Rapid Optimization: Strategies for Optimal Care of Decompensated Congestive Heart-Failure Patients in the Emergency Department

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Sooner or later all heart failure patients will present to the emergency department for medical attention. The American demographic trend of a skyrocketing elderly population coupled with the current heart-failure epidemic means that strategies optimizing emergency department care of heart failure are needed. Safe and effective management has the potential to decrease hospitalizations and intensive care unit admissions, prevent readmissions, and improve the quality of life in the heart-failure patient, as well as relieving some of the economic burden of heart-failure management from the U.S. medical care system. The emergency department observation unit provides a successful venue for the management of decompensated heart failure, and nesiritide offers the promise of shorter hospitalizations, improved quality of life, and better symptom resolution than standard therapy.
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Heart failure (HF) is predominately a disease of the elderly.[1] It is insidiously progressive and is characterized by an increasing frequency of hospitalizations, many of which begin in the emergency department (ED). In fact, it is nearly axiomatic that sooner or later all HF patients will present to the ED for medical attention. Coupling the American demographic trend of a skyrocketing elderly population with the current HF epidemic,[2] strategies optimizing ED care of HF are needed. Safe and effective ED HF management has the potential to decrease hospitalizations and intensive care unit (ICU) admissions, prevent readmissions, and improve the quality of life in the HF patient, as well as relieve some of the economic burden of HF management from the U.S. medical care system.

B-Type Natriuretic Peptide Assay as Adjunct to Clinical Presentation for Identification of Acutely Decompensated Heart Failure

In the ED, diagnosis of New York Heart Association (NYHA) class IV HF, acute pulmonary edema, and cardiogenic shock is relatively straightforward. However, end-stage and near-terminal patients constitute only 5% of the overall HF population.[2] NYHA class III patients account for up to 25%, and the remaining 70% are either class I or II. Although a correct diagnosis may be easier in the higher classes, it is the lower classes who receive the greatest benefit if identified before progressing to a higher class. Optimal management of the NYHA class IV patient has the potential to prevent mortality on the order of months, as compared to the patient diagnosed as NYHA class II, whose mortality may be delayed from months to years. Although the lower classes have the most to gain by early detection, it is at this stage of the disease that diagnosis is at its most difficult.

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A number of characteristics and coexistent conditions conspire to obscure an accurate HF diagnosis. The most common confounders are concurrent diseases, obesity, deconditioning, and female gender. Unfortunately, by virtue of being a disease of the elderly, HF occurs with greatest frequency in the same population that suffers from a high rate of coexistent disease—for example, chronic obstructive pulmonary disease (COPD) and renal failure. Furthermore, the United States is presently suffering a deconditioning and obesity epidemic. Less than one third of Americans exercise regularly, and Colorado, the thinnest state in the union, has an obesity rate of 13%. (Data from an interview with a representative from the Center for Disease Control).

Because of these confounders, HF can be a difficult diagnosis. In primary care clinics the correct diagnosis is made on the first clinic visit in only 18% of women and 36% of men.[3] In the ED, where symptoms are presumably of greater magnitude and acuity, the misdiagnosis rate is lower (12%) and evenly split between over- and underdiagnosis.[4]

The measurement of B-type natriuretic peptide (BNP) can improve diagnostic accuracy in suspected HF. In 250 dyspneic ED HF patients, clinicians blinded to BNP levels correctly diagnosed the presence or absence of HF in 88%.[4] Had the BNP assay been used in addition to clinical judgment, the correct diagnosis would have been made in all but 1 patient. The BNP assay has also been reported to distinguish HF from COPD reliably and to differentiate edema due to HF from edema from other causes.[5]

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Physiologically, the results of quantitative BNP measurement vary directly as a function of pulmonary capillary wedge pressure (PCWP), and it is in this manner that an elevated BNP detects the presence of HF. A normal BNP is considered to be less than 100 pg/mL.[6] Consequently, when the BNP is moderately elevated above the normal cut-point, other causes of an elevated PCWP must be considered as potential diagnoses. This includes conditions where an elevated PCWP is a result of non-HF pathology, such as primary pulmonary hypertension, renal failure, ascites due to hepatitis, pulmonary embolus, and other conditions. Overall, an elevated BNP assay provides sensitivity, specificity, and positive and negative predictive values for HF of 94%, 94%, 92%, and 96%, respectively.[4] When the BNP assay is less than 100 pg/mL, HF is a very unlikely explanation for the patient's symptoms. However, if the assay is positive, especially at low elevations, other causes of elevated PCWP should be considered as well as HF. In this situation, diagnostic confirmation should be sought by other testing measures. When the BNP is markedly elevated, HF is the most likely diagnosis.

Use of Nesiritide and Diuretics in Patients with Acutely Decompensated Heart Failure

Initiation of Nesiritide with Bolus and Infusion in the Emergency Department

The most compelling argument for the ED initiation of treatment in all patients ultimately destined for hospitalization arises from quality assurance data on the time to treatment of pneumonia. Investigators examining time delays in patients admitted for inpatient treatment of pneumonia reported that if antibiotic therapy was not started while the patient was still in the ED, an average of 6 additional hours were required before the first dose was actually administered.[7] This was

added to the time the patient had already spent in the ED. Ultimately, failure to initiate ED therapy translates into a significant delay in receiving definitive treatment. As with pneumonia, HF patients should have treatment initiated before leaving the department. Patients whose care can be delayed for 9–10 hours may be candidates for outpatient management rather than inpatient admission.

For HF patients who are evaluated in the ED, the method and timing of treatment can have a significant impact on patient management. The Acute Decompensated Heart Failure Registry (ADHERE) is a multicenter database of patients discharged after a hospitalization for acutely decompensated HF. In 1442 patients from 42 hospitals with an ED admission and a HF discharge, those treated with intermittent intravenous (IV) bolus therapy (eg, furosemide bolus) of any type while in the ED had a resulting mean hospitalization length of stay of 9.9 days. This was compared to the group who received any type of IV infusion therapy (eg, nesiritide) while in the ED. If a constant IV infusion was used in the ED, the mean inpatient length of stay was 6.6 days ($P = .004$). In this preliminary analysis, early infusion therapy, as opposed to intermittent bolus therapy, was associated with a significantly shorter length of inpatient hospitalization.

This data has been reinforced in a preliminary retrospective analysis of The Cleveland Clinic's experience with nesiritide (Natrecor, Scios Inc., Sunnyvale, CA) in the ED treatment of acute decompensated heart failure. We found a marked decrease in length of stay in patients receiving nesiritide compared to standard therapy. In 159 patients admitted to the hospital from the ED, 22 were started on nesiritide while still in the ED. Their average length of hospitalization was 3.7 days. This compared to 137 patients treated using standard therapy but without nesiritide, whose mean length of stay was 5.5 days. The early use of nesiritide, started while still in the ED, is associated with a marked decrease in the length of inpatient hospitalization.

With the majority of patients, experienced emergency physicians can rapidly determine when inpatient HF treatment is necessary. As with pneumonia, HF treatment should be started while still in the ED, as soon as the diagnosis and admission necessity are recognized. Although direct patient benefit is the strongest possible argument for prompt treatment, it should also be noted that the inpatient treatment of HF is driven by the Diagnostic Related Group (DRG) system. A significant delay in therapy ultimately delays discharge, such that there are negative financial incentives for a hospital to deter the ED therapy of HF.

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Avoiding the Intensive Care Unit with Rapid Transfer to Step-Down Telemetry Units

The acutely decompensated ED HF patient with severe dyspnea and hypertension is often rapidly improved by the urgent use of intravenous vasodilators. Nitroglycerin, historically the agent of choice, is an efficacious vasodilator. At adequate levels, it rapidly improves the symptoms of congestion. It is common that, within 1 hour of ED admission, patients who initially presented in severely unstable acute pulmonary edema are markedly improved. This is strictly the result of the vasodilation effect and occurs despite minimal urine output. However, because the patient is now on a nitroglycerin drip, ICU admission is commonly mandated per hospital policy.

The mandate of ICU admission for patients on a nitroglycerin drip is the consequence of pharmacodynamics. Nitroglycerin's characteristics ultimately drive the need for increased monitoring and skilled nursing unavailable in the non-ICU environment. Because nitroglycerin may rapidly induce tachyphylaxis, it is necessary to increase the dosage frequently to maintain hemodynamic efficacy. Failure to up-titrate the dose will result in a time dependent deterioration of beneficial hemodynamic effects. Dose titration must be continued until diuretic-induced decongestion occurs and overall fluid status is improved. However, with each increase in dose, a new period of potential hemodynamic instability is introduced. Hemodynamically active drugs, requiring multiple titrations, require the intensive care environment. Patients requiring a nitroglycerin drip are appropriate for the ICU environment, but at increased costs and nursing time.

Nesiritide can provide an alternative to ICU admission in these patients. Because nesiritide does not induce tachyphylaxis, initially critical ED HF patients who are stabilized on nesiritide do not require continual dose titration while waiting for diuretic-induced decongestion to occur. Intravenous nitroglycerin, in contrast, may rapidly result in tachyphylaxis. Intravenous nitroglycerin given at high dose (160 μg/min) was shown to lose vasodilating

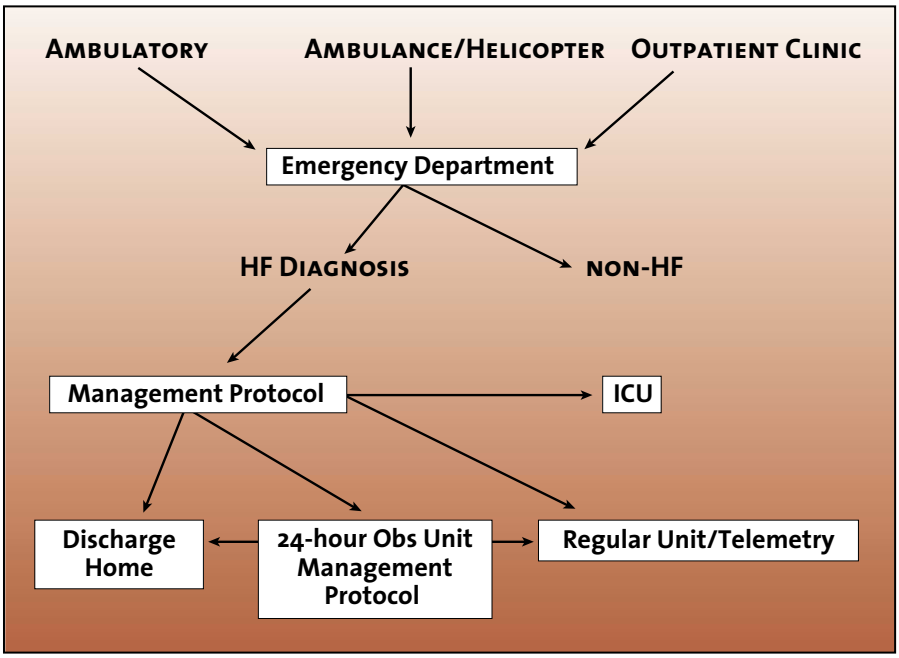

Figure 1. *Heart Failure Management Flow Diagram. HF, heart failure; Obs, observation; ICU, intensive care unit*

effect within 6 hours and the PCWP that initially fell began to rise. Therefore, once a fixed dose of nesiritide has been established, hemodynamics are more consistent than with nitroglycerin. Patients on nesiritide can be admitted from the ED to a telemetry bed, and ICU admission can be avoided.

The Vasodilator Management of Acute Decompensated Congestive Heart Failure (VMAC)[8] trial enrolled 489 acutely decompensated HF patients, of whom only half were selected for management with a pulmonary artery (PA) catheter. The non-PA catheter patients were managed clinically at the direction of the attending physician. In both the non-PA catheter and the PA catheter subsets, outcomes of dyspnea and global clinical score were superior in the nesiritide group as compared to the nitroglycerin cohort. These findings support the fact that after a period of initial ED stabilization, ICU admission for PA catheter–directed hemodynamic therapy in patients on nesiritide is unnecessary in selected patients.

Consequently, hemodynamically stable patients may be admitted to a telemetry bed instead of an ICU environment. Furthermore, patients initially admitted to the ICU may be transferred to a telemetry bed as soon as they are stabilized on a fixed dose of nesiritide. A case-control study of health care resource utilization for heart failure patients receiving nesiritide and those not receiving nesiritide within 48 hours of admission showed a reduction in ICU and length of hospital stay, less inotropic infusion use, and fewer laboratory tests.[9] Overall, there was a reduction in the use of health care resources and significant cost savings with nesiritide therapy.

Observation Unit Therapy

The ED observation unit is an effective treatment option for many conditions anticipated to require a short period of intensive therapy or diagnostic evaluation. Although the condition most extensively managed in the observation unit has been the evaluation of chest pain, the Center for Medicare and Medicaid Services (CMS) (formerly Health Care Financing Administration) recently approved outpatient billing codes for chest pain, asthma, and heart failure.

In the ED treatment of acutely

Table 1
Observation Unit Exclusion Criteria

1. Unstable vital signs
   a. Heart rate > 130
   b. Systolic blood pressure < 85 mm Hg or > 175 mm Hg after treatment
   c. O_2 saturation < 90%
   d. Unstable airway
2. Evidence of acute cardiac ischemia
   a. Ongoing ischemic chest pain
   b. Positive serum marker of ischemia (troponin, CK-MB)
   c. Electrocardiogram with ischemic change (or left bundle branch block not known to be old)
3. Cardiac arrhythmia requiring continuous intravenous intervention
4. Inadequate systemic perfusion manifested by abnormal mental status

CK-MB, creatinine kinase-MB.

decompensated HF, the relief of congestion is the rate-limiting step preventing discharge to home. It is an unusual HF patient who can be discharged after a 4-hour ED treatment course; the majority of HF patients are admitted for inpatient therapy. An alternative to inpatient admission is the ED observation unit. The observation unit offers an opportunity for a longer term of therapy and may ultimately prevent the necessity of an inpatient admission.[10] In our institution, 7% of HF patients in the ED are discharged home, 28% are admitted to the observation unit, 2% admitted to the ICU, and the remainder admitted for inpatient hospitalization (Figure 1).

The observation unit has been shown to provide safe and effective therapy in selected HF patients. In an initial retrospective study of decompensated HF patients,[11] post-discharge revisit rates in those treated in the observation unit for 24 hours, compared to patients treated on an inpatient unit and discharged home within 24 hours, were superior in the observation unit cohort. In the observation unit–treated group, there were no return visits within 1 week of admission, compared to a revisit rate of 8% in the hospitalized group. By 1 month, only 8% of observation unit patients had revisits, compared to 16% of the inpatient management group. There were no mortality differences between the two groups ($P > .05$). This established that observation unit treatment is at least as safe and effective as a similar period of inpatient hospitalization.

Because observation units generally limit treatment to less than 24 hours, have lower nursing–patient staffing ratios, and have limited invasive monitoring capability, careful patient selection is necessary to ensure that admissions are appropriate for the level of care available. Published exclusion criteria, designed to prevent admission of patients whose needs exceed the resources available in the observation unit, are listed in Table 1.[12] Patients with airway instability, a high probability of adverse outcome (eg, acute myocardial infarction), and those with hemodynamics suggestive of critical underlying pathology should be excluded.

Table 2
Observation Unit Heart Failure Protocol Entry Criteria

Must have at least 1 from each category
1. B-type natriuretic peptide > 100 pg/mL
2. History
   a. Orthopnea
   b. Dyspnea on exertion
   c. Paroxysmal nocturnal dyspnea
   d. Shortness of breath
   e. Swelling of legs or abdomen
   f. Weight gain
3. Exam
   a. Jugular venous distention or elevation in pulsation
   b. Positive abdominal jugular reflux
   c. S3/S4
   d. Inspiratory rales
   e. Peripheral edema
4. Chest X-Ray
   a. Cardiomegaly
   b. Pulmonary vascular congestion
   c. Kerley B lines
   d. Pulmonary edema
   e. Pleural effusion

Once admitted to the observation unit, many facets of medical management must be completed in a timely fashion to ensure optimum outcomes and discharge rates. Attention to the many specific individual details required for the management of HF[12] can be difficult in a busy emergency department. This includes not only medication intervention and titration, but diagnostic evaluation, patient education, and discharge planning. Protocol-driven treatment algorithms have been proven to provide superior outcomes compared to standard therapy in many facets of HF management,[13,14] including the observation unit.[10]

ED observation unit protocol-driven management can have a significant impact on outcomes compared to independent physician-driven care. In a before-and-after study of 154 patients treated for decompensated HF in the ED observation unit, the implementation of an HF management protocol resulted in significant outcome improvements.[10] Post-protocol 90-day ED HF revisit rates declined by 43% (0.90 to 0.51; $P < .0000$), as compared to pre-protocol management. Furthermore, the 90-day HF rehospitalization rate decreased by 35% (0.77 to 0.50; $P = .007$) and the 90-day rates of death and observation unit HF readmission decreased from 4% to 1% ($P = .096$) and 18% to 11% ($P = .099$), respectively. During the same period, a cost analysis determined that annualized hospital costs declined by nearly $100,000, predominately as

a result of decreased hospital admissions and readmission avoidance.[15]

The observation unit management of HF results in changes in the inpatient HF population. Ultimately, patients are diverted from inpatient units to the observation unit and from the observation unit to outpatient management. During the postprotocol period, inpatient severity of illness, indexed by the average number of billable procedures performed on each patient with a discharge diagnosis of HF, increased by 11%. This suggests an improvement in resource-matching between patients requiring intensive monitoring environments and those who can benefit from less costly observation unit care. When appropriately implemented, a protocol-driven observation unit HF management system decreases revisit rates and improves clinical outcomes.

With implementation of an HF management protocol, it is critical that patient selection is accurate. It is unlikely that a patient without HF would benefit from an aggressive vasodilation and diuresis protocol. The criteria in Table 2 are structured to help ensure that only patients likely to have decompensated congestive HF will be placed in the observation unit HF protocol.

Nesiritide is appropriate for use in the ED observation unit. Once stabilized in the ED, patients on the recommended fixed dose of nesiritide (2 μg/kg IV bolus, then a 0.01 μg/kg infusion) are candidates for further therapy in the observation unit. A preliminary retrospective review of The Cleveland Clinic experience demonstrates the impact of nesiritide incorporated within an observation unit HF protocol. In an evaluation of the discharge rates in 48 patients treated for HF in our observation unit, we found that 89% (16 of 18) of those on nesiritide were discharged within 24 hours. This compared to only 47% (14 of 30) of the patients receiving standard HF therapy. Nesiritide combined with standard therapy may offer greatly improved discharge rates. Finally, the PROACTION Trial, a large, multicenter, double-blinded, randomized study of standard observation unit therapy, with and without nesiritide, will have results available by autumn of 2002. It should help determine the magnitude of the effect of nesiritide on observation unit treatment.

Table 3
Observation Unit Discharge Criteria

1. Subjective improvement
2. Ambulatory, without long suffering orthostasis
3. Resting heart rate < 100 beats/min
4. Systolic blood pressure > 80 mm Hg
5. Total urine output > 1000 mL and no new decrease in urine output below 30 mL/hr (or < 0.5 mL/kg/hr)
6. Room air oxygen saturation > 90% (unless on home oxygen)
7. All CK-MB < 8.8 ng/mL, and troponin T < 0.2μg/L
8. No ischemic-type chest pain
9. No new clinically significant arrhythmia
10. Stable electrolyte profile

CK-MB, creatinine kinase-MB.

The only validated observation unit HF protocol published to date includes an aggressive diuretic algorithm, initiated in the ED and continued throughout the observation unit stay.[10,12] Diuretic use is driven by urine output goals of at least 500 mL in the first 2 hours, unless the creatinine is above 2.5 mg/dL, when output guidelines are halved. An initial IV dose of furosemide, equivalent to up to twice the patient's normal 24-hour dose (to a maximum of 180 mg) is usually sufficient. If the patient fails to attain the output goal, the diuretic dose is doubled and repeated. If urine output is still inadequate, inpatient admission for invasive monitoring is suggested.

Additionally, angiotensin-converting enzyme (ACE) inhibitor algorithms encourage physician initiation and uptitration toward target levels, provided there are no renal function contraindications, systolic blood pressure is adequate, and there is no history of ACE inhibitor intolerance. Unless there are significant contraindications, all HF patients should be discharged on an ACE inhibitor.[16]

The observation unit provides an opportunity for more extensive evaluation than can be performed in the ED. Ejection fraction measurement may be determined in those without an established diagnosis of systolic HF or if diastolic HF was diagnosed more than 1 year before the current presentation. This environment also offers the option of elective multidisciplinary consultations, not available in a busy ED. This is especially valuable for patients who may have difficulty in transportation to outpatient appointments. HF cardiology special-

ists may see the patient to arrange postdischarge clinic follow-up, evaluate discharge medication dosages, and screen candidates for heart transplantation listing. Other ancillary care staff may have the opportunity of consultation, including dietetics and home health care workers. Social work evaluation ensures that all patients have the ability to actually purchase their medicines, and social workers can arrange a home environment assessment to determine if there are other psychosocial, cultural, or economic factors preventing therapeutic compliance. A home health care consultation serves to ensure postdischarge follow-up nursing services for homebound or nonambulatory patients.

Because noncompliance is estimated to cause up to 50% of HF rehospitalizations,[17] patient education is a critical facet of the observation unit treatment program. It is also important to evaluate additional factors contributing to HF exacerbation. Besides bedside teaching, videotapes on HF may provide detailed education at a teachable moment for the patient. Finally, patients should be provided with literature on HF, its medications, and lifestyle modification.

Observation unit patients may be discharged at any time, if there has been a good therapeutic response. Although there are very few studies that have determined predictors of successful ED discharge, urine outputs greater than 1 L are associated with a higher rate of successful discharge from the ED observation unit.[18] Discharge criteria may help to determine patients ready to be sent home (see Table 3). Most important in this determination is the clinical assessment, but a posttreatment BNP level can assist in the disposition decision. In a study of hospitalized decompensated HF patients, patients with a rising or unchanged BNP level at discharge, despite aggressive therapy, had higher rates of death or revisits. This compared to lower rates of death or revisits if the BNP level was decreased in response to aggressive therapy.[19] Because endogenous BNP and exogenously administered nesiritide are biochemically identical, to evaluate posttreatment BNP levels, nesiritide must be turned off for approximately 2 hours (about 6 half-lives) before a posttherapy assay will reflect the endogenous state rather than the administered drug.

Main Points

- End-stage and near-terminal patients constitute only 5% of the overall heart failure (HF) population; New York Heart Association (NYHA) class III patients account for up to 25%, and the remaining 70% are either class I or II.
- Although a correct diagnosis may be easier in the higher NYHA classes, the lower classes receive the greatest benefit if identified before progressing to a higher class.
- The most common characteristics that obscure an accurate HF diagnosis are concurrent diseases, obesity, deconditioning, and female gender; HF occurs with greatest frequency in the same population that suffers from a high rate of coexistent diseases such as chronic obstructive pulmonary disease and renal failure.
- Measurement of B-type natriuretic peptide (BNP) can improve diagnostic accuracy in suspected HF; BNP assay can also distinguish HF from chronic obstructive pulmonary disease reliably and differentiate edema due to HF from edema from other causes.
- When the BNP assay is less than 100 pg/mL, HF is a very unlikely explanation for the patient's symptoms; when the BN is markedly elevated, HF is the most likely diagnosis.
- Failure to initiate therapy in the emergency department translates into a significant delay in receiving definitive treatment; HF patients should have treatment initiated before leaving the department.
- Early infusion therapy, as opposed to intermittent bolus therapy, is associated with a significantly shorter length of inpatient hospitalization.
- Unlike nitroglycerin, nesiritide does not induce tachyphylaxis; initially critical patients stabilized on nesiritide do not require continual dose titration while waiting for diuretic-induced decongestion to occur.
- Patients on nesiritide can be admitted from the emergency department to a telemetry bed, and intensive care unit admission can avoided.
- The observation unit has been shown to provide safe and effective therapy in selected HF patients. Patients with airway instability, a high probability of adverse outcome (eg, acute myocardial infarction), and those with hemodynamics suggestive of critical underlying pathology should be excluded.

Patients not meeting discharge criteria by the 24-hour observation unit length of stay limit require inpatient admission. However, even in these patients, benefit accrues from observation unit hospitalization. In patients admitted to the hospital from the observation unit after failure of therapy, mean hospitalization length of stay, inclusive of their observation unit time, was 0.8 days less than patients admitted directly from the ED to the inpatient unit.[15]

Summary

Natriuretic peptides represent an extremely important advance in the treatment of HF. The BNP assay that is now available significantly improves diagnostic accuracy over physician impression. As a therapy, nesiritide offers the promise of shorter hospitalizations, improved quality of life, and better symptom resolution than standard therapy. Lastly, the ED observation unit provides a successful venue for the management of decompensated HF. ■

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