

## CHAPTER 14

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# HEART FAILURE

ROBERT SOUFER, M.D.

The heart's primary function is to pump blood to all parts of the body, bringing nutrients and oxygen to the tissues and removing waste products. When the body is at rest, it needs a certain amount of blood to achieve this function. During exercise or times when greater demands are placed on the body, more blood is required. To meet these variable demands, the heartbeat increases or decreases, and blood vessels dilate to deliver more blood or constrict during times when less blood is required.

When a person is diagnosed with heart failure, it does not mean the heart has stopped working, but rather that it is not working as efficiently as it should. In other words, the term "failure" indicates the heart is not pumping effectively enough to meet the body's needs for oxygen-rich blood, either during exercise or at rest. The term congestive heart failure (CHF) is often synonymous with heart failure but also refers to the state in which decreased heart function is accompanied by a buildup of body fluid in the lungs and elsewhere. Heart failure may be reversible, and people may live for many years after the diagnosis is made. (See box, "Classifications of Heart Failure.")

Heart failure may occur suddenly, or it may develop gradually. When heart function deteriorates over years, one or more conditions may exist, (See box, "Effects of Heart Failure.") The strength of muscle contractions may be reduced, and the ability of the heart chambers to fill with blood may be limited by mechanical problems, resulting in less blood to pump out to tissues in the body. Conversely, the pumping chambers may enlarge and fill with too much blood when the heart muscle is not strong

enough to pump out all the blood it receives. In addition, as the architecture of the heart changes as it enlarges, regurgitation of the mitral valve may develop, making the heart failure even worse.

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### WHO DEVELOPS HEART FAILURE?

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There are an estimated 2 million people in the United States with heart failure. The incidence of chronic congestive heart failure—the number of new cases developing in the given population each year—has increased in recent years. This is possibly a result of the overall decline in deaths from coronary (ischemic) heart disease, an improvement attributed to medical advances and the fact that people are living longer.

The most common cause of congestive failure is coronary artery disease—narrowing of the arteries supplying blood to the heart muscle. Although coronary disease often starts at an early age, congestive failure occurs most often in the elderly. Among people more than 70 years old, about 8 out of 1,000 are diagnosed with congestive heart failure each year. The majority of these patients are women, probably because men are more likely to die from coronary artery disease before it progresses to heart failure.

Heart failure is also associated with untreated hypertension, alcohol abuse, and drug abuse (primarily cocaine and amphetamines) at any age. Hyperthyroidism and various abnormalities of the heart valves (particularly aortic and mitral) are among the

**Classifications of Heart Failure**

The New York Heart Association developed a system that has been used for many years to provide a standardized set of criteria for the classification of heart failure based on the severity of the condition. This is evaluated by symptoms and ability to function.

- Class I: no undue symptoms associated with ordinary activity and no limitation of physical activity
- Class II: slight limitation of physical activity; patient comfortable at rest
- Class III: marked limitation of physical activity; patient comfortable at rest
- Class IV: inability to carry on any physical activity without discomfort; symptoms of cardiac insufficiency or chest pain possible even at rest

**Effects of Heart Failure**

- Strength of muscle contractions is reduced.
- Ability of the heart chambers to fill with blood is limited, so there is less blood to pump out to tissues in the body.
- The pumping heart chambers fill with too much blood; the heart muscle is not strong enough to pump out all the blood it receives.

other disorders that can cause heart failure. In addition, viral infection or inflammation of the heart (myocarditis) or primary heart muscle disease (cardiomyopathy), and in rare instances, extreme vitamin deficiencies, can result in heart failure. (See Chapters 13 and 15.)

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## SIGNS AND SYMPTOMS

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Depending on the underlying causes, heart failure can be either acute (intense but not long-lasting) or chronic (protracted over a long time). When heart failure occurs, the forward flow of blood is slowed

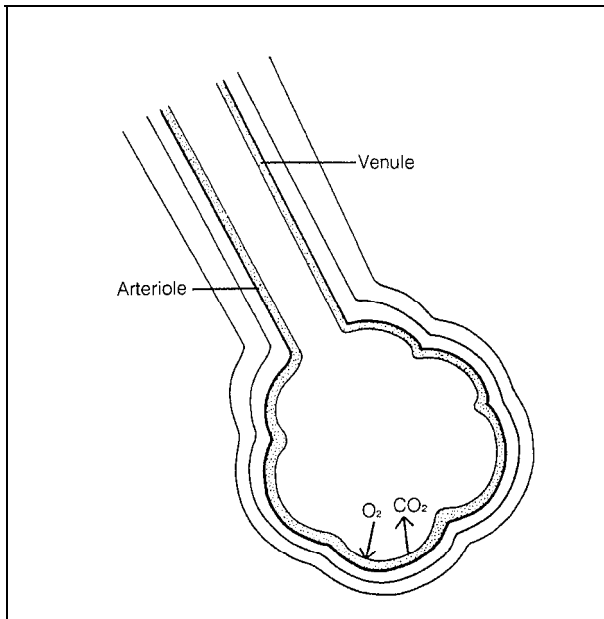
down, the quantity of blood pumped is less than adequate, and the pressure rises in the chambers of the heart, causing blood that is returning to the heart to back up in the lungs or veins. Excessive fatigue may be an early symptom. (See box, “Symptoms of Heart Failure.”) Some excess fluid may be forced out of the blood vessels into the body’s tissues. It then settles in the feet, ankles, and legs, and sometimes also in the abdomen and liver.

Dyspnea, or shortness of breath, resulting from increased pressure, fluid, or both in the lungs, is a common symptom of congestive heart failure. Although breathlessness is most likely to be noticed during exercise (known as dyspnea on exertion, or DOE), it can also be a problem at rest, particularly when the patient is lying down (when it is known as orthopnea). Individuals with orthopnea find that the condition feels worse when they are in a reclining position because the backflow of fluid and buildup in pressure from the heart interferes directly with the free flow of oxygen in the lungs.

Normally, oxygen is easily exchanged through the thin spongy tissue of the lungs. (See Figure 14.1.) If this tissue becomes waterlogged, as it does in heart failure, less oxygen can be transferred to the blood. If there is not enough oxygen, certain reflexes stimulate faster breathing. People with lung congestion as a result of heart failure usually have to prop themselves up with extra pillows in order to sleep. The number of pillows used may indicate to a physician the extent of the heart failure. When an individual wakes at night because of shortness of breath from

**Symptoms of Heart Failure**

- Shortness of breath (dyspnea)
- Shortness of breath when lying down (orthopnea)
- Shortness of breath while sleeping (paroxysmal or intermittent nocturnal dyspnea)
- Buildup of fluid in the lungs (pulmonary edema), frequently causing a person to cough up blood-tinged sputum
- Buildup of excess fluid (edema) in other parts of the body, causing weight gain, swelling of the ankles, legs, and back, and in extreme cases fluid accumulation in the abdomen (ascites)
- Fatigue, weakness, and an inability to exert oneself physically or mentally
- Blueness of the skin (cyanosis)



**Figure 14.1**  
This diagram of an alveolus (*air sac*) shows the exchange of carbon dioxide (CO<sub>2</sub>) and oxygen in the lung.

fluid settling in the lungs, the condition is known as paroxysmal (intermittent) nocturnal dyspnea. A person suffering from this typically will wake up short of breath about two to three hours after going to sleep. Standing or sitting often relieves symptoms.

One of recent history's most noted patients with heart failure was President Franklin Delano Roosevelt. He had severe hypertension that led to an enlarged heart and eventually to heart failure. For months, he was unable to lie flat in bed, so he slept in a chair. He was told that he had bronchitis, allergies, and the flu. Finally, the right diagnosis was made and treatment started. However, this was before the development of effective drugs to lower blood pressure and to treat advanced heart failure. At the time of President Roosevelt's death of a massive stroke on April 12, 1945, his blood pressure ranged between 180/110 and 230/130.

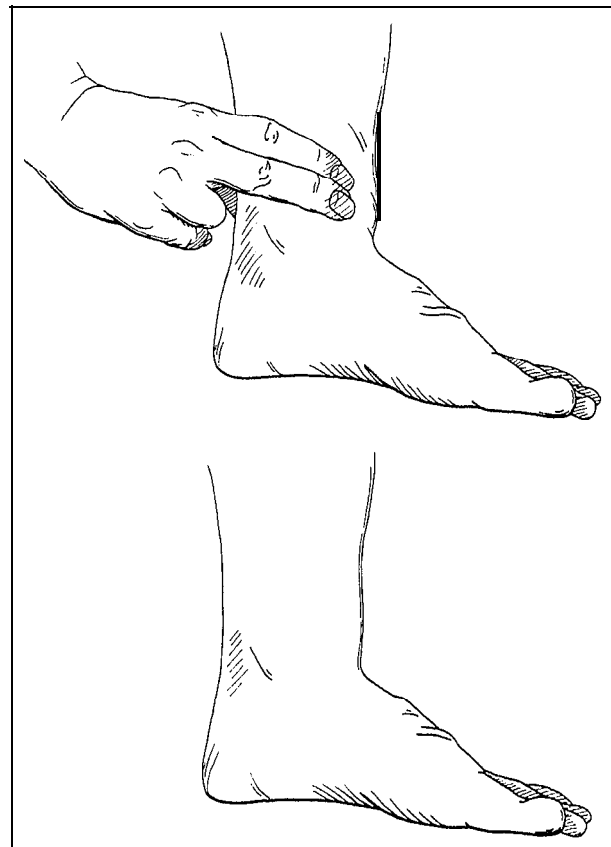
The infiltration of the body with fluid can cause more than breathing problems and sleepless nights. Patients may weigh more, because of the excess water retention, and they may have edema (swelling) of the skin and soft tissues, usually in the feet, ankles, or legs, and sometimes in the lower back. This swelling is characterized by a gradual filling out after the area is depressed with a finger. (See Figure 14.2.) In extreme cases, fluid will accumulate in the abdomen. This is called ascites and is caused when swelling of the gastrointestinal tract forces fluid through the capillaries into the abdominal cavity. Ascites usually occurs only in severe chronic heart failure.

When a marked excess of fluid accumulates in the lungs, it is known as pulmonary (lung) edema. This condition is often, but not always, acute and is frequently associated with coughing up blood-tinged, pinkish-colored sputum.

Inefficient circulation may also manifest itself as fatigue, weakness, and an inability to exert oneself physically or mentally because less blood and oxygen reach the brain. Older people in particular may suffer from confusion and impaired thinking ability.

## LEFT SIDE OR RIGHT SIDE?

The particular symptoms that an individual experiences are determined by which side of the heart is involved in the heart failure. (See box, "Symptoms of Left-Side and Right-Side Heart Failure.") For example, the left atrium (upper chamber) receives oxygen-



**Figure 14.2**  
Edema is swelling of the extremities caused by excess fluid buildup. A sign of edema in the ankles is an indentation that remains momentarily when a finger is pressed into the skin and then removed.

## Symptoms of Left-Side and Right-Side Heart Failure

### Symptoms of left-side heart failure

- Fatigue
- Shortness of breath (dyspnea)
- Shortness of breath when lying down (orthopnea)
- Paroxysmal (intermittent) nocturnal dyspnea
- Accumulation of fluid in the lungs (pulmonary edema), frequently causing a person to cough up blood-tinged sputum

### Symptoms of right-side heart failure

- Swelling (edema)
  - Dependent edema (edema that travels by gravity to the lowest portions of the body)
  - Enlargement or swelling of the liver (hepatomegaly)
  - Buildup of fluid in the abdominal cavity (ascites)
  - Edema of the skin and soft tissues, causing swelling of the feet, ankles, and legs
- Excessive urination at night caused by fluid redistribution while a person is sleeping lying down (nocturia)

ated blood from the lungs and passes it onto the left ventricle (lower chamber), which pumps it to the rest of the body. When the left side isn't pumping efficiently, blood backs up in the vessels of the lungs, and sometimes fluid is forced out of the lung vessels and into the breathing spaces themselves. This pulmonary congestion causes shortness of breath. The other major symptoms of left-sided heart failure are fatigue, dyspnea (orthopnea, paroxysmal nocturnal dyspnea), and the sputum production (sometimes bloody) that comes from pulmonary congestion.

Right-sided failure occurs when there is resistance to the flow of blood from the right heart structures (right atrium, right ventricle, pulmonary or lung artery) into the lungs or when the tricuspid valve, which separates the right atrium from the right ventricle, fails to work properly. This results in a backup of fluid and pressure in the veins that empty into the right side of the heart. Pressure then builds up in the liver and the veins in the legs. The liver enlarges and may become painful; swelling of the ankles or legs occurs.

The major symptoms of right-sided heart failure are edema and nocturia (excessive urination at night caused by fluid redistribution while a person is lying down). The different types of edema possible are de-

pendent (edema that travels by gravity to the lowest portions of the body), edema that results in enlargement or swelling of the liver (called hepatomegaly), ascites, and edema of the skin or soft tissues (only in some cases).

Because congestive heart failure causes the body to fill with excess fluids, the kidneys may not be able to dispose of the extra sodium (a component of salt) and water, a condition known as kidney failure. (Again, the term "failure" implies that the kidneys have failed and will not recover. However, as in the case of heart failure, the kidney changes maybe temporary, and proper treatment may correct much of the problem.) Sodium that would normally be eliminated through the urine remains in the body, causing it to retain even more water, thereby aggravating the problem of excess fluid associated with congestive heart failure.

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## DIAGNOSIS

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A stethoscope can be used to detect rales, crackling noises that are caused by the movement of excess fluid in the lungs. This can help locate where fluid has accumulated. By listening to breathing sounds or thumping the chest, a physician can usually tell when fluid from the lungs has leaked (pleural effusion) into the chest cavity. The fluid will also appear as a cloudy area on X-rays. The stethoscope can also detect the sounds of the heart chambers filling and emptying and the heart valves opening and closing throughout the cardiac cycle. Abnormal variations in these sounds can aid the physician in diagnosing and monitoring heart failure, because the condition is associated with one or two abnormal sounds in addition to the two sounds usually heard with the healthy heart. Another symptom, blueness of the skin (called cyanosis) accompanied by coolness and moisture, most often in the fingers and toes, indicates low levels of oxygen in the blood (called hypoxia). Edema is detected by pressing the finger against the ankle or skin and noting how long it takes the depression to refill. Liver enlargement is felt by examining the abdomen. The neck vein may also be distended. (See box, "Signs of Heart Failure During an Examination.")

A number of sophisticated diagnostic techniques may also be employed to diagnose and monitor heart failure and heart function. The two main noninvasive

## Signs of Heart Failure During an Examination

### In the heart

- Heart enlargement
- Increased heart rate (tachycardia)

### In the lungs

- Crackling noises (rales) heard through a stethoscope indicating a buildup of fluid in the lungs
- Leakage of fluid from the lungs (pleural effusion) into the chest cavity

### In other areas

- Swelling (edema) of the skin and soft tissues, usually noted in the feet and ankles
- Edema of the lower back (sacral edema)
- Buildup of fluid of the abdominal cavity (ascites)
- increased size of liver (hepatomegaly)
- Ascites

techniques for this purpose are the echocardiogram and the radionuclide angiogram. (See Chapter 10.) Both tests can quantify the level of heart dysfunction and distinguish between generalized as opposed to regional dysfunction.

In cardiac catheterization, a thin tube is introduced through a vein or artery into the heart. The procedure determines whether there are blockages in the blood vessels and measures pressures in various chambers of the heart. (See Chapter 10.)

The electrocardiogram (ECG) provides a graphic record of the heart's electrical impulses; it can detect increased wall thickness (called hypertrophy), heart enlargement, or various rhythm changes in heart failure. The ECG may also be used to monitor the effects of drug treatments on the heart. Chest X-rays can also detect an enlarged heart.

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## CAUSES

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An array of different problems can cause congestive heart failure. (See box, "Causes of Congestive Heart Failure.") Among them is coronary (ischemic) heart disease resulting from insufficient blood flow to the

myocardium, or heart muscle. This is usually caused by atherosclerosis, the buildup of fatty substances or plaque on the walls of the arteries that carry blood to the heart muscle. The heart's ability to perform decreases because ischemia results in the delivery of less oxygen and fewer nutrients to the heart muscle.

A heart attack may also cause congestive failure. During a heart attack, the heart muscle is deprived of oxygen, resulting in tissue death and scarring. The development of heart failure depends on the extent and location of scarring. (See Chapter 15.)

Long-standing high blood pressure is another common cause of heart failure. Because there is greater resistance against which the heart must pump, the heart muscle works harder. This results in an enlargement of the heart muscle, especially of the left ventricle, the heart's main pumping chamber. Eventually, this enlarged muscle tissue weakens, setting the stage for heart failure, especially if the pumping ability of the enlarged chamber greatly decreases.

Arrhythmias (irregular heartbeats) can lead to heart failure, but they usually have to be severe and prolonged, with a rapid rate of more than 140 beats per minute, and must often occur in the presence of an already weakened heart. They change the pattern of filling and pumping of blood from the heart. This condition may also lower output of blood to the point of heart failure. (See Chapter 16.)

Diseased heart valves are another cause of heart failure, which results when a narrowed or leaking valve fails to direct blood flow properly through the heart. The problem may be congenital (inborn) or due to an infection such as endocarditis or rheumatic fever. This increases the heart's workload, thereby in-

## Causes of Congestive Heart Failure (CHF)

- Coronary (ischemic) heart disease resulting from insufficient blood flow to the heart muscle (myocardium)
- A heart attack, resulting in acute damage and then scarring of heart muscle tissue
- Chronic high blood pressure
- Major cardiac arrhythmia
- Diseased heart valve(s)
- Diseased heart muscle
- Congenital heart disease

creasing risk of developing heart failure. (See Chapter 13.)

Cardiomyopathy, a disease of the heart muscle itself, can also lead to heart failure. Causes of cardiomyopathy include infection, alcohol abuse, and cocaine abuse. When heart failure seems to have no known causes, it is known as idiopathic heart failure. (See Chapter 15.)

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## HOW THE BODY TRIES TO PROTECT ITSELF

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When one system of the body is not functioning optimally, other systems may attempt to take over to make up for the problem. In the case of heart failure, several types of compensation are possible.

First, the heart chambers may enlarge, and the heart may beat more forcefully to pump out more blood for the body's needs. In time, the overworked heart muscle enlarges (much as skeletal muscles grow larger during weight muscle training), creating increased muscle fibers with which the heart can pump more forcefully.

Second, the heart may be stimulated to pump more often, thereby increasing its output.

Third, a compensation mechanism called the renin-angiotensin system maybe initiated. When the lack of blood volume coming from the heart (cardiac output) results in a decrease in the amount passing through the kidneys, the kidneys respond by stimulating the system to secrete hormones that prompt the kidneys to retain salt and water, and thereby increase blood volume. This is an attempt to compensate for the decrease in output of the heart. This leads to a rise in blood pressure as the body attempts to circulate the extra fluid volume and also ensures that adequate oxygen reaches the brain, kidneys, and other vital organs.

These compensation mechanisms keep the failing heart functioning almost normally in the early stages of heart failure. As the disease progresses, however, compensation mechanisms cannot maintain proper circulation. It may take years for a heart to go through the stages of enlarging, working harder, and finally breaking down. In many cases, as when a person has hypertension, heart failure is preventable if blood pressure is treated adequately.

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## TREATMENT

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Whenever possible, the best treatment of congestive heart failure is one of prevention. This includes diagnosing and treating high blood pressure and attempting to prevent atherosclerosis. Other important preventive steps include not smoking, using alcohol in moderation if at all, and abstaining from cocaine and other illicit drugs. A prudent diet, regular exercise, and weight control are also important.

When a patient is diagnosed as having heart failure, the first treatment is often restriction of dietary sodium. Drugs may be prescribed as well. Diuretics, available since the 1950s, are often used to help the kidneys get rid of excess water and sodium, thereby reducing blood volume and the heart's workload. (See Chapter 23.)

Digitalis, a drug that has been used since the 18th century, is still a component of modern therapy. It is prescribed to strengthen the heart's pumping action. Patients taking both diuretics and digitalis may need to supplement their levels of potassium.

Newer drugs for the treatment of heart failure include vasodilators, which cause the peripheral arteries to dilate, or open up. This reduces the work of the heart by making it easier for blood to flow. Among the newest vasodilators used for heart failure are the angiotensin-converting enzyme (ACE) inhibitors, which may be used, along with diuretics, in patients with mild-to-moderate or severe congestive failure. ACE inhibitors, which include captopril (Capoten) and enalapril (Vasotec), block the production of a substance called angiotensin II, a potent constrictor of blood vessels. If blood vessels are dilated, the amount of work needed for the heart to pump blood forward is decreased.

Other drugs used in the treatment of heart failure include calcium-channel blockers, which dilate blood vessels; beta blockers, which slow the heart (used only in unusual circumstances); and medications that affect various heartbeat irregularities. Most cases, however, respond to diuretics and digitalis, especially when ACE inhibitors are added.

Sometimes, surgery proves effective. When heart failure is due to valvular disease, surgical implantation of an artificial heart valve or valve repair may alleviate the problem. Surgery may also be helpful in correcting congenital heart defects that can lead to heart failure. Coronary artery bypass graft surgery and catheterization using a balloon to flatten fatty

deposits (called angioplasty) are among the therapeutic techniques used to prevent and treat heart failure caused by occluded, or blocked, arteries.

Heart transplants are a last resort in treating severe heart failure caused by diseased heart muscle. Although the success rate of heart transplants has significantly improved, the cost of the operation and the shortage of donor organs makes it impractical except as a last resort.

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## PROGNOSIS

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The outlook for most people with heart failure is dependent upon the cause of the heart failure and the overall degree of cardiac dysfunction. An estimated 50 percent survive more than five years after diag-

nosis. That figure, however, is an average of all patients with varying levels of severity of the disease. The prognosis for a specific person with heart failure depends to a large degree on effects of the disease, such as the level of blood output of the left ventricle, or his or her ability to exercise, as well as other factors, including age, overall health, and other medical conditions. The sooner heart failure is diagnosed and action is taken to control the problem, the better.

In many cases, heart failure can be effectively treated to prevent or slow the progression of the disease and to alleviate its symptoms. Therapy can achieve several goals: It can improve the performance of the left ventricle, prevent further deterioration of heart function, improve a patient's ability to exercise, and improve quality of life.

In addition, it is possible that in selected instances, early, effective treatment may increase a person's likelihood of improved survival.