

The Chronic Heart Failure Patient at Home: Clinical Treatment Options, Including Home Infusion of Inotropic Therapy

Chronic heart failure (CHF) is a diagnosis currently receiving a significant amount of attention. Researchers are striving to understand the complexity of the disease process and consider best practices for prevention and treatment in the most cost-effective manner, including site of care.

The purpose of this continuing education program is to review the opportunity for and requirements of care of the CHF patient at home, including the use of home inotropic infusion therapy. At the end of this program, the reader will be able to describe: the pathophysiology of heart failure; common heart failure symptoms; commonly used medications and treatment devices; and inotrope administration in the home.

Heart Failure: A Costly Condition

CHF is prevalent and has great impact, both clinically — on afflicted patients — and economically — on resource utilization. There are nearly six million patients diagnosed with heart failure in the United States, with an additional 650,000+ new cases diagnosed each year.¹ Considering only costs of care directly attributable to heart failure and excluding costs attributed to comorbid conditions, the 2030 projected cost of treating patients with HF is estimated to be \$160 billion — at least three-fold

higher than current costs.¹ And the American Heart Association predicts that the number of heart failure cases (acute and chronic) will increase by about 46% by 2030, to more than eight million people in the United States (one in every 33 people).²

Heart failure is a significant contributor to mortality — it is documented on the death certificate for one in nine deaths. Heart failure is the most frequent cause of hospitalization for people age 65 and older, and has a five-year mortality rate of about 50%.¹ With heart failure the primary diagnosis in over one million hospitalizations each year — adding up to six and a half million hospital days — and more than 15 million physician office visits, resource utilization for treatment of this condition is significant.¹

Heart failure is primarily a disease of the elderly and thus has a major impact on Medicare. Heart failure is the most common reason for hospitalization among persons over 65 years of age, accounting for 20% of all admissions in this age group.³

When injured or stressed, the body responds with a series of hemodynamic, neural, immune, and hormonal responses that help compensate for the injury. Over time, the compensatory mechanisms can be damaging, leading to heart failure.

Patients with heart failure represent 14% of the Medicare population, but disproportionately account for 43% of Medicare Part A and Part B spending.⁴ More than 2.5 million Part D enrollees were diagnosed with CHF in 2010.⁵ Given this scope, Medicare has established readmission and reimbursement standards for heart failure and is focused on appropriate resource utilization, including the avoidance of unnecessary, preventable hospital readmissions and emergency department (ED) visits.

Chronic Heart Failure: Pathophysiology

Chronic heart failure is not actually a disease. Rather, it is a syndrome, or set of symptoms, caused by an underlying disease such as hypertension, diabetes, cardiomyopathy, or coronary artery disease. Heart failure is the result of the body's responses to an underlying disease that results from a **structural** or **functional** cardiac disorder that impairs the ability of the ventricles to fill with or eject blood. The impact of heart damage secondary to the underlying disease is a multitude of hemodynamic, renal, neural, immune, and hormonal responses that then lead to cardiac structural and functional changes, and thus to symptoms of cardiac dysfunction. The major determinant of the progression of CHF is the persistent overactivation of various compensatory systems or hormones.

Even if the initial injury is stopped or slowed, these changes lead to neuroendocrine activation, specifically in the sympathetic nervous system (SNS) and the renin-angiotensin-aldosterone system (RAS). These systems activate neurohormones which, by nature, are important and useful in the short term (such as for the “fight or flight” response). However, with prolonged exposure to these neurohormones, damage to many systems ensues. For example, when the body experiences decreased cardiac output, no matter the etiology, it responds in several critical ways:

1. It stimulates the SNS to increase heart rate and contractility. The SNS is stimulated by the hormone angiotensin II to cause vasoconstriction. The vasoconstriction makes the heart work harder, ultimately leading to hypertrophy.
2. The SNS stimulates the kidneys to produce renin, as does the decreased renal perfusion caused by a decreased cardiac output. The kidneys interpret the decreased perfusion not as decreased cardiac output, but as hypotension. Renin produces angiotensin I, which converts to angiotensin II. Angiotensin II causes vasoconstriction, which then leads to elevated blood pressure. However, the cycle continues because without sufficient cardiac output, elevated blood pressure does not resolve the clinical problem of insufficient perfusion and leads, ultimately, to additional damage.
3. Angiotensin II leads to myocardial hypertrophy, decreases the release of nitric oxide (important to regulate such cardiac functions as blood pressure and to protect the heart from hypertrophy), increases oxidative stress on the cardiac arteries, increases sodium (and therefore water) reabsorption as a result of increased production

of aldosterone, and increases the risk of clotting.

The principle manifestation of such progression is a change in the geometry and structure of the left ventricle, such that the chamber dilates and/or hypertrophies and becomes more spherical; this process is referred to as *cardiac remodeling*. Change in heart chamber size and structure increases the hemodynamic stresses on the walls of the failing heart, depresses its mechanical performance, and may increase regurgitant flow through the mitral valve, all of which sustain and exacerbate the remodeling process.

The immune system also plays a part in the development of heart failure. The normal response to injury is an inflammatory response. It is the same when the injury or stress is to the heart. Proinflammatory cytokines are released, the complement system is activated, and autoantibodies are produced.

Symptoms of Chronic Heart Failure

The pathophysiologic changes of CHF and their impact on cardiac function are significant. While the cardinal manifestations of CHF are shortness of breath, fatigue, and fluid retention, patients with CHF present with numerous symptoms. Nursing symptom assessment is critical in order to monitor response to therapy or disease progression and support early intervention that can prevent unnecessary clinical sequelae or hospital and/or ED utilization. (See Table 1)

Non-Pharmacologic Interventions

Heart failure symptoms are treated both pharmacologically and non-pharmacologically. Treatment options and order of inclusion is largely determined by patient-specific symptoms and response to therapy.

Risk Factor Reduction

Lifestyle changes such as healthy eating, smoking cessation, exercise, weight loss, limited alcohol consumption, and management of hyperlipidemia can significantly reduce the risk for, and enhance the treatment, of CHF.

Ultrafiltration

Intermittent *ultrafiltration* may be performed to remove excess fluid from the body. Ultrafiltration is similar to dialysis in process, but removes water only, not waste products. The average amount of fluid removed is about 250 mL per hour. Studies have shown that fewer hospital days, rehospitalizations, and physician or ED visits occur when ultrafiltration is used.⁷ Ultrafiltration has been shown to be an effective alternative to intravenous diuretics.⁸ The American College of Cardiology (ACC), American Heart Association (AHA), and the European Society of Cardiology (ESC) recommend the use of ultrafiltration for fluid reduction for patients with refractory heart failure unresponsive to medical therapy.¹

Supportive Devices

The home CHF patient may have one of several implanted devices to support heart function.

Ventricular assist device (VAD):

This implantable pump is used either as a temporary bridge to heart transplantation or as palliative care. While once almost exclusively placed as a temporary “bridge” to keep heart failure patients alive until they could get a heart transplant,

According to the CDC, in 2010 an estimated 200,070 avoidable deaths from heart disease, stroke, and hypertensive disease occurred in the United States, 56% of which occurred among people less than 65 years old.⁶

Table 1

CHF Symptoms and Etiologies	
Symptom	Etiology
Dyspnea	<ul style="list-style-type: none"> Blood backs up in the pulmonary vein, causing fluid to leak into the lungs
Fatigue	<ul style="list-style-type: none"> Supply of oxygenated blood is inadequate
Fluid retention/Dependent edema	<ul style="list-style-type: none"> Blood flow out of the heart is impaired Blood returning to the heart through the veins backs up Kidneys are less able to dispose of sodium and water, causing fluid retention in the tissues
Persistent cough	<ul style="list-style-type: none"> Fluid builds up in the lungs
Paroxysmal nocturnal dyspnea (PND)	<ul style="list-style-type: none"> Blood backs up in the pulmonary vein, causing fluid to leak into the lungs Fluid from dependent body areas is reabsorbed when the patient is recumbent
Tachycardia	<ul style="list-style-type: none"> Heart beats faster to compensate for the loss in pumping capacity
Weight changes	<ul style="list-style-type: none"> Fluid is retained Metabolic rate increases Anorexia/nausea occurs
Pain	<ul style="list-style-type: none"> Fluid is retained Metabolic rate increases Anorexia/nausea occurs
Depression	<ul style="list-style-type: none"> Quality of life is compromised
Lack of appetite/nausea	<ul style="list-style-type: none"> Digestive system receives less blood, causing problems with digestion
Confusion, memory loss, and/or feelings of disorientation	<ul style="list-style-type: none"> Serum sodium becomes imbalanced

VADs have become so effective that physicians may use them as a treatment in and of themselves. In fact, considering the increasing number of patients reaching end-stage heart failure, the inadequate number of available donor hearts, and the continued improvements in mechanical devices, it is likely that more patients will be living longer on these devices.⁹ For some patients, left ventricular assist devices (LVADs) may be an effective alternative to heart transplants or inotropic therapy, permanently augmenting the action of the heart's main pumping chamber. Patients with advanced heart failure with an LVAD typically live longer and experience improved exercise tolerance, New York Heart Association (NYHA) functional status, and quality of life.^{10,11}

Continuous-flow LVADs consist of a pump implanted in the abdominal wall linked with tubes that connect with the patient's aorta and left

ventricle. A power cord emerging through the abdominal skin leads to a control unit worn on the belt, which is attached to battery packs worn in a shoulder harness.

VADs do pose an increased risk of stroke at an incidence of about three to 14%.^{12,13} Some patients with LVADs will be prescribed concomitant anticoagulants to lower their risk of stroke.

Implantable cardioverter defibrillator (ICD):

This device is used when patients:

- 1) Are at high risk for sudden death due to ventricular arrhythmias, or
- 2) Have chronic HF and a low ejection fraction and experience syncope of unclear origin. The ICD continuously monitors heart rhythm and is programmed to deliver "pacing impulses" to restore its natural rhythm, which avoids the need for a shock. If pacing is unsuccessful, the ICD will deliver a shock to the heart. The shock experience can be quite

significant. Some patients describe the feeling like being hit in the back with a baseball bat, being punched, or being kicked by a horse. The sensation typically lasts for a second. Most people feel it more in the back of their body than the front.

To mitigate the risk of arrhythmias and sudden death associated with inotropic therapy (see "Inotropic Therapy," on page 5), ICDs are very often used in conjunction with inotropic therapy. In large part because of the typically increased frequency of arrhythmias as patients approach end-of-life and the discomfort associated with the ICD's shock, ICDs are usually turned off when the patient progresses to hospice.

Cardiac resynchronization therapy (CRT):

This treatment may be used in addition to optimal medical therapy to treat heart failure symptoms in patients who are persistently

symptomatic. The CRT device sends small electrical signals to both ventricles to enable them to contract at the same time. This supports cardiac function by helping the heart to:

- Fill with blood and contract better,
- Contract at the proper rate, and
- Maintain a normal rhythm.

If the heart failure patient is also at high risk for arrhythmias and sudden cardiac death, CRT may be used in combination with an ICD or with a CRT device that also defibrillates. The CRT defibrillator (CRT-D) device continuously monitors the heart's rhythm. If a dangerous rhythm appears, the CRT-D delivers a shock and returns the heart to a normal rhythm.

Oxygen

Oxygen therapy is prescribed for many heart failure patients, as these patients often present with sleep apnea and orthopnea.

Cardiac Transplant

Transplant is currently the only established surgical approach to the treatment of refractory CHF. Transplant may be an option when other treatment options have failed and the patient's life expectancy without a transplant is less than one year. While some patients are not matched with a donor heart in time, based on the Organ Procurement and Transplantation Network (OPTN) website as of August 13, 2013, success rates of 87%, 71%, and 56% at one, five, and 10 years respectively, make transplant a viable option for many. Some patients will bridge to transplant with an LVAD or with inotropic therapy.

Pharmacologic Therapy

Patients are prescribed numerous medications to treat the underlying disease of CHF and/or help manage

CHF symptoms. Inotropic therapy, which is covered in the next section, is another pharmacologic option.

- **Angiotensin-converting enzyme (ACE) inhibitor:** First-line therapy typically includes an ACE inhibitor to block the conversion of angiotensin I to the pathogenic angiotensin II. ACE inhibitors slow the progression of heart failure and decrease symptoms, hospitalizations, and mortality.
- **Angiotensin receptor blocker (ARB):** If the patient cannot tolerate ACE inhibitors, an ARB may be prescribed. ARBs do not stop the conversion to angiotensin II, but block the ability of angiotensin II to work.
- **Beta blockers:** These medications are an additional first-line therapy option, typically used in combination with ACE inhibitors or ARBs to counteract the harmful effects of the sympathetic nervous system. Beta blockers are initiated at very low doses and titrated up as tolerated.
- **Diuretics:** Most heart failure patients require diuretics to promote sodium and fluid excretion. Close electrolyte monitoring is essential with the use of diuretics.
- **Isosorbide dinitrate:** This vasodilator enhances the bioavailability of nitric oxide, which is an antioxidant that protects the heart from stress and aging.

Angiotensin II:

- Supports myocardial hypertrophy
- Decreases the release of nitric oxide (NO)
- Increases oxidative stress on the cardiac arteries
- Increases sodium and water reabsorption
- Increases production of aldosterone
- Increases the risk of clotting

- **Opioids:** These medications may be prescribed not only to help ease the pain of angina, edema, or diabetic nephropathy, but also to support vasodilation and decrease both the patient's awareness of dyspnea and need for oxygen consumption.

Extensive evidence demonstrates that medications can be used to effectively treat and manage CHF by slowing disease progression, allaying symptoms, and reducing use of medical services such as hospitalization.^{14,15} However, patient adherence to CHF medications remains suboptimal, suggesting the potential for improvements in outcomes and medical cost savings. For example, Roebuck and colleagues found that patients with CHF who were adherent to medications experienced 5.7 fewer hospital days and \$8,881 in reduced medical expenditure annually compared with patients who were not adherent.¹⁶

Inotropic Therapy

Inotropic therapy is prescribed for three primary purposes: as a bridge to transplant, as a bridge to LVAD placement, or for palliative care. It is typically prescribed when the patient is no longer responding to other medications. Inotropes (dopamine, dobutamine, and milrinone) significantly increase cardiac contractility and cause systemic arterial and venous dilation. While inotropes are most often initiated in the hospital as short-term therapy for patients with acutely decompensated heart failure, some patients' heart dysfunction is so significant that they are dependent on the inotropes and require ongoing infusion therapy. Often, infusion in the home setting is an acceptable option, supporting appropriate resource utilization and improved patient and family quality of life while minimizing exposure to healthcare-acquired infections and other complications.

While there is a risk of arrhythmia-induced sudden death in patients on inotropes, this risk is significantly lessened with the simultaneous use of an ICD. In fact, current guidelines support the simultaneous use of an ICD in order to minimize that risk.² In one study of 104 patients on home inotrope infusions with an ICD placed, there were no sudden deaths over a mean therapy duration of 169 days (range of 3–1,179 days).¹⁷

The appropriate candidate for home infusion of inotropic therapy:

- Is hemodynamically stable on their current inotrope dose,
- Is willing and capable of providing the infusion and associated care, and
- Has the appropriate environment and supports.

Early identification of potential home infusion candidates is critical in order to ensure thorough candidacy assessment and appropriate patient education and other resource requirements.

Typically, the home infusion nurse will initiate patient education while the patient is hospitalized, assess therapy administration comprehension and ability via return demonstration, establish baseline vital signs, and do the “hook-up,” ensuring that the patient has a spare working pump, which is essential. Additional areas of patient education addressed by the nurse are listed in Table 2. The home infusion pharmacist will verify the physician’s orders.

Milrinone has an advantage for home use for some patients: its longer half-life. While dobutamine and dopamine have a half-life of about 2½ minutes, milrinone has a half-life of about 2½ hours.

Importantly, inotrope dosing is based on weight. A baseline weight is established at the time of discharge; this becomes the

benchmark from which adjustments will be made as necessary. To ensure that the appropriate dose is given, the pharmacist must have a current weight prior to each dispense.

The goals of inotropic therapy for CHF patients are to increase functionality of the heart, increase gas exchange and oxygenation, reduce the patient’s level of anxiety, and improve the patient’s quality of life. As nurse and pharmacist communication is essential regarding *any* changes in the patient’s clinical status, evaluation of the patient’s overall response to inotropic therapy and progress toward these overall goals is included in each patient clinical interaction. Changes from baseline should be reported to the physician or his/her designee.

Nursing visit frequency is determined by the physician orders and the patient’s response to therapy, as well as any patient needs. Medicare has specific requirements for the follow-up of Medicare beneficiaries receiving home inotropic infusion therapy. These include weekly nursing visits at minimum and quarterly physician visits, each with the required documentation completed and placed in the patient’s file.

Table 2

Components of Patient Education
<ul style="list-style-type: none"> • Medication dosing, effects, and potential adverse effects • Identification of the following physician and confirmation of the date and time of the next physician appointment • Signs and symptoms of worsening CHF • Self-monitoring (including daily weights) • Diet restrictions and requirements • Required supply inventory • IV site care • Medication bag change frequency • Pump management • When/how to call the physician • When/how to call the home infusion pharmacist and/or nurse

Conclusion

Heart failure is of increasing concern due to its current and anticipated continued growth in incidence. For the heart failure patient at home, multiple therapies, both pharmacologic and non-pharmacologic, exist to slow the progression of cardiac dysfunction and help manage the multiple symptoms commonly experienced by the heart failure patient. One therapeutic option for home administration is inotropic therapy. With clearly delineated nursing and pharmacy clinical responsibilities, including assessment and documentation, home inotropic infusion therapy supports appropriate resource utilization and improved quality of life for heart failure patients while minimizing exposure to healthcare-acquired infections and other complications. ♦

Do not use the information in this article to diagnose or treat a health problem or disease without consulting a qualified physician. Patients should consult their physician before starting any course of treatment or supplementation, particularly if they are currently under medical care, and should never disregard medical advice or delay in seeking it because of something set forth in this publication.

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Self-Assessment Quiz: The Chronic Heart Failure Patient at Home

LEARNING GOAL

To understand the incidence and clinical presentation of heart failure and to identify treatment options, with a focus on the cardiac patient at home.

LEARNING OBJECTIVES

At the end of this program, the reader will be able to:

1. Describe the pathophysiology of heart failure,
2. List common heart failure symptoms,
3. Outline requirements for inotrope administration in the home, and
4. Create a care plan that incorporates patient education, nursing assessment, and therapy monitoring criteria.

SELF-ASSESSMENT QUESTIONS

In the Quiz Answers section on the next page, fill in the correct answer for each question. To obtain two (2.0) contact hours toward CE credit, the passing score is 100%. Return your Self-Assessment Quiz to Coram via email or fax. See the next page for details on how to return to your quiz. Please allow approximately seven days to process your test and receive your certificate upon achieving a passing score.

1. Which of the following statements regarding heart failure in the United States is/are true? Heart failure is:
 - a. Diagnosed in over 650,000 people each year
 - b. The most frequent cause of hospitalization for people aged 65 and older
 - c. The primary diagnosis in over a million hospitalizations each year
 - d. Primarily a diagnosis of the elderly
 - e. A and C
 - f. B and D
 - g. All of the above
2. Chronic heart failure is a disease.
 - a. True
 - b. False
3. The major determinant of the progression of CHF is the persistent overactivation of various compensatory systems or hormones.
 - a. True
 - b. False
4. Cardiac remodeling causes:
 - a. The left ventricle to become more spherical
 - b. The left ventricle to hypertrophy
 - c. Increased hemodynamic stress of the heart wall
 - d. A and C
 - e. A, B, and C
5. The cardinal manifestations of chronic heart failure are shortness of breath, fatigue, and fluid retention.
 - a. True
 - b. False
6. Non-pharmacologic interventions for chronic heart failure include:
 - a. Cardiac transplant
 - b. Left ventricular assist devices
 - c. Lifestyle changes
 - d. B and C
 - e. A, B, and C
7. Dobutamine has a longer half-life than milrinone and therefore a higher safety profile for home administration.
 - a. True
 - b. False
8. Many patients being administered inotropes will have a concomitant internal cardioverter defibrillator.
 - a. True
 - b. False
9. Inotropic dosing is based on patient weight.
 - a. True
 - b. False
10. It is ideal but not essential for home inotropic infusion patients to have a back-up pump.
 - a. True
 - b. False

Healthline

VOLUME 23

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QUIZ ANSWERS

Fill in the key below with the correct answers to receive 2.0 Continuing Education credits.**

1. (a) (b) (c) (d) (e) (f) (g)
2. (a) (b)
3. (a) (b)
4. (a) (b) (c) (d) (e)
5. (a) (b)
6. (a) (b) (c) (d) (e)
7. (a) (b)
8. (a) (b)
9. (a) (b)
10. (a) (b)

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