 Plotnick GD, Kelemen MH, Garrett RB, et al. Acute cardiogenic pulmonary edema in the elderly: factors predicting in-hospital and one-year mortality. *South Med J.* 1982;75:565–569.
22 Maisel AS, Krishnaswamy P, Nowak RM, et al. Rapid measurement of B-type natriuretic peptide in the emergency diagnosis of heart failure. *N Engl J Med.* 2002;347:161–167.
23 Collins SP, Ronan-Bentle S, Storrow AB. Diagnosis and prognostic usefulness of natriuretic peptides in emergency department patients with dyspnea. *Ann Emerg Med.* 2003;41:532–545.
24 Rivers E, Nguyen B, Havstad S, et al. Early goal-directed therapy in the treatment of severe sepsis and septic shock. *N Engl J Med.* 2001;345:1368–1377.
25 Ander DS, Jaggi M, Rivers E, et al. Undetected cardiogenic shock in patients with congestive heart failure presenting to the emergency department. *Am J Cardiol.* 1998;82:888–891.
26 Cheng V, Kazanagra R, Garcia A, et al. A rapid bedside test for B-type peptide predicts treatment outcomes in patients admitted for decompensated heart failure: a pilot study. *J Am Coll Cardiol.* 2001;37:386–391.
27 Peacock WF, Remer, EE, Aponte J, et al. Effective observation treatment of decompensated heart failure. *Congest Heart Fail.* 2002;8:68–73.
28 Peacock WF, Craig MT. Predictors of unsuccessful treatment for congestive heart failure in the emergency department observation unit. *Acad Emerg Med.* 1997;4:493–494.
29 Peacock WF. Rapid optimization: strategies for optimal care of decompensated congestive heart-failure patients in the emergency department. *Rev Cardiovasc Med.* 2002;3(suppl 4):S41–S48.
30 Chapman DB, Torpy J. Development of a heart failure center: a medical center and cardiology practice join forces to improve care and reduce costs. *Am J Manag Care.* 1997;3:431–437.