Patients with acute heart failure syndromes (AHFS) are defined as those who present with heart failure (HF) signs and symptoms in need of urgent or emergent therapy. More than 1 million hospitalizations for AHFS occur every year, at a cost of more than $20 billion dollars. HF is the costliest and most common cause of readmission for Medicare beneficiaries. Post-discharge mortality and re-hospitalization affects approximately 45% of discharged patients within 90 days. Attempts to improve these post-discharge event rates with novel therapies have largely failed.

Robust evidence to guide clinicians on initial therapeutic management is lacking; there are no class I, level A (best evidence) recommendations regarding the use of any therapy for initial AHFS management. Despite the lack of robust evidence, smaller studies and expert opinion suggest a consensus approach to early management. Readers are referred to other textbooks for a more detailed explanation of epidemiology and pathophysiology. This article focuses on initial emergency department (ED) therapeutic management.

More than 6 million persons in the United States have a diagnosis of HF with more than 550,000 new diagnoses each year. Of the 1 million annual AHFS admissions, approximately 80% initially present to the ED. The aging of the population, combined with more patients living longer after myocardial infarction, will likely lead to an increased public health burden of HF.

Approximately half of AHFS admissions are female, and approximately half have a relatively preserved ejection fraction (EF >40%). The heterogeneity of the patient population is perhaps its most unifying characteristic; patients with AHFS have multiple comorbid cardiac and noncardiac conditions.

Despite significant reductions in cardiovascular morbidity and mortality over the last 10 years, post-discharge death and re-hospitalization from AHFS remains high,
affecting ∼45% of the discharged population within 90 days.4 Inpatient mortality remains relatively low, ranging from 4% to 9%.1,8,9,11 Attempts to improve these outcomes with novel therapies have failed, with no new therapy demonstrating any safe reduction in mortality and/or rehospitalization.12–17

At present, there are no class I, level A therapeutic guideline recommendations for AHFS.6 Present-day therapies, such as oxygen, noninvasive ventilation, intravenous (IV) loop diuretics, morphine, and nitrates are the same therapies used 40 years ago.18 Small studies as well as retrospective analyses suggest that the most commonly used therapy, IV loop diuretics, are associated with harm, including mortality, worsening renal function, and neurohormonal activation.19 Yet although no conclusive data exist, decades of use support both its safety and effectiveness at improving signs and symptoms.

Whether supportive evidence for traditional therapies will be forthcoming (eg, randomized controlled trials) is unknown. Given this important contextual caveat, that robust evidence is lacking, a framework for ED management of AHFS is presented.

INITIAL APPROACH TO PATIENTS WITH AHFS

Prompt recognition and treatment of any life-threatening illness is the first priority for any patient presenting with signs and symptoms of AHFS. This article assumes that, in the management of AHFS, there is no other precipitant or cause that is of greater treatment priority and that AHFS is a manifestation of that precipitant. For example, a patient who presents with ST-segment elevation myocardial infarction (STEMI) and AHFS, treatment of STEMI is the first priority.

DIAGNOSIS

An initial approach to ED management of AHFS is shown in Table 1.20 Because patients present with signs and symptoms rather than a diagnosis, ensuring that the patient has AHFS versus another diagnosis is a critical step, but is not always easy, because signs and symptoms of AHFS are also seen in other disease states. The most common symptom reported by patients is dyspnea or breathlessness.21 The most specific physical examination findings are an S3 and jugular venous distention (JVD).22 A chest radiograph without evidence of volume overload (eg, vascular engorgement or interstitial edema) does not rule out acute HF.20 Patients with chronic heart failure adapt to a volume-overloaded state; thus radiographic features may be absent.23,24

In the last 10 years, natriuretic peptides (NP) have established both their diagnostic and prognostic roles.25 When an HF diagnosis is in doubt, a brain natriuretic peptide (BNP) level less than 100 pg/mL largely rules out AHFS, whereas a level greater than 400 pg/mL rules in AHFS. However, these are guides and neither very high nor very low levels absolutely rule AHFS in or out. N-terminal probrain natriuretic peptide (NT-proBNP) levels have the same role, although threshold levels differ based on age.25 From a prognostic standpoint, higher NP levels are independently associated with worse outcomes.25 Use of NPs has been associated with shorter length of stay, decreased time to treatment, and even improved outcomes in AHFS; however, for some of these findings, further prospective studies are needed.25–28

DETERMINE THE CLINICAL PROFILE AND BEGIN THERAPY

Dividing patients based on their presenting characteristics is recommended, given the heterogeneity of the patient population. However, prospective evidence to support
Table 1
Initial approach to ED management of AHFS

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Treat immediate life-threatening conditions/stabilize patient</td>
</tr>
<tr>
<td>2.</td>
<td>Establish the diagnosis</td>
</tr>
<tr>
<td>3.</td>
<td>Determine clinical profile and begin initial treatment</td>
</tr>
<tr>
<td>4.</td>
<td>Determine and manage the cause or precipitant</td>
</tr>
<tr>
<td>5.</td>
<td>Alleviate symptoms (eg, dyspnea)</td>
</tr>
<tr>
<td>6.</td>
<td>Protect/preserve myocardium and renal function</td>
</tr>
<tr>
<td>7.</td>
<td>Make disposition</td>
</tr>
</tbody>
</table>

Abbreviations: BNP, brain natriuretic peptide; CAD, coronary artery disease; CXR, chest radiograph; ECG, electrocardiogram; HR, heart rate; JVD, jugular venous distention; JVP, jugular venous pressure.

a These steps usually occur in parallel, not in series.

b Retrospective data suggest that morphine is associated with worse outcomes.


this approach is minimal and is based largely on smaller studies and expert consensus opinion.29 Multiple approaches have been proposed1,20,30; central to all such proposals is the overlap between groups. The approach recommended here divides patients based on initial systolic blood pressure, an important prognostic marker.4,29

The presented framework (Fig. 1) broadly divides patients with AHFS into 3 categories: (1) hypertensive (systolic blood pressure [SBP] >140 mm Hg) (Fig. 2), (2) normotensive (SBP 90–140 mm Hg) (Fig. 3), (3) hypotensive (SBP<90 mm Hg) (Fig. 4), with a distinct initial approach for each profile. Because the clinical approach is described in each figure, it is not repeated in the text.

**THERAPEUTIC CONSIDERATIONS**

**Noninvasive Ventilation**

In acute pulmonary edema, studies have shown the benefit of noninvasive ventilation (NIV) to reduce intubation rates, through improved oxygenation and decreased work
of breathing. Because the studies to support these benefits have been small, the 3CPO trial (Cardiogenic Pulmonary Edema, n = 1069) was conducted, which concluded that there were no differences between NIV and standard oxygen therapy in terms of death or intubation rates within 7 days.

Despite this evidence from a well-designed clinical trial, which is arguably the strongest evidence for any AHFS therapy to date, most emergency physicians continue to anecdotally report the benefits of NIV. These benefits are especially noted in the absence of any significant safety concerns with short-term use, assuming appropriate patients are chosen. Thus, despite the 3CPO trial results, this author recommends NIV in patients who present with acute cardiogenic pulmonary edema. Specifically, 10 to 15 cm H₂O is recommended as a starting point with continuous positive airway pressure. Patients often improve rapidly, or, if the intervention is without benefit, it may be easily removed.

**IV Loop Diuretics**

Dosing recommendations for initial IV diuretic therapy vary. The American Heart Association (AHA)/American College of Cardiology (ACC) recommend a dose at least equal to the oral dose for those on chronic oral diuretic therapy. It is not clear whether this
should equal the total oral dose upfront or be divided. The European Society of Cardiology (ESC) recommends 20 to 100 mg of IV furosemide, depending on the severity of presentation. Similar to other therapies commonly used in AHFS, the evidence on which to base definitive guidelines for dosing are lacking because of the absence of large, well-powered trials showing its efficacy and safety. The recently published DOSE-AHF trial showed no differences between continuous versus bolus diuretic

**Fig. 2.** Hypotensive AHFS pathway. NES, nesiritide; NTG, nitroglycerin; NTP, nitroprusside.

**Fig. 3.** Hypertensive AHFS pathway. BUN, blood urea nitrogen; VS, vital signs.
dosing. However, their high-dose arm, defined as 2.5 times the oral dose divided over a 24-hour period, showed significantly greater urine output as well as greater dyspnea improvement and weight loss, albeit with a transient worsening of renal function. No differences in mortality or rehospitalization were seen at 60 days. The inclusion criteria allowed for enrollment up to 24 hours after presentation; whether enrolling patients in the ED would have led to different conclusions is unknown.

The DOSE-AHF trial suggests that higher doses may be given safely. Thus, this author recommends, as a general rule, that twice the total chronic oral dose be administered in divided doses over a 24-h period, and started in the ED. For example, if a patient is on 80 mg of oral furosemide twice a day, and your institution primarily uses twice-daily dosing, 160 mg IV is recommended as the initial starting dose. If dosing 3 times a day is more common, then 80 mg IV should be given. Reassessment of the patient, both clinically as well as in terms of urine output, is critical.

Vasodilators

Large registry data suggest that most patients are primarily treated with IV loop diuretics. However, both the hypertensive and normotensive management algorithms highlight the important role of vasodilator therapy. (Unless otherwise specified, vasodilators refers to nitroglycerin.) Previous research suggests both the safety and efficacy of vasodilators at improving signs and symptoms, and potentially outcomes. If IV nitroglycerin is not readily available, sublingual or nitroglycerin sprays should be used in appropriate patients. A general guide based on ESC guidelines for where to start dosing and titration is shown in Table 2. Given the rapid onset and short half-life of IV nitroglycerin, rapid uptitration is possible with adjustment based on clinical improvement. Fears of taking an intensive care unit (ICU) bed are unfounded; depending on local circumstances, IV nitroglycerin can often be used to stabilize the patient initially. After diuresis has begun, topical nitropaste can then be applied and the IV nitroglycerin weaned.

Early Use of Angiotensin-converting Enzyme Inhibitors

Use of sublingual angiotensin-converting enzyme inhibitors (ACEI) or IV ACEI has been given a class C recommendation or expert consensus approval by the American

![Fig. 4. Normotensive AHFS pathway. Cr, creatinine; ICU, intensive care unit; LVH, left ventricle hypertrophy.](image-url)
The College of Emergency Physicians (ACEP) clinical policy committee. However, the ESC clearly recommends against the early use of ACEI to stabilize AHFS. The differences lie in which studies are used as the basis for the recommendations. Small studies of early ACEI suggest its benefit at reducing SBP and alleviating symptoms. However, well-powered studies that definitively show efficacy at reducing signs and symptoms and, more importantly, outcomes have yet to be performed. There is a paucity of safety data, with retrospective analysis suggesting potential harm in certain populations. The idea that early neurohormonal blockade with ACEI is beneficial is often postulated, but unproved. Given the existence of other effective therapies, namely nitrates, with a long-standing tradition of empirical use as well as higher levels of evidence to support their use as supported by guidelines, use of ACEI is not recommended by this author until adequately powered studies are performed. The primary rationale lies in the potential risk for harm coupled with the availability of other agents.

**Nesiritide**

Use of nesiritide decreased considerably after retrospective analyses suggested potential safety concerns; namely worsening renal function and mortality. Largely because of these concerns, the largest trial conducted to date in AHFS, the ASCEND-HF trial (Acute Study of Clinical Effectiveness of Nesiritide in Decompensated Heart Failure) with more than 7000 patients, was conducted with results presented at the end of 2010. Briefly, the safety of nesiritide was well established, but the co-primary efficacy end points (mortality reduction or rehospitalization within 30 days and dyspnea improvement at 6 and 24 hours) were not reached. The improvement in dyspnea seen in previous studies was not duplicated.
<table>
<thead>
<tr>
<th>Author, Year</th>
<th>N</th>
<th>Subject Type</th>
<th>Study Type</th>
<th>Outcome</th>
<th>Significant Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filippatos, 2007</td>
<td>302</td>
<td>I</td>
<td>R</td>
<td>60-d death/readmission</td>
<td>BUN&gt;40 mg/dL</td>
</tr>
<tr>
<td>Gheorghiade et al, 2007</td>
<td>48,612</td>
<td>I</td>
<td>R</td>
<td>In-hospital and 30-d mortality</td>
<td>Na&lt;sup&gt;2+&lt;/sup&gt;&lt;135 mmol/L</td>
</tr>
<tr>
<td>Formiga, 2007</td>
<td>414</td>
<td>I</td>
<td>R</td>
<td>In-hospital mortality</td>
<td>Barthel index, creatinine, edema</td>
</tr>
<tr>
<td>Diercks, 2006&lt;sup&gt;a&lt;/sup&gt;</td>
<td>499</td>
<td>E</td>
<td>P</td>
<td>LOS&lt;24 h, 30-d events</td>
<td>SBP, troponin I</td>
</tr>
<tr>
<td>Rohde, 2006</td>
<td>779</td>
<td>I</td>
<td>R</td>
<td>In-hospital mortality</td>
<td>SBP&lt;124 mm Hg, Cr&gt;1.4 mg/dL, BUN&gt;37 mg/dL, Na&lt;136 mmol/L</td>
</tr>
<tr>
<td>Gheorghiade et al, 2006</td>
<td>48,612</td>
<td>I</td>
<td>R</td>
<td>In-hospital and 30-d mortality</td>
<td>SBP&lt;120</td>
</tr>
<tr>
<td>Barsheshet, 2006</td>
<td>1122</td>
<td>I</td>
<td>R</td>
<td>In-hospital mortality</td>
<td>Age, glucose, female sex, creatinine, low SBP, NYHA class III/IV</td>
</tr>
<tr>
<td>Burkhardt, 2005</td>
<td>385</td>
<td>I</td>
<td>R</td>
<td>Observation unit discharge</td>
<td>BUN</td>
</tr>
<tr>
<td>Auble, 2005&lt;sup&gt;a&lt;/sup&gt;</td>
<td>33,533</td>
<td>I</td>
<td>R</td>
<td>Inpatient complications and mortality</td>
<td>Na&lt;sup&gt;2+&lt;/sup&gt;, SBP, white blood cell count, pH, creatinine</td>
</tr>
<tr>
<td>Fonarow, 2005</td>
<td>65,275</td>
<td>I</td>
<td>R</td>
<td>Inpatient mortality</td>
<td>BUN, creatinine, SBP</td>
</tr>
<tr>
<td>Klein, 2005</td>
<td>949</td>
<td>I</td>
<td>R</td>
<td>Days hospitalized in 2 mo</td>
<td>Na&lt;sup&gt;2+&lt;/sup&gt;</td>
</tr>
<tr>
<td>Felker, 2004</td>
<td>949</td>
<td>I</td>
<td>R</td>
<td>60-d mortality/readmission</td>
<td>Age, SBP, BUN, Na&lt;sup&gt;2+&lt;/sup&gt;, Hgb, no. of past admissions, class IV symptoms</td>
</tr>
<tr>
<td>Lee, 2003</td>
<td>4031</td>
<td>I</td>
<td>R</td>
<td>30-d and 1-y mortality</td>
<td>Age, SBP, RR, BUN, Na&lt;sup&gt;2+&lt;/sup&gt;</td>
</tr>
<tr>
<td>Harjai, 2001</td>
<td>434</td>
<td>I</td>
<td>R</td>
<td>30-d readmission</td>
<td>Sex; COPD; prior admissions</td>
</tr>
<tr>
<td>Study</td>
<td>n</td>
<td>Type</td>
<td>Methodology</td>
<td>Outcomes</td>
<td>Identified Markers</td>
</tr>
<tr>
<td>------------------</td>
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<td>-------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Butler, 1998</td>
<td>120</td>
<td>I</td>
<td>R</td>
<td>Inpatient complications</td>
<td>O₂ saturation; creatinine; pulmonary edema</td>
</tr>
<tr>
<td>Villacorta, 1998</td>
<td>57</td>
<td>I</td>
<td>R</td>
<td>Inpatient/6-mo death</td>
<td>Na¹⁺; sex</td>
</tr>
<tr>
<td>Chin, 1997</td>
<td>257</td>
<td>I</td>
<td>R, S</td>
<td>60-d readmission/death</td>
<td>Marital status; comorbidity index; admit SBP; No ST-T changes</td>
</tr>
<tr>
<td>Chin, 1996</td>
<td>435</td>
<td>I</td>
<td>R</td>
<td>Inpatient complications</td>
<td>Initial SBP; RR; Na²⁺; ST-T changes</td>
</tr>
<tr>
<td>Seiker, 1994</td>
<td>401</td>
<td>I</td>
<td>PA, R</td>
<td>Inpatient mortality</td>
<td>Age; SBP; T-wave flattening; HR</td>
</tr>
<tr>
<td>Brophy, 1993</td>
<td>153</td>
<td>E</td>
<td>P</td>
<td>LOS and 6-mo mortality</td>
<td>Left atrial size; cardiac ischemia; diuresis</td>
</tr>
<tr>
<td>Esdaile, 1992</td>
<td>191</td>
<td>I</td>
<td>PA, R</td>
<td>Inpatient mortality</td>
<td>Age; chest pain; cardiac ischemia; valvular disease; arrhythmia; new onset; poor response</td>
</tr>
<tr>
<td>Katz, 1988</td>
<td>216</td>
<td>E</td>
<td>R</td>
<td>2-d complications</td>
<td>4-h diuresis; history of pulmonary edema; T-wave abnormalities; JVD</td>
</tr>
<tr>
<td>Plotnick, 1982</td>
<td>55</td>
<td>I</td>
<td>PA, R</td>
<td>Inpatient and 1-y mortality</td>
<td>Admit SBP; dyspnea; peak CPK</td>
</tr>
</tbody>
</table>

Complications include mortality.

*Abbreviations: COPD, chronic obstructive pulmonary disease; CPK, creatine phosphokinase; E, emergency department patients; Hgb, hemoglobin; I, inpatients; LOS, length of stay; NYHA, New York Health Association; PA, patient assessment; R, retrospective chart review; S, survey.*

*Identified markers of low risk.*

*Reproduced from Collins SP, Storrow AB. Acute heart failure risk stratification: can we define low risk? Heart Fail Clin 2009;5(1):79, vii; with permission.*
At present, consistent with guideline recommendations, nesiritide may be used as a vasodilator in AHFS. An additional advantage compared with nitroglycerin is that an ICU setting is not required. However, this author recommends its use as a second-line agent when nitrates are either not working or insufficient during the ED phase of management. The argument regarding nitrate tolerance does not usually apply in the ED setting.

**Morphine**

Similar to other traditional therapies, the evidence regarding morphine use in AHFS is limited. Its primary benefit lies in its vasodilatory properties as well as anxiolysis; however, retrospective analysis suggests morphine is associated with worse outcomes.\(^ {42-44}\) Guidelines are again split regarding this issue, with the Society for Chest Pain Centers recommending against the early use of morphine, whereas the ESC guidelines allow for early use, albeit with caution for respiratory depression, and recognition of the limited prospective studies on which to base this recommendation.\(^ {30,44}\)

This author limits use of morphine to the perinoninvasive ventilation setting, because the tight fitting mask may provoke some anxiety.

**DETERMINE AND TREAT THE PRECIPITANT**

Diagnosis and management of the precipitant for decompensation occurs in parallel with treatment. Common precipitants are seen in Fig. 3. Although medication and dietary indiscretion remain important considerations, treatable or reversible causes of decompensation are critical to identify and treat.

**SPECIAL CONSIDERATIONS**

**Hypotensive Profile**

Patients presenting with low SBP are rare. The temptation to immediately raise the blood pressure should be tempered by careful consideration of the overall clinical picture combined with investigation of the patient’s baseline state. Patients with end-stage or advanced HF may have reduced systolic function to such a degree that low SBP may be normal or baseline.

Inotropic agents are reserved for those patients with cardiogenic shock or evidence of hypoperfusion. Both the ESC and the AHA/ACC guidelines mention that inotropes may lead to increased risk of both short-term and longer-term adverse events.\(^ {6,30}\) However, both guidelines also recommend their use for patients in need of such supportive therapy. Given the infrequent nature of such presentations, emergent consultation with cardiology is also recommended.

**Atrial Fibrillation and HF**

The management of patients with atrial fibrillation (AF) and rapid ventricular response (RVR) and HF present a unique challenge. Although controlling the rate is the common reaction, in certain patients, treating the signs and symptoms of HF may lead to a slower heart rate as the sympathetic surge secondary to breathlessness is mitigated. In contrast, AF may be the inciting cause of HF and thus either slowing the rate or, in certain circumstances, cardioversion, may be the most important goal of therapy. With the exception of patients who are hemodynamically unstable or present with other signs suggesting immediate cardioversion, the approach must be tailored for each patient.

In general, patients with new-onset AHFS secondary to AF should either be cardioverted according to guideline recommendations,\(^ {45}\) or rate controlled. If the patient has a history of chronic HF and presents with acute decompensation, the following algorithm
may be considered: if the patient is unstable, immediate cardioversion according to guidelines should be considered. If the patient is stable, as a general rule, the use of nondihydropyridine calcium channel blockers (eg, diltiazem) may be used as per usual management of AF with RVR. In general, β-blockers should not be used.

However, it is the exceptions to these general recommendations that are important. First, is the EF known? Patients with HF and preserved EF may be more dependent on adequate filling or diastole. For these patients, use of either nondihydropyridine calcium channel blockers or short-acting β-blockers (eg, esmolol) is appropriate because there is less concern for any detrimental effects from negative inotropy. If the EF is severely reduced, empirical use of nondihydropyridine calcium channel blockers, which is commonly observed in clinical practice because of their common use in patients with AF and RVR, may have deleterious downstream consequences. Although the rate may be controlled, nondihydropyridine calcium channel blockers such as diltiazem are not short acting, with a half-life of 4 to 6 hours. Thus, the consequences of negative inotropy may be severe. However, these negative downstream effects are often not seen while the patient is in the ED, but remain important considerations. An alternative in this setting, in the absence of concerns for ongoing ischemia, is the use of IV digoxin. Contrary to traditional teaching, the effects of IV digoxin may be seen as early as 30 minutes.46

DISPOSITION

Markers of high risk have been well established in HF (Table 3). However, the absence of these high-risk features does not equate to a low-risk patient.47 Who then, is safe to discharge? Given the absence of well-defined prospectively studied guidelines, decisions should be made on an individual basis taking into account not only the patients’ clinical status but also their socioeconomic and health literacy, among other considerations. High postdischarge adverse event rates likely now lead to conservative disposition decisions favoring admission. A recent study published from a large administrative database in Canada suggests that patients discharged are at higher risk for postdischarge events than those admitted.48 Novel approaches to risk stratification are needed and are currently being studied.47 In the meantime, although not prospectively validated, discharge may be considered for those patients in whom (1) high-risk features are absent during a period of observation, (2) the precipitant for decompensation has been diagnosed and treated, (3) return to baseline compensated state has occurred, (4) a clear and detailed follow-up discharge plan is in place, and (5) physicians’ clinical impression is of low risk.

SUMMARY

Post-discharge mortality and morbidity from AHFS are high, affecting nearly half of all discharged patients within 90 days. ED therapy remains largely empiric with minimal evidence to support definitive recommendations to guide therapy. However, lessons learned from recent registries and trials suggests an approach to initial management based on clinical profiles, as defined by high, normal, or low blood pressure. Clinicians are provided with a practical and consensus-driven approach to everyday AHFS management.

REFERENCES


