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Contact Hours: **5**

# Clinical Care for the Heart Failure Patient


BY Leslie R. Crane, EdD, MSN, RN

LEARNING OUTCOME AND OBJECTIVES: Upon completion of this continuing education course, you will have a current, evidence-based understanding of the prevalence, causes, diagnostic testing, treatment, and patient care for various types of heart failure. Specific learning objectives to address potential knowledge gaps include:

- Describe heart failure.
- Summarize the epidemiology of heart failure.
- Discuss the pathophysiology and etiology of heart failure.
- Explain the relationship between heart failure and comorbidities.
- List diagnostic methods to determine presence and severity.
- Describe pharmacologic and nonpharmacologic treatment measures for heart failure.
- Explain the multidisciplinary approach to cardiac rehabilitation.
- Discuss patient education strategies to prevent recurrence and rehospitalization.

## INTRODUCTION

Heart failure (HF) is a complex syndrome of symptoms that causes the inability of the heart to pump sufficient blood throughout the body to satisfy the oxygen needs of the organs and cells. It may also be referred to as *cardiac failure* and was formerly referred to as *congestive heart failure*. HF may be caused by cardiac insult such as a myocardial infarction secondary to coronary artery disease or may be a natural effect of aging as the cardiac pump progressively weakens and becomes less effective. Two of the most common comorbidities are hypertension and diabetes (NHLBI, 2020d).

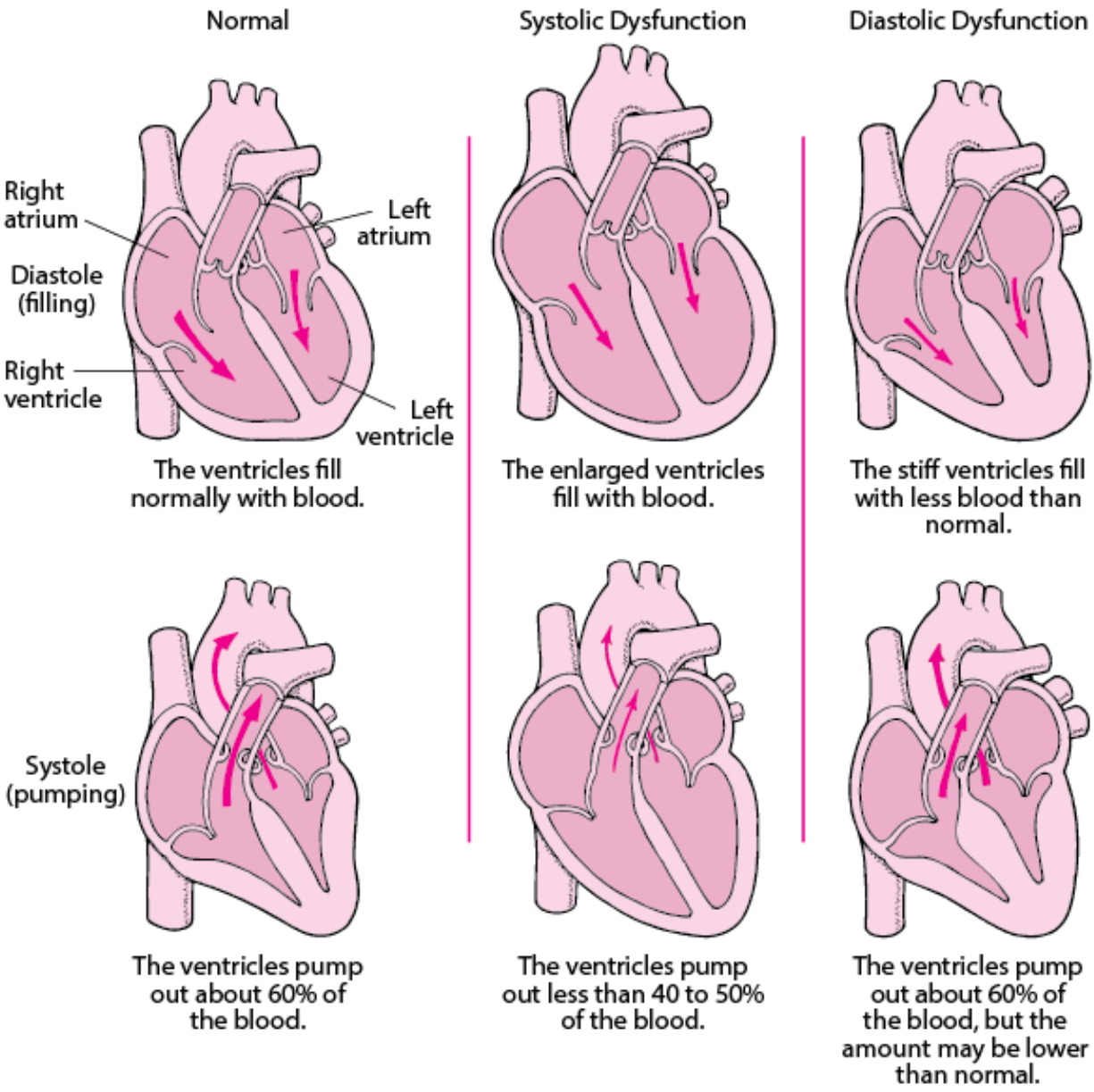
- **Systolic heart failure** is caused by weakened ventricular contractions from a dilated left ventricle that fails to pump blood effectively. This results in heart failure with reduced ejection fraction (HFrEF). Cardiac ejection fraction (EF) is the amount of blood pumped into the systemic circulation by the left ventricle, expressed as a percentage.

- **Diastolic heart failure** is decreased cardiac output in the presence of normal EF due to ventricular stiffness.

- **Right-sided heart failure** refers to failure of the right ventricle to pump blood effectively to the pulmonary arteries, thus causing a backflow of blood into the right atrium and into the venous circulation.

- **Left-sided heart failure**, which is the most common, refers to the failure of the left ventricle to pump blood to the rest of the body. When one ventricle fails, if left untreated, the other ventricle will also inevitably fail.

  (NHLBI, 2020d)




**Heart failure pumping and filling problems.** (Reprinted by permission from the Merck Manual Consumer Version, known as the Merck Manual in the United States and Canada and the MSD Manual in the rest of the world, edited by Robert Porter. © 2021, by Merck Sharp & Dohme Corp., a subsidiary of Merck & Co, Inc., Kenilworth, NJ. Available at http://www.merckmanuals.com/home.)

Heart failure can also be chronic (most common) or acute, where there are recognizable symptoms before treatment is implemented successfully (as in the case of pulmonary edema) (Harding et al., 2020).

(See also "Pathophysiology and Etiology" later in this course for more detailed descriptions.)

# IMPACTS AND EPIDEMIOLOGY OF HEART FAILURE

Nurses and other healthcare professionals are charged with giving culturally competent healthcare that recognizes the following epidemiologic factors.

## Occurrence

Heart failure affects more than 26 million people globally. It is considered a global epidemic, particularly in countries with rapidly aging populations, such as the United States and Japan. In countries where successful treatment of cardiovascular disease has improved life expectancy in general, the aging population also causes an increase in the occurrence of HF (Salam et al., 2020). HF prevalence is lowest in west sub-Saharan Africa (0.74 per 1000 in males and 0.57 per 1000 in females) (Benjamin et al., 2020).

HF affects approximately 6.9 million people in the United States and is projected to rise to more than 8 million by 2030. Approximately 650,000 people are newly diagnosed with HF each year (Virani et al., 2020; CDC, 2020a; Urbich et al., 2020).

This is attributed to three confounding factors in the population:

- People are living longer, and the elderly population is rapidly increasing, with more people in their 80s and 90s surviving with HF.
- People with acute coronary syndrome are surviving for much longer after an insult such as myocardial infarction due to earlier recognition of coronary artery disease, use of beta receptor blocking agents, and early intervention to improve coronary artery blood flow and preserve ejection fraction.
- The incidence of obesity and diabetes is increasing related to diet and exercise and affecting younger patients ages 20 to 45, who are experiencing heart failure in unprecedented numbers.
  (Benjamin et al., 2020)

Heart failure is the most common reason for hospital admissions in adults over 65 years old in the United States. Most HF hospitalizations are caused by one of five precipitants: infection, ischemia, dysrhythmia, medications, and noncompliance with diet. Patients hospitalized with worsening HF are at high risk of rehospitalization. Among patients with a single identifiable precipitant, research shows that the one-year risk for HF readmission varies with the particular precipitant. The precipitant for HF rehospitalizations is more likely to be the same precipitant as for the initial admission (Wang et al., 2020).

## Cost

The annual cost of HF is over $6.5 trillion globally. The annual cost of HF in the United States is over $30.7 billion dollars, with over half of that amount spent on hospitalizations. Other expenses include healthcare services, medications to treat heart failure, and days lost from work.

With the aging of the population, the total annual cost of HF in the United States is projected to reach $69.8 billion by 2030 when hospitalization, physician, pharmaceutical, and home healthcare costs are all considered (Benjamin et al., 2020; CDC, 2020a).

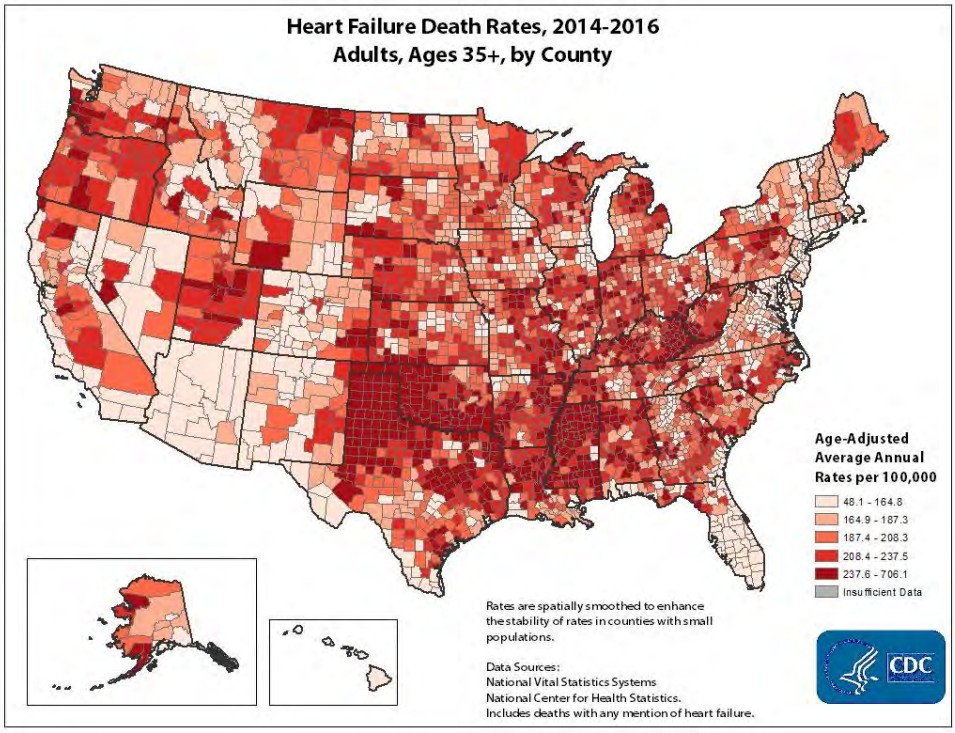
The annual median medical costs for heart failure care in the United States are estimated at $24,383 per patient. The costs are driven by heart failure–specific hospitalizations, with the median hospitalization cost per admission estimated at $15,879 per patient (Urbic et al., 2020).

HF is the second most commonly diagnosed inpatient condition billed to Medicare. Patients with HF who are admitted to an acute care hospital are medically vulnerable and have a poor prognosis, with a 2-year readmission-free survival rate as low as 17%. Risks for death and rehospitalization immediately after inpatient discharge for HF patients are greatly increased, with much of the economic burden resulting from costly hospital readmissions (Blum et al., 2020).

## Mortality

In 2018, heart failure appeared on 379,800 death certificates in the United States as the primary cause of death and accounted for 13.4% of all deaths. Geographically, the preponderance of deaths due to HF are in the southern and midwestern states (CDC, 2020a).

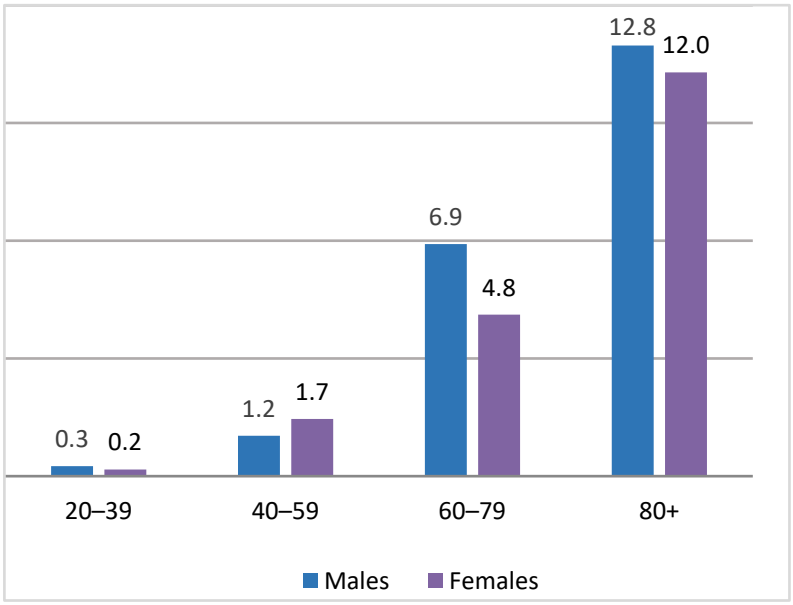
Despite improved technology and medications for treating HF, the mortality rate for HF patients who must be admitted or readmitted to an acute care hospital remains high. A longitudinal study of 73,802 HF patients found that 13.3% died within 30 days of discharge and that the total number of 30-day unplanned readmissions was 6.8% (Roshanghalb et al., 2020).




(Source: CDC, 2020a.)

## By Age

The incidence of HF in the United States after the age of 65 is 2.1%. Improved survival rates in this population are due to improved technology and medications, and this has resulted in an older group of surviving, chronic HF patients (Benjamin et al., 2020).




Percent of population with heart failure among U.S. adults by sex and age, 2013–2016.
(Source: National Health and Nutrition Examination Survey, 2013–2016.)

## Racial and Ethnic Disparities

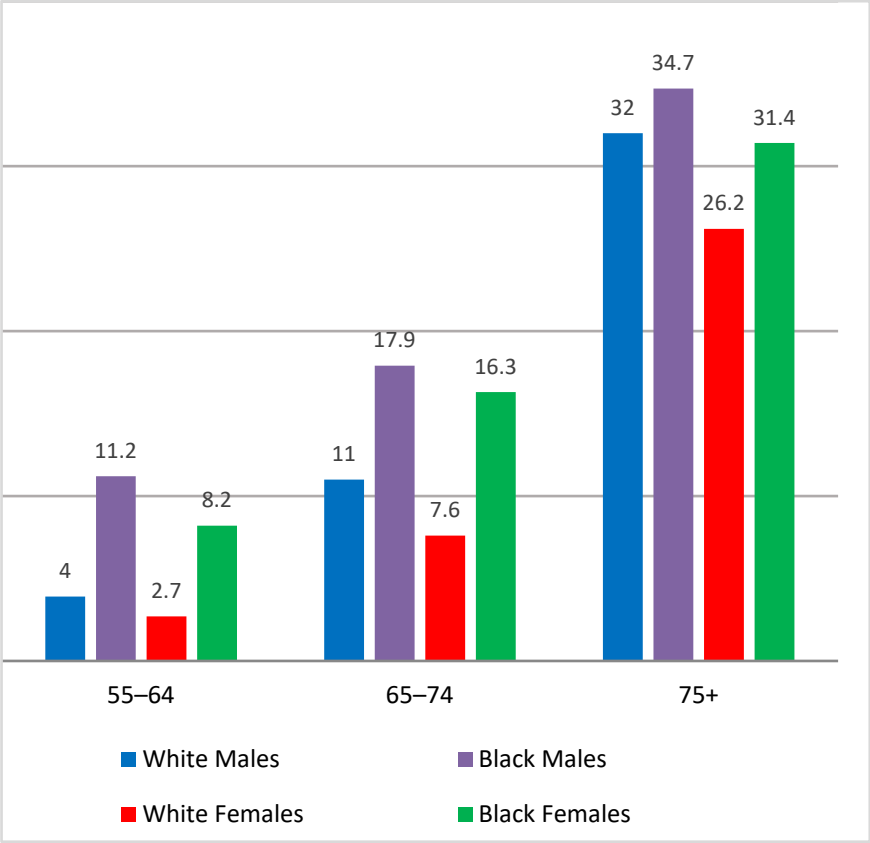
African Americans have a higher incidence of heart failure, develop symptoms at an earlier age, and experience mortality at a younger age than Whites with the same disease. African Americans with HF who are 65 years and older have more frequent hospitalizations and a mortality rate 2.5 times higher than Whites. This may be explained by African Americans' higher incidence of comorbid hypertension and diabetes than Whites. Disparities in access to healthcare may also contribute to their earlier morbidity and mortality.

African Americans are usually diagnosed with HF at an earlier age but show greater improvement with compliance with treatment. African Americans have the highest risk of developing HF, followed by Latinx, White, and Chinese Americans, in that order. This higher risk in African Americans reflects differences in the prevalence of hypertension, diabetes, and low socioeconomic status.

African Americans had the highest proportion of incident HF not preceded by clinical myocardial infarction (75%). Among African Americans, a greater proportion of HF risk (68% vs. 49% among Whites) is caused by modifiable risk factors, including elevated systolic blood pressure, hyperglycemia, coronary heart disease, left ventricular hypertrophy (LVH), and

smoking. LVH was three times more common in African Americans than in Whites (Benjamin et al., 2020).

African American patients are also more likely to be readmitted to the hospital within 30 days of admission than White or Hispanic patients. The presence of asymptomatic LV systolic dysfunction was higher in African Americans (2.7%) than in Whites, Chinese, and Latinx combined (1.7%). The following graph shows the preponderance of HF in the African American community compared to Whites, regardless of gender (Benjamin et al., 2020).




First acute decompensated heart failure annual event rates per 1,000 person years by age, sex, and race, United States, 2005–2014. (Adapted from: Atherosclerosis Risk in Communities [ARIC] Study.)

## Gender

Men are diagnosed more frequently with systolic HF; women are diagnosed more frequently with diastolic HF. Men with HF benefit more from ACE inhibitors; women with HF are more likely to have the ACE inhibitor–related cough as a persistent side effect (Harding et al., 2020).

Men are diagnosed more frequently with systolic HF due to higher prevalence of coronary artery disease (CAD). Women develop HF at an older age than men. Women are more likely to be diagnosed with diastolic HF due to a higher prevalence of hypertension. Women with HF are also more likely to have CAD, diabetes, valvular disease, and depression (Cleveland Clinic, 2019).

# PATHOPHYSIOLOGY AND ETIOLOGY

As first described above, there are several classifications of heart failure depending on the causes and duration of the illness, and HF can be any combination of these **three classifications**:

- Systolic vs. diastolic
- Left-sided vs. right-sided
- Acute vs. chronic

**Systolic vs. diastolic** heart failure refers to whether the cause of heart failure is impaired pumping of the ventricles (systolic) or impaired filling of the ventricles (diastolic). Whether the underlying problem is one of force of the contractions or altered relaxation determines whether the heart failure is considered systolic or diastolic. This is significant in that treatments vary depending upon the cause.

**Left-sided** HF refers to inefficient pumping of the left ventricle, leading to decreased cardiac output and therefore compromised perfusion. The volume of blood remaining in the left ventricle increases with each heartbeat, causing the blood to back up into the left atrium and eventually into the lungs. In **right-sided** HF the blood backs up to the right atrium and eventually to the periphery.

**Acute** heart failure refers to an episode of the illness that occurs suddenly or appears as an acute exacerbation of chronic HF (may be referred to as *acute-on-chronic HF*). **Chronic** heart failure occurs slowly over time, with the gradual deterioration of cardiac function resulting in worsening symptoms.

Some causes and signs/symptoms of heart failure are shown in the table below according to the chambers involved.

| CAUSES AND SIGNS/SYMPTOMS OF HEART FAILURE | | |
|---|---|---|
| **Classifications** | **Left-sided** | **Right-sided** |
| **Systolic HF Causes** | ● Myocardial infarction<br>● Coronary artery disease<br>● Cardiomyopathy<br>● Hypertension<br>● Valvular heart disease<br>● Tachydysrhythmias<br>● Toxins (cocaine, ethanol, chemotherapy agents)<br>● Myocarditis<br>● Postpartum cardiomyopathy | ● Right ventricular heart failure<br>● Left-sided heart failure<br>● Pulmonary embolus<br>● Pulmonary hypertension<br>● Chronic obstructive pulmonary disorder<br>● Septal defects |
| **Diastolic HF Causes** | ● Myocardial infarction<br>● Coronary artery disease<br>● Hypertrophic heart disease<br>● Pericarditis<br>● Radiation therapy to the chest<br>● Age<br>● Hypertension | ● Right ventricular hypertrophy<br>● Radiation therapy to the chest |
| **Signs/Symptoms** | ● Dyspnea/orthopnea<br>● Cheyne-Stokes respirations<br>● Paroxysmal nocturnal dyspnea<br>● Cough (orthopnea equivalent)<br>● Fatigue or activity intolerance<br>● Diaphoresis<br>● Pulmonary crackles<br>● Elevated pulmonary capillary occlusion pressure<br>● S3and S4 gallop<br>● Tachycardia<br>● Tachypnea<br>● Hepatojugular reflux | ● Jugular vein distension<br>● Hepatomegaly with ascites in severe cases<br>● Peripheral edema<br>● Loss of appetite, nausea, vomiting<br>● Elevated central venous or right atrial pressure |
| (Sole et al., 2020) | | |

## Neurohormonal Mediated Effects

HF with a reduced ventricular function results in a reduced cardiac output. Reduction of cardiac output can result in activation of the sympathetic nervous system (SNS) and the renin-angiotensin-aldosterone system (RAAS) as a compensatory mechanism. These neurohormonal responses cause physical changes in the body, particularly in the heart, kidneys, and blood vessels, as the body attempts to return to a state of homeostasis. Neurohormonal activation is one of the most common causes of the progression of heart failure.

These compensatory systems attempt to maintain a normal cardiac output by promoting retention of sodium and water, causing peripheral arterial vasoconstriction and inflammatory moderators that promote cardiac repair and remodeling. Neurohormonal activation will cause increases in cardiac preload, afterload, and left ventricular (LV) overfilling. These can lead to LV remodeling (changes in the LV shape, mass, and volume) and decreased LV pump function.

Beta-adrenergic blocking agents (beta blockers), angiotensin converting enzyme (ACE) inhibitors, aldosterone agonists, and angiotensin receptor blockers (ARBs) are prescribed for patients with HF to improve cardiac cell contractility in the failing heart caused by the activation of the neurohormonal systems in HF. The progression of HF may be reduced by beta blockers. ACE inhibitors and aldosterone agonists help prevent cardiac fibrosis in heart failure. ARBs reduce vasoconstriction, reducing the resistance against which a failing heart must pump (Hartupee & Mann, 2017).

Natriuretic peptides are hormones synthesized by the heart, brain, and other organs. Atrial natriuretic peptide (ANP) is released by the atria in response to atrial distension and so becomes elevated in a hypervolemic state such as in HF. B-type (also call *brain type*) natriuretic peptide (BNP) is synthesized by the ventricles and the brain. Serum BNP levels are used to diagnose the presence and severity of HF. They work in response to the SNS and RAAS compensatory mechanism in HF; the levels indicate necessary treatment to promote the excretion of sodium and water (Klabunde, 2019).

## Systolic Heart Failure

Systolic heart failure is a defect in ventricular pumping resulting in a reduced ejection fraction (EF) and referred to as *heart failure with reduced EF (HFrEF)*. Normal EF is 55% to 60%, but with systolic heart failure, the EF is abnormally low at <40% and in severe cases as low as 5% to 10%. A new classification of midrange EF (HFmEF) has an EF of 41%–49%.

With systolic HF, the left ventricle is unable to exert enough pressure to pump sufficient blood through the aorta and out to the rest of the body. Eventually, the left ventricle becomes dilated and hypertrophied from overwork, weakening the cardiac muscle. This results in the blood backing up into the left atrium and then into the lungs, causing pulmonary congestion and edema.

Systolic HF may be caused by increased afterload (as in hypertension), impaired contractile function (as in myocardial infarction), or mechanical abnormalities such as valvular disease.

Preload represents the volume of blood in the ventricles. Afterload represents the arterial resistance against which the ventricles pump blood. Abnormalities in the preload and afterload may also affect the cardiac output (Harding et al., 2020).

Systolic heart failure is also caused by various effects of aging. Aging causes a loss of elastin in the blood vessels, producing stiffness in the blood vessels. The myocardium also becomes stiffer due to a change in the effect of calcium in the cells and an abnormal growth in connective tissue. This causes ventricular hypertrophy contributing to cardiomegaly, an increase in the size or silhouette of the heart. A hypertrophied ventricle pumps less efficiently, resulting in heart failure.

Stiffness is further aggravated by interstitial collagen deposits in the cardiac tissue. The smooth muscle layers in the arteries become thicker, making them less elastic (Merck & Co, 2020).

## Diastolic Heart Failure

Diastolic heart failure occurs in the presence of normal EF and is referred to as *heart failure with preserved ejection fraction (HFpEF)*. In diastolic heart failure, the left ventricle is stiff or noncompliant, possibly due to hypertension or aging, causing decreased filling and high filling pressures and resulting in a reduction in cardiac output. Approximately 50% of patients with HF have HFpEF.

The reduced preload (ventricular volume) results in a diminished stroke volume (SV). As stroke volume is part of the cardiac output (CO) equation (SV x HR = CO), there is a diminished amount of blood pumped by the left ventricle into the systemic circulation.

The noncompliance of the ventricle is usually caused by hypertension. An imbalance in normal cardiac contraction and relaxation can also be due to the change in calcium function that occurs when there is an insufficient reuptake of calcium ions into the cardiac cells. Heart failure interferes with the normal reabsorption of calcium into the heart muscle. This causes the tissue to become weaker, creating a vicious cycle as the weak tissue is less able to reabsorb calcium (Merck & Co, 2020).

The characteristics of the patients with HFpEF are older age, more likely to be female, and greater prevalence of hypertension, obesity, and anemia than those with HFrEF (Benjamin et al., 2020).

**HEART FAILURE AND DECREASED CIRCULATION**

Any form of heart failure may result in decreased blood flow. Whether the HF is secondary to poor ventricular filling (diastolic) or a weak pump (systolic), the end result is less systemic perfusion and increased congestion at the cellular level. Poor perfusion to major organs may result in progressive organ failure. Poor renal perfusion may result in decreasing kidney function as evidenced by a decreasing glomerular filtration rate (GFR). Decreased cerebrovascular circulation in the form of reduced basilar artery inflow may lead to irreversible cognitive or motor impairment, as in the case of a stroke (Harding et al., 2020).

## Left-Sided Heart Failure

The most common type of heart failure is left-sided HF. It results in decreased cardiac output and increased pulmonary venous pressure as the incompletely emptied left cardiac chambers cause compromised blood flow. The left ventricle is unable to receive the blood from the left atrium, since it remains partially filled, which then makes the left atrium unable to receive the normal amount of blood from the lungs, thereby causing the lungs to become congested.

When the pulmonary artery capillary wedge pressure (PACWP) is greater than 24 mmHg, the capillaries begin to leak into the alveoli and interstitial space, escalating the work of breathing. The resultant pulmonary edema forces deoxygenated blood through the congested alveoli, diminishing the arterial oxygen content. The ability of the lungs to process deoxygenated blood and oxygenate it is significantly compromised, resulting in excessive fluid accumulation in the lungs and dyspnea.

The following are common **symptoms** of left-sided heart failure:

- Dyspnea
- Orthopnea
- Paroxysmal nocturnal dyspnea (PND)
- Cyanosis
- Pulmonary edema
- Pink, frothy sputum
- Activity intolerance
- Congestion of liver (higher pressures in the hepatic veins/inferior vena cava) and gastrointestinal tract (edema caused by increased intestinal permeability)

Some possible **causes** of left-sided HF include:

- Chronic coronary artery blockage
- Hypertension
- Excessive alcohol intake
- Myocardial infarction
- Valvular defects
- Thyroid disorders
- Heart muscle infection
- Abnormal vasculature

(Harding et al., 2020; Merck & Co, 2020)

## Right-Sided Heart Failure

Right-sided heart failure may be systolic or diastolic depending on whether the cause of failure relates to insufficiency of blood pumped out by the heart due to a weak pump or low volume. In right-sided HF, the right ventricle does not empty completely, causing the blood left in the chamber to back up into the right atrium. The elevated systemic venous pressure causes edema in dependent tissue and the abdominal viscera (ascites). This primarily affects the liver, but the stomach and intestines can also become congested. Dependent tissue edema will cause a delayed venous return of fluid and hypertension (Merck & Co, 2020).

Some common right-sided heart failure **symptoms** are:

- Swelling of the feet and ankles
- Accumulation of fluid in the peritoneal cavity (ascites)
- Hepatomegaly
- Jugular vein distension
- Anorexia, GI distress, weight loss

The most common **causes** of right-sided HF are:

- Chronic pulmonary diseases
- Pulmonary embolism
- Cor pulmonale (right ventricle dilation and hypertrophy)
- Congenital heart disease
- Primary pulmonary hypertension
- Heart valve disease
- Left-sided HF
- Right ventricular infarction

(Harding et al., 2020; Merck & Co, 2020)

**CASE**

Mi-Young, an 84-year-old woman, is brought by her granddaughter to the urgent care clinic complaining of swelling in her feet and ankles, infrequent urination, and difficulty walking. Angela, the family nurse practitioner, gets the patient settled in an exam room and performs a head-to-toe examination.

Angela notices that Mi-Young is walking slowly and with great difficulty and must lean heavily on her granddaughter's arm for support. She observes 3+ pitting edema of the feet and ankles, abdominal distention with ascites, a palpable liver, and 3+ jugular vein distention when sitting upright on the exam table. Mi-Young's vital signs are BP 168/94 mmHg, pulse

122, respirations 18, deep and unlabored, temperature normal, and an $O_2$ saturation of 89% on room air. An EKG shows a sinus tachycardia with occasional unifocal PVCs.

Angela suspects right-sided HF, explains her findings to Mi-Young, and arranges for EMT transport to the nearest hospital. She notifies the patient's primary care provider. She explains to the patient and her daughter that they will be given information to help them better understand how to take care of Mi-Young to address what is causing her symptoms and to prevent the same thing from happening again, thereby preventing a hospital stay. Angela clarifies that a plan of cardiac rehabilitation may be put into place to help her cope with her symptoms.

## Acute Heart Failure

Acute heart failure is the sudden onset of the signs and symptoms of HF, resulting in an urgent medical condition requiring immediate intervention. It may also manifest as the pulmonary edema that results after an abnormal accumulation of fluid in the lungs. This fluid compromises oxygenation, making it difficult for the patient to breathe. The heart starts to beat faster as a compensatory mechanism to improve oxygenation. The rapid heart rate causes the heart muscle to become exhausted, forming the foundation for the blood to become backed up or congested.

Acute HF typically occurs after a sudden insult to the myocardium, such as a myocardial infarction (MI). It may result in pulmonary edema if there is insult to the left ventricle. The following are common **causes** of acute heart failure:

- MI
- Liver failure
- Kidney failure
- Hematological conditions (such as anemias and coagulopathies that cause hemodynamic imbalance and edema)
- A sudden exacerbation of a chronic disease (acute-on-chronic HF)

The **symptoms** of acute HF are:

- Production of frothy, pink sputum with coughing
- Auscultation of adventitious breath sounds such as crackles
- Hypoxia that may result in panic/anxiety, tachycardia, shortness of breath, restlessness, orthopnea, or confusion
- Jugular vein distention
- Cyanosis

(Harding et al., 2020)

## Chronic Heart Failure

Chronic heart failure is a syndrome of ongoing ventricular dysfunction characterized by a progressive worsening of symptoms in which the heart no longer supplies adequate blood volume to satisfy the body's circulatory needs. Once there is a reason for the heart to begin failing—for instance, as chronic hypertension or an acute injury such as a myocardial infarction—the heart works harder to compensate for decreased output, and the increased cardiac workload causes the heart to fail even more.

The following are general **clinical manifestations** of chronic heart failure:

- Fatigue
- Dyspnea
- Paroxysmal nocturnal dyspnea (PND)
- Tachycardia
- Edema
- Nocturia
- Skin changes
- Behavioral changes
- Chest pain
- Weight changes
  (CDC, 2020a; Harding et al., 2020)

When a patient with chronic HF has an acute exacerbation with increased symptoms, it may be referred to as *acute-on-chronic HF*.

**CASE**

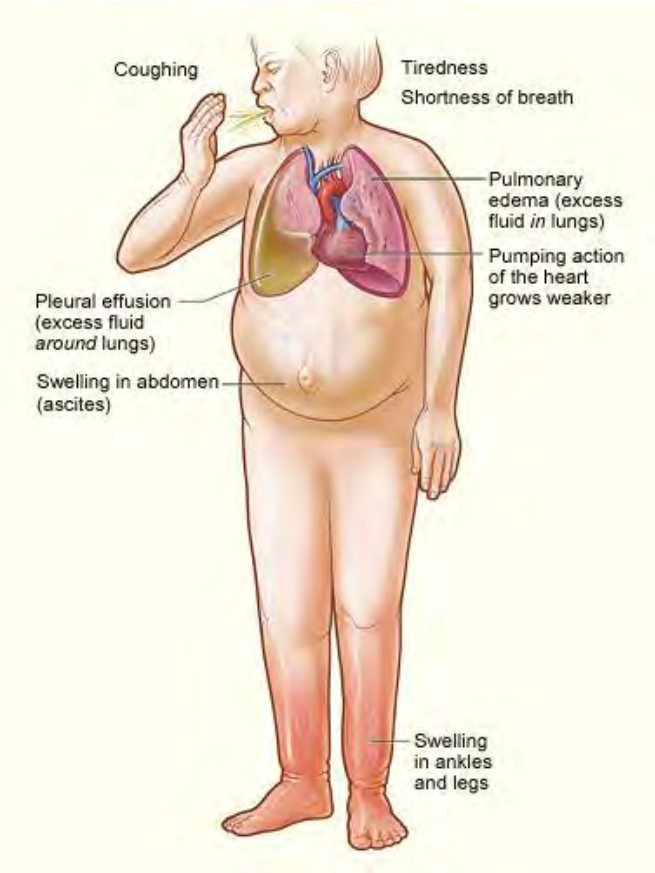
Antoinette is a 75-year-old, morbidly obese African American woman who is admitted to Sunshine Coast Hospital for the fifth time for recurring symptoms of heart failure. It has been 18 days since her last admission for these same symptoms. She has a history of hypertension, hypercholesterolemia, type 2 diabetes, and hypothyroidism. Her physician has ordered dietary and physical therapy consultations to support her in her efforts to lose weight and control her blood sugar.

At her initial physical therapy consultation, she seems downcast and dejectedly tells the evaluating therapist, Warren, that everyone in her family has some form of heart disease and "there's just nothing I can do about it." Warren validates Antoinette's feelings by agreeing that genetic risk factors for heart disease cannot be helped and are a valid concern. He then goes on to discuss the fact that other modifiable risk factors, such as weight, blood pressure, and blood sugar, are more within Antoinette's control and that her multidisciplinary healthcare team will help her to gain more control over these factors.

Antoinette brightens a bit at this and tells Warren about her recent dietary consult, where the dietitian recommended a diabetes diet in order to help get her weight and blood pressure under better control. Warren tells Antoinette that physical therapy can also help with these factors and that the two of them will work together to craft a realistic and progressive cardiopulmonary conditioning program of therapeutic exercises.

Antoinette diligently follows the recommendations of her dietitian and goes to PT twice weekly for a period of eight weeks. On her last day of PT, she proudly tells Warren that she has been experimenting with a heart-healthy cookbook and now uses olive oil in place of canola oil and wheat bread instead of white. She is happy to report that her blood sugar has lowered by several points, she has lost 7 pounds, and she feels more in control of her food choices. When Antoinette finishes her last PT session, she is noticeably less fatigued and less short of breath than she was at her first session. Warren takes her blood pressure and announces that it, too, has lowered significantly over the past two months.

Antoinette and Warren review a long-term exercise program for Antoinette to continue independently at home, including an after-dinner walk, working in her newly planted vegetable garden, and joining a weekly aquatic exercise class at the local senior center. As she leaves the clinic, Antoinette gives Warren a hug, thanks him for helping her to feel more in control of her health and promises to bring him some tomatoes from her garden.




Major signs and symptoms of heart failure. (Source: NHLBI, 2020d.)

## Risk Factors

Risk factors for heart failure include:

- Advanced age
- Dietary and lifestyle factors
- Obesity
- Genetic disposition

Comorbidities may also put someone at greater risk for HF and include:

- Myocardial infarction
- Hypertension
- Diabetes
- Renal failure
- Metabolic syndrome
- Untreated sleep apnea
  (Benjamin et al., 2020; CDC, 2020a)

**Advanced age** (>70 years) usually results in increased afterload due to increased arterial resistance. This is caused by thickening of the smooth muscle and a loss of elastin in the blood vessels. Calcium changes and interstitial collagen deposits in the myocardium cause a loss of elasticity, affecting the ability to pump blood out of the ventricles.

**Women** experience a higher occurrence of diastolic failure than men. Women with diabetes are more predisposed to HF. Women have a higher incidence of obesity, which is another risk factor for HF. Women also have a higher incidence of increased left ventricular end-diastolic pressure, or preload.

**Dietary and lifestyle factors** also impact HF risk. HF is higher in males with hypertension, whereas healthy lifestyle factors (normal weight, not smoking, regular physical activity, moderate alcohol intake, and consumption of fruits and vegetables) are related to lower risk of HF. The use of tobacco products containing nicotine causes the release of catecholamines, resulting in the vasoconstriction that causes hypertension, and hypertension causes increased vascular resistance that may cause HF over time.

**Obesity** may be a precipitating factor for HF. It can be associated with diabetes, hypercholesterolemia, and hypertension, all common comorbidities with HF.

Individuals may be predisposed to acquiring HF because of specific **genes or gene mutations** they have inherited. Cardiovascular disorders such as hypertension, coronary artery disease, and cardiomyopathy (a weakening of the heart muscle) all have a genetic link and may predispose a

patient to HF. Cardiomyopathy alone may be connected to as many as 40 defective genes (Harding et al., 2020).

Cocaine causes cardiac injury through both ischemic and toxic pathways. Cocaine increases the synaptic catecholamine concentration, producing coronary vasoconstriction. Prolonged cocaine use results in ischemia producing cell death and myocardial fibrosis. Myocardial toxicity plays a major role in cocaine-induced cardiac injury. Chronic alcohol consumption can cause extensive oxidative injury to the mitochondria. Marijuana-induced coronary vasospasm and tachycardia, in conjunction with excessive cocaine use, may contribute to a risk of sustaining a myocardial infarction (Chapel & Husain, 2018).

African Americans have a greater proportion of HF risk (68%) than Whites (49%), which is largely attributable to modifiable risk factors such as elevated systolic blood pressure, hyperglycemia, coronary heart disease, left ventricular hypertrophy, and smoking (Benjamin et al., 2020).

The American Heart Association's **"Life's Simple 7" guidelines** are associated with a lower lifetime risk of HF. They include stopping smoking, lower BMI, physical activity for at least 30 minutes at least five times per week, healthy diet, lower-range cholesterol, BP <140/90 mmHg, and glucose within advised parameters (Benjamin et al., 2020).

# HEART FAILURE AND COMORBIDITIES

Comorbidities associated with heart failure include hypertension, myocardial infarction, diabetes, renal failure, metabolic syndrome, and respiratory insufficiencies.

## Hypertension

Hypertension is the most common comorbidity of heart failure. Hypertension that includes a chronic BP of >160/90 mmHg increases the life risk of developing HF by 1.6 times that of a usual BP reading of <120/80 mmHg at all ages (Benjamin et al., 2020).

Hypertension reflects increased vascular resistance to the efforts of the heart, especially the left ventricle, to pump blood to the body. The harder the heart works to pump blood, the more work the muscle (myocardium) must do. As with any muscle, the more work required to pump blood, the larger the muscle grows to work effectively. This results in myocardial hypertrophy, creating a larger, less-flexible muscle that must in turn work even harder, causing ventricular remodeling. Ventricular remodeling results in large, oddly shaped contractile cells, increased oxygen consumption, increased cardiac workload, increased wall tension, and impaired contractility (Harding et al., 2020).

Uncontrolled hypertension is also the most common cause of a HF exacerbation. Since it is a modifiable risk factor for heart failure, early recognition and intervention for hypertension helps to prevent further worsening of cardiac function. Managing blood pressure is an essential part of preventative care to avoid the recurrence of aggravated HF symptoms. Blood pressure

management is a multifaceted, multidisciplinary approach that includes medications, diet, exercise, and establishment and support of activities of daily living.

Cardiac dilation occurs when a sustained BP elevation causes enlargement in the cardiac chambers, usually the left ventricle. This causes the myocardial fibers to stretch in response to increased volume at the end of diastole. The degree of stretch is related to the force of the contraction during systole (the Frank-Starling law). This is a compensatory mechanism that supports BP, cardiac output, and perfusion, but eventually fails as the patient decompensates and starts to experience HF (Harding et al., 2020).

## Myocardial Infarction

Myocardial infarction (MI) is a common comorbidity for heart failure. An MI in the area of the left ventricle (LV) may cause a dysfunctional LV, leading to a drop in cardiac output due to incomplete emptying of the ventricle. This causes the myocardium to have to exert greater effort to pump blood to the rest of the body. After time, this increased effort causes the cardiac pump to be less effective, eventually leading to HF.

Cell injury in the infarcted area causes an inflammatory response. As cardiac output and subsequent renal blood supply drops, the renin-angiotensin-aldosterone system (RAAS) goes into effect. Additionally, the production of antidiuretic hormone (ADH) stimulates further production of the vasoconstrictor endothelin, causing arterial vasoconstriction that will increase cardiac contractility and hypertrophy, intensifying the effects of HF.

Infarcted myocardial tissue becomes akinetic (motionless), causing pump failure (systolic failure, or HFrEF). As discussed earlier in this course, poor coronary artery blood flow causes myocardial ischemia that may lead to an infarction of the myocardial tissue over time. Infarcted tissue is necrotic, losing all former abilities, including contractility. The necrotic tissue is therefore no longer capable of movement, causing a decrease in the strength of the heart to function as a pump. This pump failure affects the amount of blood emptied through force from the affected chamber(s). When the left ventricle is affected, a smaller volume of blood leaving the left ventricle to the aorta affects the ability of the other cardiac chambers to empty, causing congestion.

## Diabetes

Diabetes mellitus (DM) is frequently associated with heart failure. The dramatic increase in the number of people diagnosed with diabetes will most likely cause a similar growth in the number of people with HF.

One population study found that those with diabetes had a higher body mass index, plasma insulin level, and serum glucose level than those without diabetes, whereas both sample groups had similar ejection fractions. After a 10.8-year follow-up period, the patients with DM had a 21% incidence of HF compared to a 12% incidence among those without DM (Klajda et al., 2020).

Another correlation between diabetes and HF is that insulin is a powerful sodium-retaining hormone. Patients with type 1 diabetes who are receiving insulin have a greater tendency to retain fluid, thus exacerbating the effects of HF. Patients with type 2 diabetes and HF who are taking empagliflozin (a sodium-glucose transporter 2 inhibitor) showed a reduction in hospitalizations. Those with no HF had a lower incidence of developing the disease over time (Fukuoka et al., 2020).

High blood sugars result in vascular scarring in the layer of the tunica intima affecting circulation. Prolonged periods of uncontrolled blood glucose levels, now recommended to be <150 mg/dL, result in permanent scarring and cause significant impact as blood flow is affected. This may result in poor tissue healing, blindness, renal failure, and HF as the effect of compromised circulation takes its toll on arteries and organ systems over time.

Poor peripheral circulation causes decreased venous return, reducing ventricular filling. Reduced ventricular filling results in a lower cardiac output and reduced ejection fraction. This can cause HF as the cardiac muscle attempts to compensate for the decreased amount of blood volume exiting the left ventricle and the congestion of blood due to sluggish circulation.

## Renal Failure

Renal failure is associated with adverse outcomes in patients with HF. Renal dysfunction, defined as an estimated glomerular filtration rate (eGFR) of <60 mL/minute, is highly prevalent in HF patients.

Reduced renal blood flow because of compromised circulation with a reduced ejection fraction may cause the kidneys to perform poorly. A reduced volume of blood passing through the kidneys will reduce the amount of blood to be filtered, resulting in higher levels of waste products, including nitrogenous wastes (i.e., BUN, creatinine).

In HF combined with renal failure, stimulation of the sympathetic nervous system and the renin-angiotensin-aldosterone system (RAAS) causes the excretion of catecholamines and angiotensin II, among other substances. The release of angiotensin II produces ventricular remodeling. Abnormal neurohormonal responses can also exacerbate the degree of heart failure. The RAAS acts to control blood pressure by promoting fluid retention and vasoconstriction. When cardiac output drops, decreased renal circulation causes the kidneys to release renin, initiating the RAAS response. This causes fluid sodium retention and will increase the blood pressure and the workload in an already failing heart (Harding et al., 2020).

## Metabolic Syndrome

Metabolic syndrome is a group of risk factors that may predispose an individual to heart disease, including HF, diabetes, and stroke. It is characterized by a collection of health issues that includes obesity, high triglycerides, high levels of high-density lipoprotein cholesterol, hypertension, and high blood glucose. An individual is considered to have metabolic syndrome if they have at least three of these five factors (Harding et al., 2020; Popa-Fotea et al., 2020).

The progression of HF correlates highly with a patient with metabolic syndrome. Minor increases in serum glucose cause a high risk for HF. Insulin resistance occurs with 60% of patients with HF. Metabolic syndrome correlates with both systolic and diastolic HF (Popa-Fotea et al., 2020).

### Respiratory Insufficiency

Many HF patients have respiratory comorbidities such as chronic obstructive pulmonary disease (COPD) or asthma. COPD and asthma are both characterized by respiratory limitations, often caused by inflammation in the airway. Both HF and respiratory patients share several of the same symptoms, such as dyspnea, fatigue, psychological disturbances, deconditioning, and exercise intolerance.

Pleural effusion can be a common complication of HF. Pleural effusion is when the natural fluid between the two layers of the pleura that exists for lubrication becomes excessive secondary to increased pressure in the pulmonary capillaries. The clinical manifestations are dyspnea, cough, and chest pain. These symptoms may imitate symptoms of acute HF and confound a clinician's ability to diagnose the specific cause of the worsening symptoms unless a physical assessment and diagnostic tests are performed (Harding et al., 2020).

**COVID-19 AND HEART FAILURE**

COVID-19 is an acute, sometimes severe, often fatal, respiratory disease that is caused by the novel coronavirus SARS-CoV-2. Serious diseases that may be a long-term result of a case of COVID-19 with more extreme symptoms include dysrhythmias, cardiomyopathy, acute cardiac injury, thromboembolism, pulmonary emboli, disseminated intravascular coagulation (DIC), hemorrhage, arterial clots, Guillain-Barré syndrome (rare), sepsis, shock, and multiorgan failure (Merck & Co., 2020).

Heart failure as a pre-existing condition and COVID-19 both have similar risk factors, tend to cause polypharmacy, and promote nutritional challenges. HF risk factors such as advanced age, male gender, elevated D-Dimer and lactate dehydrogenase levels, and a higher NYHA score translate to a higher percentage of mortality for patients with a concomitant COVID-19 infection. The inflammation common to both diseases potentiates a poor outcome for the patient. The presence of both diseases causes an increase in dysrhythmias: tachycardia, bradycardia, prolonged QT interval, and polymorphic ventricular tachycardia (Khan, 2021).

## DIAGNOSIS OF HEART FAILURE

The diagnosis of heart failure is primarily made based on symptoms and backed by more precise diagnostic tests to either rule out similar disease processes or confirm a diagnosis of HF.

## Health History

Taking a focused health history is an essential part of reaching a differential diagnosis of HF. This may include any medical or surgical history, list of medications taken, recent diagnostic test results, any concerning or pertinent symptoms (such as orthopnea, paroxysmal nocturnal dyspnea, weight gain, abdominal bloating, reduced appetite, and dyspnea-free activity), family cardiac history, and vital signs. It may be taken by a physician or an advanced practice nurse.

## Physical Examination

A physical examination is performed to verify the subjective complaints of the patient and further determine a diagnosis of HF. Abnormal findings may support the diagnosis of HF.

**Cardiovascular** examination includes blood pressure, heart rate, pulses, and cardiac auscultation. Chest pain may occur from decreased coronary artery perfusion secondary to decreased cardiac output or coronary artery obstruction. The point of maximum impulse (PMI), which is the point furthest from the sternum where the cardiac impulse can be felt, may be displaced due to left ventricular hypertrophy.

**Intake and output** and **daily weights** are measured accurately using a consistent method to determine fluid balance or overload.

Inspection of the **skin** for edema or skin discoloration will show the presence of fluid retention. Copper-colored, shiny lower-leg and ankle discoloration accompanied by dry, flaky skin may indicate recurrence of swelling and reabsorption of fluid. Moderate or severe heart failure may produce visible shortness of breath. The skin may be pale, ashen, or cyanotic. Jugular veins may appear distended. The skin may be cold and clammy from vasoconstriction.

**Palpation** is used to determine the severity of peripheral edema and whether a depression (pitting) is produced that does not resolve immediately. The abdomen is palpated to establish hepato- or splenomegaly. Abdominal tenderness over the liver is indicative of hepatic congestion.

**Auscultation** of the heart and lungs may elicit adventitious breath sounds, such as crackles as in the case of pulmonary edema or pleural effusion caused by left-sided HF. S3 and S4 heart sounds or a cardiac murmur may be heard. Labored respirations may indicate hypoxia, pulmonary edema, pleural effusion, and hypervolemia.

**Vital signs** are usually checked every 1 to 8 hours during hospitalization based on the severity of the HF and checked with each physician or clinical visit, where the patients bring in a log of their blood pressures that they have taken themselves. Hypertension is common due to increased venous resistance (afterload) or hypervolemia from fluid retention. Tachycardia >100 beats per minute is often an early sign of HF as a compensatory mechanism for decreased cardiac output.

**Cardiac monitoring** may need to be performed continuously to assess for dysrhythmias. The respiratory rate may be elevated (>14 to 16 breaths per minute) due to pulmonary edema or decreased cardiac output as the body attempts to increase oxygen intake to compensate for hypoxia.

**Hemodynamic monitoring** when a patient is in the ICU may include continuous BP monitoring via an arterial line as well as cardiac output , pulmonary artery pressure, and pulmonary artery capillary wedge pressure via a pulmonary artery or Swan-Ganz catheter. Diuretic medications and ultrafiltration or aquapheresis (fluid removal) orders are based on these readings to remove excess sodium and fluid.

**Oxygen saturation** is decreased (<94%) in the presence of fluid in the lungs and may need to be monitored continuously, necessitating supplemental oxygen or positive pressure to be given (Harding et al., 2020).

## Electrocardiogram

An electrocardiogram (ECG) is performed to determine the presence of any dysrhythmias, including an abnormal heart rate, since damage to the ventricular myocardium following an acute myocardial infarction may result in ventricular dysrhythmias. This can also be observed on the patient's cardiac monitor atrial fibrillation. The ECG can also reveal evidence of myocardial ischemia indicating coronary artery disease as an indirect cause of HF. This may be performed by nurses, emergency room technicians, medical assistants, lab technicians, or ECG technicians.

## Chest X-Ray

A chest X-ray may show cardiomegaly, which is common in protracted HF. It may also display abnormalities in the cardiac chambers, pulmonary congestion, displacement of the heart, and abnormalities of the lungs and greater blood vessels. This is performed by a radiology technologist. It may only be officially read by a physician, particularly a radiologist, or an advanced practice nurse.

## Treadmill Stress Test

A treadmill stress test is performed to determine activity tolerance. It is used to diagnose coronary artery disease, cardiac valvular disease, and chronic HF. It is performed concurrently with ECG and BP monitoring by a physician or trained clinician. The testing is stopped if the patient experiences extreme hypertension, tachycardia, or chest pain (NIH, 2020). A treadmill stress test is preferable to assess activity tolerance, but a chemical stress test with nuclear imaging may be needed for those unable to physically walk or raise their heart rate to a target goal (Morgan, 2021).

## Echocardiogram

An echocardiogram shows abnormalities of the valves, the size and structure of the heart and chambers, and the condition of the pericardial sac and the ascending aorta. The ejection fraction

is also measured during an echocardiogram, signifying the strength of the myocardium as a pump. Therefore, an echocardiogram is crucial in determining whether the HF is systolic or diastolic. This is performed by a trained sonographer who uses conducting gel and a transducer to transmit information to a specialized computer via sound waves. It is evaluated by a cardiologist.

## Cardiac Catherization

Cardiac catheterization (heart cath), or coronary angiography, is a highly invasive procedure in which a physician advances a thin, flexible catheter via the radial or femoral artery (for a left cardiac catheterization) and through the internal jugular, femoral, or subclavian veins (for a right cardiac catheterization) to obtain right-sided heart pressures. Dye is then injected into the arteries, and a radiologic video (cine) is taken to measure the degree of blockage in any of the coronary arteries. During this procedure, an angioplasty and stent placement may be performed. Each coronary artery will reveal the percentage of obstruction, guiding the need for and type of intervention. Coronary artery disease is one possible cause of heart failure (NIH, 2020).

## Labwork

**BNP** (B-type natriuretic peptide) testing is the most definitive diagnostic test for HF. This biomarker establishes both the presence and severity of HF. BNP levels are also frequently rechecked to measure the success or failure of treatment. Normal range for BNP is <100 pg/ml. The higher the reading, the more severe the HF.

The neurohormone BNP is produced by myocardial cells. An increase in this hormone is caused by increased atrial or ventricular diastolic wall stretch to show the degree of left ventricular failure, as in HF. The BNP level may read as normal in heart failure in patients with HFpEF. Patients with acute decompensated HFpEf may have an elevated BNP (100–500 pg/ml), but lower than patients with HFrEF. Obesity sometimes causes decreased BNP production and increased BNP clearance, resulting in lower BP levels, sometimes to the point of normal (Yancy et al., 2017).

**Other diagnostic labwork** for heart failure includes:

- A complete blood count (CBC) will determine the presence of infection or anemia.
- A comprehensive metabolic panel (CMP) measures electrolytes, kidney function (BUN and creatinine), liver function, glucose, calcium, magnesium, and albumin.
- Urine sodium is measured to determine the possibility of sodium retention.
- Urine specific gravity measures urine concentration.
- Thyroid function is measured to rule out thyroid disease as a cause of HF, and for elderly patients and those with atrial fibrillation.
- Serum iron, ferritin, and TIBC are measured to distinguish the possible causes of anemia.
- Serum interleukin-6 is a cytokine that signals the presence of inflammation.

- C-reactive protein (CRP) is produced by the liver and is increased in the presence of inflammation.
- Tumor necrosis factor-a (TNF) is a cytokine that signals the presence of inflammation. (Merck & Co, 2020)

**NYHA FUNCTIONAL CLASSIFICATIONS**

A widely accepted and long-established system of HF classification is the New York Heart Association (NYHA) functional classifications. It distinguishes different levels of heart failure severity according to the patient's ability to perform certain physical activities.

| Class | Patient Ability |
|---|---|
| I | No physical limitations |
| II | Slight limitations; comfortable only at rest; minimum activity starts to produce the symptoms of HF |
| III | Marked limitations; comfortable only at rest; moderate activity produces HF symptoms |
| IV | Unable to perform any activity without symptoms of HF; symptoms while at rest |

(Shoemaker et al., 2020; Sole et al., 2020)

**ACC/AHA* 2001 STAGING SYSTEM**

| Stage | Description |
|---|---|
| A | At high risk of developing heart failure, but without structural heart disease or symptoms of HF (e.g., people with hypertension, coronary artery disease, diabetes, history of drug or alcohol abuse, rheumatic heart disease, or family history of cardiomyopathy) |
| B | Structural heart disease with or without symptoms of HF (e.g., left ventricular structural changes, heart valve disease, or history of myocardial infarction) |
| C | Structural heart disease with prior or current symptoms of HF (e.g, shortness of breath, fatigue, or symptom-free and receiving treatment for prior symptoms) |
| D | Refractory or end-stage HF requiring specialized interventions such as cardiac transplantation or compassionate care such as hospice |

* American College of Cardiology/American Heart Association

(Shoemaker et al., 2020; Sole et al., 2020)

# TREATING HEART FAILURE

There are several levels of treatment parameters for heart failure. While there is no cure, the treatment goals are:

- Symptom management
- Prevention of exacerbation
- Prevention of advancement to worse functional classifications

**Collaborative management** refers to the combined efforts of the various healthcare team members who combine therapies and areas of expertise to manage symptoms and prevent exacerbations. A well-coordinated, collaborative approach can also prevent advancing to a worsening level of function.

**Medications** may be used to improve cardiac output, reduce cardiac workload, improve symptoms, reduce mortality, and reduce the occurrences of readmission to the hospital.

**Surgical interventions** such as heart valve replacement or repair, internal cardiac defibrillators, transtelephonic electrocardiographic transmission devices, coronary artery bypass grafts, or heart transplants are used to treat and repair some of the underlying causes of HF, reduce dysrhythmia, improve organ perfusion, and reduce mortality.

**Cardiac assist devices** serve to improve organ perfusion.

**Supportive devices** treat symptoms and reduce the occurrence and length of hospitalizations. Human embryonic stem cell therapy can reduce cardiac tissue necrosis. Cardiac monitoring devices continually collect and analyze cardiac-related data and can alert the clinician to the presence of important physiological events, often before symptoms occur.

**Nutritional therapy** helps to promote weight reduction and prevent edema.

## Collaborative Management

Patients with heart failure receive treatment from a wide spectrum of healthcare professionals. Acute and chronic phases of the disease therapy, including cardiac rehabilitation, require specialists to deal with the assorted aspects of needed care. The individual disciplines may include physicians, different levels of nurses (RN, advanced practice, vocational or practical nurse), physical therapists, occupational therapists, pharmacists, respiratory therapists, nutritionists or registered dietitians, mental health professionals, and social workers.

The use of a coordinated, multidisciplinary heart failure team results in improved outcomes for HF patients both when hospitalized and as outpatients. The introduction of such teams to provide expertise in the initiation and management of therapy decreases inpatient and one-year mortality rates, hospital length of stay, and the number of hospital readmissions for HF (Boa Sorte Silva et al., 2020).

**CASE**

Miguel is in the hospital for the fourth time for symptoms of heart failure. He is 79 years old, moderately obese, has type 2 diabetes, and has a stage 3 pressure injury (ulcer) on his heel. He is unable to walk because of pain from the ulceration. He and his family are native Spanish speakers.

Miguel's physician has determined that the patient is stable and ready for discharge but also recognizes that there are some barriers to his being well cared for at home, where he lives with his daughter. Miguel's daughter has not yet had the opportunity to practice dressing changes on Miguel's heel ulcer due to language barriers with the inpatient nursing staff. Miguel's heel ulcer has affected the stability of his gait as well as his standing balance for functional tasks, which poses a safety risk in the home setting. Miguel's daughter has also told the nurse that the food choices suggested by the inpatient dietitian did not make any mention of culturally specific foods that her father most enjoys.

Miguel's physician determines that Miguel and his family need instruction in diet, wound care, and mobility, particularly ambulation and strength training. On the physician's orders, Miguel is seen by a certified wound care/ostomy nurse, the dietitian, a physical therapist, an occupational therapist, and a discharge planner before his discharge.

The wound care nurse makes a thorough examination of the heel ulceration. She orders a MediHoney paste, applies it to the wound, and dresses it. She is fluent in Spanish and explains to Miguel's daughter how to treat the wound when he goes home. She gives his daughter samples of the MediHoney and some dressing material and explains that she can obtain more in any pharmacy or grocery store with a pharmacy section.

The dietitian uses the services of a certified medical translator to instruct the daughter in preparing a calorie- and carbohydrate-limited ADA diet for Miguel. She asks for suggestions from the daughter about Miguel's favorite foods and incorporates some of the daughter's Mexican specialties into the diet plan, with instructions on substitutions for traditional high-carbohydrate foods like tortillas, beans, and rice.

The physical therapist evaluates Miguel and recommends the use of a rolling walker with partial weight-bearing for all ambulation while his foot wound heals. He provides gait training to instruct Miguel in partial weight-bearing in order to minimize pressure on his heel wound. The physical therapist also educates both Miguel and his daughter regarding the importance of regular ambulation to improve circulation and prevent edema.

The occupational therapist evaluates Miguel and observes his execution of ADLs (activities of daily living) such as hygiene, grooming, eating, and dressing. She suggests that the patient may benefit from the use of a covered cup for liquid intake and large utensils to facilitate eating since his advanced age and diabetes have caused visual impairment. The occupational therapist also suggests the use of a weekly medication holder to help the daughter organize Miguel's daily medications to prevent omissions or errors.

The discharge planner also uses the services of the medical interpreter to arrange for admission to a rehabilitation facility to help Miguel with functional mobility and to prepare him to eventually be discharged home.

## Pharmacologic Interventions

### MEDICATIONS TO REDUCE CARDIAC WORKLOAD

In HF there are many factors that can increase the workload of the heart. Excess circulating volume forces the heart to work harder to pump an increase of fluid throughout the body. Stress may produce a rapid heart rate, causing the heart to work overtime. Hypertension reflects vascular resistance against which the heart must pump harder to produce cardiac output. Antihypertensives exert individual chemical properties to control physical response to sympathetic nervous system stimulation, vasoconstriction, or fluid overload secondary to sodium and fluid retention.

**Aldosterone (mineralocorticoid receptor) antagonists** are used in HF to promote diuresis as a means of lowering blood pressure to reduce myocardial tissue damage, cardiac myopathy, and fibrosis. These have shown to reduce mortality and hospital readmission in HF patients. Examples include spironolactone and eplerenone (Kruik-Kollöffel et al., 2020).

**Angiotensin converting enzymes (ACE) inhibitors** reduce vascular resistance by interfering with the renin-angiotensin-aldosterone system (RAAS) to reduce the conversion of angiotensin I to angiotensin II. This decreases aldosterone excretion and sodium retention to reduce blood pressure and improve blood flow. Angiotensin II is a powerful vasoconstrictor short-term and over the long run affects the blood vessels' tissue growth that results in remodeling of the vessel walls and causes hypertension. Examples include enalapril (Vasotec), lisinopril (Zestril), and captopril (Capoten). Asian Americans have a high (up to 50%) risk for ACE inhibitor–induced cough as a side effect (Harding et al., 2020; Sole et al., 2020).

**Angiotensin receptor blockers (ARBs)** similarly affect the RAAS to reduce the pressure in the heart and may be prescribed for those who cannot take ACE inhibitors due to chronic cough or angioedema. These drugs include losartan (Cozaar) and valsartan (Diovan) (Sole et al., 2020).

**Angiotensin receptor-neprilysin inhibitors (ARNIs)** are a newer classification of drugs for the treatment of HF. The FDA has approved sacubriril/valsartan (Entresto) as the first drug in this category to be used with NYHA classes II, III, or IV. This drug has two main effects: the first, from the valsartan, is a similar effect to ACE inhibitors and ARBs (see above); the second, from the sacubritil, strengthens a hormone regulated by the heart muscle itself, which releases BNP. BNP causes vasodilatation and increases sodium excretion by the kidneys and an increased diuresis. These result in a significant reduction in hospitalization and mortality. Known side effects are hypotension, dizziness, syncope, hypovolemia, hyponatremia, cough, and renal insufficiency (Docherty et al., 2020).

**Vasodilators** increase the internal diameter of the blood vessels to promote better blood flow and reduce blood pressure.

**Nitrates** cause vasodilation and increased venous capacity by relaxing the smooth muscle of blood vessel walls. When HF accompanies myocardial ischemia secondary to CAD, nitrates are particularly beneficial, causing coronary artery dilation and improving blood flow to the myocardium to relieve or prevent chest pain. Examples of nitrates are isosorbide dinitrate (Isordil) and sublingual nitroglycerin. The most common side effects of nitrates are vasodilation of peripheral arteries, resulting in reduced venous resistance and lowered blood pressure, and headache. African Americans are the only ethnic group for whom the combination drug isosorbide dinitrate/hydralazine (BiDil) is approved as treatment for HFrEF (Harding et al., 2020; Sole et al., 2020).

**Loop diuretics** promote renal excretion of fluids and sodium chloride to decrease the circulating intravascular volume, which reduces blood pressure. This action takes place in the ascending loop of Henle in the renal tubules. Excretion of excess fluid reduces cardiac workload and oxygen consumption. Examples of loop diuretics are furosemide (Lasix), bumetanide (Bumex), and torsemide (Demadex).

**Vasopressin-2 receptor antagonist** tolvaptan (Jynarque, Samsca) in renal failure patients with HF, when added to conventional therapy, has shown improved dyspnea symptoms, lower doses of loop diuretics needed, and increased urine output than for those patients treated with loop diuretics alone. This has proven effective for renal dysfunction patients, since they are usually refractory to loop diuretics, requiring higher doses that are themselves the cause of increased renal dysfunction. Tolvaptan is a selective vasopressin-2 receptor antagonist that acts on the distal portion of the nephron and inhibits the kidney's ability to reabsorb water (Sole et al., 2020).

## MEDICATIONS TO IMPROVE CARDIAC OUTPUT

Positive inotropic agents increase the force of cardiac contractions (inotropic effect) to improve cardiac output. Some reduce the heart rate (chronotropic effect), allowing for more complete ventricular filling to increase stroke volume. **Catecholamines** are positive inotropic agents given to HF patients with severe disease. They are powerful vasoconstrictors, acting to support failing blood pressure.

- Dopamine and norepinephrine are endogenous catecholamines used in severe or end-stage HF to increase contractility, but which also cause increased cardiac workload and dysrhythmias. They may be used to support a failing heart that awaits transplantation.

- Dobutamine is a synthetic catecholamine with similar actions but that does not increase systemic vascular resistance.

- Milrinone is a widely used inotrope that increases myocardial contractility by inhibiting phosphodiesterase and thereby allowing an influx of calcium into the myocardial cells. Milrinone increases cardiac output by reducing BP through vasodilation. It may not be used in patients with renal disease, HF caused by ischemia, or hypotension.

Heart failure patients who take **digitalis** preparations experience a reduction in symptoms, expanded exercise tolerance, and improved quality of life. They do not experience decreased

mortality rates, however. Digitalis preparations present a significant risk for toxicity, particularly in the presence of electrolyte imbalance. Hyper- or hypokalemia, hypercalcemia, and hypomagnesemia may cause potentially fatal dysrhythmias in patients taking digitalis. The most common medication in this category is digoxin (Lanoxin) (Sole et al., 2020).

**GUIDELINE-DIRECTED MEDICAL THERAPY (GDMT)**

In a recent study, GDMT proved to reduce the mortality for patients with HFrEF as well as patients with coronary artery disease in need of surgery. Giving the patients the combination of one or more antiplatelet drugs, a statin to reduce serum cholesterol and triglycerides, a beta-blocker to reduce cardiac workload, and an angiotensin-converting enzyme inhibitor (ACEI) or an angiotensin receptor blocker (ARB) reduced mortality rates compared to those with the same diagnoses on other drug regimens (Wolfe et al., 2020).

## MISCELLANEOUS MEDICATIONS

Three specific **beta-adrenergic blocking agents (beta blockers)** have been shown to reduce mortality in patients with HF with reduced ejection fraction (HFrEF): metoprolol succinate (Toprol XL), bisoprolol (Zebeta), and carvedilol (Coreg). These may also have a dose-related effect, increasing the EF and therefore increasing cardiac output. Beta blockers are started at low dose, as they may reduce cardiac contractility (Harding et al., 2020).

The heart failure agent (hyperpolarization-activated cyclic nucleotide gated channel blockers) **ivabradine** (Corlanor) is a pharmaceutical treatment specifically for heart failure that is designed to prevent patient readmission to the hospital. It may be used in patients with a stable but symptomatic reduced ejection fraction of <35%, sinus rhythm, and a HR >70. It acts by reducing the heart rate, thus preventing the disease process from progressing. Side effects are phosphenes (visual disturbances) and dysrhythmias, the most common of which is bradycardia. Ivabradine is given to HF patients who are already taking the maximum dose or are unable to take beta-blocking agents (Amgen, 2019).

**B-type natriuretic peptide (BNP)** treatments given subcutaneously show promise due to the capacity to improve left ventricular function and urine output. The prototype is the recombinant human BNP nesiritide (Natrecor). Initial studies of BNP treatment to prevent recurrence of heart failure symptoms and hospital readmissions showed that the subcutaneous route of administration did not cause hypotension as had previous studies with intravenous medications. Further studies are needed to prove the efficacy of subcutaneous BNP treatments (Sole et al., 2020).

## PHARMACOLOGIC AGENTS HELD OR USED WITH CAUTION IN HEART FAILURE

**Antidysrhythmic agents** are generally withheld in HF, except amiodarone given for ventricular dysrhythmias. Other antidysrhythmic agents may exacerbate the symptoms of heart failure.

**NSAIDs**, **ACE inhibitors**, and **diuretics** when given in combination may cause renal damage as evidenced by a reduced glomerular filtration rate (GFR). NSAIDs reduce the synthesis of

vasodilatory prostaglandins and may inhibit the systemic antihypertensive effect of ACE inhibitors. As ACE inhibitors and diuretics are often used in the treatment of HF, it is recommended that other mid-level range pain relievers be used instead, such as acetaminophen (Tylenol). Anti-inflammatory medications such as ibuprofen may cause toxicity when used in conjunction with calcium channel blockers, as are commonly used in HF. Anti-inflammatory medications and immunomodular agents such as infliximab often cause fluid retention, which can exacerbate edema in patients with HF.

**Thiazolidinediones**, also known as glitazones, such as pioglitazone and rosiglitazone are insulin activators that may increase sodium retention and aggravate HF symptoms in patients with diabetes with comorbidities for both diseases. These medications may cause fluid retention, edema, and weight gain in class III and IV HF. This may necessitate readmission to the hospital for HF because of the exacerbation of symptoms (McCuistion et al., 2019).

**Beta-adrenergic blocking agents** in acute HF are used judiciously because of the possibility of reducing cardiac contractility and therefore the strength of the cardiac chambers pumping blood to the rest of the body. When beta blockers are used in HF, they are started in the lowest possible doses to achieve therapeutic effect, and the doses are then titrated up slowly if more drug is needed (Harding et al., 2020). Both the patient's providers and nurses monitor vital signs closely and observe for signs of reduced cardiac contractility such as blood pressure variations, tachycardia, auscultation of an S3 heart sound, or pulsus alternans (a pulse that alternates strong and weak on palpation).

#### METFORMIN RESTRICTIONS DROPPED

A meta-regression analysis of changes in the U.S. Food and Drug Administration boxed warning regarding the use of Metformin suggests that previous prohibitions with giving metformin to HF patients no longer hold. Metformin use in chronic diseases such as kidney disease, liver disease, and heart failure are no longer believed to increase mortality, so the restrictions have been dropped. In fact, evidence shows that the use of metformin in HF with preserved ejection faction (HFpEF) reduces mortality and hospitalization rates. The drug is especially effective with patients with an ejection fraction >50% (Halabi et al., 2020).

## Surgical Interventions

Surgeries can be performed to repair conditions that contribute to severe HF, particularly when nonsurgical treatments alone are ineffective. When the underlying cause of heart failure is corrected, such as by a cardiac valve replacement, the condition itself may improve, depending on the severity of the disease. Hypertrophy of the myocardium, for example, particularly the left ventricle, can only be repaired by a cardiac transplant. (The degree of damage to the myocardium, however, may make the patient a poor candidate for transplantation.)

### VALVE REPLACEMENT/VALVE REPAIR

Cardiac valve malfunction can be caused by either stenosis that does not allow the blood to flow through to the next chamber or prolapse that prevents the valve from closing completely

(atresia), causing regurgitation. Depending on the volume of blood allowed to remain in the cardiac chambers, this regurgitation may cause the affected chamber to have to pump harder to empty, resulting in HF. Of concern is left ventricular dysfunction, as cardiac output is then compromised, causing HF.

The most common valve to be repaired via a surgical procedure is the mitral valve, which prevents regurgitation from the left ventricle into the left atrium. The most common type of valve to be replaced via a surgical procedure is the aortic valve, which prevents regurgitation from the aorta into the left ventricle. The pulmonic and tricuspid valves rarely undergo replacement or repair.

### *Valve Repair*

Valve repair surgery is a closed-heart procedure requiring the patient's heart to be monitored continuously by a nurse or monitor technician specially trained to recognize dysrhythmias on the cardiac monitor. This patient will be cared for by a cardiologist as well. The placement of clips to prevent the backflow of blood is the most common method of repair of the mitral valve. The average length of stay in the hospital following valve surgery is two to seven days depending on the degree of invasiveness inherent in the procedure.

Types of surgical valve repair include:

- Patching holes or tears with tissue to provide more support at the base of the valve
- Removing or reshaping tissue so that the valve can close more effectively
- Separating valve flaps that are fused due to a congenital defect

### *Valve Replacement*

The traditional method for valve replacement requires open-heart surgery, necessitating the patient be transferred to the intensive care unit. Care is provided by critical care nurses specially trained to recover such a patient as well as a respiratory therapist if the patient requires a ventilator. A thoracic surgeon performs the surgery, and the patient is also cared for in the postoperative phase by a cardiologist.

The surgeon may use a biological valve from either pig, cow, or human heart tissue, which will last approximately 15 years and require anticoagulation. An artificial valve may also be used; it will last longer but requires that the patient take anticoagulants for life.

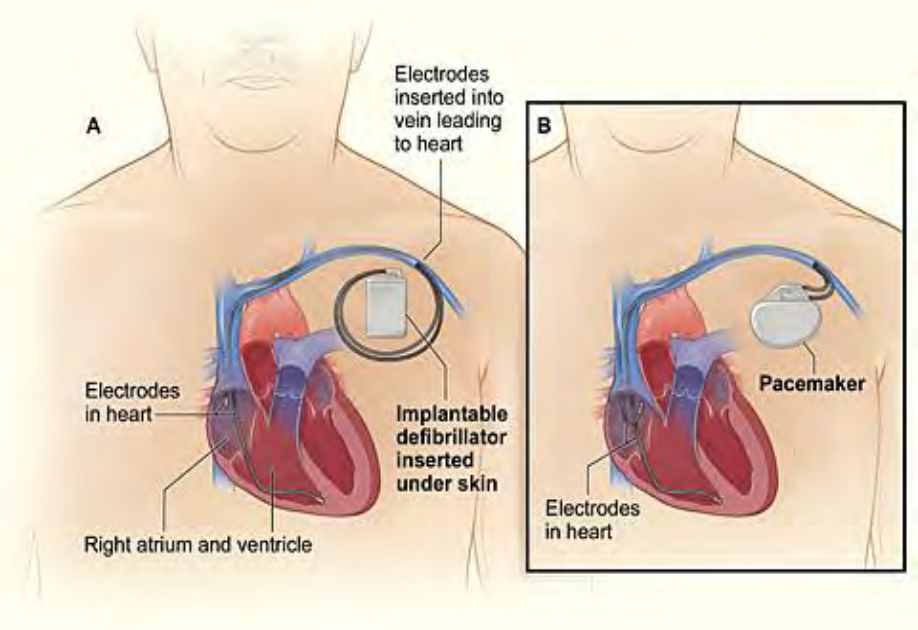
Transcatheter aortic valve replacement (TAVR) is an interventional approach. In patients who are not good candidates for traditional valve replacement surgery, a TAVR may be tried. The approach is via an inflatable balloon catheter via the femoral artery or transapically through the ribs. The balloon places the artificial valve within the existing

valve. When the balloon is inflated, the artificial valve expands. The new valve then displaces the old, damaged valve and begins to function in its place (NHLBI, 2021a).

## IMPLANTATION OF A CARDIAC DEFIBRILLATOR

Ventricular fibrillation, a life-threatening dysrhythmia, occurs at an alarming rate in patients with HF. This is particularly true of those with coronary heart disease as a comorbidity. The ability to have an internal device, an internal cardiac defibrillator (ICD), sense and correct this dysrhythmia has the potential capability to save lives. The device is a small computer implanted in the chest or abdomen and connected to wires inserted into one to three cardiac chambers. When the computer reads a sustained ventricular rhythm, it administers a shock to attempt to restore a more normal heart rhythm (NHLBI, 2021b). Its battery is replaced approximately every 20 years.

A recent study found a 13% increase in life expectancy in HF patients who received an ICD compared to those with similar levels of HF without an ICD (NHLBI, 2021c).




**Comparison of an ICD and a pacemaker.**
**Figure A (left)** shows the location and general size of an ICD in the upper chest; the wires with electrodes on the ends are inserted into the heart through a vein in the upper chest.
**Figure B (right)** shows the location and general size of a pacemaker in the upper chest; the wires with electrodes on the ends are inserted into the heart through a vein in the upper chest. (Source: NHLBI, 2021b.)

## CORONARY ARTERY BYPASS GRAFT/PERCUTANEOUS CORONARY INTERVENTION

One of the most common comorbidities with HF is coronary artery disease. The blocked coronary arteries of CAD inhibit the flow of blood, and therefore the oxygen bound to the hemoglobin molecule, to the myocardium, resulting in cardiac ischemia. If this disease progresses, an MI may occur. The infarcted area of the cardiac muscle then becomes akinetic,

affecting the ability of the heart muscle to pump with its former strength. This causes the chambers of the heart to diminish in their ability to pump blood and empty with each contraction. If the area of the myocardium affected is the left ventricle, significant changes in the heart's capacity for pumping blood to the rest of the body may be severely compromised, eventually resulting in HF.

CAD leads to angina pectoris and MI, the two components of acute coronary syndrome (ACS). As stated above, the occurrence of an MI can lead to heart failure by causing left ventricular dysfunction. Heart failure and left ventricular dysfunction are predictors of high mortality risk in patients with ACS. Earlier intervention with revascularization surgery—by grafting the patient's own veins or arteries to bypass the obstructed coronary arteries—may prevent an MI and the subsequent HF. In a percutaneous coronary intervention (PCI) procedure, the coronary arteries are cleared by a percutaneous transluminal coronary angioplasty (PTCA) and held open by the placement of a stent. This is performed in less severe CAD or for patients who may be poor surgical candidates (Sole et al., 2020).

The patient is cared for in the ICU immediately postoperatively until the patient is extubated from the mechanical ventilator, temporary pacemaker wires have been removed, and the patient is hemodynamically stable. The patient will remain on a cardiac monitor throughout the entire hospital stay and will start on cardiac rehabilitation before being discharged.

## HEART TRANSPLANTATION

Cardiac transplantation can be a life-saving measure and is most commonly performed in the case of end-stage HF that is refractory to medical treatment. In the case of HF caused by akinetic heart muscle or exacerbated by myocardial hypertrophy, nothing else will significantly alleviate symptoms, prevent progression of the disease, or prolong life.

This is a highly specialized surgery performed at only a handful of medical centers. The personnel involved in all aspects of this procedure are rigorously trained and are usually all critical care experts. In the United States, the list of patients awaiting cardiac transplantation is approximately 3,000, with approximately 2,000 hearts available per year.

Devices such as the A5000 Circulatory Support System and the BVS 5000 Biventricular Support System are FDA-approved as bridge-to-transplant (BTT) systems to support a failing heart until a matching donor heart is available. These are used as life-saving measures in the case where the patient would otherwise die but has a chance of recovery with a transplant. These patients are critically ill and monitored in an ICU while awaiting transplantation. (See also "Cardiac Assist Devices" below.)

The one-year post transplantation survival rate is 85% to 90%, and the three-year survival rate is 75%. The most common postoperative complications are rejection, infection, sudden cardiac death, malignancy, and cardiac vasculopathy (accelerated CAD) (Harding et al., 2020).

**NURSE'S ROLE IN SURGERY**

- Ensure diagnostic test results (e.g., laboratory tests, ECG, and X-rays) are on the chart that accompanies the patient to surgery or in the electronic medical record
- Obtain the patient's signature for informed consent for surgery after the surgeon and anesthesiologist or nurse anesthetist have explained the procedures and possible negative outcomes to the patient (surgeon or anesthesiologist may also obtain the signed consent)
- Fill out a preoperative checklist, including a recent set of vital signs, how long the patient has been taking nothing by mouth (NPO), brief medical and surgical history, allergies, disposition of any belongings, surgical procedure to be performed, any medications taken that day, time of last voiding, and that the consent is signed
- Inform the family or any visitors where to wait until the surgery is completed (surgical waiting room) and let them know that someone will be in touch with them throughout the surgery
- For a patient with heart failure who is on vital cardiac or diabetes medications that should not be held due to the NPO status, administer with one sip of water per physician's order
- For the operating room circulating nurse, just before the surgical procedure, conduct a "time out" with the surgeon, anesthesiologist, surgical technician, and anyone else involved in the surgery to identify and verify the patient and the procedure to be done (Harding et al., 2020)

**CASE**

Alison is a certified respiratory therapist with 27 years of experience. She has worked the past 14 years at City Medical Center as the lead RT on the nightshift in the ICU. City Medical Center is an organ transplantation center, and Alison has seen dozens of heart, lung, and a few heart/lung transplants.

Tonight the ICU nurses are recovering a 68-year-old heart transplant patient with end-stage heart failure. He will be transferred out of the ICU when he becomes extubated, has his temporary pacemaker wires withdrawn, and is hemodynamically stable. The postoperative recovery is complicated by the fact that the patient has a comorbidity of moderately severe COPD and is having difficulty being weaned off the mechanical ventilator.

Working as a team, the ICU nurse, the pulmonologist on call, the anesthesiologist still in the hospital after surgery, and Alison work to get the patient extubated. The nurse gradually withdraws pain medication and sedation to allow the patient to become more alert and participate in his care. When he is sufficiently awake to breathe on his own, the patient becomes anxious, causing his heart rate and blood pressure to increase to abnormal levels. The anesthesiologist gives the order by phone for Alison and the ICU nurse to extubate the patient when he is responsive and the tidal volumes measured by Alison are normal. As the

ICU nurse prepares to suction the patient, Alison deflates the pilot balloon on the endotracheal tube and slowly withdraws the tube from the patient's throat. Together they complete a successful extubation.

## Cardiac Assist Devices

Cardiac assist devices are used in heart failure patients in whom drug therapy is no longer adequate. They have the effect of improving organ perfusion and decreasing cardiac workload. They are considered temporary measures used to stabilize an HF patient who has sustained an injury or is awaiting heart transplantation.

### INTRAAORTIC BALLOON PUMP (IABP)

This device reduces the systolic blood pressure to reduce afterload and thus decrease the cardiac workload and enhance the aortic diastolic pressure to improve coronary arterial blood flow. For HF patients, it works primarily as a bridge-to-transplant while they are hospitalized and waiting for an appropriate organ to be available.

A balloon is percutaneously inserted through the femoral artery into the thoracic aorta. The pump provides counterpulsation (opposite to the ventricular contractions) that causes the balloon to deflate and inflate, causing a rise in diastolic arterial pressure that improves coronary blood flow to the myocardium.

Contraindications include irreversible brain damage, major coagulopathy such as disseminated intravascular coagulation (DIC), terminal illnesses, abdominal or thoracic aortic aneurysms, moderate to severe aortic insufficiency, or generalized peripheral vascular disease.

Complications include dislodged plaque, aortic dissection, thromboembolism, compromised peripheral circulation, thrombocytopenia, blocked arteries, infection, and improper timing of inflation.

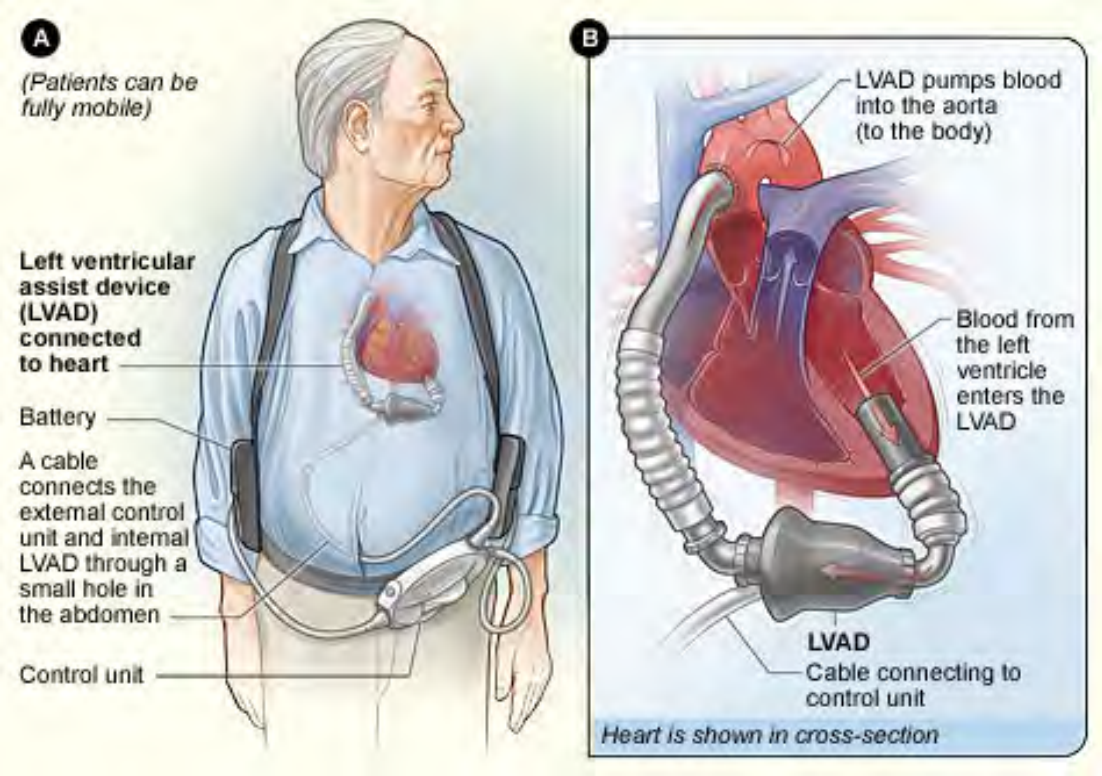
### LEFT VENTRICULAR ASSIST DEVICE (LVAD)

An LVAD provides long- or short-term support for a heart that is failing. It is more compact than an IABP and allows the patient to be more mobile. The device may be inserted internally, such as in the peritoneum, or externally in a blood vessel. LVADs move blood from the left side of the heart to the device and then to the aorta to temporarily support circulation. They may be used in patients with HF for failure to wean from a cardiovascular bypass pump after open-heart surgery, after an MI, or as a bridge-to-transplant.

When the patient with heart failure is discharged from the hospital with such a device in place, daily function and the need to protect the device will affect the patient's ADLs. An occupational therapist will assist the patient to manage the physical manipulation skills required to function with an LVAD. These may include placing the device in a fanny pack for ambulation or a waterproof case for showering, changing the batteries, and using fine motor control to manipulate the settings. By helping patients and their families learn adaptive skills to

accommodate an LVAD, occupational therapists help HF patients maintain independence and return to work, school, and travel more safely (Abramson et al., n.d.).

Contraindications for an LVAD include small body surface area, renal or liver failure not following a cardiac event such as an MI, and comorbidities that limit life expectancy to less than three years. Complications are the same as for an IABP but are less likely to occur.




Left ventricular assist device. (Source: Singhvi & Trachtenberg, 2019.)

**CASE**

Jesse is an occupational therapist in a regional medical center. Jesse's patient, Julia, a 74-year-old female, will be discharged with a newly implanted left ventricular assist device (LVAD). Julia is weak and lacks fine motor control in her fingers. Although the external controller on the device weighs only about five pounds, she complains that the fanny pack that houses the controller when she's ambulatory "feels like a ton of bricks."

Jesse works with Julia on improving her fine motor control to adjust the dials on the controller and teaches her how to change the battery on the device. Jesse also determines that the patient wasn't wearing the pack correctly and helps her make the appropriate adjustments for it to fit more comfortably.

## Supportive Devices for Symptom Management

There are a wide variety of devices and treatments that can be used to treat many of the coexisting symptoms that heart failure patients may be experiencing. These symptoms may be because of the disease itself or may be related to comorbidities or independently occurring problems.

### CPAP / BiPAP / APAP

Continuous positive airway pressure (CPAP), bi-level positive airway pressure (BiPAP), or automatic positive airway pressure (APAP) are commonly used to treat sleep apnea. Sleep apnea is a condition in which a person ceases respirations while asleep for a period of 10 seconds or longer, sometimes gasping for air when respirations resume. The most common cause is obesity. This can result in hypertension, hypoxia, and tachycardia during the period of breathlessness, resulting in a CVA or MI occurring during sleep.

A CPAP, BiPAP, or APAP device is connected to a face mask or nasal pillow to deliver positive pressure to force the airway to remain open and allow the passage of air. The differences among these devices include: CPAP delivers a continuous pressure, BiPAP delivers different pressures for inhalation and exhalation, and APAP delivers pressure within a set range only when the person experiences a period of apnea. If the patient continues to be hypoxic during the cessation of apnea, oxygen can be spliced into the PAP tubing to increase the amount of oxygen available to the patient (Harding et al., 2020).

### CARDIAC RESYNCHRONIZATION THERAPY

Cardiac resynchronization therapy (CRT) is a well-established method for improving cardiac function and coordinating biventricular contractions. CRT improves left ventricular function and therefore hemodynamic efficiency or cardiac output. A small titanium device containing a computer is surgically implanted into the chest wall and connects to wires extending to each ventricle. It acts similarly to a cardiac pacemaker but causes the ventricles to contract in time with each other. In patients for whom these therapies are successful, the outcomes are relief of HF symptoms, improved exercise function, and increased life expectancy.

Biventricular pacing improves ventricular function by resynchronizing the heartbeat through pacing both ventricles. This is used for treating HF patients with intraventricular conduction delays, which cause the right and left ventricles to beat out of synch with each other, leading to decreased systolic function, an inefficient pump, and aggravated HF (Harding et al., 2020).

## Human Stem Cell Therapy

Embryonic stem cells (ESC) that have been altered to become cardiopoietic cells (cardiac-committed) show promise of reversing necrosis in cardiac tissue. When differentiated ESC are amplified to become cardiac progenitor cells, they are imbedded in a fibrin patch into the damaged cardiac tissue. This improves cardiac function and reduces the severity of heart failure by restoring the ability to pump to some previously akinetic (unmoving) areas of the

myocardium. In one study, the ejection fraction improved from 38% to 45% ±3%, on average (Yamada et al., 2020).

Stem cells may also be derived from an individual's own bone marrow or from their own healthy cardiac tissue, bringing about an improvement in their cardiac tissue. However, after approximately one week of cardiac muscle damage, the heart stops signaling for help in the form of stem cells, and the damage repair remains largely incomplete. More recent studies have shown that the introduction of highly selected donor stem cells, the individual's own healthy cardiac tissue given at the time of a myocardial infarction (MI), or the individual's own healthy cardiac tissue or donor cardiac tissue given late after an MI, to be more effective for tissue repair (Cleveland Clinic, 2021).

## Cardiac Monitoring

Cardiac monitoring devices—particularly ambulatory devices such as wearable devices, smartphones, and other sensors—have become popular for continual monitoring of cardiac diseases such as HF. Such devices provide early detection of physiological events and can alert patients and clinicians of the need to seek medical attention.

**Wearable monitoring devices** and smartphone-based solutions can provide continuous cardiac monitoring and ambulatory monitoring capabilities for:

- ECG
- Heart rate
- Arrhythmia
- Blood pressure
- Cardio-respiratory fitness
- Stress
- Respiratory rate
- Temperature
- Oxygen saturation
- Ischemia
- Apnea
  (Sana et al., 2020)

**Implanted devices** include the FDA-approved CardioMEMS HF system, which is implanted in the pulmonary artery during a right heart catheterization to measure pulmonary pressures. It is used on HF patients with NYHA Class III heart failure symptoms. HF treatment such as drug dosages are then adjusted based on the pulmonary artery pressure (PAP) reading. The patient-initiated readings are wirelessly transmitted to a secure website and monitored by the patient's physicians (Harding et al., 2020).

## Nutritional Therapy

Nutritional therapy is essential in treating an individual with heart failure. A nutritional consultation with a registered dietitian is usually performed during the initial hospital visit for HF during phase 1 of cardiac rehabilitation (see also "Cardiac Rehabilitation" below). This consultation is usually ordered to provide the patient and close family members with information to control the exacerbation or intensification of HF symptoms. Failure to comply with a low-sodium, fluid-restricted diet is one of the most likely reasons for a patient with HF to be readmitted to the hospital.

### WEIGHT REDUCTION

Weight reduction is a key component in treating HF and preventing a worsening of symptoms. Obesity contributes to hypertension, which increases systemic vascular resistance and causes the ventricles to work harder to pump blood. Many HF patients, with or without hypertension, are advised to start a DASH (Dietary Approaches to Stop Hypertension) diet. This diet supports weight loss through consumption of fruits and vegetables, low- or nonfat dairy, lean meats, beans, seeds, nuts, and less sugar (Harding et al., 2020).

### FLUID RESTRICTION

Fluid restriction is a treatment modality used to prevent volume overload, which can be caused by the accumulation of fluid in the peripheral tissues (resulting in edema in right-sided HF) or in the lungs (resulting in pulmonary edema in left-sided HF).

Fluid restriction is advised for patients with moderate or severe HF, especially those with renal disease as a comorbidity. Liquids from all sources are usually limited to less than 2,000 ml per day or per healthcare provider orders. HF patients are encouraged to weigh themselves daily at the same time of day and in similar clothing to monitor sudden weight gains indicative of fluid retention.

When the heart is unable to pump fluid effectively, a lower circulating volume reduces the cardiac workload and decreases the possibility of fluid retention and edema. In the hospital, it is the nurse's responsibility to maintain a strict intake and output measurement when a patient has a fluid restriction ordered. The nurse records and reports the intake and output (I & O) fluid balance each shift and every 24 hours to ensure the patient is not retaining fluid. Nursing observations of jugular vein distension, peripheral edema, and lung sounds are also essential.

### SODIUM RESTRICTION

Patients with heart failure are usually counseled to restrict sodium intake (1–2 grams/day) to prevent fluid retention. The affinity that sodium and water have for each other suggests that limiting the intake of sodium will prevent the kidneys from retaining fluid due to the increased serum sodium levels. The retained fluid can then lead to peripheral and dependent edema in earlier stages in HF and hypertension or shortness of breath in later stages.

Studies about the reduction of HF that relate directly to restricting sodium intake are inconclusive. Sodium restriction is usually recommended as an adjunct for HF patients for the possible benefits but is not considered to be effective without the concurrent use of pharmaceutical agents.

This is an area of some controversy, with conflicting study results indicating that the practice of sodium restriction cannot be considered evidence-based. A search of the literature does not provide clear proof of a threshold level of acceptable sodium intake for a HF patient. Historical recommendations have been for a moderate restriction of 2,000 mg of sodium per day for a person with HF with mild to moderate fluid retention and 1,000 mg per day for those with severe fluid retention. Recent studies, however, do not support these recommendations (Sole et al., 2020).

**AHA HEART FAILURE GUIDELINES**

Since 2016, the American Heart Association has provided hospitals with evidenced-based guidelines to promote adherence to proven protocols for HF patients designed to shorten hospital stays, reduce hospital readmissions, and maximize reimbursement for hospitals from Medicare, Medicaid, and private insurers. The guidelines upon discharge include:

- Prescription of angiotensin-converting enzyme (ACE) inhibitor, angiotensin reception blocker (ARB), or angiotensin receptor-neprilysin inhibitor (ARNi), if appropriate for that patient
- Prescription of a beta-adrenergic blocking agent (beta-blocker), if appropriate
- Prescription of a combination of hydralazine and isosorbide dinitrate for African American patients, if appropriate
- Prescription of an aldosterone agonist, if appropriate
- Assessment of left ventricular function
- Establishment of a postdischarge appointment within 7 days of discharge
- Deep vein thrombosis (DVT) prevention measures for nonambulatory patients
- 60 minutes of HF education by a qualified heart failure educator
- Maintenance of BP <140 systolic and <90 diastolic
- A written copy of dietary instructions
- A written copy of discharge instructions
- A follow-up phone call within 48 to 72 hours of discharge

(Yancy et al., 2017)

# CARDIAC REHABILITATION

Cardiac rehabilitation is an organized, multidisciplinary therapy proven to advance better outcomes for heart failure patients in the areas of exercise capacity and quality of life. In 2014, the Centers for Medicare and Medicaid expanded coverage for cardiac rehabilitation to include patients with stable, chronic HF. This is defined as patients with left ventricular ejection fraction of 35% or less and NYHA functional class II to IV symptoms that occur despite being on optimal medical therapy for 6 weeks or more (AHA, 2021).

## Phases of Cardiac Rehabilitation

There are four distinct phases of cardiac rehabilitation:

1. Acute
2. Subacute
3. Intensive outpatient therapy
4. Independent ongoing conditioning

**Phase 1** starts while the patient is in the hospital after an initial occurrence of HF or an exacerbation. This phase consists primarily of education of the patient and family and the introduction of an exercise program. During phase 1 the initial goals are:

- Assess exercise tolerance and effects of mobility on exacerbation of symptoms
- Create an individualized plan of care with input from all members of the care team (physicians, nurses, occupational therapists, physical therapists, pharmacist, discharge planners, etc.)
- Begin preliminary safe exercises to improve mobility and cardiac health
- Explain and address any risk factors
- Introduce appropriate assistive devices (see below) and begin use

**Phase 2** starts after discharge and takes place in an outpatient setting such as a physician's office, clinic, or independent physical therapy practice. This phase lasts three to six weeks. Exercise is performed under observation and often during cardiac monitoring to determine the effect of gradually increasing activity on heart rate, exertion level, and heart regularity during exercise. Aerobic exercises are introduced under controlled conditions to establish tolerance. The patient is taught how to check their own pulse for rate and regularity. (An irregular rhythm is indicative of dysrhythmia that may be potentially life threatening.) The exercise program started in the hospital in phase 1 is adjusted to patient tolerance and endurance. The primary goal in this phase is to safely return the patient to functional mobility while being closely monitored for physiologic response (Sears, 2019).

**Phase 3** includes more independent and group exercises with more self-monitoring. Increased exercises are practiced under the guidance of a physical therapist to monitor for adverse symptomatic response. The patient is introduced to the concept of rating of perceived exertion (RPE). Exertion parameters include heart rate, respiratory rate, perspiration, and muscle fatigue. The patient may be asked to rate how hard the exercise feels on a subjective scale such as the Borg RPE Scale (see below) (CDC, 2020a; Mayo Clinic, 2021; Sears, 2019).

**BORG RPE SCALE**

| Rating | Level of Exertion |
|---|---|
| 6 | No exertion |
| 7 | |
| 7.5 | Extremely light |
| 8 | |
| 9 | Very light |
| 10 | |
| 11 | Light |
| 12 | |
| 13 | Somewhat hard |
| 14 | |
| 15 | Hard (heavy) |
| 16 | |
| 17 | Very hard |
| 18 | |
| 19 | Extremely hard |
| 20 | Max exertion |

(CDC, 2020b)

**Phase 4** includes independent and ongoing physical conditioning to preserve optimal health. This is a self-regulated maintenance phase with ongoing monitoring by healthcare personnel (Sears, 2019).

**ADDRESSING PATIENT NEEDS IN ALL AREAS**

Cardiac rehabilitation provides information, exercises, and adaptation techniques in activities of daily living to encourage patients with heart failure to perform in an optimal state of function. The various disciplines involved in an individualized cardiac rehabilitation program focus on the following six areas:

- Physiologic (physicians, nurses, physical therapists, exercise physiologists, occupational therapists, respiratory therapists)
- Psychological (mental health workers, social workers, nurses)
- Mental (mental health workers, social workers, nurses, physicians)
- Spiritual (clergy, nurses)
- Economic (social workers, nurses)
- Vocational (occupational therapists)

While the patient's physiologic needs may be the primary focus of most of the healthcare professionals and take the greatest amount of time, other patients' needs must be included in an all-inclusive cardiac rehabilitation program (Harding et al., 2020).

## Respiratory Therapy

Heart failure patients with respiratory comorbidities in cardiac rehabilitation require the same respiratory services as any chronic respiratory patients. Use of maintenance supplemental oxygen, chest auscultation, lung capacity measurement, medication administration by inhalation and nebulization, and education are all the responsibility of the respiratory therapist in cardiac rehabilitation (Clevenger, 2019).

There is a high prevalence of sleep-disordered breathing (SDB) in patients with heart failure. SDB is known to have a deleterious effect on morbidity and increase mortality in this patient population. The treatment of choice for this disorder is the use of a positive airway pressure device while sleeping. The efficacy of treatment with continuous positive airway pressure (CPAP) and bilevel positive airway pressure (BiPAP) is monitored by respiratory therapists and pulmonary physicians (Yamamoto et al., 2020).

## Physical Therapy

There are numerous documented benefits derived from physical therapy in a cardiac rehabilitation program. Regular exercise, particularly when performed after a prolonged period of sedentary behavior, may produce improvement in oxygen capacity, cardiac output, blood lipid levels, blood pressure, coronary artery blood flow, muscle mass, flexibility, psychological state, and weight loss and control (Shoemaker et al., 2020).

Physical therapy goals in cardiac rehabilitation are determined by the patient in conjunction with the physical therapist. Including the patient in setting these goals is likely to promote better compliance with the agreed-upon exercise regime.

## BENEFITS

Direct potential benefits of physical therapy for heart failure include:

- Decrease in the number of hospital admissions
- Decreased mortality in patients with HFpEF
- Improved cardiac capacity and reserve flow, both at rest and with exercise
- Reduced blood pressure both in the short term (i.e., during an exercise session) and long term (i.e., resting blood pressure)
- Improved coronary circulation and myocardial oxygenation
- Improved maximum oxygen uptake ($VO_2$ max)
- Reduction in occurrence and length of depression
- Improved quality of life
  (Physiopedia, 2021)

## PATIENT EVALUATION

During phase 1 of cardiac rehabilitation while the patient is still in the hospital, an acute care physical therapist is added to the rehabilitation team to assess the patient, perform an initial evaluation, and create an individualized exercise plan. The initial physical evaluation may include:

- Heart rate
- Blood pressure
- Oxygen saturation
- Upper extremity function including strength and range of motion (ROM)
- Lower extremity strength and ROM
- Functional mobility such as walking and self-care tasks
- Heart and lung auscultation
- Monitoring  symptomatic response to exercise
  (Sears, 2019)

### FUNCTIONAL TESTS

Standardized functional mobility tests may be included as part of a comprehensive physical therapy evaluation. Examples of commonly-used tests include:

- Timed Up-and-Go (TUG): Measures walking ability, dynamic balance, functional mobility, and fall risk
- Six-minute walk distance (6MWD): Measures ADL performance, response to cardiopulmonary exercise, and walking ability
- Berg Balance Scale (BBS): Measures static and dynamic balance, falls risk, and potential needs for assistive devices
- Functional Independence Measure (FIM): Assesses physical, psychological, and social function for patients with ADL-related motor impairments (e.g., feeding, grooming, bathing, dressing, elimination)

(Sears, 2020; Byrd et al., 2019)

## TREATMENT PLANNING AND INTERVENTIONS

Physical therapists, in collaboration with the other members of the rehabilitation team, establish an individualized plan of treatments and interventions to help cardiac patients optimize their functional mobility and activity tolerance. Therapeutic exercise programs designed to optimize physical functioning and psychological well-being within a patient's individual activity tolerance are a key part of physical rehabilitation.

The purpose and goals of individualized therapeutic exercise may include optimizing function in multiple areas of patient function, including (but not limited to) aerobic capacity, circulation, endurance, balance and stability, range of motion, functional strength and mobility, ADL performance, injury prevention and/or reduction, and eventual return to highest possible level of desired activities (Roe, 2021).

In the cardiac rehabilitation setting, physical therapists establish a specific plan of exercise for each patient, including the types and frequency of exercises to be performed. With the goal of helping patients to optimize their cardiopulmonary function, these exercises may include some combination of walking, rowing, cycling, jogging, or other appropriate endurance activities, as tolerated. If indicated, physical therapists may also assist patients with airway clearance techniques, such as specific breathing strategies, body positioning, and manual or mechanical techniques.

Strength and endurance training is also a key component of cardiac rehabilitation, including instructing patients in how to safely and appropriately warm-up, stretch, and gradually build their exercise tolerance to a consistent and beneficial level (Mayo Clinic, 2021; Sears, 2019).

Functional mobility deficits occur frequently in chronically ill patients, including those with HF. Physical therapists may recommend appropriate assistive devices as needed for patients with mobility issues (such as canes, walkers, crutches, wheelchairs, etc.) and provide training in their safe and correct use. An assistive device may ultimately, though not always, become necessary for some HF patients to maintain at least some degree of mobility independence.

## Occupational Therapy

Patients with moderate to severe heart failure require some assistance with ADLs. Poor cognitive function and poor physical fitness may impair patients' abilities to perform complex tasks, causing them to make mistakes. Disabilities with ADLs are a strong predictor of readmission to a hospital, often within the 30-day period that precludes federal or state agencies paying for the additional admissions.

According to the American Occupational Therapy Association (AOTA, 2020), the following interventions by an occupational therapist serve to reduce the number of hospital readmissions:

- Providing recommendations and training for caregivers
- Determining whether patients can live safely independently or require further rehabilitation or nursing care
- Addressing existing disabilities and fall prevention with assistive devices so patients can safely perform ADLs (e.g., toileting, bathing, dressing, preparing a meal)
- Performing home safety assessments before discharge to suggest modifications to the patient's home
- Assessing cognition and the ability to physically manipulate objects like medication containers and providing training where necessary
- Assessing the ability to perform social participation and determining strategies to prevent barriers and reduce isolation and depression

Transitional care programs (from facility to home) that include OT have been documented as reducing readmissions up to 45%. Occupational therapists assist patients with heart failure to address both ADLs and instrumental activities of daily living (IADLs), including dressing, feeding, hygiene, cooking, cleaning, shopping, elimination, and more. Instruction in IADLs requires integration of physical and cognitive factors and skills. OTs may also instruct patients in cardiac rehabilitation in the use of adaptive devices to assist them with the ability to conduct ADLs without concurrent activity intolerance (Roberts et al., 2020).

If the patient will be dependent on mobility assistive devices in the long term, environmental accommodations may be recommended for the patient's dwelling. These modifications may require significant structural changes to the patient's living space and could take a considerable amount of time and expense.

Other recommended assistive devices for patients with mobility issues may include grab bars in the bathtub, shower, and by the toilet; shower chairs; and elevated toilet seats. The occupational therapist can recommend their use and placement and educate the patient and family about their use.

Noncompliance with medications is a common reason patients with HF exhibit worsening of their symptoms and are readmitted to the hospital. While nurses, physicians, and

pharmacologists educate the patient and their family about the medications, occupational therapists help ensure that patients take medications correctly and improve compliance. They explain the use of medication diaries, calendars, and pill sorter boxes. They also work with patients to improve fine-motor control to manipulate devices such as pill sorters.

Severe heart failure (NYHA levels III and IV) may cause cognitive impairment, resulting in a reduced quality of life due to an inability to perform complex cognitive functions and a lack of desire to engage socially. The occupational therapist works with these patients to encourage them to take on as many cognitive and psychomotor activities as they are capable of doing and to educate the patient and their families about the benefits of remaining socially active to maximize participation in meaningful activities and roles. If the degree of the patient's cognitive impairment necessitates a caregiver, the occupational therapist instructs the caregiver in how to accommodate the patient's impairment (Roberts et al., 2020).

**CASE**

Bonnie Stevens is a 68-year-old patient in the telemetry unit at Westside, a small community hospital. She is newly diagnosed with left-sided HF with an acute episode and exhibits dyspnea on exertion; orthopnea; a cough productive of pink, frothy sputum; and severe exercise intolerance. She has a history of degenerative joint disease of the right hip and refuses to consider surgery. She also has a history of moderate hypertension, for which she takes lisinopril.

Bonnie dislikes doctors and hospitals and has resisted seeking medical help for her increasingly worsening symptoms to the point of deteriorating health and function. She also prefers to stay at home alone, saying her hip pain makes it too difficult to enjoy the activities she used to do with friends, such as bridge games, book club, and women's club dinners. Her son and daughter-in-law eventually convinced her to see their family physician, who admitted her to the hospital to improve her breathing, address her mobility issues, and start her on a treatment program.

Bonnie is admitted to the emergency department, where her vital signs are measured at BP 178/98, HR 120, respiratory rate 32, temperature 99.8 °F, and $O_2$ saturation of 89% on room air and 92% on 2 L of oxygen. She complains of a 4-out-of-10 left-sided chest pain with each inspiration. She's sitting upright on the hospital gurney, bent forward over the over-the-bed table in obvious respiratory distress. She is placed on a cardiac monitor, has an IV started, is placed on an oxygen cannula on 2 L/m. Labs are drawn, a 12-lead EKG performed, and a portable AP and lateral chest X-ray (CXR) done. Upon review of the results of the lab and diagnostic tests, the cardiologist on call to the ED admits Bonnie to the hospital.

The significant results are:

- Arterial blood gases on $O_2$ @ 2 L/m:
  - pH 7.29 (7.35–7.45)
  - $pCO_2$ 32 (35–45 mmHg)

  - $pO_2$ 70 (75–100 mmHg)
  - $HCO_3$ 20 (22–28 mEq/l)
  - Base excess -3 (-2 – +2)
- BNP 1,542 (100–400 pg/ml)
- $O_2$ sat 90% (94%–100%)
- EKG showing sinus tachycardia with rare PVCs
- CXR showing left-sided pulmonary edema in the base

The cardiologist writes orders for Bonnie for diuretics and additional antihypertensives and to begin cardiac rehabilitation with consultation by physical therapy, occupational therapy, dietitian, and a medical social worker. As part of phase 1 of cardiac rehab, the physician orders occupational therapy and physical therapy consultations for evaluations and recommendations.

Included in the physical therapy evaluation is the TUG exam to help determine Bonnie's functional mobility and risk of falling. After these tests, Jack, the physical therapist, provides gait training in order to teach Bonnie the safe and appropriate use of a front-wheeled walker in order to allow her to offload weight from her painful hip while ambulating. Bonnie reports that using the walker significantly reduces her pain while walking, whereupon Jack recommends she continue to use it after returning home. Since Bonnie's front porch has four stairs, Jack also provides stair safety training using the practice stairs in the physical therapy department. He instructs Bonnie in how to use a "step-to" pattern, leading with the nonpainful leg when ascending and with the painful leg when descending, as well as how to safely manage the walker on the stairs by carrying it folded in one hand while holding the handrail with the other.

Monica, the occupational therapist, discusses with Bonnie the option of using the powered scooter that is available at most grocery stores to do her shopping. She educates her on using a pill sorter and the calendar application on her smartphone to remind her when to take the new medications her doctor has prescribed to treat her HF.

Tammy, the registered dietitian, discusses a 2 gm sodium diet and a 1,500 ml daily fluid restriction with Bonnie and her family. She teaches them how to read the labels on all grocery products and to set up a beginning diet that will include healthy varieties of as many of Bonnie's favorite foods as possible to promote compliance with the diet.

Tran, the social worker, discusses resources in the community such as cardiac rehabilitation exercise classes at the local YWCA and explains the importance of continuing social activities to prevent depression, encourage an active lifestyle, and promote better quality of life.

## Follow-up after Discharge / Prevention of Readmission

Check-up calls after discharge are usually performed by the nurse. Whether the HF patient is seen in the emergency department, an acute care hospital setting, or a physician's office, follow-up calls to inquire about vital signs (BP and heart rate), edema, shortness of breath, increased fatigue, or a sudden weight gain may alert the primary care practitioner to the need for adjustments in treatment. Timely changes in dosages of medications or other treatment may forestall the patient having to be seen in the emergency department or readmitted to the hospital.

### NURSE NAVIGATORS

A nurse navigator is a clinician (usually an RN, a nurse practitioner, or a clinical nurse specialist) who integrates long-term healthcare for complex and chronically ill patients. While more common among cancer patients, nurse navigators who specialize in cardiology may serve in this capacity for chronic cardiac diseases such as HF. The purpose is to improve health outcomes and reduce the recurrence of hospital admissions by eliminating short-term, episodic, or fragmented care. The nurse navigator reviews orders and the clinical pathway to promote effective communication with patients and their families, patient advocacy, holistic patient assessments, improved health literacy, self-management, reduced hospital lengths of stay, and reduction in the number of hospital readmissions (Byrne et al., 2020).

### HOME HEALTH

The use of home health nurses in conjunction with follow-up physician visits within one week after discharge has shown to reduce hospital readmissions for HF patients. When home health nurses continue education on acute HF symptoms, risk factors for exacerbations of HF acuity, reinforcement of medication regimes, and support of patient self-management, the avoidable occurrence of hospital readmissions may be reduced. This model of nursing care includes detection of disease exacerbation, judging deterioration in patients, ascertaining conditions needing immediate intervention, observation of the patient's appearance, listening to patients' concerns and questions, continued management of the patient postdischarge, and instructing patients and families (Taniguchi et al., 2020).

### HOME TELEHEALTH

Home telehealth can be included in an existing care pathway as an alternate service delivery model for a HF patient following a hospital admission for HF exacerbation. An electronic device monitors daily weight, BP, pulse, and glucose and transmits this data to the patient's primary care provider's smarphone. Needed interventions, such as medication dosage adjustment and dietary changes, can then be initiated quickly to prevent further deterioration of physical stability.

For instance, amid the public health crisis secondary to COVID-19, when continuity of patient care was maintained via telehealth in spite of necessary reductions in face-to-face meetings between patients and caregivers, patients expressed satisfaction with the delivery of care and showed improvement (Zahoransky & Lape, 2020).

### LAB VALUES

Certain laboratory values must be monitored periodically in HF patients. Early detection and treatment of abnormal laboratory values will promote the patient's well-being. B-type natriuretic peptide (BNP) is repeated to determine if the HF is worsening. A drop in red blood cells, particularly hemoglobin, could compromise systemic oxygenation. BUN and creatinine values are used to assess renal function. Other common blood tests include electrolytes (including magnesium, calcium, and potassium), glucose, albumin, ferritin, and liver tests. Urine sodium levels could be an indication that ACE inhibitors or diuretics are working (Merck & Company, 2020).

### BODY WEIGHT

A precipitous increase or decrease in body weight is indicative of fluid shifts. Any gain or loss of more than 1 to 2 pounds in a single day suggests retention or release of a large amount of fluid rather than an actual gain or loss of body weight.

## SELF-CARE EDUCATION

Readmissions for heart failure are caused by multiple factors, including failed self-care. Heart failure self-care education is therefore standard prior to hospital discharge and is included in a multidisciplinary cardiac rehabilitation program. HF patients who receive a focused education program before discharge are significantly more likely to be compliant with recommendations, have an improved quality of life, and promote their own health.

The quality of patient education in HF directly influences mortality and reduces risk-related behavior and the need for hospital readmissions (Salahodinkolah et al., 2020). Teaching the patient to focus on symptom monitoring, medication management, a low-sodium diet, activity tolerance, and psychosocial strategies promotes self-care that will reduce the frequency of hospital readmissions in HF patients (Bennett et al., 2020).

Several evidence-based educational interventions have proven effective in teaching HF patients how to progress in self-care. These interventions include face-to-face teach-back training, home visitation by follow-up phone call, group training, and e-learning.

A cohesive, multidisciplinary plan for education involves all the patient's caregivers: physicians, nurses (including advanced practice nurses), medical social workers, respiratory therapists, physical therapists, occupational therapists, and discharge planners.

### Principles of Patient Education

The following are necessary principles in successful patient and family teaching:

- The patient and caregivers are made aware of the need for learning by all members of the multidisciplinary team.

- A health literacy assessment is done to evaluate the ability to comprehend what is being taught. Health material should be written on a fifth-grade level to promote global comprehension. If necessary, the material is provided in the patient and family's primary language.
- Goals are realistic.
- Teaching takes place after a crisis has passed and those involved are ready to receive learning; it takes place before discharge to allow time for family involvement, teach-backs, and re-demonstration.
- The use of medical terminology is limited.
- Anticipatory guidance gives the patient and caregivers a better idea of what to expect during recovery and rehabilitation.
- Perceived control allows the patient to make decisions about what actions are obtainable to achieve desired success.
- Follow-up visits and reassessments with healthcare personnel are important to evaluate progress and the need for any readjustments in the teaching plan.
  (Harding et al., 2020)

**MAWDS**

*MAWDS* is a mnemonic device used to assist in remembering the most essential aspects of treatment in the area of lifestyle changes. This tool for heart failure self-management health teaching helps the patient and family to minimize symptoms and to reduce the occurrence of rehospitalization. *MAWDS* stands for:

**M**edications
**A**ctivity
**W**eight
**D**iet
**S**ymptoms

In a 21-facility study in Utah, 1,500 patients were taught to use the MAWDS mnemonic for HF self-management and to track these five points of data in a notebook. The 5-year survival rate for these patients was 7.4% higher than patients who were not taught this self-management tracking method.

A much larger study begun in 2018 will use data from the original Utah MAWDS study to assess outcomes of HF patients who use a smartphone MAWDS application to track their own self-management data in the five areas listed for treatment and prevention of exacerbations. The data will then be used at meetings or discussions with clinicians to fine-tune treatment parameters to prevent exacerbation of symptoms (Intermountain Health Care, 2021).

## Medication Management Education

Medications are one of the most important treatment parameters in HF. Nonadherence to medication regimes is one of the two most commons reasons that patients with HF are rehospitalized. (The other is noncompliance with dietary restrictions.) Therefore, it is incumbent upon healthcare professionals to ensure patient and family understanding of every aspect of pharmacologic treatment modalities before discharge to home or a long-term care facility. Communication with potential caregivers should be included as well.

Good teaching standards require instructions to be given in a language that is well-understood by the person who will be responsible for dispensing the medications, whether that person is the patient, a family member, or a caregiver. Evidence also shows that patients are more likely to be compliant with medication schedules when they understand what they are for and are told how important they are. It is also suggestive of better effectiveness if the patient is told what outcome to expect.

The correct dosage of HF medications is essential to their effectiveness. Unless the importance of giving or taking the correct medication is understood, the patient may not benefit from the intended therapeutic effects. Due to the high cost of pharmaceuticals, the patient or family may occasionally try to reduce the medication dose in order to make the prescription last longer or to share the medications with another. Emphasis must be made about the possible outcomes if the correct dose is not taken as ordered.

Certain medications, such as antihypertensives, cannot be stopped suddenly without producing a rebound effect. This information must be explained to the patient and family.

## Teaching Exercise (Activity) Tolerance

Exercise is a crucial component of daily activity for someone with HF. Exercise tolerance is the ability to obtain maximum workload and duration while moving. With the guidance of a physical therapist or exercise physiologist, a person with HF can stay as active as possible for as long as possible and potentially reap the resultant health benefits. The clinician teaches the patient and family specific exercises, within appropriate parameters, to optimize strength and endurance without causing an oxygen deficit secondary to exercise intolerance (Physiopedia, 2020). (See also “Cardiac Rehabilitation” earlier in this course.)

Oxygen consumption is the amount of oxygen used during activity. A certain amount of oxygen is consumed even while at rest. People with HF must pace themselves to ensure that using oxygen stores in the body too quickly does not cause shortness of breath or dyspnea. Medications to regulate heart rate and BP may be given to minimize oxygen consumption. Physical therapists and respiratory therapists work with other care team members to create a physical activity plan to keep the patient with heart failure active while minimizing symptoms of hypoxia (Harding et al., 2020).

## Teaching Respiratory Management

Respiratory management is an indispensable aspect of patient and family teaching. Patients with moderate to severe HF may intermittently or permanently require oxygen supplementation or respiratory treatment to remain out of the hospital. Thus, a respiratory therapist is an extremely valuable member of the care team.

### OXYGEN SUPPLEMENTATION

Oxygen supplementation may be needed for exacerbations of shortness of breath and dyspnea or may be a permanent feature. Some HF patients may require continuous oxygen even at rest, and others may require oxygen only while active. The supplementation may be in the form of portable oxygen by cylinder, small tank, or an oxygen concentrator. Cylinders and tanks must be refilled periodically, while a concentrator uses the 21% oxygen always available in the surrounding air and concentrates it to deliver a somewhat higher amount, usually measured in liters per minute (L/m).

A nonrebreather mask is a disposable, plastic oxygen mask that covers most of the face and is the only nonventilated oxygen device that can deliver 100% oxygen. But most patients prefer not to wear a mask covering their face and will wear a nasal cannula that can deliver no more than 6 L/m.

Oximetry devices measure the concentration of oxygen in the capillaries to evaluate the need for reduction of oxygen consumption, the need for oxygen supplementation, or the effectiveness of oxygen supplementation to maintain an oxygen saturation of 94% to 100% in the absence of respiratory disease.

(See also “CPAP/BiPAP/APAP” earlier in this course.)

### POSITIONING

Many patients with HF are more comfortable sitting and even sleeping at a high angle up to 90 degrees (orthopnea). In this position, it is more possible to expand the bases of the lungs while inhaling, optimizing the amount of oxygen made available. For this reason, some patients commonly sleep in a chair or have a bed with a movable base in which the head of the bed can be elevated (Harding et al., 2020).

## Teaching Weight Management

The closer a person with HF is to their optimal weight, the more active they can be, the less likely they are to need readmission to a hospital with a diagnosis of HF, and the longer their life expectancy. The person or persons in charge of the cooking for the patient may require instruction to promote weight loss and prevent fluid retention while maintaining adequate nutrition and hydration. A registered dietitian or nutritionist may be called in on consultation to help select menus and dishes that will accomplish these goals. Personal preferences, cost, availability, and cultural differences are all typical considerations when meal planning.

Prevention of fluid retention is a fundamental part of patient and family education for patients with HF. Fluid or volume overload can cause the patient to be rehospitalized. In the context of dietary noncompliance, it is the second most common cause for readmission with a diagnosis of HF (noncompliance with a medication regime being the first). Sodium and fluid restrictions are an essential part of self-care education.

(See also "Nutritional Therapy" earlier in this course.)

**CASE**

Dorothy is a nurse on a busy telemetry unit in a large medical center in the southwest, and with 10 years of experience on the telemetry unit, she is now considered expert in teaching HF. She just returned from an education seminar on patient instruction in HF care, where she learned that evidence supports one hour of focused discharge teaching by an expert in HF instruction as successful in prolonging the period between hospital admissions (provided the patient is compliant with teaching).

Dorothy's patient Bill is being discharged after his third admission for HF in one year. She arranges for the charge nurse to cover her other patients so that she can devote the time to discharge teaching that her patient needs. Dorothy includes Bill's wife in the teaching, since she knows his wife will be helping Bill take his medications and will continue to do the cooking for the two of them.

As part of her teaching, Dorothy has Bill explain to her what each discharge medication is and when he will take each one. She discusses sodium and fluid restrictions and has his wife explain how she will be able to include some of Bill's favorite foods on the meal plan. She has the physical therapist come into Bill's room to review his home exercise program with him. She makes his follow-up appointment for him within one week of leaving the hospital and promises to call within the next two to three days to check on him.

## CONCLUSION

Heart failure is a global epidemic, particularly in countries with a rapidly aging population. In the United States, HF is the most common reason for hospital admission among those over 65 years of age. Half of patients diagnosed with HF die within five years, both nationally and internationally. There are known racial, ethnic, gender, socioeconomic, and age differences that produce varied responses to the disease and to treatments.

There are many different forms of heart failure. Each one represents a distinct set of symptoms leading to the diagnosis. The failure may occur on the right or the left side of the heart, resulting in fluid retention or respiratory symptoms, respectively. Over time, failure of one side of the heart or the other will result in both sides of the heart failing. The patient with HF will exhibit either a reduced (HFrEF) ejection fraction or a preserved (HFpEF) ejection fraction. Systolic HF will exhibit a low EF; diastolic HF will exhibit a normal EF.

Risk factors for heart failure include advanced age, female gender, tobacco use, obesity, excessive drinking, and genetic disposition. Some factors, such as smoking, drinking, and obesity, are modifiable, and lifestyle changes in these areas may prevent HF or slow the progression. Illness caused by the COVID-19 virus has emerged recently as a comorbidity of HF. Similar risk factors and mutual exacerbation of symptoms have also caused HF to be a determining survival factor in COVID-19.

The definitive test to confirm a diagnosis of heart failure is a blood test measuring the level of the neurohormone released in HF, B-type natriuretic peptide (BNP). Normal results are <100 pg/ml. The higher the level of the BNP, the more severe the degree of HF. Oher diagnostic tests are performed to determine cardiac and pulmonary function and the presence and degree of any comorbidities such as diabetes, liver or renal failure, COPD, hypertension, or any other heart diseases.

HF may be treated by medications, surgical procedures, or the implantation of devices designed to support the heart that is failing, occasionally as a bridge-to-transplant. HF patients are usually on cardiac monitors when they are in an acute care hospital, necessitating time in an intensive care, step-down critical care, or telemetry unit if they are ambulatory.

A great deal of research and clinical trials have been performed to reduce the readmission rate of HF patients to the hospital. Billions of dollars are spent in the United States each year for the treatment of HF, mostly on hospitalization. Patient and family teaching, cardiac rehabilitation, the promotion of self-care, and prevention of the worsening of the HF patient's condition all serve as methods to prevent the recurrence of HF symptoms that could necessitate readmission to the hospital.

Caring for heart failure patients is a multidisciplinary approach. Physicians, nurses, respiratory therapists, physical therapists, occupational therapists, exercise physiologists, mental health workers, social workers, dietitians, discharge planners, technicians, and families all work together for the benefit of heart failure patients.

**RESOURCES**

American Association of Heart Failure Nurses
http://www.aahfn.org

Heart failure (American Heart Association)
https://www.heart.org/en/health-topics/heart-failure

Heart failure (NIH/Medline Plus)
https://medlineplus.gov/heartfailure.html

Heart failure (National Heart, Lung, and Blood Institute)
http://www.nhlbi.nih.gov/health/health-topics/topics/hf

Heart Failure Society of America
https://hfsa.org/

## REFERENCES

Abramson M, Harvey J, Greenfield M, Lauman S, & Metzler D. (n.d.). Partners in therapy: a case study of OT intervention for a recipient of a left ventricular access device. *Advance for Occupational Therapy Practitioners*, 16–20.

American Heart Association (AHA). (2021). What is cardiac rehabilitation? Retrieved from https://www.heart.org/en/health-topics/cardiac-rehab/what-is-cardiac-rehabilitation

Amgen. (2019). What is Corlanor? Retrieved from https://www.corlanor.com/what-is-corlanor-chronichf-treatment/

Andersen J, Gerds TA, Gislason G, Schou M, Torp-Pedersen C, Hlatky MA, Møller S, Madelaire C, & Strandberg-Larsen K. (2020). Socioeconomic position and one-year mortality risk among patients with heart failure: a nationwide register-based cohort study. *European Journal of Preventive Cardiology*, *27*(1), 79–88. doi:10.1177/2047487319865946

Astellas Pharma. (2018). Lexiscan. Retrieved from https://www.astellas.us/docs/lexiscan.pdf

Benjamin EJ, Muntner P, Alonso A, Bittencourt MS, Callaway CW, Carson AP, et al. (2020). Heart disease and stroke statistics—2019 update: a report from the American Heart Association. *Circulation, 139*(10). Retrieved from https://www.ahajournals.org/doi/10.1161/CIR.0000000000000659

Bennett A, Nxumalo K, Pike W, & Carroll O. (2020). Abstract P480: the distinct role of occupational therapy in addressing the self-care management needs of patients with heart failure. *Circulation, 141.* Retrieved from https://www.ahajournals.org/doi/abs/10.1161/circ.141.suppl_1.P480

Blum MR, Øien H, Carmichael HL, et al. (2020). Cost-effectiveness of transitional care services after hospitalization with heart failure. *Annals of Internal Medicine, 172*, 248–57. doi:10.7326/M19-1980

Boa Sorte Silva NC, Pulford RW, Lee DS, & Petrella RJ. (2020). Heart failure management insights from primary care physicians and allied health care providers in Southwestern Ontario. *BMC Family Practice*, *21*(1), 1–9. doi:10.1186/s12875-020-1080-y

Byrd R, Smith P, Mohamedaly O, Snyder LD, & Pastva AM. (2019). A 1-month physical therapy–based outpatient program for adults awaiting lung transplantation: a retrospective analysis of exercise capacity, symptoms, and quality of life. *Cardiopulmonary Physical Therapy Journal, 30*(2), 61–9. doi:10.1097/CPT.0000000000000087

Byrne AL, Hegney D, Harvey C, Baldwin A, Willis E, Heard D, Judd J, Palmer J, Brown J, Heritage B, Thompson S, & Ferguson B. (2020). Exploring the nurse navigator role: a thematic analysis. *Journal of Nursing Management*, *4*, 814. doi:10.1111/jonm.12997

Centers for Disease Control and Prevention (CDC). (2020a). Heart failure. Retrieved from https://www.cdc.gov/heartdisease/heart_failure.htm

Centers for Disease Control and Prevention (CDC). (2020b). Perceived exertion: Borg perceived rating of exertion scale. Retrieved from https://www.cdc.gov/physicalactivity/basics/measuring/exertion.htm

Chapel DB & Husain AN. (2018). Acute-onset heart failure secondary to long-standing abuse of alcohol, cocaine, and marijuana. *Toxicology Research and Application*, *2*. doi:10.1177/2397847318770726

Cleveland Clinic. (2021). Heart disease: stem cell therapy. Retrieved from https://my.clevelandclinic.org/health/diseases/17508-heart-disease-stem-cell-therapy

Cleveland Clinic. (2019). Heart failure and women. Retrieved from https://my.clevelandclinic.org/heaalth/diseases/1708-heart-failure-in-women

Clevenger R. (2019). The role of respiratory in the management of congestive heart failure. Retrieved from https://rtsleepworld.com/2019/10/18/the-role-of-respiratory-in-the-management-of-congestive-heart-failure/

Docherty KF, Vaduganathan M, Solomon SD, & McMurray JJV. (2020). Sacubitril/valsartan: neprilysin inhibition 5 years after PARADIGM-HF. *JACC Heart Failure, 8*(10), 800–10. doi:10.1016/j.jchf.2020.06.020. Erratum in *JACC Heart Failure,8*(12), 1057. PMID:33004114.

Fukuoka S, Dohi K, Takeuchi T, Moriwaki K, Ishiyama M, Omori T, & Fujimoto N. (2020). Mechanisms and prediction of short-term natriuretic effect of sodium-glucose cotransporter 2 inhibitor in heart failure patients coexisting type 2 diabetes mellitus. *Heart and Vessels*, *9*, 1218. doi:10.1007/s00380-020-01597-x

Fagih AA, Mariam AO, Saleh AB, Fahmi A-K, Khalid D, & Yahya AH. (2020). Remotely monitored inactivity due to COVID-19 lockdowns: potential hazard for heart failure patients. *Saudi Medical Journal*, *41*(11), 1211ff.

Halabi A, Sen J, Huynh Q, & Marwick TH. (2020). Metformin treatment in heart failure with preserved ejection fraction: a systematic review and meta-regression analysis. *Cardiovasc Diabetol, 19*(1), 124. doi:10.1186/s12933-020-01100-w

Harding MM, Kwong J, Roberts D, Hagler D, & Reinisch C. (2020). *Lewis medical-surgical nursing assessment and management of clinical problems* (11th ed.). St. Louis: Elsevier.

Hartupee J & Mann DL. (2017). Neurohormonal activation in heart failure with reduced ejection fraction. *Nature reviews. Cardiology*, *14*(1), 30–8. doi:10.1038/nrcardio.2016.163

Intermountain Health Care. (2021). Self-management: MAWDS for heart failure. Retrieved from https://intermountainhealthcare.org/services/heart-care/treatment-and-detection-methods/heart-failure-management/

Khan E. (2021). Heart failure and COVID-19: synergism of two inflammatory conditions? *British Journal of Community Nursing, 26*(1), 18–25.

Kaunda RE. (2019). Atrial and brain natriuretic peptides. *Cardiovascular physiology concepts.* Retrieved from https://www.cvphysiology.com/Blood%20Pressure/BP017

Klajda MD, Scott CG, Rodeheffer RJ, & Chen HH. (2020). Diabetes mellitus is an independent predictor for the development of heart failure: a population study. *Mayo Clinic Proceedings*, *95*(1). doi:10.1016/j.mayocp.2019.07.008

Kruik-Kollöffel WJ, van der Palen J, Doggen CJM, van Maaren MC, Kruik HJ, Heintjes EM, Movig KLL, & Linssen GCM. (2020). Heart failure medication after a first hospital admission and risk of heart failure readmission, focus on beta-

blockers and renin-angiotensin-aldosterone system medication: a retrospective cohort study in linked databases. *PLoS ONE, 15*(12), 1–18. doi:10.1371/journal.pone.0244231

Mayo Clinic. (2021). Cardiac rehabilitation. Retrieved from https://www.mayoclinic.org/tests-procedures/cardiac-rehabilitation/about/pac-20385192?p=1

McCuistion LE, Vuljoin DiMaggio K, Winton MB, & Yeager JJ. (2019). *Pharmacology: a patient-centered nursing process approach* (10th ed.). St. Louis: Elsevier.

Merck & Co. (2021). Heart failure (HF) (congestive heart failure). *Merck Manual, Consumer Version.* Retrieved from https://www.merckmanuals.com/home/heart-and-blood-vessel-disorders/heart-failure/heart-failure-hf

Merck & Co. (2020). Heart failure. *Merck Manual, Professional Version.* Retrieved from https://www.merckmanuals.com/professional/cardiovascular-disorders/heart-failure/heart-failure-hf

Morgan K. (2021). Personal communication.

National Heart, Lung, & Blood Institute (NHLBI). (2021a). Heart valve disease. Retrieved from https://www.nhlbi.nih.gov/health-topics/heart-valve-disease

National Heart, Lung, & Blood Institute (NHLBI). (2021b). Defibrillators. Retrieved from https://www.nhlbi.nih.gov/health-topics/defibrillators

National Heart, Lung, & Blood Institute (NHLBI). (2021c). The survival benefit of an implantable defibrillator for heart failure lasts at least 10 years. Retrieved from https://www.nhlbi.nih.gov/news/2020/survival-benefit-implantable-defibrillator-heart-failure-lasts-least-10-years

National Heart, Lung, & Blood Institute (NHLBI). (2020d). Heart failure. Retrieved from https://www.nhlbi.nih.gov/health-topics/heart-failure

National Institutes of Health (NIH). (2020). Heart health tests. *Medline Plus.* Retrieved from https://medlineplus.gov/hearthealthtests.html

Nationwide Children's. (2017). Transtelephonic monitor (TTM) 30-day looping event monitor. Retrieved from https://www.nationwidechildrens.org/family-resources-education/health-wellness-and-safety-resources/helping-hands/transtelephonic-monitor-looping

Physiopedia. (2021). Physical activity and cardiovascular disease. Retrieved from https://physio-pedia.com/Physical_Activity_and_Cardiovascular_Disease

Popa-Fotea N-M, Michu MM, & Dorobantu M. (2020). Metabolic syndrome, nutritional deficits and heart failure. *Journal of Hypertension Research*, *6*(1), 10ff. Retrieved from http://link.gale.com/apps/doc/A625500000/AONE?u=uphoenix&sid=AONE&xid=3ecdcf87

Roberts P, Robinson M, Furniss J, & Metzler C. (2020). Occupational therapy's value in provision of quality care to prevent readmissions. *American Journal of Occupational Therapy, 74,* 7403090010. doi:10.5014/ajot.2020.743002. Retrieved from https://ajot.aota.org/article.aspx?articleid=2765260

Roe M. (2021). Personal communication.

Roe M. (2020). Fall prevention: interventions for balance problems and risks. Retrieved from https://wildirismedicaleducation.com/courses/fall-prevention-ceu

Roshanghalb A, Mazzali C, & Lettieri E. (2020). Composite outcomes of mortality and readmission in patients with heart failure: Retrospective review of administrative datasets. *Journal of Multidisciplinary Healthcare*, 539. doi:10.2147/JMDH.S255206

Salahodinkolah MK, Ganji J, Moghadam SH, Shafipour V, Jafari H, & Salari S. (2020). Educational intervention for improving self-care behaviors in patients with heart failure: a narrative review. *Journal of Nursing & Midwifery Sciences*, *7*(1), 60–68. doi:10.4103/JNMS.JNMS_19_19

Salam AM, Sulaiman K, Alsheikh-Ali AA, Singh R, AlHabib KF, Al-Zakwani I, & Asaad N. (2020). Precipitating factors for hospitalization with heart failure: prevalence and clinical impact observations from the Gulf CARE (Gulf aCute heArt failuRe rEgistry). *Medical Principles and Practice*, *3*, 270. doi:10.1159/000503334

Sana F, Isselbacher EM, Singh JP, Heist EK, Pathik B, & Armoundas AA. (2020). Wearable devices for ambulatory cardiac monitoring: JACC state-of-the-art review. *J Am Coll Cardiol, 75*(13), 1582–92. doi:10.1016/j.jacc.2020.01.046

Sears B. (2020). What is a timed up and go (TUG) test? Retrieved from https://www.verywellhealth.com/the-timed-up-and-go-test-2696072

Sears B. (2019). The four phases of cardiac rehabilitation. Retrieved from https://www.verywellhealth.com/four-phases-of-cardiac-rehabilitation-2696089

Shoemaker MJ, Dias KJ, Lefebvre KM, Heick JD, & Collins SM. (2020). Physical therapist clinical practice guideline for the management of individuals with heart failure. *Physical Therapy, 100*(1), 14–43.

Singhvi A & Trachtenberg B. (2019). Left ventricular assist devices 101: shared care for general cardiologists and primary care. *Journal of Clinical Medicine*, *8*, 1720. doi:10.3390/jcm8101720

Sole ML, Klein D, & Moseley M. (2020). *Introduction to critical care nursing* (8th ed.). St. Louis: Elsevier Saunders.

Taniguchi C, Okada A, Seto N, & Shimizu Y. (2020). How visiting nurses detect symptoms of disease progression in patients with chronic heart failure. *International Journal of Qualitative Studies on Health & Well-Being, 15*(1), 1–11. doi:10.1080/17482631.2020.1735768

Urbich M, Globe G, Pantiri K, et al. (2020). A systematic review of medical costs associated with heart failure in the USA (2014–2020). *PharmacoEconomics, 38,* 1219–36. doi:10.1007/s40273-020-00952-0

Virani SS, Alonso A, Benjamin EJ, Bittencourt MS, Callaway CW, Carson AP, et al. (2020). Heart disease and stroke statistics—2020 update: a report from the American Heart Association. *Circulation, 141*(9). Retrieved from https://pubmed.ncbi.nlm.nih.gov/31992061/

Wang N, Farrell M, Hales S, Hanvey K, Robertson G, Sharp P, & Tofler G. (2020). Prevalence and seasonal variation of precipitants of heart failure hospitalization and risk of readmission. *International Journal of Cardiology*, *316*, 152–60. doi:10.1016/j.ijcard.2020.04.084

Wolfe NK, Mitchell JD, & Brown DL. (2020). The independent reduction in mortality associated with guideline-directed medical therapy in patients with coronary artery disease and heart failure with reduced ejection fraction, *European Heart Journal—Quality of Care and Clinical Outcomes*. Retrieved from https://academic.oup.com/ehjqcco/advance-article-abstract/doi/10.1093/ehjqcco/qcaa032/5824297

Yamada S, Arrell DK, Rosenow CS, Bartunek J, Behfar A, & Terzic A. (2020). Ventricular remodeling in ischemic heart failure stratifies responders to stem cell therapy. *Stem Cells Translational Medicine, 9*(1), 74–9.

Yamamoto S, Yamaga T, Nishie K, Nagata C, & Mori R. (2020). Positive airway pressure therapy for the treatment of central sleep apnoea associated with heart failure. *Cochrane Database System Review, 12*(12), CD012803. doi:10.1002/14651858.CD012803.pub2

Yancy CW, Jessup M, Bozkurt B, Butler J, Casey DE, et al. (2017). 2017 ACC/AHA/HFSA focused update of the 2013 ACCF/AHA guideline for the management of heart failure: a report of the American College of Cardiology/American Heart Association task force on clinical practice guidelines and the Heart Failure Society of America. doi:10.1161/CIR.0000000000000509

Zahoransky MA & Lape JE. (2020). Telehealth and home health occupational therapy: clients' perceived satisfaction with and perception of occupational performance. *International Journal of Telerehabilitation*, *12*(2), 105–24. doi:10.5195/ijt.2020.6327

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# TEST

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**1.** The most common type of heart failure (HF) is:

a. Diastolic HF due to ventricular stiffness.
b. Systolic HF due to weak ventricular contractions.
c. Left-sided HF due to reduced pumping by the left ventricle.
d. Right-sided HF due to reduced pumping by the right ventricle.

**2.** The incidence of heart failure is increasing rapidly in younger patients in the United States because:

a. More people are going to the doctor.
b. The incidence of obesity and diabetes is also increasing.
c. Doctors are better able to diagnose the disease.
d. People are under more economic stress.

**3.** A sign/symptom indicating possible left-sided heart failure is:

a. Tachypnea.
b. Increased appetite.
c. Decreased central venous pressure.
d. Bradycardia.

**4.** Which is a **correct** statement regarding systolic heart failure?

a. It may lead to a decrease in the size of the heart.
b. The vessel walls and myocardium may become softer.
c. It results in a reduced ejection fraction.
d. Decreased afterload is a common cause.

**5.** Which is the most common comorbidity of heart failure?

a. Renal failure
b. Cocaine or alcohol abuse
c. Grave's disease
d. Hypertension

**6.** Metabolic syndrome has been found to be associated with which form of heart failure?

a. Both diastolic and systolic
b. Only diastolic
c. Only systolic
d. Neither diastolic nor systolic

**7.** The diagnosis of heart failure is **primarily** made based on:

a. Vital signs.
b. ECG.
c. Symptoms.
d. Chest X-ray.

**8.** The most definitive labwork for heart failure is:

a. Complete blood count (CBC).
b. Hemoglobin (Hgb).
c. Thyroid function.
d. B-type natriuretic peptide (BNP).

**9.** A common feature of medications used for heart failure is that they:

a. Increase heart rate.
b. Reduce cardiac workload.
c. Cause chest pain.
d. Decrease cardiac output.

**10.** In the transcatheter aortic valve replacement (TAVR) approach to correcting a diseased heart valve, the valve is replaced via:

a. Open-heart surgery.
b. Popliteal vein.
c. Femoral artery.
d. Renal artery.

**11.** The purpose of an internal cardiac defibrillator (ICD) is to:

a. Allow the physician to monitor heart rhythm.
b. Provide easier access to obtaining an EKG.
c. Prevent myocardial infarction (MI).
d. Sense and correct dysrhythmia.

**12.** Which is a **correct** statement regarding the left ventricular assist device (LVAD)?

a. It has more complications than an intraaortic balloon pump (IABP).
b. It is indicated for use only in male patients.
c. It provides long- or short-term support for a heart that is failing.
d. It is indicated for use in patients with a life expectancy of less than one year.

**13.** Which is a **correct** statement regarding cardiac resynchronization therapy (CRT):

a. It causes the ventricles to contract in time with one another.
b. It improves exercise function but decreases life expectancy.
c. It reduces hospitalizations in all patients with heart failure.
d. It involves a computer carried on the outside of the body.

**14.** American Heart Association guidelines to promote patient adherence to heart failure protocols include:

a. A follow-up phone call by a clinician within 48 to 72 hours of discharge.
b. Ten minutes of patient heart failure education by a qualified educator.
c. Scheduling a postdischarge appointment to take place within 1 month of discharge.
d. Maintaining the patient's blood pressure at or below 120/80.

**15.** Which is **not** measured by the Timed-Up-and-Go (TUG) test?

a. Functional mobility
b. Walking ability
c. Motor impairments
d. Dynamic balance

**16.** When making a post-discharge follow-up phone call to check on a heart failure patient, the nurse inquires about:

a. Finances.
b. Bowel movements.
c. Blood glucose.
d. Blood pressure and heart rate.

**17.** Electronic devices are typically used in home telehealth to monitor a patient's:

a. Respirations.
b. Weight.
c. Skin tone.
d. Dietary intake.

**18.** Health materials for patient education should be written at which grade level?

a. Kindergarten
b. First grade
c. Fifth grade
d. High school

**19.** In the lifestyle self-management mnemonic tool *MAWDS*, the "D" stands for:

a. Drugs.
b. Days.
c. Dislikes.
d. Diet.

**20.** Other than dietary noncompliance, the most common reason that patients with heart failure are rehospitalized is:

a. Nonadherence to medication regimes.
b. Dehydration.
c. Inadequate sleep.
d. Lack of physical exercise.