

Congestive Heart Failure

The heart is composed of two independent pumping systems, one on the left side and one on the right. The right chamber, or right atrium, of the heart relaxes and expands to fill with blood that has returned from the body. (This relaxed action causes *diastolic pressure*, recorded as the second and lower number when measuring blood pressure). The used blood is poor in oxygen and rich in carbon dioxide. It enters a second muscular chamber called the right ventricle, which pumps the blood into the lungs where it exchanges the carbon dioxide for oxygen. This blood, now oxygen-rich, returns through pulmonary veins to the left atrium in the heart where it is pumped back out to the body by the left ventricle. The left ventricle has thicker muscles than the right in order to perform contractions powerful enough to force the blood through the main artery (the aorta) to all parts of the body. (This strong contraction causes *systolic pressure*, the first and higher number measured for blood pressure.)

Congestive heart failure is not a disease but a condition that occurs when the heart is unable to pump enough blood to meet the needs of the body's tissues. When the heart fails, it is unable to pump out all the blood that enters its chambers. To help determine severity, physicians use a calculation called an ejection fraction, which is the percent of the blood pumped out during each heart beat. An ejection fraction of 50% to 75% is normal. In most cases of heart failure the left side fails, causing *systolic dysfunction*, in which fluid backs up and accumulates in the lungs. The ejection fraction in such cases falls below 40%; in severe failure it may drop as low as 5%. Right-sided heart failure, which is much less common, causes *diastolic dysfunction*, in which fluid entering the heart backs up, causing the veins in the body and tissues surrounding them to swell. In such cases, the ejection fraction is paradoxically normal or high. Given the interconnected nature between the chambers of the heart, left-sided failure may ultimately precipitate failure in the right side of the heart.

Heart failure can occur in several ways. The ventricle muscles of the heart may become thin and weakened and dilate to the extent that they cannot pump the blood with enough force to reach all the body's tissues. In other cases, the heart muscles stiffen or thicken so they lose elasticity and cannot relax; insufficient blood enters the chamber and so not enough blood is pumped out into the body to serve its needs. Sometimes the valves of the heart, which control the flow of blood leaving the heart, are abnormal; they may narrow, causing a back-up of blood or they may close improperly so that blood leaks back into the heart. Mechanisms that the body uses to compensate for inefficient pumping action can, over time, change the architecture of the heart and finally lead to irreversible problems. As a result of these changes, the body's vital organs do not receive enough oxygen and nutrients, and the body's wastes are removed more slowly; eventually vital systems break down.

What Causes Congestive Heart Failure?

Damage to the mechanisms that control the input to and output of blood from the heart is usually the last stage of one of several heart or circulatory diseases. Heart failure can be a direct result of one of these diseases or it can occur over time as the heart tries to compensate for abnormalities caused by these conditions.

Coronary Artery Disease

Congestive heart failure may develop slowly from heart damage due to atherosclerosis, a build-up of cholesterol deposits on the walls of the arteries supplying the heart muscle with oxygen. Heart failure in such cases most often results from a localized pumping

defect in the left side of the heart.

Damage after a Heart Attack

People now often survive heart attacks, but eventually many develop heart failure from the physical damage done to the heart muscles by the attack. Heart attack recovery is probably one of the major factors in the dramatic increase in heart failure cases over the past decade.

High Blood Pressure

Uncontrolled high blood pressure, or hypertension, can cause a heart attack but it is also a major cause of heart failure even in the absence of an attack. In hypertension, the heart muscles thicken to compensate for increased blood pressure, and over time the force of their contractions weakens and they have difficulty relaxing, thereby preventing the normal filling of the heart with blood. Researchers have detected a defect in animal heart cells, which causes them to enlarge in response to high blood pressure. These enlarged cells undergo molecular changes that result in calcium loss, a mineral crucial for healthy heart contractions. The defect appears to be irreversible, making early detection and reduction of high blood pressure extremely important preventive measures. It should be noted, however, that the successful treatment of high blood pressure is proving to be an effective measure for preventing heart failure.

Diabetes

Diabetes contributes to heart failure, not only because of its association with obesity, high blood pressure, and coronary artery disease, but also because specific mechanisms that contribute to diabetes itself may also damage the heart.

Valvular Heart Disease

The valves of the heart, which control the flow of blood leaving the heart, can narrow, causing a back-up of blood, or they can close improperly, causing blood to leak back into the heart. In the past, rheumatic fever, which scars the heart valves and prevents them from closing, was a major cause of death from heart failure. Fortunately, antibiotics have relegated this disease to a minor cause of heart failure. Birth defects may also cause abnormal valvular development.

Cardiomyopathies

Cardiomyopathies are diseases that damage the heart muscles and lead to heart failure. Genetic factors or birth defects may play a role in the development of these conditions.

Dilated Cardiomyopathy. Dilated cardiomyopathy involves an enlarged heart ventricle, in which the muscles thin out rather than becoming thick, causing reduced systolic blood pressure. Although this condition is also associated with a genetic factor, the cause is often not known (in which case it is called *idiopathic* dilated cardiomyopathy). Research is strongly indicating that many cases may be the result of an autoimmune response, in which infection-fighting antibodies attack a person's own proteins in the heart, mistaking them for foreign agents.

Hypertrophic Cardiomyopathy. In hypertrophic cardiomyopathy, the heart muscles become thick and contract with difficulty. Some research indicates that this occurs

because of a genetic defect that causes a loss of power in heart muscle cells and, subsequently, diminished pumping strength. To compensate for this power loss, the heart muscle cells grow. This rare condition is the cause of many occurrences of sudden death in young athletes

Other Causes

Alcoholism may also produce heart failure, since chronic abuse can damage the heart muscles or cause hypertension. Severe emphysema is a major cause of right-sided congestive heart failure. Other less common causes of heart failure include excessive salt consumption, hyperthyroidism, thiamin deficiency, pneumonia, high fever, and failure of the liver or kidneys. Rarely, certain viral illnesses cause an infection of the heart muscle known as acute myocarditis, which produces temporary, but potentially life-threatening, heart failure. Long term use of anabolic steroids (testosterone shots and similar male hormones abused by athletes and others trying to build muscle mass) are dangerous in many ways, among them is the increased risk for heart failure.

Heart Failure Caused by Corrective Mechanism

High blood pressure and the failing heart itself trigger a number of hormonal and neurochemical mechanisms to correct imbalances in pressure and blood flow. Unfortunately, while these corrective responses help in the short term, they increase the work of the heart and can do considerable damage over the long term. The brain responds to the failing heart pump by stimulating stress hormones, in particular a powerful one called norepinephrine (commonly called adrenaline). These hormones flood the heart, causing it to beat faster. The heart also responds to overload by enlarging to increase the amount of blood, which leads to structural damage called ventricular remodeling. The muscular walls of this dilated heart become thinner and inefficient, and the faster heartbeat accelerates the damage. As the volume of blood pumped to the kidneys falls, the kidneys respond by retaining water and salt, which, in turn, increases the edema in the body. To make matters worse, the body's arteries respond to a lower blood volume by constricting, thereby forcing the heart to work even harder to pump blood through these narrowed vessels, thereby increasing blood pressure. Of special interest to researchers is endothelin, a powerful protein involved in blood vessel constriction, which is produced in high levels in congestive heart failure patients. Promising studies are reporting that drugs blocking endothelin are improving survival in animals with heart failure.

Studies also indicate that the failing heart may damage itself further by producing high levels of TNF-alpha, an immune factor known as a cytokine, which is released by the immune system when tissues, including heart muscle tissues, are injured. High levels of TNF-alpha are known to cause fatigue, weight loss, shortness of breath, and weak pumping action, and experts now believe that high levels of the substance produced by heart cells can actually impair the heart's structure.

What are the Symptoms of Congestive Heart Failure?

Many symptoms of heart failure result from the congestion that develops as fluid backs up into the lungs and leaks into the tissues. Other symptoms result from inadequate delivery of oxygen-rich blood to the body's tissues. Since heart failure can progress rapidly, it is essential to consult a physician immediately if any of the following symptoms are detected.

Symptoms of Left-Side Heart Failure

In left-side heart failure, the more common condition, the first symptoms are usually fatigue and shortness of breath (dyspnea) caused by fluid in the lungs. Patients typically report that they feel out of breath after mild exertion. (This is unlike the breathlessness of angina, which feels like a heavy weight pressing on the chest.) An asthma-like wheezing is another common symptom. Patients may also complain of a dry hacking cough that occurs a few hours after lying down but then stops after the patient sits up. Over time, patients lose muscle weight due to low cardiac output. Central sleep apnea, in which the brain fails to signal the muscles to breathe during sleep, is a common condition associated with heart failure. Sleep apnea causes disordered breathing at night. If heart failure progresses, the apnea may be so acute that the sufferer, unable to breathe, may awaken from sleep in panic.

Ultimately, fluid in the lung (pulmonary edema) may develop. When this happens, in addition to dyspnea, patients sometimes have a cough that produces a pinkish froth. Patients may experience a bubbling sensation in the lungs and feel as if they are drowning. Typically, the skin is clammy and pale, sometimes nearly blue. This is a life-threatening situation and the patient must go immediately to an emergency room.

Symptoms of Right-Side Heart Failure

As with left-side heart failure, an early symptom of right-sided failure is fatigue. Right-side failure leads to the accumulation of fluid, first in the feet, next in the ankles and legs, and finally in the abdomen. The liver may also be enlarged. Although their appetites are often depressed, patients with congestive heart failure gain weight because they retain salt and water. At the same time, patients gradually lose muscle mass as the tissues become oxygen depleted.

Who Gets Congestive Heart Failure?

Heart failure is the most common reason for hospitalization in the elderly. Nearly five million Americans now suffer from heart failure, and as the population ages the incidence of congestive heart failure is rising dramatically. Estimated annual diagnosed cases rose from 250,000 people in 1970 to nearly 700,000 in 1992. Men are at higher risk than women, although the difference narrows with age. The cause of heart failure in men is more likely to be coronary artery disease; in women heart failure is more apt to be the result of high blood pressure or unknown causes. African Americans are at higher risk for the disease than white Americans and are two and a half times more likely to die from it before age 65. It is most dangerous in African American women. African Americans have a higher rate of high blood pressure and diabetes, two major risk factors for congestive heart failure, but the difference can also be accounted for by disparities in the care received by each group. A family history of early congestive heart failure caused by cardiomyopathies may predispose people to the disease. Other conditions that make one susceptible to coronary artery disease and therefore congestive heart disease are smoking and sedentary living. Alcohol abuse, which damages the heart, also predisposes a person to heart failure. People with any long term disease that places stress on the heart or circulatory system are at risk for heart disease. Survivors of early childhood cancers have a risk for developing congestive heart failure in later years. In one study, this complication was more common in women and when high rates of the drug doxorubicin had been administered during chemotherapy. Relatives of people with dilated cardiomyopathy have a significantly increased risk for heart failure, with almost 30% of family members showing some heart abnormality in one study.

How Serious Is Congestive Heart Failure?

About 250,000 people die of heart failure each year. For people over 65, it is the number one cause of death. About 80% of patients with congestive heart failure survive the first three months after diagnosis; about two-thirds survive a year afterward. Those that survive appear to function well. Women whose heart failure is caused by valvular heart disease, high blood pressure, or alcohol abuse have a better survival rate than men with similar conditions. Their survival rate, however, is equal to men when heart failure is caused by coronary artery disease or heart attack. One important indicator of a poor outlook is the development of cardiac cachexia, which is unintentional rapid weight loss (a loss of at least 7.5% of normal weight within six months). About half of the patients who die do so because of arrhythmias (irregular beating of the heart) that often accompany heart failure. Death can also be caused by acute pulmonary edema (fluid in the lungs). The discouraging mortality rates are now being questioned by many experts who cite increasing success with new treatments, the results of which have not yet appeared in studies of people who currently have heart failure.

Classification of Severity

A classification system was developed by the New York Heart Association to grade congestive heart failure by severity of symptoms. These classifications help physicians determine treatment options.

- **Class I.** No limitation of physical activity. No shortness of breath, fatigue, or heart palpitations with ordinary physical activity.
- **Class II.** Slight limitation of physical activity. Shortness of breath, fatigue, or heart palpitations with ordinary physical activity, but patients are comfortable at rest.
- **Class III.** Marked limitation of activity. Shortness of breath, fatigue, or heart palpitations with *less than* ordinary physical activity, but patients are comfortable at rest.
- **Class IV.** Severe to complete limitation of activity. Shortness of breath, fatigue, or heart palpitations with *any* physical exertion and symptoms appear even at rest.

It is important to note however that this method of classification is limited. Symptoms may not relate to the actual severity of the condition. One study found that half of heart failure patients who complained of breathlessness after exercise had only mild heart abnormalities. On the other hand, some patients do not report fatigue or shortness of breath after physical activity and yet they may have severe heart damage. Experts suggest that physicians be sure to consider other factors, including obesity, medications, and depression when assessing a patient.

How Can Congestive Heart Failure Be Prevented?

Prevention of Conditions Leading to Heart Failure

Prevention of heart failure relies principally on preventing or slowing the progression of diseases that damage the heart, especially coronary artery disease, hypertension, and diabetes. Everyone should always seek a lifestyle that includes regular exercise, a diet low in saturated fat, cholesterol, and salt and, at the same time, avoid smoking, alcohol abuse, obesity, and excessive mental stress. Medications may be needed for those who

have hypertension, high cholesterol levels, or diabetes.

Prevention after a Heart Attack

Use of a drug known as an angiotensin-converting enzyme (ACE) inhibitor has been shown to significantly reduce the risk of progression to congestive heart failure in heart attack patients. Now studies are finding that combining a drug known as a beta blocker with the ACE inhibitor is even more protective. (*For a discussion of these drugs, see What Is the Treatment for Congestive Heart Failure?, below*).

What Other Diseases Show the Same Symptoms as Congestive Heart Failure?

A number of other conditions may produce symptoms suggestive of heart failure. Shortness of breath is seen in asthma, certain allergic reactions, near-drowning, pneumonia, inhalation of toxic substances or smoke, high altitude sickness, and emphysema. Some patients with angina may interpret the chest tightness associated with this syndrome as shortness of breath. Swollen ankles can result from varicose veins or phlebitis. Liver or kidney failure also causes fluid retention.

How Is Congestive Heart Failure Diagnosed?

Physicians can often make a clinical diagnosis of heart failure with a medical history and careful physical examination, checking particularly for enlargement of the heart, irregular heart sounds, abnormal sounds in the lungs, swelling or tenderness of the liver, fluid retention, and elevation of pressure in the veins of the neck. Often, it is difficult to confirm a diagnosis of heart failure or determine its severity once a diagnosis has been made, and further tests are usually needed.

Laboratory Tests

Blood and urine tests are used to check for malfunctions of the liver and kidneys. Blood tests can also be used to evaluate cholesterol and blood sugar levels and to check for anemia and thyroid disease. A blood test that measures concentrations of substances called natriuretic peptides, which are produced when pressures or volumes within the heart increase, may prove to be effective in screening and even diagnosing patients with possible congestive heart failure. Of particular importance is one called B-type natriuretic peptic (BNP). After a diagnosis of congestive heart failure is established, simple blood tests that measure lymphocyte counts may prove helpful in predicting the outcome. Lymphocytes are important infection-fighting white blood cells, and low numbers reflect high levels of stress hormones, which increase the risk of heart malfunction. In one study, patients with normal to high lymphocyte counts had a four-year survival rate of 78% compared to 34% in patients with lower counts.

Electrocardiogram

An electrocardiogram (ECG) is a simple test, often conducted in the physician's office. Electrical leads are placed at several locations on the patient's chest and limbs. Although an ECG cannot diagnose heart failure, the test is inexpensive and useful in many ways. It can indicate underlying heart disease by suggesting enlargement of the heart muscle (cardiomyopathy), coronary artery disease, or abnormal cardiac rhythms. One study reported that it may be effective in screening out patients who do not need a more accurate (but more expensive) echocardiogram for a definite diagnosis. Another study

indicated that a certain type of rhythm pattern seen on an ECG, called a prolonged QT interval, might predict those at risk for sudden death from congestive heart failure and could be used for determining more intensive treatment.

Exercise Stress Test

Measuring heart rate, blood pressure, and oxygen consumption while a patient is exercising appears to be a more accurate method for determining the degree of heart impairment than taking such measurements while the patient is at rest.

Imaging Techniques

X-rays, particularly an X-ray procedure known as radionuclide ventriculography, can reveal cardiac enlargement or evidence of fluid accumulation around the heart and lungs. X-rays are helpful both to diagnose congestive heart failure and to confirm the effectiveness of treatment.

Echocardiography is a noninvasive, entirely safe test, which uses ultrasound to image the heart as it is beating. Cardiac ultrasounds provide accurate indications of valve function and the flow of blood through the heart's chambers. They are extremely valuable in patients with congestive heart failure, because they can reveal whether the failure is on the left, the right side, or both. Echocardiograms also indicate the ejection fraction, the percent of the blood pumped out during each heart beat. Echocardiography may also be useful for early detection of potential heart failure in people who have not had a heart attack; those identified as at risk using this method have a dilated left ventricle, even if their hearts are still able to contract normally.

Angiography

Physicians may recommend angiography if they suspect that blockage of the arteries is contributing to heart failure. During this procedure a thin tube, or catheter, is inserted into one of the large arteries in the arm or leg and then gently guided through the artery until it reaches the heart. The catheter measures internal blood pressure at various locations, giving the physician a comprehensive picture of the extent and nature of the heart failure. When dye is injected through the tube into the heart, x-rays can be taken to depict the dye's movement through the heart and arteries. These images, known as angiograms, help locate problems in the heart's pumping action or blockage in the arteries. Major complications of angiography include stroke, heart attacks, and kidney damage, but these risks are very low (about 0.1%) if the procedure is done in a center that performs it at least six times a week.

What Are the Drug Treatments for Congestive Heart Failure?

The primary conditions causing heart failure should be treated first, including coronary artery disease, valvular abnormalities, high blood pressure, arrhythmias, anemia, and thyroid dysfunction. If heart failure persists after treating underlying causes, drug treatments and life-style changes are generally designed to achieve three goals: increasing the strength of the heart's contraction; reducing the work of the heart; and reducing salt and water retention. This is accomplished through drug therapy, rest, and dietary salt restriction.

Three classes of medications have been the standard treatments for heart failure: *vasodilators* (drugs that dilate blood vessels); *inotropics* (drugs that increase the heart's ability to contract); and *diuretics* (drugs to reduce fluid). One drug from a fourth class,

beta blockers, has recently been added to the armament. The specific medication or, more commonly, a combination of these medications, is determined by the type and severity of the heart failure.

ACE Inhibitors and Other Vasodilators

Vasodilators improve both the quality and duration of life for heart failure patients. They open the arteries and veins, thereby reducing the heart's workload and allowing more blood to reach the tissues. Vasodilators are particularly useful in treating heart failure associated with high blood pressure and dilated cardiomyopathy. Several classes of vasodilators are available, the most effective being the ACE inhibitors.

Angiotensin-Converting Enzyme (ACE) Inhibitors. Currently the most important vasodilators are angiotensin-converting enzyme (ACE) inhibitors; these drugs block the formation of angiotensin II, a powerful enzyme that raises blood pressure, constricts blood vessels, and leads to salt retention. Although experts believe that at least 50% to 75% of patients with congestive heart failure should be treated with ACE inhibitors, a current study indicates that primary care doctors are only prescribing them for 22% and specialists for 46% of patients. Women and nonwhites are even less likely to get ACE inhibitors than white males. Even worse, about 15% of patients are being prescribed expensive calcium channel blockers, which may even have adverse effects for patients with heart failure. ACE inhibitors are of particular benefit for patients with left ventricular systolic dysfunction; those patients should take drugs indefinitely unless specific conditions make the drugs inappropriate. Some cardiologists are concerned that ACE inhibitors are still not being prescribed by their family physicians for many patients who might benefit from them. Commonly used ACE inhibitors are captopril (Capoten), quinipril (Accupril), enalapril (Vasotec), and lisinopril (Prinivil, Zestril). Captopril, which has the most predictable onset and shortest duration, is most often used for initial therapy when patients must be cautiously monitored for low blood pressure. Enalapril has been found to improve survival over combinations of other types of vasodilators (hydralazine and nitrates), and some studies have indicated that it might actually reduce heart damage by inhibiting the remodeling process that can cause heart attacks after heart failure. Yet another study found that high doses of lisinopril were more effective than low doses and do not cause significantly more adverse effects. Experts say these findings should apply to all ACE inhibitors. A persistent cough is a common and irritating side effect. The primary adverse effect of ACE inhibitors is low blood pressure, which can be severe in some patients, particularly when therapy is first initiated. Because of this, ACE inhibitors have not been used for patients who have pulmonary edema (fluid in the lungs), a condition commonly accompanied by low blood pressure. One study found, however, that the drugs may benefit even these patients, assuming that blood pressure is not excessively low to begin with. Kidney failure is a rare complication that can occur during initial therapy. Taking ACE inhibitors may also lead to excessive potassium levels, and so they are not generally given with potassium-sparing diuretics or potassium supplements. (Diuretics, in general, are often very important for many heart failure patients, however, even those taking ACE inhibitors.)

Hydralazine and Nitrates. The oral direct-acting vasodilators hydralazine (Apresoline) and isosorbide dinitrate (Iso-Bed Isorbid) improve symptoms and may prolong life when used in combination. Intravenous nitroglycerin (Nitro-Bid IV, Nitrostat IV, Tridil) and intravenous nitroprusside (Nitropress) are useful in short-term therapy of acute heart failure and acute pulmonary edema. Intravenous nitroglycerine tends to lose effectiveness quickly, but one study showed that patients who were also given oral hydralazine continued to tolerate this drug. Combinations of hydralazine with nitrates are more effective than either drug used alone and are recommended when patients cannot tolerate ACE inhibitors.

Angiotensin II Receptor Antagonists. Angiotensin II receptor antagonists have benefits similar to ACE inhibitors and may have fewer or less severe side effects, including coughing. They may also have positive effects on blood vessels. Valsartan and losartan are being tested for congestive heart failure. In studies comparing losartan to ACE inhibitors, losartan was as effective in improving heart function and symptoms as the ACE inhibitors enalapril and captopril, but it is not yet known if these newer drugs will have the same benefits on long-term survival.

Calcium-Channel Blockers. Calcium channel blockers are vasodilators commonly used for high blood pressure and angina, but standard calcium channel blockers worsen heart failure and so these drugs should not be used under most circumstances. Recent studies have also been reporting a number of other adverse effect. A recent study found, for example, that people with type 2 diabetes who were treated with a long-acting calcium channel blockers had a significantly higher risk for heart attacks than those taking an ACE inhibitor. Unfortunately, they are currently over-prescribed for patients with heart failure. A newer generation calcium-channel blocker, amlodipine (Norvasc), may reduce death rates in a small subgroup of heart failure patients who have idiopathic dilated cardiomyopathy without coronary artery disease.

Inotropic Drugs and Digitalis

Digitalis. Until recently, the inotropic drug digitalis was the first-line therapy for heart failure. Digitalis increases the strength of the heart's contractions, reduces heart size, and reduces certain arrhythmias. Derived from the foxglove plant, it has been used to treat heart disease since the 1700s and is still the only oral inotropic agent in general use. Controversy has been on-going for more than 100 years over whether the benefits of digitalis outweigh its risks and adverse effects. In general, digitalis does not reduce mortality rates, although it improves symptoms; patients who take digitalis are also hospitalized slightly less often than those not taking the drug. Many experts now believe that patients should first be prescribed drugs proven to prolong life, such as an ACE inhibitor or the beta blocker carvedilol, before digitalis is recommended. Digitalis may be useful for patients with systolic dysfunction characterized by low ejection fractions and is helpful in heart failure patients with atrial fibrillation, a type of rapid, irregular heart beat. Digitalis may even be harmful in some patients with heart failure, particularly when caused by diastolic dysfunction characterized by normal to high ejection fraction.

Although several digitalis preparations are available, most physicians today prescribe digoxin (Lanoxin). While digitalis is generally a safe drug, it can have toxic side effects caused by overdose or other accompanying conditions. The most serious side effects are arrhythmias, abnormal heart rhythms that can be life-threatening. Factors which increase the risk of toxicity include advanced age, low blood potassium levels (which can be caused by diuretics), hypothyroidism, anemia, valvular heart disease, and impaired kidney function. Digitalis interacts with many other drugs, including, but not limited to, quinidine, amiodarone, verapamil, flecainide, amiloride and propafenone. Patients should be sure to tell the physician about all of their other medications. Early signs of toxicity may be irregular heart beat, nausea and vomiting, stomach pain, fatigue, visual disturbances (e.g., yellow vision, seeing halos around lights, which may also flicker or flash), and emotional and mental disturbances. Some of these side effects may also be mild and not harmful. Toxic side effects used to be experienced by nearly 25% of patients taking digitalis, but now that a blood test can be used to monitor the level of the drug in the blood, toxicity is down to 2%. In any case, a recent study reported that for most patients with mild to moderate heart failure low-dose digoxin may be as effective as higher doses. If side effects exist, but are mild, patients should still consider continuing with digitalis if other benefits are experienced. It was found that patients who stopped taking digoxin after using it in combination with ACE inhibitors were at risk for worsening

heart failure.

Other Inotropic Drugs. There was a surge of interest in other oral inotropic agents, including vesnarinone, milrinone, flosequinan, and amrinone. Large studies of these agents, however, were disappointing and some even reported increased mortality rates.

Diuretics

Diuretics have long been used to relieve fluid retention, a hallmark of congestive heart failure and aggressive use of diuretics, even in people taking ACE inhibitors, can reduce hospitalizations and improve exercise capacity. Diuretics act on the kidneys to rid the body of excess salt and water. They reduce the accumulation of fluid in the legs, abdomen, and lungs, lower blood pressure, and improve the efficiency of the circulation. Side effects of diuretics include low blood pressure, dehydration, and kidney dysfunction; they also may trigger gout, increase blood sugar and triglyceride, LDL, and overall cholesterol levels, and may deplete the B vitamin thiamin. Although many diuretics are available, they are generally categorized as thiazides and loop diuretics, used with or without potassium-sparing agents. It is important to note that a recent study found an increased incidence of hospitalization in patients who were taking nonsteroidal anti-inflammatory drugs (NSAIDs) along with diuretics. Common NSAIDs include aspirin, ibuprofen (Advil), and naproxen, among many others.

Thiazides. Thiazides, including hydrochlorothiazide (HydroDiuril, Esidrex), chlorthiazide (Diuril), metolazone (Zaroxolyn), and chlorthalidone (Hygroton), are usually prescribed for patients with mild heart failure and good kidney functioning.

Loop Diuretics. Loop diuretics, such as furosemide (Lasix), bumetanide (Bumex), and ethacrynic acid (Edecrin), are generally used for more severe heart failure, especially when kidney function is impaired. Loop diuretics are used intravenously to treat pulmonary edema and acute congestive heart failure; a thiazide and a loop diuretic may be administered simultaneously. Fluid may persist in the lungs even after standard treatment for congestive failure, limiting the patient's ability to function normally. One study treated patients with this condition very aggressively with furosemide to further reduce fluids, but no improvement was seen. Another method using a filtration technique was more successful.

Potassium-Sparing Agents. Potassium loss is a major problem with diuretic use. Unless patients are also taking ACE inhibitors, which raise potassium levels, the physician may recommend a potassium supplement or the use of a potassium-sparing diuretic, such as spironolactone (Aldactone), amiloride (Midamor), and triamterene (Dyrenium), along with a thiazide or loop diuretic. All patients receiving diuretics with or without potassium-sparing drugs should have their blood potassium levels checked at regular intervals.

Beta Blockers

Beta blockers prevent norepinephrine (adrenaline) from binding to heart cells, which affects the frequency and force of heart beats. Because these drugs *reduce* the pumping action of the heart in the short term, they were not normally used for treatment of heart failure. Elevated levels of norepinephrine, however, are also associated with severe heart failure and many studies have now shown that carvedilol (Coreg), an atypical mild beta blocker with some vasodilating properties, has important benefits for many patients. Combinations of this beta blocker with other heart failure medications can improve heart function and size and reduce mortality rates in patients with mild to severe heart failure. Its positive effect on symptoms, including the ability to perform physical exercise,

however, is not as apparent. Although it appears to be effective for heart failure from nearly any cause, the drug may be more useful for certain people, including those with dilated cardiomyopathy, and patients with fast heart rates (faster than 82 beats per minute). Carvedilol must be monitored and the dosages regulated very carefully, however, since heart failure may actually worsen in the early stages of treatment. It should not be used in people with asthma, those with very slow heart beats (bradycardia), patients on intravenous inotropics, or people with certain heart conduction disorders. Bucindolol is a similar beta blocker under investigation. Other, older beta blockers being studied for heart failure include metoprolol (Lopressor) and labetalol (Normodyne, Trandate). One recent study found that beta blockers in general * not just carvedilol * reduced mortality rate in heart failure patients by over 30%. Experts warn however that because of the increased dangers during early treatment, the wide-spread use of beta blockers for heart failure warrants caution and these drugs, including carvedilol, should be administered only by specialists experienced in treating heart failure.

Anti-Clotting Drugs

Two studies have reported that heart failure patients taking drugs that prevent blood clots, including warfarin (Coumadin), aspirin, or dipyridamole (Persantine) significantly reduced the risk of death. Both studies were primarily investigating the ACE inhibitor enalapril, and in one of the studies, patients who took enalapril along with aspirin or dipyridamole did slightly less well than those taking the anti-clotting drugs alone (but still did better than patients who were taking none of these drugs). Experts warn, however, that until more studies are done, anti-clotting drugs should be used with caution in heart failure patients unless they have atrial fibrillation, previous thromboembolism, or other risk factors for blood clots.

Drugs for Arrhythmias

Drugs used to treat irregular heart beats (arrhythmias), which are a particular danger for congestive heart patients, have not been very successful in prolonging survival when used as part of the treatment regimen for congestive heart failure. Trials using low doses of the anti-arrhythmic drug amiodarone (Cordarone) reported improved mortality rates in patients with severe heart failure who also had elevated heart rates of more than 90 beats per minutes. Not only was there a reduction in death rate, but the patients' ability to function was also improved. Another study found that a combination of amiodarone and hydralazine improved survival in women with atrial fibrillation, a condition marked by rapid twitching of the heart walls. The drug apparently has no benefit for those with slower heart rates.

Other Drugs for Relief of Symptoms

Ipratropium (Atrovent), a drug normally used by asthma patients, was tested in a small study of smokers and nonsmokers with congestive heart failure for improving lung function. Breathing improved in all patients who were administered four puffs of the drug using an inhaler. The drug has no known adverse effects on the heart, and there were no other side effects in this group. More studies are needed.

Theophylline, an asthma drug, was found to improve oxygen levels and lung function in heart failure patients who also experienced central sleep apnea, the disordered breathing syndrome associated with left-side heart failure.

Experimental Drugs

Experimental drugs that include pentoxifylline and TNFR:Fe block tumor necrosis factor (TNF). TNF is produced by the immune system and causes inflammation, dilation, and other abnormalities in the heart and may be a leading factor in the development of heart failure. Pentoxifylline is showing promise in reversing symptoms of heart failure in human trials and TNFR:Fe has reversed symptoms in animal studies. One promising study reported that patients with recent-onset dilated cardiomyopathy who were given intravenous immune globulin while waiting for transplantation experienced improved function to the point that nearly all were removed from the transplant list. Drugs that inhibit parts of the nervous system or hormonal pathways that lead to heart failure are also being investigated. A unique drug, BNP, whose vasodilating properties decrease pressure in the heart and increase pumping strength, is showing promise in trials. A cold virus is being used to deliver to the heart genes of a calcium-transporting enzyme, called adenosine triphosphatase, or ATPase; theoretically, by supplying calcium to heart muscles, the enzyme could strengthen their contractions. Neither animal nor human studies have been conducted and the use of such a drug, if feasible, is years away.

What Are the Surgical Treatments for Congestive Heart Failure?

Surgical Procedures for Causes of Congestive Heart Failure

While drug therapy is the most common approach to heart failure, certain patients may require surgical interventions. Patients with severe coronary artery disease may benefit from angioplasty or bypass surgery. Patients with faulty heart valves can have artificial valve replacement surgery.

Heart Transplantation

Class III and IV patients who suffer from severe heart failure and whose symptoms do not improve with drug therapy may be candidates for heart transplantation. Traditionally transplants have been performed only on patients under 60, but studies indicate that selected older patients can benefit from this procedure and one study found that older transplant patients achieved a better quality of life than younger patients. While the risks of this procedure are high, the two-year survival rate is about 78% and after five years it ranges from 50% to over 70%. About 76% of transplant patients are male and 85.4% are white. In general, the highest risk factors for death three or more years after a transplant operation are coronary artery disease and the adverse effects (infection and certain cancers) of immunosuppressive drugs used in the procedure. Older patients are at particular risk for cancers from these drugs and for osteoporosis, but their rejection rates appear to be similar to those of younger patients.

Alternatives to or Holding Measures until Transplantation

In any one month, about 4,000 people are registered for a heart transplant procedure, although only about an average of 166 transplants are performed each month. A number of procedures are now available for patients who are waiting for transplantations; some may even offer permanent alternatives. Studies indicate that most patients in stable condition can be managed safely with medications for many months while waiting for a transplant. Portable pumps that continuously infuse medications such as dopamine and prostaglandin E-1 can allow the patient to remain mobile and active. Other procedures may also be performed to help maintain heart function.

Left Ventricular Assist Device (LVAD). In those whose heart beat has slowed

dangerously (a condition known as bradycardia), a left ventricular assist device (LVAD) may be implanted in the chest to increase the pumping action of the heart. Until recently, LVAD required a large, hospital-based immobile console to which the patient was attached while waiting for a transplant. Miniaturized battery-powered LVAD units, however, may allow many patients to leave the hospital and even resume normal activities, such as work, golf, and sexual activity. Eventually these smaller devices may even provide a permanent solution for some patients who are not candidates for transplantation. There are risks, however, involved with LVADs, including bleeding, blood clots, and right heart failure.

Ventricular Remodeling. Ventricular remodeling (also called partial left ventriculectomy or the Batista procedure, after its inventor) may allow some patients with dilated cardiomyopathy to avoid a heart transplant. The procedure involves first removing a section of healthy heart muscle weighing about three ounces. The surgeon then reshapes the heart to a more normal size and form and repairs any faulty heart valves. The procedure is effective in about 75% of cases; unfortunately, if it fails, the patient must have an immediate heart transplant. The procedure is not used for people whose heart failure developed from coronary artery disease or after a heart attack. Ventricular remodeling is a new procedure and not yet widely available; early trials in the U.S. have reported positive results and improvement has been sustained in the Brazilian patients whose hypertrophy resulted from valvular or viral disease. In cases where the muscle itself was diseased, the hearts have begun to redilate. Even in such cases, however, the procedure can be repeated.

Dynamic Cardiomyoplasty. Dynamic cardiomyoplasty is useful in carefully selected patients with congestive heart failure. The procedure detaches one end of a muscle from the back and wraps it around the ventricles of the heart. After a few weeks, these relocated muscles are conditioned with electrical stimulation to behave and beat as if they were heart muscles. The procedure benefits the failing heart in many ways, including improving systolic pressure, limiting dilation of the heart, and reducing heart muscle stress. Oddly, the procedure seems to improve symptoms significantly although it has only a modest effect on actual blood circulation. One long-term study reported that heart muscle structure was preserved in 84% of patients. Survival rates were estimated to average 54% after seven years, but they may be higher or lower depending on individual characteristics. The procedure does not preclude a later transplant operation.

Intra-aortic Balloon Pump. The intra-aortic balloon pump (IABP) is a device that is helpful for maintaining heart function for people waiting for transplants. Usually, it is used only for short periods, but recent studies indicate that patients may be able to use it safely for somewhat longer periods (an average duration of 23 days in one study).

What Are the Life Style Recommendations for Congestive Heart Failure?

Between 30% to 47% of patients who require hospitalization for heart failure are back in the hospital again within six months. Many people return because of life-style factors, such as poor diet, failure to comply with medications, and social isolation.

Home Support and Rehabilitation Programs

In one study, elderly people who had no emotional support at home had triple the risk of a heart attack after hospitalization for heart failure than those who did have such support. (In women, this risk was eightfold.) In yet another study, the greatest risk factor for death and readmission to the hospital after a first hospitalization for heart failure was being

single regardless of the health of the patient at discharge. In a number of studies, programs that offer intensive follow-up to ensure that the patient complies with lifestyle changes and medication regimens at home are reducing rehospitalization and costs and improving survival. Patients without available rehabilitation programs should seek support from local and national heart associations and groups.

Diet and Weight

Heart failure patients should weigh themselves each morning and keep a record. A sudden increase in weight of more than two or three pounds may indicate fluid accumulation and should prompt an immediate call to the physician. Rapid wasting weight loss over a few months is a very serious sign and may indicate the need for surgical intervention. All heart failure patients should limit their salt intake, and in severe cases, very stringent salt restriction may be necessary. Patients should not add salt to their cooking and their meals. They should also avoid foods high in sodium; these include ham, bacon, hot dogs, lunch meats, prepared snack foods, dry cereal, cheese, canned soups, soy sauce, and condiments. Some patients may need to reduce their water intake as well. People with high cholesterol levels or diabetes require additional dietary precautions. One study indicated that foods high in nutrients called flavonoids may have some benefit; such foods include tea, apples, onions, and red wine. In any case, a diet low in saturated fats and high in fiber, fresh fruits and vegetables is always recommended. A small study reported that taking capsules L-arginine, found in health food stores, may have some benefit. This amino acid appears to reduce endothelin, a protein that cause blood vessel constriction and is found in high amounts in heart failure patients. It is important to stress that no supplement or diet can cure heart failure.

Rest and Exercise

Traditionally, heart failure patients have been discouraged from exercising. Now, exercise is proving to be helpful for many patients and, when performed under medical supervision, does not pose a risk for a heart attack. In one study, patients between the ages of 61 and 91 increased their oxygen consumption by 20% after six months by engaging in supervised treadmill and stationary-bicycle exercises. People not used to exercising should start with five to 15 minutes of easy exercise with frequent breaks. Although the goal would be to build to 30 to 45 minutes of walking, swimming, or low-impact aerobic exercises three to five times every week, any amount of time spent exercising is useful, assuming that the physician has approved the exercise program. One study found that performing daily hand grip exercises improved blood flow through the arteries of patients with heart failure. This was backed up by a more recent study that suggested that the loss of strength in small muscles, such as those in the hand, may produce as much exercise intolerance as heart failure itself.

Bed rest may be required in cases of severe congestive heart failure. To reduce congestion in the lungs, the patient's upper body should be elevated; for most patients, resting in an armchair is better than lying in bed. Relaxing and contracting leg muscles is important to prevent clots. As the patient improves, progressively more activity will be recommended.

Warm Baths and Saunas

Experts have traditionally recommended that people with heart failure avoid warm baths, which can increase the heart rate. Now, one study has reported that carefully controlled bathing for short periods may not be harmful and, in fact, may be beneficial, increasing cardiac output and ejection fraction. Warm water may behave like a vasodilating drug,

opening up the vessels gently and improving circulation. The people in the study sat in water up to their chests at 106 degrees Fahrenheit or in a dry sauna at 140 degrees Fahrenheit. In both situations they sat for 10 minutes with their torsos tilted at 45 degrees. None of them experienced pain in the heart, shortness of breath, or irregular heart beats. Prolonged periods in hot or even warm conditions can be dangerous, however. Any patient with heart failure should consult the physician first, not bathe unaccompanied, and be sure that the temperature does not go above the ones described in this report for either water bathing or dry saunas.

Stress Reduction

Stress reduction techniques may have direct physical benefits lowering stress hormones, including cortisol (which suppresses the immune system) and norepinephrine (also known as adrenaline), the chemical messenger associated with heart dysfunction. Many effective stress reduction techniques, including meditation and relaxation methods, are available.