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

- Define heart failure.
- Summarize the impacts and epidemiology of heart failure.
- Discuss pathophysiology and etiology.
- 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.
- Discuss elements of patient and family education.
- Describe a multidisciplinary approach to cardiac rehabilitation.
- Explain strategies to prevent recurrence of heart failure and rehospitalization.

INTRODUCTION

Heart failure (HF) is a complex syndrome of symptoms that causes the inability of the heart to pump a sufficient amount of blood throughout the body to satisfy the oxygen needs of the organs and cells. It may also be referred to as cardiac failure or 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 (CDC, 2016).

- Systolic HF is caused by weakened ventricular contractions that result 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 HF** is decreased cardiac output (CO) in the presence of normal EF due to ventricular stiffness.
- **Right-sided HF** refers to failure of the right ventricle to pump blood to the lungs.
- **Left-sided HF**, 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.

Heart failure can also be chronic (most common) or acute (as in the case of pulmonary edema) (Gordin & Fonarow, 2016; Lewis et al., 2017).
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 approximately 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 (Dokainish et al., 2015; Ponikowski et al., 2015).

HF affects approximately 5.7 million people in the United States and is projected to rise to 8.5 million by 2030. Approximately 650,000 people are newly diagnosed with HF each year. Heart failure is the most common reason for hospital admissions in adults over 65 years old in the United States. It is also the most common reason for hospital readmissions, with 25% of all patients admitted to acute care hospitals with a diagnosis of HF being readmitted within 30 days and 67% within a year (CDC, 2016; Ponikowski et al., 2015; Krumholz & Dhruva, 2017).

HF is increasing in the United States at alarming rates. According to the American Heart Association, the incidence of heart failure increased from about 5.7 million (2009–2012) to about 6.5 million (2011–2014) in the adult population (AHA, 2017a). This is attributed to three confounding factors in the population:

- People are living longer, and the elderly population is rapidly increasing, with the first Baby Boomers (those born between 1946 and 1964) now in their 70s.
- People with acute coronary syndrome are surviving for much longer after an insult such as an MI due to earlier recognition of coronary artery disease, use of beta receptor blocking agents, and early intervention to improve coronary artery blood flow.
- The incidence of obesity and diabetes is increasing related to diet and exercise and affecting younger patients. (Collins & Dias, 2015)

Cost

The annual cost of HF is over $6.5 trillion globally. The annual cost of HF in the United States is $30.1 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 $53.1 billion by 2030 when hospitalization, physician, pharmaceutical, and home healthcare costs are all considered (CDC, 2016; Lewis et al., 2017; Ponikowski et al., 2015).
Medical costs in the United States typically increase three-fold in the last 2 years of life regardless of diagnosis. With HF as a diagnosis in the last 6 months of life, the cost of healthcare in that period increases 6.8 times. The markedly increased health and economic effects of HF are primarily the result of more hospital admissions, greater readmissions with shorter turn-around time, more cost, and shorter life expectancy (Swindle et al., 2016).

**Mortality**

About half of those diagnosed with heart failure die within five years of diagnosis. HF accounts for 1 in 9 deaths of adults in the United States. Globally, survival rates for hospitalized patients have improved with the introduction of evidence-based treatment strategies similar to those used in the United States. Nevertheless, 2% to 17% of patients hospitalized with HF throughout the world die while admitted to hospitals. The rate at which people in other countries hospitalized with heart failure die within a year of admission is 17% to 45%, with about half dying within five years (CDC, 2016; Graven et al., 2015). Medical outcomes are better when socioeconomic conditions such as higher education, increased income, and the presence of a partner are all taken into consideration (Verma et al., 2017).

(Source: CDC, 2016.)
Age

Heart failure is the number one cause of acute care hospitalization and readmission in patients older than 65 years in the United States. The average age of those living with HF is 70 years in the United States and 59 years globally. Hospitalized patients in sub-Saharan Africa tend to be 55 years old or younger. Hospitalized patients in Asia and the Pacific Rim also tend to be younger than Westerners. It is hypothesized, but not evidenced, that the higher prevalence of diabetes as a comorbidity to heart failure and the higher occurrence of smoking in Asian heart failure patients may lead to the earlier morbidity rate in this population, resulting in a younger surviving cohort (Bank et al., 2017).

Cultural and Ethnic Disparities

African Americans have a higher incidence of HF, 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.

African Americans are usually diagnosed with HF at an earlier age but show greater improvement with compliance with treatment (Steele & Steele, 2015). African American patients are also more likely to be readmitted to the hospital within 30 days of admission than white or Hispanic patients (Aseltine et al., 2015). Native Americans and Alaska Natives have an incidence of mortality less than African Americans and whites but more than Asians/Pacific Islanders and Hispanics (Sidney et al., 2017).

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 side effect (Lewis et al., 2017).

HEART FAILURE AND SOCIOECONOMIC STATUS (SES)

SES includes partner status, education, annual income, and employment. Studies show that patients with HF who have spouses or life partners, an education beyond high school, an income of >$25,000/year, and employment of any kind are associated with better baseline functional capacity and quality of life. HF patients with partners have better medication compliance and event-free survival. Patients with HF in lower socioeconomic communities have higher hospitalization rates. However, these are not considered individual predictors of long-term outcomes for HF patients. The studies that looked into these specific socioeconomic factors do not take into account nonmodifiable lifestyle, physiologic, and genetic risk factors (Verma et al., 2017).
PATHOPHYSIOLOGY AND ETIOLOGY

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 versus diastolic
- Left-sided versus right-sided
- Acute versus chronic

Systolic versus 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 insufficient volume 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.

<table>
<thead>
<tr>
<th>CAUSES AND SIGNS/SYMPTOMS OF HEART FAILURE</th>
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<tbody>
<tr>
<td>Classifications</td>
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<tr>
<td><strong>Systolic HF Causes</strong></td>
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</tbody>
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### Diastolic HF Causes

- Myocardial infarction
- Coronary artery disease
- Hypertrophic heart disease
- Pericarditis
- Radiation therapy to the chest
- Age
- Hypertension

### Signs/Symptoms

- Dyspnea/orthopnea
- Cheyne-Stokes respirations
- Paroxysmal nocturnal dyspnea (PND)
- Cough (orthopnea equivalent)
- Fatigue or activity intolerance
- Diaphoresis
- Pulmonary crackles
- Elevated pulmonary capillary occlusion pressure
- S1 and S2 gallop
- Tachycardia
- Tachypnea
- Hepatojugular reflux

- Right ventricular hypertrophy
- Radiation therapy to the chest
- Jugular vein distension
- Hepatomegaly with ascites in severe cases
- Peripheral edema
- Loss of appetite, nausea, vomiting
- Elevated central venous or right atrial pressure

Source: Sole et al., 2016.

### 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 <45% and in severe cases as low as 5% to 10%.

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, 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 (Lewis et al., 2017).
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 (Shah, 2017).

**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 (CO). 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 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 (Ding et al., 2017; Shah, 2017; Smith et al., 2016).

**HEART FAILURE AND DECREASED CIRCULATION**

Any form of HF 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 (Erkelens et al., 2017; Lewis et al., 2017).

**Left-Sided Heart Failure**

The most common type of HF 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 all of 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 pulmonary capillary pressure 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 HF:

- 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 (GI) tract (edema caused by increased intestinal permeability) (Liu et al., 2017; Mukund et al., 2016)

Some possible causes of left-sided HF include:

- Chronic coronary artery blockage
- Hypertension
- Excessive alcohol intake
- Myocardial infarction
- Valvular defects
- Hypothyroidism
- Heart muscle infection
- Abnormal vasculature
  (Lewis et al., 2017; Shah, 2017)

**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. 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 (Teerlink et al., 2016).

Some common right-sided HF 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

(Lewis et al., 2017; Shah, 2017)

**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, pulse 122, respirations 18, deep and unlabored. 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. 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 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 HF:

- 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
  (Lewis et al., 2017)

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

(Lewis et al., 2017)

When a person with chronic HF has an acute exacerbation due to a new injury or worsening conditions, it is called *acute on chronic HF*.

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**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 and more 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 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 comes 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.

Heart failure signs and symptoms. (Source: National Heart, Lung, and Blood Institute.)
Risk Factors

Risk factors for heart failure include:

- Advanced age
- Female gender
- Tobacco use
- Obesity
- Genetic disposition

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

- Myocardial infarction
- Hypertension
- Diabetes
- Renal failure
- Metabolic syndrome

**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. Diabetic women are more predisposed to HF. Women have a higher incidence of obesity, which is another risk factor for HF. Women have a higher incidence of increased left ventricular end-diastolic pressure, or preload (Schwarzl et al., 2016).

The use of **tobacco** products containing nicotine causes the release of catecholamines, resulting in the vasoconstriction that causes hypertension. Hypertension causes increased vascular resistance that may cause HF over time (Taylor et al., 2016).

**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 (Lewis et al., 2017).
High-dose alcohol abuse can cause or exacerbate HF. Prolonged use can cause myocyte (muscle cell) hypertrophy, interstitial fibrosis, weaker contractions, and ventricular enlargement. Any of these can cause systolic or diastolic ventricular dysfunction that can result in HF, dysrhythmias, or death (Fernandez-Sola & Porta, 2016).

Extended cocaine use may cause nonischemic cardiomyopathy, including HF. This may be exacerbated by cocaine’s side effect of severe tachycardia (Nguyen et al., 2015).

HEART FAILURE AND COMORBIDITIES

**Hypertension**

Hypertension is the most common comorbidity of heart failure. 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 wall tension, and impaired contractility.

Hypertension is also the most common cause of a HF exacerbation (Sharma & Felker, 2016). As 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 (BP) 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 (Lewis et al., 2017).

**Myocardial Infarction (MI)**

Myocardial infarction is a common comorbidity for heart failure. An MI may cause a dysfunctional left ventricle, leading to a drop in cardiac output due to incomplete emptying of the ventricle. This then causes the myocardium to have to exert greater effort. 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 is frequently associated with heart failure. Approximately 30% of all persons diagnosed with HF also have diabetes. 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.

A recent meta-analysis of over 507,000 individuals with type 2 diabetes found that insulin use, advancing age, and increasing values of fasting glucose and hemoglobin A1C to be the strongest risk factors for incident HF. Another study showed that each 1% increase in hemoglobin A1C translated to a 30% risk for developing HF over a nine-year follow-up period (von Haehling et al., 2016).

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 35% reduction in hospitalizations. Those with no HF had a lower incidence of developing the disease over time (von Haehling et al., 2016).

High blood sugars result in vascular scarring 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 (SNS) and the renin-angiotensin-aldosterone system (RAAS) system 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 (Lewis et al., 2017).

Metabolic Syndrome

Metabolic syndrome is a relatively new 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 sugar. An individual is considered to have metabolic syndrome if they have at least three of these five factors (Lewis et al., 2017).

In a large retrospective study, Asian patients with high risk factors including at least two markers for metabolic syndrome were evaluated to determine the possibility of metabolic syndrome factors correlating with one form of HF or another. Patients in the group who exhibited hypertension and elevated triglycerides were found to be independently associated with diastolic HF. Patients who exhibited hypertension and elevated fasting plasma glucose were found to be independently associated with systolic HF. The results were elicited without any discrepancies as far as gender, height, or weight. The prevalence of diastolic HF or systolic HF tends to increase with increasing metabolic syndrome severity (Tang et al., 2014).

Respiratory Insufficiency

Many HF patients have respiratory comorbidities such as 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 (Lewis et al., 2017).

**DIAGNOSIS OF HEART FAILURE**

The diagnosis of heart failure is primarily made based on symptoms, backed by more precise diagnostic tests to either rule out similar disease processes or confirm a diagnosis of HF (Don-Wauchope & McKelvie, 2015).

**Health History**

Taking an extensive 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, 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. The point of maximum impulse (PMI), the point furthest from the sternum where the cardiac impulse can be felt, may be displaced due to left ventricular hypertrophy.

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. With the patient seated, the jugular veins are palpated to determine distention. The abdomen is palpated to establish hepat- or splenomegaly.

**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 4 to 8 hours during hospitalization and with each physician or clinical visit. 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. 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.

Oxygen saturation is decreased (<94%) in the presence of fluid in the lungs, necessitating supplemental oxygen to be given.

Electrocardiogram

An electrocardiogram (ECG) is performed to measure heart rate and determine the presence of any dysrhythmias since damage to the ventricular myocardium may result in ventricular dysrhythmias. 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, and displacement of the heart. 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 (TST) is performed to determine activity tolerance. A 6-minute walk test on a flat surface may be substituted for patients unable to tolerate a TST. It is performed by a physician or trained clinician.

A possible substitution for a patient who is unable to run on a treadmill is a cardiac nuclear stress test done after injecting Lexiscan and radioactive isotopes intravenously. The Lexiscan causes vasodilation of the blood vessels, including the coronary arteries, allowing greater visibility. The isotopes will light up under the nuclear medicine scan, showing any blockages in the coronary arteries. The Lexiscan is injected by a physician, often a cardiologist. The isotopes are injected by a certified nuclear medicine technician (CNMT), who also conducts the scan. The cardiologist is responsible for reading the results (Astellas Pharma, US, 2017).

Echocardiogram

An echocardiogram may show 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 (Lewis et al., 2017). Therefore, an echocardiogram is crucial in determining whether the HF is systolic or diastolic. This is performed by a trained sonographer and evaluated by a cardiologist.
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. 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 (Don-Wauchope & McKelvie, 2015).

Normal range for BNP is <100 pg/ml (Medline Plus, 2017). The higher the reading, the more severe the HF. One factor that may moderately reduce the presence of the hormone in the blood is morbid obesity. This may cause the condition to be inaccurately excluded from diagnosis (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, liver function, glucose, calcium, and proteins.
- Urine sodium is measured to determine the possibility of sodium retention in HF.
- Urine specific gravity measures urine concentration.
- Thyroid function is tested to rule out thyroid disease as a confounding comorbidity in HF.
- Serum iron is 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.

Cardiac Catheterization

In a cardiac catheterization (coronary angiography), dye is injected into the coronary arteries to determine patency. 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 HF.

Magnetic Resonance Imagery (MRI)

An MRI scan is a noninvasive procedure that shows cardiac tissue, ejection fractions, cardiac output, and the presence of aneurysms or obstructed blood vessels (Lewis et al., 2017).
NYHA FUNCTIONAL CLASSIFICATIONS

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

<table>
<thead>
<tr>
<th>Class</th>
<th>Patient Ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>No physical limitations</td>
</tr>
<tr>
<td>II</td>
<td>Slight limitations; comfortable only at rest; minimum activity starts to produce the symptoms of HF</td>
</tr>
<tr>
<td>III</td>
<td>Marked limitations; comfortable only at rest; moderate activity produces HF symptoms</td>
</tr>
<tr>
<td>IV</td>
<td>Unable to perform any activity without symptoms of HF; symptoms while at rest</td>
</tr>
</tbody>
</table>

Source: Lewis et al., 2017.

ACC/AHA* 2001 STAGING SYSTEM

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>At high risk of developing heart failure, but without structural heart disease or symptoms of HF (for example, people with hypertension, coronary artery disease, diabetes, history of drug or alcohol abuse, rheumatic heart disease, or family history of cardiomyopathy)</td>
</tr>
<tr>
<td>B</td>
<td>Structural heart disease with or without symptoms of HF (for example, left ventricular structural changes, heart valve disease, or a history of MI)</td>
</tr>
<tr>
<td>C</td>
<td>Structural heart disease with prior or current symptoms of HF (for example, shortness of breath, fatigue, or symptom-free and receiving treatment for prior symptoms)</td>
</tr>
<tr>
<td>D</td>
<td>Refractory or end-stage HF requiring specialized interventions such as cardiac transplantation or compassionate care such as hospice</td>
</tr>
</tbody>
</table>

* American College of Cardiology/American Heart Association

Sources: Graham, 2017; Sole et al., 2016.

TREATING HEART FAILURE

There are several levels of treatment parameters for HF. 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 (ICD), transtelphonic electrocardiographic transmission (TET) devices, coronary artery bypass grafts (CABG), 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 assistive devices (CADs) 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. A CardioMems HF system continually measures pulmonary arterial pressure (PAP).

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.

Physicians see patients in a variety of settings, including acute and long-term care facilities, clinics, and their offices. They are primarily responsible for assessment, initial diagnosis, and ordering medications and treatments based on diagnostic results, physical examination, and feedback from the other healthcare team members.

Nurses carry out physician orders, enact patient and family teaching, provide ongoing assessments, formulate plans of care, assist with activities of daily living, and arrange for healthcare resources or services. They can be found in all the settings in which HF patients find themselves. Advanced practice nurses, particularly nurse practitioners, may act in the stead of physicians in prescribing and initiating treatment. There are also additional certifications in cardiac rehabilitation for nurses, occupational therapists, and physical therapists.

Physical therapists evaluate physical limitations and help recommend, teach, and encourage appropriate therapeutic exercise interventions. They also instruct in the use of adaptive equipment and devices, particularly ambulatory aids or wheelchairs. They participate in and may take leadership roles in conducting cardiac rehabilitation programs.
Occupational therapists assist patients in activities of daily living (ADLs), promote health management, instruct in the use of adaptive equipment and devices, assist in discharge planning, and promote more independent function.

Respiratory therapists assist in evaluating and maintaining optimal pulmonary function. They teach patients about breathing exercises to conserve oxygen and regulate oxygen administration in a variety of inpatient and outpatient settings.

Nutritionists or registered dietitians create a dietary intake program specific to the individual patient needs. They take into consideration the need for weight loss or gain and sodium and fluid intake reduction to prevent fluid retention. A nutritional consultation is often ordered while the patient is hospitalized for one-on-one teaching about dietary changes.

Social workers focus on helping the patient to maintain a healthy home environment and healthcare network. They make information available about finding health resources for the patient and family from what is available in the community.

Mental health professionals address the depression and anxiety that often accompany HF. Restricted activity, diet, work, and other lifestyle changes may necessitate temporary or long-term psychotherapy.

Pharmacists may recommend suitable combinations of drugs to treat HF. They may review patient pharmacologic drug regimens and follow up on outcomes. They intervene if ordered medications or combinations of prescribed medications and over-the-counter drugs or herbal preparations have deleterious interactions and need to be adjusted. Pharmacists keep abreast of newly marketed medications or those still in clinical trials and advise about the efficacy of their use in treatment of HF.

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 (Masters et al., 2017).

**CASE**

Miguel is in the hospital for the fourth time for symptoms of HF. He is 89 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 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 (SNS) stimulation, vasoconstriction, or fluid overload secondary to sodium and fluid retention.

**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).

**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. These drugs include losartan (Cozaar) and valsartan (Diovan).

**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 isorbide dinitrate (Isordil) and sublingual nitroglycerin (NTG). The most common side effect of nitrates is vasodilation of peripheral arteries, resulting in reduced venous resistance and lowered blood pressure (Vallerand et al., 2015).

African Americans are the only ethnic group for whom the combination drug isosorbide dinitrate/hydralazine (BiDil) is approved as treatment for HF. Asian Americans have a high (up to 50%) risk for ACE inhibitor–induced cough as a side effect (Lewis et al., 2017; Ponikowski et al., 2015).

**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) (Lewis et al., 2017; Mayo Clinic, 2017a).

**Vasopressin-2 receptor antagonist** tolvaptan in renal failure patients with HF, when added to conventional therapy, showed improved dyspnea symptoms, lower doses of loop diuretics needed, and increased urine output than for those patients treated with loop diuretics alone. This proved 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 (Matsue et al., 2016).
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 or hypotension.

HF 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) (Tariq & Aronow, 2015).

MISCELLANEOUS MEDICATIONS

Three specific beta-adrenergic blocking agents (beta blockers) 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 (Lewis et al., 2017).

The heart failure agent (hyperpolarization-activated cyclic nucleotide gated channel blockers) ivabradine (Corlanor) is a new 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 less than 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 (Davis, 2017; Gordin & Fonarow, 2016).

Brain natriuretic peptide (BNP) treatments given subcutaneously show promise in having the capacity to improve left ventricular function and urine output. Initial studies of BNP treatment to prevent recurrence of heart failure symptoms and hospital readmissions showed the
subcutaneous route of administration did not cause hypotension as had the previous studies with intravenous medications. Further studies are needed to prove the efficacy of subcutaneous BNP treatments (Sharma & Felker, 2016).

**PHARMACOLOGIC AGENTS HELD OR USED WITH CAUTION IN HF**

**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. 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 (King et al., 2016).

**Thiazolidinediones**, also known as glitazones, are insulin activators that may increase sodium retention and aggravate HF symptoms in diabetics with comorbidities for both diseases. This may necessitate readmission to the hospital for HF because of the exacerbation of symptoms (von Haehling et al., 2016).

**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 (Lewis et al., 2017). Both the patient’s doctors 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 recent meta-analysis of changes in the U.S. Food and Drug Administration boxed warning regarding the use of Metformin suggests that previous prohibitions no longer hold. Metformin use in chronic diseases such as kidney disease, liver disease, and HF are no longer believed to increase mortality, so the restrictions have been dropped (Crowley et al., 2017).

**Surgical Interventions**

Surgeries can be performed to repair conditions that contribute to severe HF, particularly when various 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, 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.

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 (Medline Plus, 2017).

A 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 back-flow 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.

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 still requires a ventilator. A thoracic surgeon performs the surgery, and the patient is also cared for in the postoperative phase by a cardiologist.

Transcatheter aortic valve replacement (TAVR) is a newer approach currently in clinical trials (Orban et al., 2017). 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 (AHA/ASA, 2017).

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 (NIH, 2017). Its battery is replaced approximately every 20 years.
A large retrospective cohort study of over 23,000 patients with ICDs performed in the United States showed that patients who received insertion of an ICD while hospitalized for HF received significant benefits. These benefits were measured as a decrease in overall mortality, particularly sudden cardiac death. The study showed that the greatest benefit was for patients no older than their 60s and with mild to moderate HF. The device did not treat or reverse the effects of HF (Chen et al., 2015).

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: NIH, 2017.)

TRANSTELEPHONIC ELECTROCARDIOGRAPHIC TRANSMISSION (TET)
TET devices record cardiac monitor results when activated by the patient for suspected problems and then transmit the results over a telephone line to the patient’s primary care provider. The telephone receiver is placed over the device and a button is pushed to transmit the data. These can be used for patients with cardiac pacemakers, ICDs, and infrequently occurring but significant dysrhythmias (Long Island Heart Associates, 2017).

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, or without movement, 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. As stated above, the occurrence of an MI can lead to HF by causing left ventricular dysfunction. HF 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 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 (Popovic et al., 2016).

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 only at 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 “Circulatory 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) (Lewis et al., 2017).
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 HF 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

CASE

Alison is a certified respiratory therapist (CRT) with 27 years of experience. She has worked the past 14 years at City Medical Center (CMC) as the lead RT on the nightshift in the ICU. CMC 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 HF. 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.

Circulatory Assist Devices (CADs)

CADs are used in HF 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.

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 access 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 are that 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 (Lewis et al., 2017).

**CARDIAC RESYNCHRONIZATION THERAPY (CRT)**

CRT is well-established for improving function and reducing hospitalizations in two thirds of patients with advanced HF. 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 (Martignani et al., 2015).

Biventricular pacing improves ventricular function by resynchronizing the heart beat 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 (Lewis et al., 2017).

**Human Embryonic Stem Cell Therapy**

Embryonic stem cells that have been altered to become cardiac 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 (Menasché et al., 2015).

**CardioMEMS HF System**

This is an FDA-approved HF monitoring system that is implanted in the pulmonary artery during a right heart catheterization to measure pressures. HF treatment is 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.

A study of CardioMEMS use showed an overall 33% reduction in hospital readmissions for heart failure and a 50% reduction for heart failure with preserved ejection fraction (HFpEF). In a retrospective analysis, PAP-guided management produced a 57% reduction in mortality in patients with heart failure with reduced ejection fraction (HFrEF) in conjunction with appropriately titrated pharmacological management (Lewis et al., 2017; St. Judes Medical, 2017).

**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. This consult 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 (Das, 2015).

**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 Dietary Approaches to Stop Hypertension (DASH) diet. This diet supports weight loss through consumption of fruits and vegetables, low- or nonfat dairy, lean meats, beans, seeds, nuts, and less sugar.

**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. 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 fluid balance each shift and every 24 hours to ensure the patient is not retaining fluid.

**SODIUM RESTRICTION**

Patients with heart failure are usually counseled to restrict sodium intake 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 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 (Yancy, 2016).

**AHA REHABILITATION GUIDELINES**

Since 2016, the American Heart Association (AHA, 2016b) has provided hospitals with evidenced-based guidelines to promote rehabilitation of 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 an adrenergic beta 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

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, 2016a; AHA, 2017b; Kelly et al., 2016).

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, et al.)
• 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 (Sears, 2017a; Sears, 2017b)
Phase 2 starts after discharge and takes place in an outpatient setting such as a physician’s office, clinic, or free-standing 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 and heart regularity. Aerobic exercises are introduced under controlled conditions to establish tolerance. The patient is taught how to check his/her 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.

Phase 3 includes more independent and group exercises with more self-monitoring. Increased exercises are practiced under the guidance of a physical therapist to check for adverse symptomatic response. The patient is introduced to the concept of the rating of perceived exertion (RPE). Exertion parameters include heart rate, respiratory rate, perspiration, and muscle fatigue (Sears, 2017a). The patient may be asked to rate how hard the exercise feels on a scale (such as the Borg RPE Scale shown below).

<table>
<thead>
<tr>
<th>Rating</th>
<th>Level of Exertion</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>No exertion</td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>7.5</td>
<td>Extremely light</td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Very light</td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Light</td>
</tr>
<tr>
<td>12</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Somewhat hard</td>
</tr>
<tr>
<td>14</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Hard (heavy)</td>
</tr>
<tr>
<td>16</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Very hard</td>
</tr>
<tr>
<td>18</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Extremely hard</td>
</tr>
<tr>
<td>20</td>
<td>Max exertion</td>
</tr>
</tbody>
</table>

Source: CDC, 2015.

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, 2017a).
ADDRESSING PATIENT NEEDS IN ALL AREAS

Cardiac rehabilitation provides the information, exercises, and adaptation techniques in activities of daily living to encourage patients with HF 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, 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 physiologic needs may be the focus of the majority of the healthcare professionals and take the most amount of time, other patients’ needs must be included in an all-inclusive cardiac rehabilitation program (Lewis et al., 2017).

Respiratory Therapy

Heart failure patients with respiratory comorbidities in cardiac rehabilitation require the same respiratory services as any chronic respiratory patients might. Use of maintenance supplemental oxygen, lung capacity measurement, medication administration by inhalation and nebulization, and education are all the responsibility of the respiratory therapist in cardiac rehabilitation (Nonoyama et al., 2016).

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 PAP is monitored by respiratory therapists and pulmonary physicians (Fox et al., 2017).

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, increasing cardiac output, blood lipid levels, blood pressure, coronary artery blood flow, muscle mass, flexibility, psychological state, and assisting weight loss and control.
The following are direct potential benefits of physical therapy:

- Improved cardiac capacity, both at rest and with exercise
- Increased ability to remain active before experiencing any exercise symptoms, such as angina
- Reduced blood pressure both in the short term (during an exercise session it may not increase as much) and the long term (resting blood pressure may be reduced)
- Vasodilation, improving circulatory volume
- Prevention of further development of atherosclerosis
- Improved coronary circulation so the myocardium gets the oxygen it needs (Andal & Nalini, 2015)

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 (Sears, 2017b)

Additionally, the initial physical examination by the physical therapist in phase 1 of cardiac rehabilitation may include:

- Auscultation of the heart and lungs sounds
- Observation of any visible signs of physical exertions
- Skin conditions

The physical therapist may administer functional tests such as the Timed Up-and-Go (TUG) test to measure walking ability, dynamic balance, functional mobility, and fall risk. The patient is asked to rise from being seated in a chair, walk three meters, turn, return to the chair, and be seated. The test is used as a tool to predict which patients may benefit from a fall-risk program based on gait and to project morbidity and mortality based on induced shortness of breath caused by the brief, measured increase in activity (Mesquita et al., 2016).
The six-minute walk distance (6MWD) test measures exercise capacity by having a patient walk quickly on a hard, flat surface for six minutes in duration. A 30-meter course may be set out to measure the distance. Possible purposes of the test are:

- As a one-time measure of functional status to establish a baseline
- To provide information about a patient’s ability to perform ADLs
- To evaluate the response of the bodily systems to exercise including the heart, lungs, and circulation
  (Leader, 2017)

Physical therapists, in collaboration with the other members of the rehabilitation team, establish a series of progressive exercises designed to optimize physical functioning and psychological well-being without causing activity intolerance. The physical therapist establishes a specific plan of exercise, including the types and frequency of exercises in cardiac rehabilitation. These exercises may include walking, rowing, cycling, jogging, or any other endurance activity. Strength training is also a therapeutic component of physical rehabilitation. The physical therapist teaches the patient warming-up and stretching exercises and encourages the patient to build up to a consistent exercise regime of three to five times per week (Mayo Clinic, 2017b).

Mobility is one of the most common deficits of chronically ill patients, including those with HF. Physical therapists recommend appropriate assistive devices as needed for patients with mobility issues 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**

Up to 75% of all 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 (Alosco et al., 2015).

According to the American Occupational Therapy Association (AOTA, 2016), 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 with assistive devices so patients can safely perform activities of daily living (e.g., using the bathroom, bathing, getting dressed, making a meal)
- Performing home safety assessments before discharge to suggest modifications
• Assessing cognition and the ability to physically manipulate things like medication containers and providing training where necessary

• Working with physical therapists to increase the intensity of inpatient rehabilitation

Occupational therapists assist patients with heart failure to address IADLs (instrumental activities of daily living) and ADLs including dressing, feeding, hygiene, cooking, cleaning, shopping, elimination, and more. They 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.

If the patient will be dependent on mobility assistive devices long term, environmental accommodations may be recommended for the patient’s dwelling. Some of these modifications may include installation of a ramp or lift or the widening of doorways, as needed. These modifications may require significant structural changes to the patient’s living space and will take a considerable amount of time and expense (Geisbrecht et al., 2017).

Other recommended assistive devices for patients with mobility issues may be 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 (Morales et al., 2017).

Noncompliance with medications is a primary reason patients with HF exhibit worsening of their symptoms and need readmission 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. 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 as HF patients report 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 (Foster et al., 2011).

### 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 O2 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, has labs drawn, a 12-lead EKG done, and a portable AP and lateral chest X-ray (CXR) done.

The significant results are:

- **Arterial blood gases on O2 @ 2 L/m:**
  - pH 7.29 (7.35–7.45)
  - pCO2 32 (35–45 mmHg)
  - pO2 70 (75–100 mmHg)
  - HCO3 20 (22–28 mEq/l)
  - Base excess -3 (-2 – +2)

- **BNP 1,542 (100–400 pg/ml)**
- **O2 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 determine the level of her ability to function. 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 phone 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 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 a nurse practitioner, who coordinates healthcare for a specific group of patients. While usually used for cancer patients, nurse practitioners 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. 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 (McGinnis, 2017; Seldon et al., 2016).

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 admissions for HF patients by up to 8%. 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 in this population (Marske, 2016; Murtaugh et al., 2017).
HOME TELEHEALTH

Home telehealth can be included in an existing care pathway in place 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 smart phone. Needed interventions, such as medication dosage adjustment and dietary changes, can then be initiated quickly to prevent further deterioration of physical stability. This method of monitoring has shown to reduce the occurrence of hospital readmissions (Brainerd & Hawkins, 2015).

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. Urine sodium levels could be an indication that ACE inhibitors or diuretics are working.

BODY WEIGHT

A precipitous increase or decrease in body weight is indicative of fluid shifts. Any gain or loss of more than one to two 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

Self-care is an active process that involves disease-specific activities to promote decreased morbidity and physiological stability. In patients with HF these activities include medications, nutrition, fluid restriction, and exercise. Compliance with these activities in the middle- to older-age population with HF shows significant improvement in outcomes, including reduced need for hospital admissions (Albert et al., 2014; Graven et al., 2015).

Teaching that focuses on a specific patient’s disease processes and recovery supply the patient and family with the tools they need to make informed decisions about their healthcare needs and to become active participants in their self-care.

Heart failure self-care education is standard prior to hospital discharge and is included in a multi-disciplinary 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, have a higher peak exercise capacity, have an improved NYHA functional classification, and have lower plasma B-type natriuretic peptide levels, indicating improvement in the severity of the disease. The quality of patient education in HF directly influences mortality and the need for hospital readmissions (Albert et al, 2014).
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. Goals are based on physician and advanced practice nurse orders. The methods of teaching and evaluation are set in the multidisciplinary plan of care.

- 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, teachbacks, 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.
  (Lewis et al., 2017)

A recent observational cohort study showed that when HF patients have a higher health literacy level regarding their disease, the 30-day hospital readmission rate and emergency room visits are significantly reduced. Twenty-two percent of all HF patients are readmitted to the hospital within 30 days of discharge. An additional 10% return to the hospital via an emergency department visit. In the study, 48.3% of the participants determined to have low health literacy, including those found to be illiterate, were readmitted to the hospital within 30 days after discharge or appeared in the emergency department for HF (Cox et al., 2017).
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 reduce the occurrence of rehospitalization. MAWDS stands for:

- Medications
- Activity
- Weight
- Diet
- Symptoms

(Intermountain Health Care, 2016)

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 five-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, 2017).

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 pharmacological 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 cut the medication dose in half to make the prescription last longer or 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, a person with HF can stay as active as possible for as long as possible and potentially reap the resultant health benefits. The physical therapist will teach the patient and family specific exercises, within appropriate parameters, to optimize strength and endurance without causing an oxygen deficit secondary to exercise intolerance (Gupte & Hamilton, 2016). (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. PTs and RTs will 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 (Lewis et al., 2017).

**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. 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 need to be refilled periodically, while a concentrator uses the 21% oxygen 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 (Albert et al., 2014, Lewis et al., 2017).

**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 need 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. She just returned from an education seminar on patient instruction in HF care, and with 10 years of experience on the telemetry unit, she is now considered expert in teaching HF. In the seminar, she learned that evidence supports one hour of focused discharged 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. It is the greatest reason for readmission to a hospital, with 25% of discharged patients with HF patients returning for readmissions within 30 days. 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.

The definitive diagnostic test for heart failure is the blood test measuring the level of the neurohormone 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. Other 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.

Heart failure 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 their residence in an intensive care unit, a step-down critical care unit, or a telemetry unit if they are ambulatory.
A great deal of research and clinical trials has 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, 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)
http://www.heart.org/HEARTORG/Conditions/HeartFailure/Heart-Failure_UCM_002019_SubHomePage.jsp

Heart failure (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
http://www.hfsa.org/

REFERENCES


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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. Heart failure is considered an epidemic in countries with:
   a. A rapidly aging population.
   b. A high rate of poverty.
   c. A large number of immigrants entering the country.
   d. A system of socialized medicine.

3. According to the American Heart Association, the incidence of heart failure is increasing rapidly in the United States because:
   a. More people are going to the doctor.
   b. The incidence of obesity and diabetes is increasing.
   c. Doctors are better able to diagnose the disease.
   d. People under more economic stress.

4. Heart failure is classified according to the:
   a. Type of damage done to the heart.
   b. Age of the patient.
   c. Patient’s blood pressure reading.
   d. Causes and duration of the illness.

5. A sign/symptom indicating possible left-sided heart failure is:
   a. Tachypnea.
   b. Increased appetite.
   c. Decreased central venous pressure.
   d. Bradycardia.
6. 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.

7. Which is the most common comorbidity of heart failure?
   a. Renal failure
   b. Diabetes
   c. Grave’s disease
   d. Hypertension

8. 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

9. The diagnosis of heart failure is primarily made by:
   a. Echocardiogram.
   b. ECG.
   c. Symptoms.
   d. Chest X-ray.

10. 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).

11. A primary goal of collaborative management for heart failure is to:
    a. Manage symptoms and prevent exacerbations.
    b. Minimize the use of pharmaceutical interventions.
    c. Limit the need for the use of specialists.
    d. Cure the patient of the disease.
12. 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.

13. Which medications are generally withheld in treating heart failure?
   a. Antibiotics
   b. Antidysrhythmic agents
   c. Pain relievers
   d. Steroids

14. According to a recent meta-analysis, which drug is no longer prohibited for use in treating heart failure?
   a. Lasix
   b. Inderal
   c. Penicillin
   d. Metformin

15. In the newer 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.

16. 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.

17. Which is a correct statement regarding the left ventricular access device (LVAD)?
   a. It has more complications than an intraaortic balloon pump (IABP).
   b. It is indicated for use only on 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.
18. 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.

19. Failure to comply with which type of diet is most likely to result in hospital admission for a patient with heart failure?
   a. Low-sugar
   b. Low-fat
   c. Low-sodium, fluid-restricted
   d. Low-protein

20. American Heart Association guidelines to promote rehabilitation of heart failure patients 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.

21. Phase 2 of cardiac rehabilitation begins:
   a. During the inpatient stay.
   b. After facility discharge.
   c. According to the patient’s condition.
   d. One year postdischarge.

22. Which is not measured by the Timed-Up-and-Go (TUG) test?
   a. Fall risk
   b. Walking ability
   c. Ability to climb stairs
   d. Dynamic balance

23. Which area addressed by occupational therapists is a leading cause of hospital readmission for heart failure patients?
   a. Adaptive equipment usage
   b. Functional mobility
   c. Medication management
   d. Energy conservation
24. When making a postdischarge follow-up phone call to check on a heart failure patient, the nurse inquires about:
   a. Finances.
   b. Bowel movements.
   c. Blood sugar.
   d. Blood pressure and heart rate.

25. Electronic devices are typically used in home telehealth to monitor a patient’s:
   a. Respiration.
   b. Weight.
   c. Skin tone.
   d. Dietary intake.

26. Health materials for patient education should be written at which grade level?
   a. Kindergarten
   b. First
   c. Fifth
   d. High school

27. In the mnemonic “MAWDS,” the “D” stands for:
   a. Drugs.
   b. Days.
   c. Dislikes.
   d. Diet.

28. 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.

29. Which mode is used to deliver 100% oxygen supplementation to the patient with heart failure?
   a. Oxygen concentrator
   b. Nasal cannula
   c. Nonrebreather mask
   d. Oximetry device
30. Which is **not** a typical consideration when educating a patient and family about meal planning?

   a. Cultural differences
   b. Personal preferences
   c. Household size
   d. Cost