Managing Acute Decompensated Heart Failure

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KEYWORDS

• Heart failure • Myocardial infarction • Cardiomyopathy • Hospitalizations

KEY POINTS

- In patients with acute decompensated heart failure, an important first step is to determine the factors that precipitated the deterioration in cardiac function or increased the body's demand.
- Such factors can include myocardial ischemia, poorly controlled hypertension, atrial fibrillation, anemia, thyroid disease, noncompliance with medications, excessive salt or fluid intake, as well as deterioration in kidney function.
- Patients often require management in an intensive care unit setting, which allows for gradual volume removal, telemetric monitoring, and ongoing electrolyte replacement.
- Patients with end-stage heart failure may progressively deteriorate despite maximal medical therapy.
- Some patients with end-stage heart failure are candidates for a ventricular assist device or cardiac transplantation; for those who are not, end-of-life care should be openly discussed.
- Precipitants of heart failure can include systolic dysfunction, diastolic dysfunction, acute dysrhythmia, or valvular heart disease.
- Vigilance for the triggers of heart failure exacerbations gives the physician the best chance of recognizing the occasional patient with a reversible cause.

INTRODUCTION: NATURE OF THE PROBLEM

Acute decompensated heart failure (ADHF) refers to the sudden onset of fatigue, breathlessness, and edema that occurs when cardiac function cannot keep pace with the body's demand. This may occur due to impaired contractility during systole, impaired relaxation during diastole, acute abnormalities of rhythm, or valve dysfunction. ADHF may occur de novo, as for example with acute myocardial infarction. Most cases, however, occur due to exacerbation of an underlying chronic cardiomyopathy.

ADHF is a growing medical problem. It is the leading reason for hospital admission among patients over age 65.[1] It is the most costly cardiovascular disorder in Western countries, and the short-term mortality following hospital admission in most studies exceeds 10%.[2]

In evaluating the patient with ADHF caused by cardiomyopathy, consideration of the cause may help the physician identify treatable, reversible causes. Depending on the patient population studied, cases of cardiomyopathy generally segregate with one-third due to hypertensive heart disease, one-third due to ischemic heart disease, and one-third due to myocyte heart disease (Fig. 1). Myocyte heart disease is predominantly made up of patients with idiopathic cardiomyopathy. However, it also includes such diverse causes as genetic familial cardiomyopathies, peripartum cardiomyopathy, coxsackie viral cardiomyopathy, and exposure-related cardiomyopathies including

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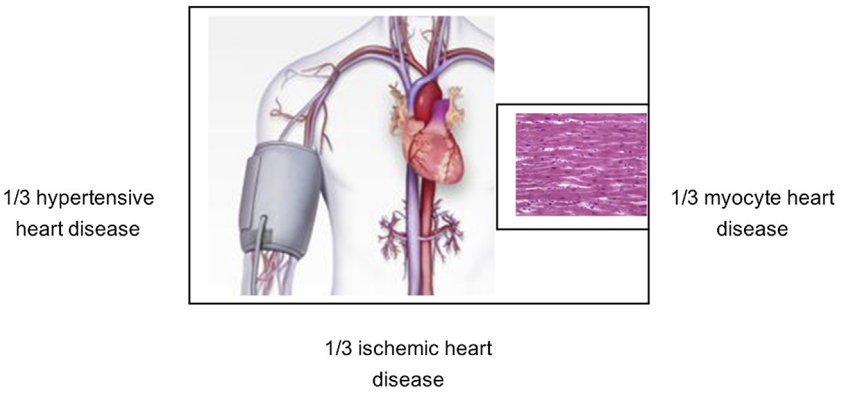

Fig. 1. Cardiomyopathy-related heart failure. The 3 principal etiologies are shown. Hypertensive heart disease is illustrated by the blood pressure cuff. Ischemic heart disease is shown by the heart's coronary arteries. Myocyte heart disease is indicated with the close-up histologic section of cardiac muscle. (Source: American Heart Association.)

those due to alcohol, cocaine, or chemotherapeutic agents.

ADHF is generally precipitated by a new disturbance that places hemodynamic load on an already failing ventricle. Such precipitants can include tachyarrhythmias, acute anemia, or systemic infection. The most common cause, however, of reversible cardiac decompensation is noncompliance: either with diet, salt restriction, medications, or a combination. Even a small increase in dietary sodium, a change in fluid intake, or intermittent failure to take a medication can trigger a heart failure exacerbation in this population. Use of drugs such as nonsteroidal anti-inflammatory agents may blunt diuresis and the vasodilatory effects of the renin-angiotension-aldosterone antagonists, thus resulting in ADHF.[3] For treatment, coronary revascularization can be an effective approach if active angina accompanies the heart failure. The benefit of revascularization is most pronounced when large amounts of viable myocardium are suitable for revascularization. Indeed, the most common contributing comorbidities are active myocardial ischemia, poorly controlled hypertension, or initiation of atrial fibrillation. Any of these can contribute to ADHF. In addition, patients are now being treated more commonly for diuretic resistance and the cardiorenal syndrome. Kidney dysfunction is now recognized as a late-stage exacerbating factor that plays a larger role as patients become more refractory to medication therapy. This has led to an increasing use of ultrafiltration for diuretic-resistant patients[4] and hemodialysis for patients with progressive kidney disease. Each of these strategies can play a role in re-establishing a new set point for the heart failure patient's fluid balance and hemodynamic stability.

MANAGEMENT GOALS

Patients with ADHF generally present with some combination of dyspnea, fatigue, volume overload, hypotension, and end-organ dysfunction. The first goal is to relieve symptoms, especially in patients who have signs of congestion. The goals of medical treatment are to bring the ventricular filling pressures down to the normal range and optimize end-organ perfusion. While hospitalized, there is the ability to assess the patient's often complex medication regimen and the patient's ability to comply. Similarly, hospitalization allows for a period of patient education focused on salt and fluid restriction and on daily monitoring of body weight as a surrogate for fluid retention.

Finally, the time in hospital allows the physician to readdress advanced treatment options. These may include antiarrhythmic therapy or cardioversion for atrial tachyarrhythmias, coronary revascularization for patients with treatable ischemic heart disease, or cardiac resynchronization therapy for patients with significant dyssynchrony as evidenced by QRS duration on electrocardiogram (ECG) greater than 120 to 130 milliseconds. Still more aggressive treatments, including support with ventricular assist device or pursuing cardiac transplantation, can be entertained.

PHARMACOLOGIC STRATEGIES

Intravenous diuretics, especially furosemide and bumetanide, have remained the primary first-line treatment for ADHF for many decades. The optimal dosing of diuretic therapy remains controversial. A randomized study published in 2011 studied high-dose and low-dose strategies and

studied continuous infusions versus intermittent dosing.[5] This study showed no significant difference in the patient global assessment of symptoms. There was also no difference in the change in renal function. For this reason, the dosing of loop diuretics continues to remain a matter of personal preference.

Vasodilators are a longstanding bellwether of treatment for ADHF. These include intravenous and oral nitrates, hydralazine, angiotensin-converting enzyme inhibitors, angiotensin II receptor blockers, and intravenous sodium nitroprusside. The combination of nitrates and hydralazine is particularly beneficial for patients with impaired kidney function (serum creatinine >2.5) and for African-American patients with heart failure.[6] Nitroprusside has the distinct advantage of decreasing neurohormonal activation, although the need for invasive hemodynamic monitoring during its use has been a substantial impediment to its more widespread use.

Intravenous nesiritide (human B-type natriuretic peptide) acts to cause natriuresis and vasodilation. It is approved for relief of dyspnea in patients with acute heart failure. The ASCEND-HF (Acute Study of Clinical Effectiveness of Nesiritide in Decompensated Heart Failure) study randomly assigned patients with acute heart failure to nesiritide or placebo.[7] The patients received 24 to 168 hours of treatment on top of standard medical care. The primary endpoints were a dyspnea scale, rehospitalization for heart failure, or death within 30 days. This study showed that nesiritide was not associated with a change in the rate of death and rehospitalization. It also was not associated with a change in kidney function. Following the publication of the study, the use of nesiritide has lessened. However, it is not clear whether a 24-hour treatment course as was used in the study is really long enough to obtain the benefit.

Vasopressin receptor antagonists are a class of medications that produce selective water aquaresis, and thus ameliorate hyponatremia. The EVEREST (Efficacy of Vasopressin Antagonism in Heart Failure Outcome Study with Tolvaptan) study enrolled 4133 heart failure patients in a randomized, double-blind, placebo-controlled fashion.[8] At the median follow-up of 9.9 months, there was no mortality benefit or rehospitalization benefit for patients treated with the vasopressin receptor antagonist tolvaptan. Most patients in the study, however, had heart failure without hyponatremia. Chronic hyponatremia in association with heart failure can be a significant source of morbidity. Features can include gait instability, unsteadiness, propensity for falls, chronic mental confusion, and increased burden on caregivers.[9] Because hyponatremia in heart failure generally portends a pathologic, low output cardiac state, the aquaretic medications may still have a role in patients with heart failure and symptomatic hyponatremia.

Intravenous positive inotropic agents have enjoyed a long history of use for ADHF. Dobutamine is a mixed beta1 and beta2 receptor agonist. It is the most widely used of these agents. There are, however, few randomized controlled trial data evaluating this drug. In contrast, intravenous milrinone is a phosphodiesterase-3 inhibitor. The randomized controlled OPTIME-CHF (Outcomes of a Prospective Trial of Intravenous Milrinone for Exacerbations of Chronic Heart Failure) trial assessed patients in whom inotropic therapy was indicated but not required.[10] The patients who randomized to milrinone developed more hypotension, atrial arrhythmias, and early treatment failure. The endpoints of death and rehospitalization showed a disadvantage to milrinone as compared with placebo, especially in patients with cardiomyopathy caused by an ischemic rather than nonischemic etiology. This has led to a general recommendation against use of this medication except in patients who present with signs of cardiogenic shock, end-organ hypoperfusion, acidosis, or cognition impaired by low cardiac output.

HEMODYNAMIC STRATEGIES

Direct measurement of cardiac hemodynamics is one way to choose and regulate medication treatment in ADHF. The ESCAPE (Evaluation Study of Congestive Heart Failure and Pulmonary Artery Catheterization Effectiveness) trial randomized patients such that 1 group received clinical medical therapy based on symptoms and physical examination signs. They were compared against patients in another group who received a pulmonary artery catheter-guided approach.[11] Therapies to vasodilate, to diurese, and to provide inotropic support were guided clinically in 1 arm and guided by the invasive hemodynamic assessments in the other arm. Surprisingly, the study demonstrated no significant difference in the primary endpoint of days alive and out of the hospital over a 6-month follow-up period. For this reason, routine management of ADHF using invasive hemodynamic assessment is now reserved for patients with worsening end-organ dysfunction due to hypoperfusion, hypotension, or kidney failure.

For most patients, a clinical assessment of filling pressure (dry vs wet) and systemic perfusion (warm vs cold) will provide the same information as an invasive pulmonary artery catheter for selecting treatment medications (**Fig. 2**). Identification of high filling pressures (wet) is judged by symptoms

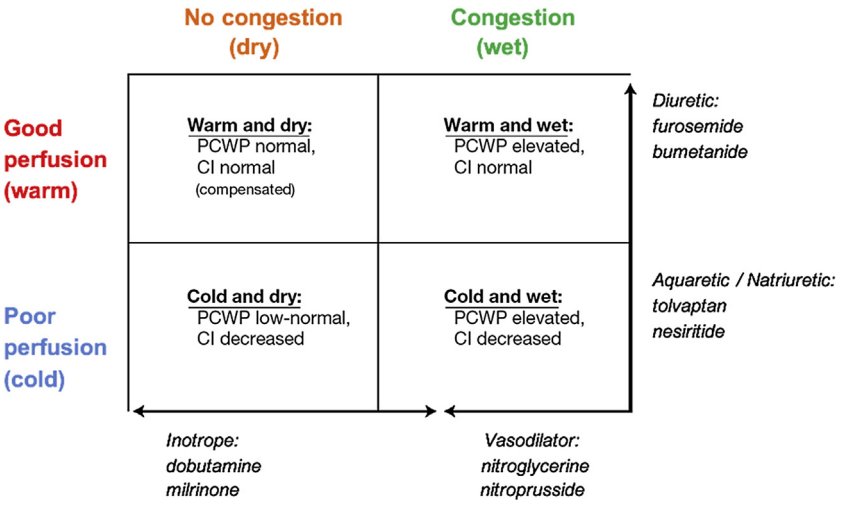

Fig. 2. Hemodynamic schema for heart failure assessment. The patient's volume status is shown across the top. The perfusion status is shown down the left side. Arrows indicate the three hemodynamic quadrants that make up decompensated heart failure. Medications are shown next to the hemodynamic profiles that they most benefit. CI, cardiac index; PCWP, pulmonary capillary wedge pressure.

of orthopnea and edema and by signs of jugulovenous distension and S3 gallop. Rales on pulmonary examination have a poor negative predictive value. Patients with longstanding elevation in filling pressures often have no rales at all. Identification of reduced cardiac output and poor perfusion (cold) is evidenced by cool extremities, hypotension, and impaired cognition. This assessment is important for determining an initial strategy of treatment. Optimal treatment generally includes diuretics for wet patients, vasodilators for cool wet patients, and positive inotropes for cool dry patients.

SELF-MANAGEMENT STRATEGIES

Hospitalizations for ADHF are currently estimated to exceed $1 million annually in the United States. In addition, the 30-day readmission rate for patients with ADHF is estimated at 27%.[12] This is the highest readmission rate among all medical conditions. Most the health care costs for ADHF are generated by inpatient hospital care. This is a large economic burden likely to grow larger as the US population's mean age continues to rise.

Strategies to improve outcomes now include self-care and self-management. Self-care refers to a patient's commitment to adhere to medications. It also focuses on following dietary restrictions and exercise recommendations. Self-management then extends this concept to a patient who can determine his or her own volume status and adjust diuretic medications accordingly.

Strategies of self-management can then be advanced to multidisciplinary teams for home visitation, structured telephone support, and telemonitoring from a remote location. Telemonitoring aims to transfer physiologic patient information, such as body weight, blood pressure, and oxygen saturation through telephone or wireless networks. Recent studies, including TIM-HF (Telemedical Interventional Monitoring in Heart Failure), have been unable to show an impact of remote monitoring on rehospitalization rates or on mortality.[13]

EVALUATION AND ADJUSTMENT

The unreliability of patients collecting their own data has led to more automated methods. Implantable devices have been developed that allow transmission of recorded data through a transmitter to a central database. The information is then made available to the physician, who can interpret the data and make needed medication adjustments. An implantable pulmonary artery sensor has been developed for this purpose. The CHAMPION (Cardiomems Heart Sensor Allows Monitoring of Pressure to Improve Outcomes in NYHA Class III Patients) trial evaluated its effectiveness. This trial showed a reduction in hospitalizations for heart failure by nearly 30% in the class III heart failure subgroup.[14] With the large number of heart failure patients in the United States, the potential benefit for home monitoring to reduce the episodes of ADHF seems enormous.

The current monitoring methods for patients with ADHF all require ongoing input from the physician. The physician is expected to diagnose any clinical deterioration and make the appropriate medical decisions to avoid rehospitalization. These devices and their implantation are expected

to be costly. However, it is hoped that strategies of this type will ultimately be cost-effective by reducing the financial burden of repeated episodes of heart failure.

SUMMARY

ADHF occurs when cardiac function falls below the demands of the body. In patients with ADHF, an important first step is to determine the factors that precipitated the deterioration in cardiac function or increased the body's demand. Such factors can include myocardial ischemia, poorly controlled hypertension, atrial fibrillation, anemia, thyroid disease, noncompliance with medications, excessive salt or fluid intake, and deterioration in kidney function. Patients often require management in an intensive care unit setting. This allows for gradual volume removal, telemetric monitoring, and ongoing electrolyte replacement. Patients with end-stage heart failure may progressively deteriorate despite maximal medical therapy. Some patients are then candidates for implantation of a ventricular assist device or for cardiac transplantation. For those who are not, end-of-life care should be openly discussed.

The precipitants of heart failure can include systolic dysfunction, diastolic dysfunction, acute dysrhythmia, or valvular heart disease. The cardiomyopathies generally occur due to a fairly even split among hypertensive disease, coronary disease, and myocyte disease. Vigilance for the triggers of heart failure exacerbations gives the physician the best chance of recognizing the occasional patient with a reversible cause.

The current health care system is placing an ever-increasing premium on avoiding recurrent hospitalizations for heart failure. Thus, specialists in this field are likely to be increasingly in demand. Physicians are being asked to improve systems of care to the point where heart failure can be managed with frequent outpatient adjustments, rather than repeated exacerbations requiring hospitalization. As such, today's paradigm is to repeatedly reoptimize the patient's hemodynamic neurohormonal set point, and thus minimize the decompensations.

REFERENCES

1. Dec GW. Management of acute decompensated heart failure. Curr Probl Cardiol 2007;32:321–66.
2. Allen LA, O'Connor CM. Management of acute decompensated heart failure. CMAJ 2007;176(6):797–805.
3. Page J, Henry D. Consumption of NSAIDs and the development of congestive heart failure in elderly patients: an underrecognized public health problem. Arch Intern Med 2000;160:777–84.
4. Costanzo MR, Saltzberg M, O'Sullivan J, et al. Early ultrafiltration in patients with decompensated heart failure and diuretic resistance. J Am Coll Cardiol 2005;46:2047–51.
5. Felker GM, Lee KL, Bull DA, et al. Diuretic strategies in patients with acute decompensated heart failure. N Engl J Med 2011;364(9):797–805.
6. Taylor AL, Ziesche S, Yancy C, et al, for the African-American Heart Failure Trial Investigators. Combination of isosorbide dinitrate and hydralazine in blacks with heart failure. N Engl J Med 2004;351:2049–57.
7. O'Connor CM, Starling RC, Hernandez AF, et al. Effect of nesiritide in patients with acute decompensated heart failure. N Engl J Med 2011;365:32–43.
8. Konstam MA, Gheorghiade M, Burnett JC Jr, et al. Effects of oral tolvaptan in patients hospitalized for worsening heart failure: The EVEREST Outcome Trial. JAMA 2007;297:1319–31.
9. Renneboog B, Musch W, Vandemergel X, et al. Mild chronic hyponatremia is associated with falls, unsteadiness, and attention deficits. Am J Med 2006;119(1):71.e1–8.
10. Felker GM, Benza RL, Chandler AB, et al, for the OPTIME-CHF Investigators. Heart failure etiology and response to milrinone in decompensated heart failure: results from the OPTIME-CHF study. J Am Coll Cardiol 2003;41:997–1003.
11. Binanay C, Califf RM, Hasselblad V, et al, ESCAPE Investigators and Study Coordinators. Evaluation study of congestive heart failure and pulmonary artery catheterization effectiveness. The ESCAPE Trial. JAMA 2005;294:1625–33.
12. Bui AL, Fonarow GC. Home monitoring for heart failure management. J Am Coll Cardiol 2012;59(2):97–104.
13. Koehler F, Winkler S, Schieber M, et al. Impact of remote telemedical management on mortality and hospitalizations in ambulatory patients with chronic heart failure: the telemedical interventional monitoring in heart failure study. Circulation 2011;123:1873–80.
14. Abraham WT, Adamson PB, Bourge RC, et al. Wireless pulmonary artery haemodynamic monitoring in chronic heart failure: a randomized controlled trial. Lancet 2011;377:658–66.