

High Blood Pressure

WHAT IS HIGH BLOOD PRESSURE?

High blood pressure, also called hypertension, is, simply, elevated pressure of the blood in the arteries. Hypertension results from two major factors, which can be present independently or together:

- The heart pumps blood with excessive force.
- The body's smaller blood vessels (known as the *arterioles*) narrow, so that blood flow exerts more pressure against the vessels' walls.

Although the body can tolerate increased blood pressure for months and even years, eventually the heart may enlarge (a condition called *hypertrophy*), which is a major factor in heart failure. Such pressure can also injure blood vessels in the heart, kidneys, the brain, and the eyes.

Two numbers are used to describe blood pressure:

- *Systolic*. The systolic pressure (the higher and first number) measures the force that blood exerts on the artery walls as the heart contracts to pump out the blood.
- *Diastolic*. The diastolic pressure (the lower and second number) is the measurement of force as the heart relaxes to allow the blood to flow into the heart.

Blood pressure is measured in millimeters of mercury (mm Hg). For example, excellent blood pressure would be less than 120/80 mm Hg (systolic/diastolic). Blood pressure is now categorized as optimal, normal, high normal, and hypertensive. The hypertensive category is further divided, according to severity. [See *Table Blood Pressure and Its Treatments.*]

American expert groups recommend that any blood pressure above normal should be treated. Some experts are concerned, however, that such guidelines may unnecessarily increase the use of antihypertensive drugs.

Health dangers from blood pressure may vary among different age groups and depending on whether systolic or diastolic pressure (or both) is elevated. A third measurement, pulse pressure, is becoming important as an indicator of severity:

- High *systolic* blood pressure (the first and higher number) appears to be a significant indicator for heart complications, including death, in all ages, but especially in middle-aged and older adults. In fact, elevated systolic pressure may pose a significant danger for heart events and stroke events even when diastolic is normal, a condition called *isolated systolic hypertension*. The wider the spread between the systolic and diastolic measurements, the greater the danger. Isolated systolic hypertension is the most common form of hypertension in people older than fifty; in one study it comprised 87% of hypertension cases in people between ages 50 and 59.
- High *diastolic* pressure (the second and lower number) is a strong predictor of heart attack and stroke in *young* adults and in people of any age with *essential hypertension*. This is high blood pressure from unknown causes and occurs in the great majority of cases. [See *Hypertension Categories, below.*]

- Pulse pressure is the difference between the systolic and the diastolic readings. It appears to be an indicator of stiffness and inflammation in the blood-vessel walls. The greater the difference between systolic and diastolic numbers, the stiffer and more injured the vessels are thought to be. Although not yet used by physicians to determine treatment, evidence is suggesting that it may prove to be a strong predictor of heart problems, particularly in older adults. Some studies suggest that in people over 45 years old, every 10-mm Hg increase in pulse pressure increases the risk for stroke increases by 11%, cardiovascular disease by 10%, and overall mortality by 16%. (In younger adults the risks are even higher.)

Hypertension Categories

Some experts categorize hypertension into the following types:

Primary Hypertension. Primary hypertension is also known as *essential* or *idiopathic hypertension*. About 90% of all high blood pressure cases are this type. The causes of essential hypertension are unknown but are certainly based on complex processes in all major organs and systems, including the heart, blood vessels, nerves, hormones, and the kidneys.

Secondary Hypertension. Secondary hypertension comprises about 5% of high blood pressure cases. In this condition, the cause has been identified.

Isolated Systolic Hypertension. This occurs when systolic hypertension is over 160 mm Hg but diastolic pressure is normal. It is related to arteriosclerosis (hardening of the arteries).

Pregnancy Induced Hypertension. This condition occurs during pregnancy if blood pressure increases by more than 15 mm Hg above normal.

White Coat Hypertension. This form of hypertension is elevated blood pressure that occurs only during a visit to the doctor's office.

BLOOD PRESSURE RANGES AND ACTIONS TAKEN		
Blood Pressure Category	Ranges for Most Adults (systolic/diastolic)	Actions Taken after Initial Diagnosis
Optimal Blood Pressure (systolic/diastolic)	Systolic below 120 mm Hg Diastolic below 80 mm Hg	No action.
Normal Blood Pressure	Systolic 120 to 130 mm Hg Diastolic 80 to 85 mm Hg (The upper numbers should be minimum goal for everyone, particularly people with diabetes.)	Rechecked every two years.
High Normal Blood	Systolic 130 to 139 mm Hg	Blood pressure monitored at home and

Pressure	Diastolic 85 to 89 mm Hg	patient should be evaluated for organ damage.
Hypertension (High Blood Pressure)	Systolic above 140 mm Hg Diastolic above 90 mm Hg (In middle age and older people, systolic pressure above 140 mm Hg suggests higher health risks even when diastolic pressure is normal or low.)	
Mild Hypertension (Stage 1)	Systolic 140 to 159 mm Hg Diastolic 90 to 99 mm Hg	Same as high normal. If no organ damage, retesting at least twice a week for several weeks. If organ damage present, start drug therapy.
Moderate Hypertension (Stage 2)	Systolic 160 to 179 mm Hg Diastolic 100 to 109 mm Hg	Same as high normal. If no organ damage, retesting at least twice a week for several weeks. If organ damage present, start drug therapy.
Severe Hypertension (Stage 3)	Systolic 180 to 209 mm Hg Diastolic 110 to 119 mm Hg	Same as high normal. Consider immediate drug therapy regardless of organ damage evidence.
Very Severe Hypertension (Stage 4)	Systolic greater than 210 mm Hg Diastolic greater than 120 mm Hg	Same as high normal. Consider immediate drug therapy regardless of organ damage evidence.
<p>Note: If one measurement is normal and the other elevated, the higher category of either measurement is usually used to determine severity. For example, if systolic pressure is 165 (moderate) and diastolic is 92 (mild), the patient would still be diagnosed with moderate hypertension. It should be strongly noted that a high systolic pressure compared to a normal or low diastolic pressure should be a major focus of concern in most adults.</p>		

Blood Pressure in Children

A child's blood pressure is normally much lower than an adult's. Children are at risk for hypertension if they exceed the following levels:

- Ages three to five: 116/76
- Ages six to nine: 122/78
- Ages 10 to 12: 126/82
- Ages 13 to 15: 136/86

WHAT WILL CONFIRM THE DIAGNOSIS OF HIGH BLOOD PRESSURE?

Measuring Blood Pressure

It is a rare physical examination that does not include blood pressure measurement. The process is familiar to everyone:

- First, patients should not smoke or drink caffeinated beverages within 30 minutes of the measurement.
- The standard instrument used to measure blood pressure is called a mercury sphygmomanometer. (Electronic devices are also available.)
- An inflatable cuff with a meter attached is placed around the patient's arm over the artery, while the patient is seated.
- The person taking the blood pressure listens through a stethoscope.
- If a first blood pressure reading is above normal, the health professional may take two or more measurements separated by two minutes with the patient sitting or lying down, as well as one measurement taken after the patient has been standing for two minutes.

Although this test has been used for more than 90 years, it is not completely accurate or sensitive. The following can bias the results.

Falsely *low* pressure reading can be caused by the following:

- Recent exercise.
- Not smoking for a while after heavy, long-term smoking.
- White coat normotension (also called isolated home hypertension). This is a condition in which a person's blood pressure registers as normal at the doctor's office, even though it is actually somewhat elevated. It tends to occur in men, especially those who are past smokers, older, or alcohol users. One study suggested that it still posed a risk for heart problems that was similar to uncontrolled hypertension.

Falsely *high* pressure can result from the following:

- An arm cuff that is too small.
- Talking during the test.
- Having recently consumed foods or beverages (such as coffee) that raise blood pressure.
- White-coat hypertension. This is a phenomenon in which a patient's blood pressure rises in the presence of a physician and, presumably, returns to normal at home. Some researchers suggest that the incidence of true white coat hypertension is very low, only 5%, and that physicians should always suspect true hypertension when blood pressure is elevated in the office. Studies have further suggested that white-coat hypertension actually may pose a risk for future heart problems, although the increased danger appears to be small compared with the risk in those with steady mild hypertension. If white-coat hypertension is suspected, home monitoring is important.

If the outcome is high normal or above, the patient should be monitored at home and have further tests to determine if the organs are affected. An average of all the measurements will be considered in the diagnosis of hypertension. [*For details See Box Blood Pressure Ranges and Actions taken.*]

Home Monitoring

Monitoring Equipment. A number of home tests are available for checking blood pressure between doctor visits: A physician may loan a patient a portable unit that records blood pressure during a full day's activity. This test, known as ambulatory monitoring, is particularly useful for those who experience wide blood pressure swings, such as those who have white-coat hypertension or show resistance to drug therapy. In fact, according to one study, accurately measuring blood pressure at home over a full day was a significantly better predictor of cardiovascular risk than standard office-based measurements. To improve clinical outcomes, devices are now available that allow 24-hour ambulatory blood pressure monitoring and electronically store results for analysis by the physician. It is not clear if their added benefits justify their expense, however.

Cuffs and Stethoscopes. Manual cuffs and stethoscopes are fairly accurate, but they require practice to use, and the cuff must be the right size (one size does not fit all). Devices that use a digital readout and a cuff that can be electronically inflated and deflated are proving to be as accurate as a stethoscope.

Blood Pressure Variations at Home. In general, everyone's blood pressure varies in the same way throughout a given day. In monitoring at home, it is important to note these changes:

- Blood pressure is usually highest at work.
- It drops slightly at home.
- It then normally dips to its lowest level during sleep. There are important exceptions. Certain people have a condition called *nondipper hypertension*, in which blood pressure does not fall at night. Postmenopausal women appear to be at particular risk for this phenomenon, and it may pose a special danger for heart disease and stroke (particularly in older African American women). It has also been linked to salt-sensitivity and insulin resistance.

- Upon waking, pressure in most people typically increases suddenly. In people with severe high blood pressure, this is the highest risk period for heart attack and stroke.

Some studies have reported that when patients record and report their own blood pressure, they are unreliable and don't always tell the truth. Despite the difficulties and controversy surrounding this issue, home blood pressure monitoring has been shown to encourage patients to use measures that control their blood pressure and thereby reduce the risk of cardiovascular events.

Physical Examination for Complications of Hypertension

If blood pressure is elevated, the physician will check the patient's pulse rate, examine the neck for distended veins or an enlarged thyroid gland, check the heart for enlargement and murmurs, and examine the abdomen and the eyes.

Medical History

If hypertension is suspected, the physician should obtain the following information:

- A family and personal medical history, especially incidence of high blood pressure, stroke, heart problems, kidney disease, or diabetes.
- Risk factors of heart disease and stroke, including tobacco use, salt intake, obesity, physical inactivity, and unhealthy cholesterol levels.
- Any medications being taken.
- Any symptom that might indicate so-called *secondary hypertension* (that is, caused by another disorder). Such symptoms include headache, heart palpitations, excessive sweating, muscle cramps or weakness, or excessive urination.
- Any emotional or environmental factors that could affect blood pressure.

Laboratory and Other Tests

If a physical examination indicates hypertension, additional tests may help determine whether it is *secondary hypertension* or *essential hypertension* (no other disorder is present) and whether organ damage is present. They include the following:

- Blood tests and a urinalysis. (Performed to check for a number of factors, including potassium levels, cholesterol, blood sugar, infection, kidney function, and other possible problems. Measuring blood levels of the protein creatinine, for example, is important for all hypertensive patients in order to determine kidney damage. Higher concentrations may also be an indicator of heart disease.)
- An electrocardiogram (ECG).
- An exercise stress test. This could be important for those with borderline hypertension. Stress-induced blood pressure in such patients has been associated with a risk for left ventricular hypertrophy, a serious complication in which the muscles on the left side of the heart become enlarged. Studies also suggest that an excessive rise in systolic pressure during exercise indicates a risk for coronary artery disease, and stroke.

WHAT CAUSES HIGH BLOOD PRESSURE?

Essential Hypertension

Hypertension is referred to as essential, or primary, when the physician is unable to identify a specific cause. It is by far the most common type of high blood pressure. The causes of this type are unknown but are likely to be a complex combination of genetic, environmental, and other factors.

Genetic Factors. A number of genetic factors or interactions between genes play a major role in essential hypertension. Experts appear to have located the chromosomes (13 and 18) that house the genes responsible for blood pressure regulation, although pinning down the range of specific genes involved in hypertension is more difficult.

Abnormalities in the Angiotensin-Renin-Aldosterone System. Genes under intense study are those that regulate a group of hormones known collectively as the angiotensin-angiotensin-converting enzyme-angiotensin II system. This system influences all aspects of blood pressure control, including blood vessel contraction, sodium and water balance, and cell development in the heart.

Experts believed that this system evolved millions of years ago to protect early humans during drought or stress by retaining salt and water and narrowing blood vessels to ensure adequate blood flow and repair injured tissue. With industrialization, however, this system wreaks havoc on modern humans by intensifying the effects of our high-salt diets and sedentary lifestyle. Of particular importance in these harmful responses are the hormone aldosterone and a peptide (which are components of proteins) called angiotensin II.

Inherited Abnormalities in the Sympathetic Nervous System. Studies suggest that some people with essential hypertension may inherit abnormalities of the *sympathetic nervous system*. This is the part of the autonomic nervous system that controls heart rate, blood pressure, and the diameter of the blood vessels.

Insulin Resistance and Diabetes Type 2. Hypertension is strongly associated with diabetes, both type 1 and 2. Kidney damage is generally the cause of high blood pressure in diabetes type 1. Obesity and insulin resistance are the factors associated with hypertension in type 2 diabetes, the more common type. People with type 2 diabetes generally have normal or high levels of insulin, a critical hormone in the metabolism of sugar. However, they are unable to use the insulin, the condition called *insulin resistance*. Without insulin, blood glucose (sugar in the blood) rises, the hallmark of diabetes.

Some research indicates that obesity is the one common element linking insulin, diabetes type 2, and high blood pressure. Obesity is common in both type 2 diabetes and hypertension. Oddly, however, studies have found a stronger association between hypertension and insulin resistance in *thin* patients as well as overweight people with type 2 diabetes. Some research indicates that insulin resistance may cause sodium retention, a contributor to high blood pressure.

In any case, regardless of the causal connections, people who have both insulin resistance or full-blown diabetes plus hypertension have a significantly greater chance for heart attack, kidney disease, and stroke than people who have only high blood pressure.

Obesity. Obesity on its own has a number of possible effects that could lead to hypertension. It may blunt certain actions of insulin that open blood vessels, and it may cause structural changes in the kidney and abnormal handling of sodium. It is also associated with alterations in the systems that regulate blood flow.

Low Levels of Nitric Oxide. The gas nitric oxide can be produced in the body, where it affects the smooth muscles cells that line blood vessels; it helps keep them relaxed, flexible. It may also help prevent blood clotting. Low levels of nitric oxide have been observed in people with high blood pressure (particularly in African Americans) and may be an important factor in essential hypertension.

Secondary Hypertension

Secondary hypertension has recognizable causes, which are usually treatable or reversible.

Medical Conditions. A number of medical conditions can cause secondary high blood pressure:

- Kidney disease is the most common cause of secondary hypertension, particularly in older people.
- Sleep apnea, a disorder in which breathing halts briefly but repeatedly during sleep, is now highly associated with hypertension. A weak but still higher than normal association with high blood pressure has even been observed in those who snore or have mild sleep apnea. The relationship between sleep apnea and hypertension has been thought to be largely due to obesity, but major studies are finding a higher rate of hypertension in people with sleep apnea regardless of their weight. Treating sleep apnea with a device known as *nasal continuous positive airway pressure* may have modest benefits blood pressure as well.
- Other medical conditions that contribute to temporary hypertension are pregnancy, cirrhosis, and Cushing's disease.

Medications. Certain prescription and over-the-counter drugs can cause temporary high blood pressure. Some include the following:

- Corticosteroids.
- Long-term use of nonsteroidal anti-inflammatory drugs (NSAIDs) may injure the kidney and is an important cause of secondary hypertension in the elderly population. Such drugs include aspirin, ibuprofen (Advil, Motrin, Rufen), naproxen (Anaprox, Naprosyn, Aleve), and many others. Of these drugs, aspirin appears to have the least detrimental effect on blood pressure.
- Cold medicines containing pseudoephedrine have also been found to increase blood pressure in hypertensive people, although they appear to pose no danger for those with normal blood pressure.
- Oral contraceptives (the Pill) increase the risk for high blood pressure, particularly in women who are older, obese, smokers, or some combination. Stopping the Pill nearly always reduces blood pressure, although a recent study suggests that oral contraceptives may produce a small but significant increase in diastolic pressure that persists in some older women who have been off the Pill for years.

Alcohol, Coffee, and Cigarettes

- *Alcohol.* An estimated 10% of hypertension cases are caused by alcohol abuse (ie, three alcoholic drinks a day or more, with heavier drinkers having higher pressure). In one study, binge-drinkers had even higher blood pressure than people who drank regularly. One study found alcohol abuse associated with low diastolic but high systolic pressure.

Moderate drinking (one or two drinks a day) has benefits for the heart and may even protect against some types of stroke. Of some concern was a study suggesting the even low or moderate drinking may increase the risk for hypertension in African Americans. Red wine specifically may have chemicals that benefit blood pressure. (Red grape juice may have the same advantages) *It is critical, in any case, for people who can't drink moderately to abstain from alcohol.*

- *Smoking.* Smoking is a major risk factor. One study reported that smokers have blood pressures up to 10 points higher than nonsmokers.
- *Caffeine.* Caffeine causes a temporary increase in blood pressure, which has been thought to be harmless in people with normal blood pressure. Studies are suggesting, however, that regular, heavy coffee drinking (an average of 5 cups per day) can boost blood pressure, and there is growing evidence that a high intake of coffee may be harmful in people with hypertension and may even increase their risk for stroke. Drinking coffee also increases excretion of calcium, which also may affect blood pressure. (Anyone who drinks coffee should maintain an adequate calcium intake.)

Other Causes of Secondary High Blood Pressure. Temporary high blood pressure can result from a number of other conditions or substances.

- Stress.
- Intense workouts (eg, snow shoveling, jogging, speed walking, tennis, heavy lifting, heavy gardening).
- Long-term consumption of large amounts of licorice.
- Exposure to even low levels of lead also appears to cause hypertension in adults. More studies are needed to clarify this relationship.

WHO GETS HIGH BLOOD PRESSURE?

An estimated 50 million Americans have high blood pressure. Over 30% of these people are unaware that their blood pressure is abnormal. And although over half are on medication, only about quarter of them have their blood pressure under good control. Older people are less likely to be treated adequately. The majority of people with high blood pressure have the mild type, but even this condition requires attention.

Age and Gender

Age is the major risk factor of hypertension. In both men and women, the risk for high blood pressure increases as one ages. More men than women have hypertension until age 55, After that the ratio reverses, and over time women gain on men and finally overtake them. In all, mortality rates from hypertension are higher in women than in men.

Ethnicity

Compared to Caucasians, they have 1.8 times the rate of fatal stroke, 1.5 times the risk for fatal heart disease, and 4.2 times the rates of end-stage kidney disease. In general, about 36% of African men and women have hypertension; it may account for over 40% of all deaths in this group.

In fact, the prevalence of high blood pressure among African Americans is among the highest in the world. The rates of hypertension in Hispanic Americans, Caucasians, and Native Americans are about equivalent (ranging from 24% to 27%). (Individuals of Mexican descent, compared to Spanish descent, may have a lower risk.) The rate is much lower in Asian Pacific Islanders (9.7% in men and 8.4% in women). In one study, however, nearly three quarters of older Japanese American men were hypertensive.

A number of theories have addressed the reasons for this difference:

- Some studies have indicated that African Americans may have lower levels of nitric oxide and higher levels of a peptide called endothelin-1 (ET-1) than Caucasians. (Nitric oxide keeps blood vessels flexible and open and ET-1 narrows blood vessels.)
- African Americans have a higher risk for an impaired response to angiotensin (Ang II), which is a peptide important in regulating salt and water balances. (African Americans are more likely to be salt-sensitive than other groups.)
- and income disparities and dietary issues may explain many of the differences in blood pressure rates observed between ethnic groups. For example, while African-Americans have a disproportionately high rate of hypertension, one study in rural African villages, where diets are rich in fish, reported only a 3% rate of high blood pressure among the natives. Another study reported that Caucasian as well as African Americans in the Southeast have a higher incidence of hypertension and stroke than people in other US regions. The Southeast also has a higher rate of obesity, stress, anxiety, and depression, and diets low in potassium and high in salt, all related to a lower socioeconomic level. In any case, hypertension appears to be dangerously undertreated in major minority groups. Inadequately controlled hypertension is the major factor for the higher mortality rate from heart disease among African Americans.

Weight

Obesity. About one-third of patients with high blood pressure are overweight. Even moderately obese adults have double the risk of hypertension than people with normal weights. In fact, the increase in blood pressure in aging Americans may be due primarily to weight gain. (In other cultures old age does not necessarily coincide with weight gain or high blood pressure.) Children and adolescents who are obese are at greater risk for high blood pressure when they reach adulthood.

Thinness. Interestingly, thin people with hypertension are at higher risk for heart attacks and stroke than obese people with high blood pressure. Experts surmise that thin people with hypertension are likely to have conditions such as an enlarged heart or stiff arteries that cause the high blood pressure and also pose greater dangers to health.

Low Birth Weight. Low birth weight, particularly in females, has been associated with high blood pressure in both childhood and adulthood. (One study suggested that breast-feeding these babies may help reduce this risk.) Another study reported high levels of stress hormones in babies with low birth weight, which could increase the risk for high blood pressure later on. Low-birth weight is also associated with subsequent obesity, a major contributor to hypertension.

Family History

Some experts now believe that essential hypertension may be inherited in 30% to 60% of cases. According to one study, being a brother or sister of someone with premature coronary artery disease is a greater risk factor for hypertension than having a parent with the disease. A family

history of heart disease is considered to be a major risk factor for high blood pressure in younger adults (under 65).

Emotional Factors

People who are anxious or depressed may have over twice the risk for high blood pressure than those without these problems.

Mental Stress. Recent evidence confirms the association between stress and hypertension (high blood pressure). In one 20-year study, for example, men who periodically measured highest on the stress scale were twice as likely to have high blood pressure as those with normal stress. The effects of stress on blood pressure in women were less clear. Job stress and lack of career success have been specifically linked to high blood pressure in both men and women.

Anxiety. Studies suggest that anxiety is risk factor for hypertension, particularly in women.

Depression. There is increasing evidence that depression has actual physiological effects that impair the heart, as well as contributing to destructive behaviors, such as weight gain, smoking, or alcohol abuse. In a 2000 study of young people, both African Americans and Caucasians, those who scored highest on a depression test had about twice the risk of high blood pressure as those with the lowest score. This link was particularly strong in African Americans. In fact, it was the strongest risk factor in this group.

Seasonal Factors

Seasonal changes may influence variations in blood pressure, with hypertension increasing during cold months and declining during the summer, particularly in smokers. While cold may narrow blood vessels, lack of light has also been associated with higher blood pressure.

HOW SERIOUS IS HIGH BLOOD PRESSURE?

Hypertension can cause certain organs (called target organs), including the kidney, eyes, and heart, to deteriorate over time. High blood pressure was responsible for nearly 43,000 American deaths in 1999 and was listed as the primary or contributing cause of death in an estimated 227,000 cases. The death rate from high blood pressure is estimated to have increased by 21% between 1989 and 1999. High blood pressure contributes to 75% of all strokes and heart attacks. It is particularly deadly in African Americans.

Emergency Conditions

Malignant hypertension, an emergency condition resulting from untreated primary hypertension, can be lethal. [See What Are the Symptoms of High Blood Pressure?, *below.*]

Stroke

About two-thirds of people who suffer a first stroke have moderate elevated blood pressure (160/95 mm Hg or above). Hypertensive people have up to ten times the normal risk of stroke, depending on the severity of the blood pressure. Hypertension is also an important cause of so-called silent cerebral infarcts, which are blockages in the blood vessels in the brain that may predict major stroke or progression to dementia over time.

Mental Problems and Dementia

Uncontrolled chronic high blood pressure is also associated with reduced short-term memory and mental abilities. Isolated systolic hypertension may pose a particular risk for complications in the brain. Fortunately, controlling blood pressure with medications can reduce or even prevent memory loss and mental decline due to hypertension. (Antihypertensive drugs may even help protect against Alzheimer's in people with genetic susceptibility to this disease.)

Heart Disease

Among older patients, high blood pressure is the major risk factor for heart disease. Two studies in 2001 further reported that high blood pressure in young men poses a higher risk for heart disease later on, and in one of the studies, fewer years of life.

Heart Attack. About half of people who suffer their first heart attack have moderate (160/95 mm Hg) or above hypertension. High blood pressure increases the risk for a heart attack by up to five times, depending on the severity of the hypertension.

Heart Failure. Hypertension precedes congestive heart failure in between 75% and 90% of heart failure cases. High blood pressure has various effects that cause the heart to fail, including the following:

- To compensate for increased blood pressure, the heart must work harder to pump blood, and so its muscles thicken (called hypertrophy), usually in the left side (called left-ventricle dysfunction). These thickened muscles pump inefficiently, and over time, the force of their contractions weakens. The heart muscles then have difficulty relaxing and filling the heart with blood. The heart begins to fail.
- The failing heart then triggers a number of hormonal and neurochemical mechanisms to correct imbalances in blood pressure and flow. This response, called *remodeling*, is helpful in the short run but very destructive and irreversible over time.
- As part of the remodeling process, the heart muscle cells elongate. The muscular walls of the heart dilate and become thinner and inefficient. The cells themselves undergo molecular changes that result in calcium loss, a mineral crucial for healthy heart contractions.
- The end-result of remodeling is that the volume of blood pumped to the kidneys falls, and the kidneys respond by retaining water and salt, which, in turn, increases fluid build-up in the body.
- To make matters worse, the body's arteries respond to a lower blood volume by constricting; this forces the heart to work even harder to pump blood through these narrowed vessels, thereby increasing blood pressure, and the cycle continues.

Kidney Disease

End-Stage Kidney Disease. High blood pressure causes 30% of all cases of end-stage kidney disease (medically referred to as end-stage renal disease or ESRD). Only diabetes leads to more cases of kidney failure. In fact, although antihypertensive therapy has reduced the incidence of stroke and heart attack, the incidence in ESRD has almost doubled in the last decade.

Kidney Cancer. Men with high blood pressure may also have a higher risk of kidney cancer.

Effect on the Eyes

High blood pressure can injure the eyes, causing a condition called retinopathy.

Bone Loss

Hypertension also increases the elimination of calcium in urine that may lead to loss of bone mineral density, a significant risk factor for fractures, particularly in elderly women. In one study of Englishwomen, those with the highest blood pressure lost bone density at nearly twice the rate of those in the lowest range. It is not clear whether this effect occurs in men or in non-Caucasian women.

Sexual Dysfunction

Sexual dysfunction is more common and more severe in men with hypertension, and particularly in smokers, than it is in the general population. Many of the drugs used to treat hypertension are thought to cause impotence as a side effect; in these cases, it is reversible when the drugs are stopped. More recent evidence is suggesting, however, that the disease process that causes hypertension itself is the major cause of erectile dysfunction in these men. Newer anti-hypertensive agents, including angiotensin-converting enzyme (ACE) inhibitors and angiotensin-receptor blockers (ARBs), are less associated with erectile dysfunction. In fact, ARBs, such as losartan (Cozaar), may be particularly effective in restoring erectile function in men with high blood pressure who suffer from impotence. Sildenafil (Viagra) was reported to be successful in achieving erections in almost two-thirds of patients with controlled high blood pressure, but at this time its safety for men with uncontrolled hypertension is unclear. [For more information see *Impotence (Erectile Dysfunction)*.]

Pregnancy and Preeclampsia

Severe, sudden high blood pressure in pregnant women is one component of a condition called preeclampsia (commonly called toxemia) that can be very serious for both mother and child. It occurs in up to 10% of all pregnancies, usually in the third trimester of a first pregnancy, and resolves immediately after delivery. Other symptoms and signs of preeclampsia include protein in the urine, severe headaches, and swollen ankles.

This condition may be caused by a failure of the placenta to embed properly in the uterus, which causes it to misconnect with the mother's blood vessels. As a result, the fetus does not receive a sufficient blood supply and the mother's own blood pressure increases to replace it.

The reduced supply of blood to the placenta can cause low birth weight and eye or brain damage in the fetus. Severe cases of preeclampsia can cause kidney damage, convulsion, and coma in the mother and can be lethal to both mother and child.

Women at risk for preeclampsia (particularly those with existing hypertension) may benefit from having an ultrasound of uterine arteries at 20 to 24 weeks' gestation followed, if abnormal, by 24-hour blood pressure monitoring.

Outlook for Children with Hypertension

Results of studies evaluating outcomes of children with hypertension suggest that early abnormalities, including enlarged heart and abnormalities in the kidney and eyes, may occur even

in children with mild hypertension. Children and adolescents with hypertension should be monitored and evaluated for any early organ damage.

WHAT ARE THE SYMPTOMS OF HIGH BLOOD PRESSURE?

No Symptoms

Hypertension has aptly been called the "silent killer" because it usually produces no symptoms. Untreated hypertension increases slowly over the years. It is important, therefore, for anyone with risk factors to have their blood pressure checked regularly and to make appropriate lifestyle changes. Such recommendations are urged for individuals who have overall high-normal blood pressure, mild or above systolic with normal diastolic pressure, family histories of hypertension, or who are overweight or over age 40.

Symptoms of Malignant Hypertension

In rare cases (fewer than one percent of hypertensive patients), the blood pressure rises quickly (with diastolic pressure usually rising to 130 or higher), resulting in malignant or accelerated hypertension. This is a life-threatening condition and must be treated immediately. People with uncontrolled hypertension or a history of heart failure are at increased risk for this crisis.

People should call a physician immediately if these symptoms occur:

- Drowsiness.
- Confusion.
- Headache.
- Nausea.
- Loss of vision.

WHAT ARE THE GENERAL GUIDELINES FOR CHOOSING THE APPROPRIATE TREATMENTS FOR HIGH BLOOD PRESSURE?

Determining Treatments

Healthy life style changes are imperative for anyone, and are critical for people with even normal blood pressure and above. Drug treatments for hypertension are proving to be very important, although it is not altogether clear when they should be started, particularly for people with high-normal or mild high blood pressure.

To help make basic treatment choices for people with high-normal or high blood pressure, The National Heart, Lung, and Blood Institute has created categories (denoted as Groups A, B, and C) according to a patient's risk factors for heart disease. Applying these categories to the severity of hypertension helps determine whether lifestyle changes alone or medications are needed. [

See *Table Treatment Recommendations by Stage and Risk Groups.*]

TREATMENT RECOMMENDATIONS BY STAGE AND RISK GROUPS

RISK GROUPS	BLOOD PRESSURE STAGES (systolic/diastolic)			
	High Normal Blood pressure (130-139/85-89)	Mild (Stage 1) Blood Pressure (140-159/90-99)	Moderate (Stage 2) Blood Pressure (160-179/100-109)	Severe Blood Pressure (Stage 3 and 4) (over 180/110)
Risk Group A Have no risk factors for heart disease.* Note: only women are in this group.	Life style changes only. (Exercise and dietary program with regular monitoring.) It should be noted that high normal still poses a risk for heart disease even in people with Group A.	Year trial of lifestyle changes only.	Lifestyle changes and medications.	Lifestyle changes and medications.
Risk Group B Have at least one risk factor for heart disease* (excluding diabetes) but have no target organ damage (such as in the kidney, eyes, or heart or existing heart disease).	Lifestyle changes only.	Six month trial of lifestyle changes only. (Medications considered for patients with multiple risk factors.)	Lifestyle changes and medications.	Lifestyle changes and medications.
Risk Group C Have diabetes with or without target organ damage and existing heart disease (with or without risk factors for heart disease).	Lifestyle changes and medications.	Lifestyle changes and medications.	Lifestyle changes and medications.	Lifestyle changes and medications.

* Risk factors for heart disease include the following: smoking, unhealthy cholesterol and lipid levels, diabetes, being over 60 years old, being a man or

postmenopausal woman, and women under 65 and men under 55 with a family history of heart disease.

WHAT LIFESTYLE CHANGES ARE NEEDED TO CONTROL HIGH BLOOD PRESSURE?

A 2001 study suggested that following a simple dietary regimen may improve blood pressure. It suggested that lowering the intake of protein, sodium, and alcohol can improve both systolic and pulse pressures. Increasing potassium intake improves both blood pressure measurements.

DASH Diet.

A diet known as Dietary Approaches to Stop Hypertension (DASH) is now recommended as an important step in managing blood pressure. This diet is not only rich in important nutrients and fiber but also includes foods that contain far more electrolytes, potassium, calcium, and magnesium, than are found in the average American diet. It makes the following recommendations:

- Avoid saturated fat (although include calcium-rich dairy products that are no- or low-fat).
- When choosing fats, select monounsaturated oils, such as olive or canola oils. (One study reported a reduced need for anti-hypertension medication in people with a high intake of virgin olive oil, but not sunflower oil, a polyunsaturated fat.)
- Choose whole grains over white flour or pasta products.
- Choose fresh fruits and vegetables every day. Many of these foods are rich in fiber, which may help lower blood pressure. Important foods include most fruits (especially potassium-rich fruits including bananas, oranges, prunes, and cantaloupes) and vegetables (especially carrots, spinach, celery, alfalfa, mushrooms, lima beans, potatoes, avocados, broccoli). Note: Grapefruit and bitter oranges (also called Seville or sour oranges) boost the effects of calcium-channel blocking drugs, which are often used for hypertension. (Regular oranges do not appear to pose any hazard.)
- Include nuts, seeds, or legumes (dried beans or peas) daily.
- Choose modest amounts of protein (preferably fish, poultry, or soy products). Soy in combination with fiber-rich foods or supplements may have specific benefits. Oily fish may also be particularly beneficial. They contain omega-3 fatty acids, which have been associated with heart and nerve protection [see *below*].

In one study, after eight weeks on the diet, subjects from a broad range of backgrounds experienced a significant reduction in blood pressure. Evidence now also suggests that it may be a good diet for lowering LDL cholesterol levels--although the beneficial HDL levels also decline. The significance of these effects are not yet known.

Salt Restriction

A combination of the DASH diet and salt restriction is extremely effective in reducing blood pressure. (Each approach has positive benefits, but the combination is best.) Some individuals should take particular measures to restrict salt.

- *People at Risk for Salt-Sensitivity (African Americans, Diabetics, the Elderly).* About half of people with hypertension have blood pressure that reacts significantly to salt. Such people are known to be *salt-sensitive*. High-salt diets in anyone who is salt-sensitive may harm the heart, kidney, and brain and increase the risk for death, regardless of their blood pressure. (Even people with normal blood pressure can be salt-sensitive.) Among those at highest risk for salt sensitivity are African Americans, people with diabetes, and elderly people. A 2001 study, for example, reported that reducing sodium intake in older people, including African Americans, was very effective in controlling their hypertension. Still because testing for salt-sensitivity is not easy, experts recommend that *everyone* proactively restrict their daily salt-intake.
- *Overweight People.* Overweight individuals may absorb and retain sodium differently from people with normal weights. In fact, one 1999 study reported that high sodium intake was associated with an increased risk of heart disease and all-cause mortality in overweight, but not in normal weight, people. Unfortunately, because overweight people generally consume more calories, they are also likely take in more sodium.
- *People on Anti-Hypertensive Drugs.* Restricting salt also enhances the benefits of nearly all standard antihypertensive drugs by reducing potassium loss, and may help protect against kidney disease in patients who are also taking calcium-blocker drugs.

Everyone, regardless of their blood pressure, should consume less than 2,400 milligrams (about one teaspoon) of sodium each day. People with hypertension should strive for even lower intake. Simply eliminating table and cooking salt can be beneficial. Salt substitutes, such as Cardia, containing mixtures of potassium, sodium, and magnesium are available, but they are expensive. It should be noted, however, that about 75% of the salt in the typical American diet comes from processed or commercial foods, not from food cooked at home, so the benefits of table-salt substitutes are likely to be very modest. Some sodium is essential to protect the heart, but most experts agree that the amount is significantly less than that found in the average American diet. If people cannot significantly reduce the amount of salt in their diets, adding potassium-rich foods might help to restore a healthy balance.

Potassium, Magnesium, and Calcium. Some experts believe that sufficient intake of minerals, particularly potassium, magnesium, and calcium, may be more beneficial than salt restriction for reducing blood pressure.

- **Potassium.** Studies have indicated that potassium deficiencies increase the risk for high blood pressure. More important more recent studies indicate that a potassium-rich diet may reduce hypertension. The best source of potassium is from the fruits and vegetables that contain them. In fact, there is some evidence that a potassium-rich diet can reduce the risk of stroke by 22% to 40%. [For some of these foods, see Dash Diet, *above*.] Some patients, such as those taking certain diuretics that do not spare potassium, may require supplements. Excess potassium, however, can cause abdominal distress, muscle weakness, and, in rare cases, dangerous heart events. Some people should be particularly cautious about potassium supplements, including those with conditions, such as diabetes or kidney disease, that increase potassium levels or who are taking medications, such as ACE inhibitors or potassium-sparing diuretics, that limit the kidney's ability to excrete potassium.
- **Magnesium.** Some studies reported that magnesium supplements may induce small but significant reductions in blood pressure. No major studies, however, have been done on

long-term benefits or risks of magnesium supplements. A major 2001 study on diet found no effect on blood pressure from magnesium intake from foods.

- **Calcium.** Calcium regulates the tone of the smooth muscles lining blood vessels, and population studies have found that people who have sufficient dietary calcium have lower blood pressure than those who do not. Hypertension itself increases calcium loss from the body. Some, but not all, studies have found modest beneficial effects on blood pressure from calcium supplements. Sufficient calcium is important, in any case, for strong bones.

Supplements

Omega 3 Fatty Acids. Omega 3 fatty acids (docosahexaenoic and eicosapentaenoic acids) are found in oily fish. Studies are indicating that they may have specific benefits for many medical conditions, including hypertension. They appear to help keep blood vessels flexible and may also help protect the nervous system. The fatty acids are also available in supplements, although over-the-counter supplements are not regulated and their effects on health are not known. The long-term effects on blood pressure are not known.

Antioxidant Supplements. Antioxidants are any substances that help the body eliminate oxidants, or oxygen free radicals, which are damaging particles produced as part of the body's chemical processes. Some antioxidant supplements, including vitamins C and E and alpha-lipoic acid, are being studied for possible benefits in protecting against hypertension by preventing injury in the blood vessels. Alpha-lipoic acid for example prevented elevated blood pressure in rats. Vitamin C apparently also has specific benefits for hypertension by preventing dangerous effects on nitric acid, the substance that keeps arteries flexible.

Caffeine Intake, Alcohol, and Smoking

Everyone should quit smoking and, if they drink alcohol, should do so in moderation. In healthy people with normal blood pressure, drinking a couple of cups of coffee a day is unlikely to do any harm. Caffeine drinkers, however, might do better to choose tea, which may have beneficial nutrients, and people with existing hypertension should avoid caffeine altogether.

Weight Loss

An estimated 97 million adults in the US are overweight or obese. Weight gain seems to be a primary determinant in blood pressure increase, and weight loss may be even more important than salt restriction in controlling blood pressure. Losing weight, particularly in the abdominal area, immediately reduces blood pressure and helps reduce heart size. Weight loss, particularly accompanied by salt restriction, may allow patients with mild hypertension, even older people, to safely reduce or go off medications. The benefits of weight loss on blood pressure appear to be durable. [For more information, see *Weight Control and Diet*.]

Exercise

Positive Effects on Blood Pressure. Regular exercise helps keep arteries elastic, even in older people, which in turn ensures blood flow and normal blood pressure. Sedentary people have a 35% greater risk of developing hypertension than athletes do.

High-intensity exercise may not lower blood pressure as effectively as moderate intensity exercise. The following are some observations that support this approach:

- In one study, moderate exercise (jogging two miles a day) controlled hypertension so well that more than half the patients who had been taking drugs for high blood pressure were able to discontinue their medication.
- Studies have indicated that Yoga and Tai Chi, an ancient Chinese exercise involving slow, relaxing movements, may lower blood pressure almost as well as moderate-intensity aerobic exercises.
- Before exercising, people with hypertension should avoid caffeinated beverages, which increase heart rate, the workload of the heart, and blood pressure during physical activity.

Negative Effects. Each year an estimated 75,000 heart attacks (or 5% of all attacks) occur after heavy exertion, leading to 25,000 deaths. Older people and those with uncontrolled hypertension or other serious medical conditions should be very cautious. Studies report that older people who begin vigorous exercise are at a slightly higher than average risk for a heart attack during the first year, but over time, regular exercise is likely to be protective.

The following activities may pose particular dangers for high-risk individuals.

- Intense workouts (snow shoveling, slow jogging, speed walking, tennis, heavy lifting, heavy gardening). They tend to stress the heart, raise blood pressure for a brief period, and may cause spasms in the arteries leading to the heart.
- Competitive sports, which couple intense activity with aggressive emotions.

Effects of Anti-Hypertensive Drugs on Exercise. Certain antihypertensive medications, including diuretics and beta-blockers, can interfere with exercise capacity. ACE inhibitors or calcium-channel blockers are the best drugs for active individuals. However, patients who must take drugs that interfere somewhat with exercise capability should still adhere to an exercise program and consult a physician on how best to balance medications with exercise.

Good Sleep Habits

Insufficient sleep may raise blood pressure in patients with hypertension, placing them at increased risk of cardiovascular morbidity and mortality. According to a 1999 Italian study, blood pressure and heart rate were higher the morning after a sleep-deprived night compared with the morning after a full night of sleep. Stress hormone levels increase with sleeplessness, which can activate the sympathetic nervous system, a strong player in hypertension. Patients who have chronic insomnia or other severe sleep disturbances should consider consulting sleep experts if life style measures are not helpful. Physicians whose hypertensive patients are habitually poor sleepers should consider long-acting blood pressure medications to help counteract the increase in blood pressure that occurs in the early morning hours. [See *Insomnia*.]

Stress Reduction and Psychologic Therapy

Improving mood or relieving stress may be helpful. The following are some studies suggesting possible benefits:

- Studies suggest that stress reduction programs, such as those that use cognitive-behavioral therapy, can reduce blood pressure. In some cases people can even go off medication.

- Two small studies also reported that active religious faith was associated with healthy blood pressure levels, possibly indicating the combined benefits of a strong social network and reduced stress from spiritual activities. (Listening to religious services on the radio or watching them on television had no impact on blood pressure.)
- Even pets can provide healthful support. In a small 2001 study, medication had no effect on blunting blood pressure that increased in response to stress, but owning a pet did.
- In another study, a simple relaxation technique called transcendental meditation (TM), which involves silent repetition of a single sound, was shown to be effective in reducing blood pressure.

WHAT ARE THE GENERAL GUIDELINES FOR DRUG THERAPY FOR HIGH BLOOD PRESSURE?

Advantages of Drug Treatments

Aggressive drug treatment of long-term high blood pressure can significantly reduce the incidence of mental decline and death from heart disease and other serious physical effects of hypertension. In people with diabetes, controlling both blood pressure and blood glucose levels prevents serious complications of that disease. Anti-hypertensive agents may even prevent mental decline, including in people genetically susceptible to Alzheimer's disease.

Antihypertensive Categories

Dozens of antihypertensive drugs are available. They usually fall into the following categories:

- Diuretics, which cause the body to excrete water and salt.
- Beta-blockers, which block the effects of adrenaline, thus easing the heart's pumping action and widening blood vessels.
- ACE inhibitors, which reduce the production of angiotensin, a chemical that causes arteries to constrict.
- Vasodilators, which expand blood vessels.
- Calcium-channel blockers, which help decrease the contractions of the heart and widen blood vessels.

A single-drug regimen can often control mild to moderate hypertension. More severe hypertension often requires a combination of two or more drugs.

Recommendations for Specific Antihypertensives in Various Patient Populations

What to prescribe and who to prescribe it to are questions of on-going debate and investigation. In general, the following are some recommendations:

For Most Patients without Complicating Conditions. Beta-blockers, diuretics, or both are usually recommended as first-line treatment for patients without complications. These agents are

inexpensive, safe, and effective for such people. One analysis of many studies reported that diuretics were better than beta-blockers on all important points, including reducing heart attacks, strokes, and mortality rates. In fact, studies that have reported benefits were generally reporting on combinations of diuretics and beta-blockers. One study even suggested that the combination is less effective than diuretics alone in some people. Of concern, in fact, are studies reporting an increase in type 2 diabetes in people who take beta-blockers. (There was some concern that diuretics also carried this risk, but a 2000 study of 12,550 patients that confirmed a risk for beta-blockers found no evidence that diuretics posed the same danger.) Results on ACE inhibitors are so positive that some experts believe they should be added as first-line agents, particularly in people at high risk for heart failure.

For Older Adults. Diuretics continue to be the best choice for most older adults. A 1999 study reported, in fact, that diuretics may protect against dementia. Combinations may be needed. Because of a concern for drug interactions, some physicians are reluctant to give anti-hypertensive drugs to elderly patients with other risk factors for heart disease. Studies in 2001 reported, however, that the use of diuretics or beta blockers in this population, including those with isolated systolic hypertension, lowered their risks for heart attack, stroke, and heart failure.

For African Americans. Diuretics are also the best choice for many African Americans, who are more likely to be salt-sensitive and so respond well to these drugs. It had been widely thought that African-American patients usually did not respond to ACE inhibitors. A 2000 report indicated, however, that when taken in higher doses and when salt is restricted, ACE inhibitors are effective and also protect the kidneys in this population. (Calcium-channel blockers are often used in this population, but they do not appear to prevent either heart or kidney complications and they are very expensive.)

For Patients with Diabetes. Studies are now suggesting the people with diabetes need to control their blood pressure to 130/85 mm Hg or lower to protect the heart and help prevent other complications common to both diseases. In general, ACE inhibitors are the first choice for people with diabetes, since they also appear to protect the kidneys. In many cases, however, combinations are required to achieve blood pressure goals. In such cases, low-dose diuretics or calcium-channel blockers are added as needed.

For Patients with Obesity. Treating hypertension in people who are obese may present problems. Losing weight is critical, but some of newer and effective weight-loss agents, such as sibutramine (Meridia), may actually raise blood pressure. People with obesity also often have metabolic abnormalities that may be exacerbated by anti-hypertensive medications. ACE inhibitors and angiotensin receptor blockers may be helpful in such cases.

For Patients with Isolated Hypertension. Isolated high systolic pressure is usually treated with a diuretic. A long-acting calcium-channel blocker may be an alternative, particularly for elderly patients with diabetes, although some experts believe beta-blockers are still the best choice even in this group.

For Patients with Heart Failure. People with heart failure should be given ACE inhibitors and diuretics.

Pregnant Patients. Most women who develop high blood pressure only during pregnancy (gestational hypertension) are at low risk for preeclampsia and require no treatment other than monitoring. Treating pregnant women who have chronic, mild hypertension is probably not necessary, although no large studies have been done to confirm this. Many of the standard antihypertensive drugs, particularly ACE inhibitors, have potentially harmful effects to a fetus. The beta-blocker atenolol is also associated with adverse effects on the fetus; studies on other beta-blockers are conflicting. Treatment for preeclampsia ranges from monitoring to emergency treatments, depending on severity. It does not respond well to standard drug treatments. Preventive treatment using magnesium sulfate during labor is recommended by some experts.

Side Effects and Problems in Compliance

One of the most difficult issues that hypertensive patients face, particularly those with primary hypertension, is that the treatment may make them feel worse than the disease, which is almost always without symptoms. Patients face a life-long prospect of taking drugs with unpleasant side effects, reducing their salt intake, exercising, and watching their diet. Whatever the difficulties, compliance with a drug and lifestyle program is worth the effort and the cost. It is very important, in any case, to rigorously maintain a drug regimen.

Withdrawal from Antihypertensive Medications

Patients whose blood pressure has been well-controlled and who are able to maintain a healthy life style may choose to withdraw from hypertensive medications. They should do so in a step-down manner (gradual reduction) and be monitored regularly. Stopping too quickly can have adverse effects, including serious effects on the heart. The highest success rates are more likely in those who lose weight and reduce sodium intake and who are able to control their blood pressure within five years of an initial diagnosis and treatment with a single agent.

WHAT ARE THE SPECIFIC DRUG TREATMENTS USED FOR HIGH BLOOD PRESSURE?

Diuretics

For decades, diuretics, which cause reduction of water and sodium, have been the mainstays of antihypertensive therapy and are still considered the first choice by experts, especially for treating the elderly and African-American patients.

Benefits of Diuretics. Some of the benefits reported on diuretics include the following:

- Diuretics significantly reduce the risk for stroke; they may in fact be the most important anti-hypertensive agent for preventing this brain attack. They also appear to protect against stroke in people without hypertension.
- They are associated with lower risk for heart attack (although this is not as significant as their protection against stroke).
- They may also protect against blood clots.
- Diuretics may help reduce the rate of fractures in elderly people who have taken them for a long time.

Diuretic Types. Diuretics come in many brands and are generally inexpensive. Some need to be taken once a day, others twice a day.

Three primary types of diuretics exist:

- **Thiazides.** Thiazides often serve as the basis for high blood pressure treatment, either taken alone for mild to moderate hypertension or used in combination with other types of drugs. There are many thiazides and thiazide-related drugs; some common ones are chlorothiazide (Diuril), chlorthalidone (Hygroton), indapamide (Lozol), and hydrochlorothiazide (Esidrix, HydroDiuril).

- Loop diuretics. Loop diuretics block sodium transport in parts of the kidney; they act faster than thiazides and have a great diuretic effect. It is important therefore to control the medication and avoid dehydration and potassium loss. Loop diuretics include bumetanide (Bumex), furosemide (Lasix), and ethacrynic acid (Edecrin).
- Potassium sparing agents. Some potassium-sparing diuretics include amiloride (Midamor), spironolactone (Aldactone), and triamterene (Dyrenium).

Problems with Diuretics. The loop and thiazide diuretics deplete the body's supply of potassium, which, if left untreated, increases the risk for arrhythmias. Arrhythmias are heart rhythm disturbances that can, in rare instances, lead to cardiac arrest. In such cases, physicians will either prescribe lower doses of the current diuretic, recommend potassium supplements, or use potassium-sparing diuretics either alone or in combination with a thiazide. Potassium-sparing drugs have their own risks, which include dangerously high levels of potassium in people with existing elevated levels of potassium or in those with damaged kidneys. It should be noted, however, that, in general, all diuretics are more beneficial than harmful.

Common Side Effects. Common side effects of diuretics are fatigue, depression, irritability, urinary incontinence, loss of sexual drive, breast swelling in men, and allergic reactions. Diuretics can trigger attacks of gout. They may also increase the risk of gastrointestinal (GI) bleeding. Diuretics may raise cholesterol level and, used alone, they have no effect on enlarged heart size (hypertrophy). Arrhythmias can also occur as an interaction between diuretics and certain drugs, including some antidepressants, anti-arrhythmic drugs themselves, and digitalis.

Beta-Blockers

Benefits of Beta-blockers. Beta-blockers have the following benefits for people with high blood pressure:

- They affect the force and frequency of heartbeats.
- They slow certain metabolic processes.
- They ease the workload of the heart.

They are very effective in reducing blood pressure and have been associated with the following positive effects on the heart:

- They are now well known for reducing deaths from heart disease.
- In one study, the beta-blocker atenolol (Tenormin) reduced left ventricular hypertrophy and, when used with the diuretic chlorthalidone, was found to significantly reduce the risk for heart failure, particularly in patients at high risk for it.
- Studies are now finding that certain beta-blockers called nonselective beta-blockers (such as carvedilol) may improve heart function, symptoms, and survival in patients with mild to moderate heart failure.

Beta-blocker Brands. Many beta-blockers are now available, including propranolol (Inderal), acebutolol (Sectral), atenolol (Tenormin), betaxolol (Kerlone), carteolol (Cartrol), metoprolol (Lopressor), nadolol (Corgard), penbutolol (Levatol), pindolol (Visken), carvedilol (Coreg), and timolol (Blocadren). The drugs may differ in their effects and benefits.

Problems with Beta-Blockers. On the downside, studies are reporting that, when used alone, they

may reduce blood pressure, but they do not reduce mortality rates. And, of concern are studies reporting an increase of type 2 diabetes in people who take beta blockers. Because they can narrow bronchial airways and constrict blood vessels, patients with asthma, emphysema, and chronic bronchitis should avoid them whenever possible. Some beta-blockers tend to lower HDL cholesterol (the beneficial cholesterol) by about 10%; the effect is most marked in smokers.

Common Side Effects. Fatigue and lethargy are the most common psychologic side effects. Some people experience vivid dreams and nightmares, depression, and memory loss. Dizziness and lightheadedness may occur upon standing. Exercise capacity may be reduced. Other side effects may include coldness in the extremities (that is, legs and toes; arms and hands), asthma, decreased heart function, gastrointestinal problems, and sexual dysfunction. If side effects occur, the patient should call a physician, but it is extremely important not to stop the drug abruptly. Angina, heart attack, and even sudden death have occurred in patients who discontinued treatment without gradual withdrawal.

Angiotensin Converting Enzyme Inhibitors

Angiotensin converting enzyme (ACE) inhibitors block the effects of the angiotensin-renin-aldosterone system, which is thought to have many harmful effects on the heart and blood vessels. These agents have the following health benefits.

- They may be very important agents for patients with diabetes. They may help protect the kidneys and the hearts of these patients, independently of their effect on blood pressure.
- They may help prevent changes in the heart muscle cells leading to heart failure, specifically in reducing enlargement of the left side of the heart, a major risk factor for heart failure.
- ACE inhibitors can improve a patient's odds of surviving a heart attack.

Brands. ACE inhibitors include captopril (Capoten), enalapril (Vasotec), quinapril (Accupril), benazepril (Lotensin), ramipril (Altace), perindopril (Aceon), and lisinopril (Prinivil, Zestril).

Problems with ACE Inhibitors. ACE inhibitors are expensive and, in general, effective only in combination with other anti-hypertensive agents. Although ACE inhibitors are now recommended for heart failure patients, of great concern is research suggesting that aspirin (and other so-called NSAIDs) *increases* the risk for heart failure in patients taking ACE inhibitors. NSAIDs are commonly used by patients with heart disease to prevent heart attacks. Although ACE inhibitors can protect against kidney disease, they also increase potassium retention in the kidneys. This increases the risk for cardiac arrest if levels become too high. Because of this action, they are not generally given with potassium-sparing diuretics or potassium supplements.

Side effects include an irritating cough, excessive drops in blood pressure, and allergic reactions. (In some people, the cough is intolerable. Iron supplements or the drug picotamide may prove to help reduce the frequency of coughs.) One rare but severe side effect, granulocytopenia, which is an extreme reduction in white blood cells, has been observed.

Vasodilators

Vasodilators, which widen blood vessels, are often used in combination with a diuretic or a beta-blocker. They are almost never used by themselves. Representative vasodilators include hydralazine (Apresoline), clonidine (Catapres, available in tablets or as a skin patch), and Minoxidil (Loniten). Some of these drugs should be used with caution or not at all in people with angina or who have had a heart attack.

Calcium-Channel Blockers

Calcium-channel blockers, or calcium antagonists, have an immediate effect on reducing blood pressure. Despite this, studies continue to report that they are inferior to the other anti-hypertensive agents in preventing heart events, stroke, or kidney complications. They are also more expensive than diuretics or beta-blockers. There is even some evidence that they pose higher risks for heart attack, heart failure, and other major adverse cardiovascular events than do other agents. Some experts now believe they should be used only as a last resort.

Calcium-Channel Blocker Brands. Calcium-channel blockers approved for high blood pressure include diltiazem (Cardizem, Dilacor), amlodipine (Norvasc), felodipine (Plendil), isradipine (DynaCirc), verapamil (Calan, Isoptin, Verelan), nisoldipine (Sular), nicardipine (Cardene), and nifedipine (Adalat, Procardia). Others under investigation are lercanidipine (Zanidip) and nitrendipine.

Side Effects. Side effects vary among different preparations. Most drugs can cause fluid accumulation in the feet, along with constipation, fatigue, impotence, gingivitis, flushing, and allergic symptoms. Interactions with foods and drugs also differ depending on the drug. For example, verapamil interacts with digoxin, but diltiazem does not. Overdose on many of these agents can cause a severe drop in blood pressure. Note: Grapefruit and Seville, or sour, oranges, boosts the effects of calcium-channel blocking drugs, which are often used for hypertension. Seville oranges are often used in marmalade or other condiments. (Regular oranges do not appear to pose any hazard.)

Angiotensin-Receptor Blockers

Drugs known as angiotensin-receptor blockers (ARBs), also known as angiotensin II receptor antagonists, are similar to ACE inhibitors in their ability to lower blood pressure. ARBs may have fewer or less severe side effects, including cough. It is not yet known if ARBs protect the heart, benefits found with ACE inhibitors. Many comparison studies are underway. In a very promising 2002 study, the ARB losartan reduced the risk of heart attack, death, and stroke more effectively than the beta blocker atenolol. This is the first study finding any drug superior to a beta blocker for achieving these results. They may even improve quality of life when added to a drug regimen--a finding also found with no other anti-hypertensive drugs. In fact, evidence suggests they may improve sexual function in men. They also have positive effects on the kidneys.

Brands. Brands include losartan (Cozaar, Hyzaar), candesartan (Atacand), telmisartan (Micardis), eprosartan (Teveten), irbesartan (Avapro), and valsartan (Diovan). In one study, eprosartan was more effective than enalapril in reducing systolic pressure in African American patients. A combination medication containing ARBs and the diuretic hydrochlorothiazide (Diovan HCT, Atacand HCT) is also available.

Alpha Blockers

Alpha blockers, such as doxazosin (Cardura) and prazosin (Minipress), widen arterioles and veins and thereby reduce blood pressure. However, a major study on doxazosin was stopped when it was associated with a higher risk of chest pain, stroke, and congestive heart failure compared with a diuretic. At this time, until more is known, they are still recommended for reducing blood pressure if no other agents are effective.

Experimental Agents

Neutral Endopeptidase Inhibitors (NEPs). Neutral endopeptidase inhibitors (NEPs) are similar to ACE inhibitors. Their primary action is to produce higher levels of an enzyme called atrial natriuretic peptide, which has the following effects:

- It opens blood vessels.
- Induces fluid elimination.
- Opposes the actions of the compensating systems responsible for ongoing damage of the failing heart.

Agents under investigation include omapatrilat (Vanlev), candoxatril, and ecadotril. Results of two 2001 studies comparing omapatrilat with ACE inhibitors suggest that the NEP may offer some advantages in patients with heart failure. However, the agents are not indicated for hypertension at this time after patients with high blood pressure reported a higher risk (0.7%) for angioedema, a sudden and severe allergic reaction that causes swelling in the eyes, mouth, and may close off the throat. (ACE inhibitors also can cause this reaction but the risk is lower.) Other side effects are very similar to those of ACE inhibitors, including coughing.

WHERE ELSE CAN HELP BE FOUND FOR HIGH BLOOD PRESSURE?

National Heart, Lung, and Blood Institute, Information Center, P.O. Box 30105, Bethesda, MD 20892. Call (301-496-4000) or (<http://www.nhlbi.nih.gov/hbp/>)
A part of the National Institute of Health, this organization offers printed information.

The web site also includes the DASH diet. For latest expert guidelines on hypertension (<http://www.nhlbi.nih.gov/health/prof/heart/index.htm#hbp>)

American College of Cardiology, Heart House, 9111 Old Georgetown Rd., Bethesda, MD 20814-1699. Call (800-253-4636) or (301-897-5400) or (<http://www.acc.org/>)

American Heart Association. 7272 Greenville Ave., Dallas, Texas 75231-4596.

Call (800-242-8721) or (www.americanheart.org).

This is a primary source of information about heart problems. The organization will send free pamphlets and reading material, including useful diet information and locations of local representatives.

The American Society of Hypertension. 515 Madison Ave, Suite # 1212, New York, NY 10022.

Call (212-644-0650) or (<http://www.ash-us.org/>)

An extremely information site on the heart. (<http://www.heartinfo.org>)

Information on the DASH diet

(<http://www.nhlbi.nih.gov/health/public/heart/hbp/dash/>)

Offers a useful heart risk evaluation test. (<http://www.heartriskevaluations.com/>)

Addresses health issues for African Americans (<http://blackhealthcare.com/>)

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