High Blood Pressure

High blood pressure (sometimes called hypertension) has been nicknamed the silent epidemic because of its far-reaching consequences. Today, nearly one of every three American adults (65 million people) has high blood pressure. In 2002, high blood pressure was implicated in almost 50,000 deaths. It is the 13th largest cause of death in the United States (American Heart Association 2005). Amazingly, studies based on the well-known Framingham Heart Study have estimated that a 55-year-old person who has normal blood pressure has a 90-percent lifetime risk of getting high blood pressure (Vasan RS et al 2002). High blood pressure has been associated with damage to blood vessels in the eyes, heart, brain, and kidneys (Wong ND et al 2005).

Sadly, however, millions of Americans who think their blood pressure is under control may be wrong. Numerous studies have shown that most people treated with antihypertensive drugs (drugs that lower blood pressure) still have higher-than-optimal blood pressure (American Heart Association 2005; Hyman DJ et al 2002). According to physicians at the Baylor College of Medicine, only 27 percent of Americans who have high blood pressure have their blood pressure effectively controlled to levels below 140 mm Hg (Hyman DJ et al 2002). The problem is worse among elderly women. A study published in 2005 in the Journal of the American Medical Association found that the high blood pressure of 77 percent of women older than 80 years was not sufficiently controlled even if they were under a physician's care (Lloyd-Jones DM et al 2005).

Perhaps most alarming of all, in many of these studies, the optimal blood pressure target was identified as less than 140/90 mm Hg, the cutoff level normally used to diagnose high blood pressure. However, studies have shown that a level of less than 120/80 mm Hg is even safer. This means that millions of Americans are candidates for blood pressure control even though they have not been identified as having high blood pressure (Chobanian AV et al 2003).

Because high blood pressure is a multifactorial problem, effective management is rarely achieved through one drug. Instead, optimal management often requires a broad-based approach that includes both pharmaceutical and nutritional components, along with regular self-monitoring of blood pressure. Compelling evidence indicates that many conditions that lead to and sustain high blood pressure can be corrected through an integrative approach emphasizing lifestyle modification, pharmaceutical agents, and nutritional support. These approaches will be discussed in detail throughout this chapter.

WHAT IS HIGH BLOOD PRESSURE?

Blood pressure is a measurement of the force exerted by blood as it flows through the arteries. High blood pressure occurs when there is an increase of force against the arterial wall, with potentially damaging consequences. Among adults, a normal blood pressure measure is considered to be below 120/80 mm Hg. Any blood pressure reading higher than this reflects elevated blood pressure.

The force of blood pressure is measured in two stages: when the heart is contracting (systolic pressure) and relaxing (diastolic pressure). Blood pressure is always expressed in pressure units of millimeters of mercury (mm Hg), and written as systolic over diastolic pressure. For example, a blood pressure reading of 120/80 mm Hg would mean a systolic pressure of 120 mm Hg and a diastolic pressure of 80 mm Hg.

Table 1 gives the four blood pressure classifications according to the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure:

Table 1. General Blood Pressure Guidelines for Individuals With No Other Known Disease

Blood Pressure Classification	Systolic (mm Hg)	Diastolic (mm Hg)
Normal	Less than 120	Less than 80
Prehypertension	120 – 139	80 – 89
Stage 1 hypertension	140 – 159	90 – 99
Stage 2 hypertension	More than 159	More than 99

Source: Chobanian AV et al 2003

Physicians classify hypertension as either essential or secondary. Essential hypertension, which accounts for about 80 percent of cases, has no known cause. Secondary hypertension is caused by another condition (Table 2):

Table 2. Causes of Secondary Hypertension

Renal:

- Secretion of excess aldosterone (a steroid hormone secreted by the adrenal cortex that regulates salt and water balance)
- Kidney disease
- Atherosclerotic narrowing of the renal artery (the major artery supplying the kidney)

Endocrine:

- Oral contraceptives
- Hormonal changes or imbalances
- Adrenocortical hyperfunction, such as Cushing's disease and syndrome, primary hyperaldosteronism, hereditary or congenital syndromes
- Acromegaly (a disease caused by the secretion of excessive amounts of growth hormone)

Neurogenic:

- Psychogenic (of mental or emotional origin)
- Damage to the central nervous system, such as damage to the spinal cord, increased intracranial pressure, or tumors

Miscellaneous:

- Sleep apnea
- Constriction or narrowing of the aorta
- High concentrations of calcium in the bloodstream
- Carcinoid tumors that secrete serotonin
- Toxemia of pregnancy

Source: Kasper DL et al 2005.

High blood pressure is dangerous in part because it rarely causes symptoms at first but is a risk factor for many other conditions. According to data gathered as part of the Framingham Heart Study, people who have high blood pressure are at significantly increased risk of developing dangerous conditions related to high blood pressure. In this study, for every 10 mm Hg increase in systolic pressure, there was a doubling of the risk of having a heart attack or stroke or of having kidney failure (Kannel WB 2003; Klag MJ et al 2003; Wolf PA 2003).

Although it rarely happens, high blood pressure occasionally causes symptoms such as dizziness, vertigo, tinnitus, dimmed vision, fatigue, palpitations, impotence, and even fainting (Kasper DL et al 2005). Extremely elevated blood pressure can cause a headache upon awakening or, even more rarely, nosebleed, nausea, or vomiting (Swales JD 1994).

THE DOUBLE DANGER OF HIGH BLOOD PRESSURE AND ENDOTHELIAL DYSFUNCTION

In recent years, researchers have made tremendous strides in understanding the connection between high blood pressure and various cardiovascular diseases. It turns out that elevated blood pressure damages arteries at a basic level—the endothelium.

Arteries are made up of three layers. The outer layer is mostly connective tissue that provides support to the inner two layers. The middle layer is smooth muscle that contracts and expands to facilitate circulation and maintain optimal blood pressure. The inner layer of arteries is known as the endothelium. This layer is composed of a thin layer of cells that protects the integrity of the artery, promotes blood clotting in case of injury, communicates with the smooth muscle layer, and helps prevent toxins such as low-density lipoprotein (LDL) from penetrating into the middle of the artery.

When the endothelial layer is damaged, it can result in a thickened arterial wall and the abnormal aggregation of white blood cells. The accumulation of lipids such as LDL and triglycerides in the area can also occur. Sensing an injury, the endothelium stimulates a healing response that ultimately leads to an atherosclerotic plaque. Endothelial dysfunction is linked with the development of atherosclerosis, a leading cause of cardiovascular events (Kannel WB 1995; Collins R et al 1990).

High blood pressure and endothelial dysfunction are closely associated. Elevated blood pressure has been shown to contribute significantly to endothelial dysfunction. Physicians routinely measure the effects of high blood pressure by looking at target organ damage. In other words, treatment decisions are based on how much damage is being caused to organs such as the kidneys, eyes, or heart by elevated blood pressure. In recent years, the endothelium has been added to the list of target organs that can be

damaged by high blood pressure (Felmeden DC et al 2005; Hausberg M et al 2005). High blood pressure has been shown to cause functional alterations in the endothelium that, in turn, are associated with decreased arterial mobility and increasing stiffness in the arterial wall (Hausberg M et al 2005).

This stiffness can have serious consequences. Arteries are far from passive tubes through which blood flows. Healthy arteries actually contract with the heart to help maintain hemostasis and regulate blood pressure. When the arteries can no longer contract sufficiently because they are too stiff, additional stress is placed on the heart's main pumping chamber, the left ventricle. As a result, the left ventricle may be enlarged (left ventricular hypertrophy) (Palmieri V et al 2005). Left ventricular hypertrophy is often the first sign that damage from uncontrolled high blood pressure has started to occur (Kannel WB et al 2005). If left ventricular hypertrophy is not treated, it may evolve into congestive heart failure.

The connection between endothelial dysfunction and high blood pressure is strong enough that progressive researchers believe endothelial function should be routinely measured among people who have high blood pressure (Cohuet G et al 2006; Felmeden DC et al 2005; Hausberg M et al 2005). By the time symptoms develop, significant damage has already been done. If endothelial dysfunction is diagnosed early, however, treatment can mitigate the damage (Cohuet G et al 2006).

CONVENTIONAL TREATMENT OF HIGH BLOOD PRESSURE

Standard treatment of high blood pressure includes lifestyle modifications such as losing weight and cutting down substantially on salt intake. It may also include using prescription medications. Physicians may prescribe two or more classes of antihypertensive drugs in an effort to adequately control blood pressure (Fahey T 2004).

There are six primary classes of antihypertensive drugs:

- **Thiazide diuretics**. Thiazide or thiazidelike diuretics act on the kidneys to help rid the body of salt and water through urination. With less fluid in the body, blood volume goes down, which results in a fall in blood pressure (Fahey T 2004). Adverse effects of thiazide diuretics include sexual dysfunction, glucose intolerance, gout, low postassium level (hypokalemia), and low sodium level (hyponatremia).
- **Beta blockers**. Studies show that beta blockers are uniquely effective for treating high blood pressure in individuals who have had a heart attack because they decrease both the risk and the severity of a second heart attack. However, these drugs may worsen blood glucose control, elevate triglyceride level, and lower high-density lipoprotein (HDL—sometimes called the “good” cholesterol).
- **Angiotensin-converting enzyme (ACE) inhibitors**. Angiotensin is made when the kidneys receive a signal to raise blood pressure. ACE inhibitors prevent or reduce the production of angiotensin, which keeps vessels from narrowing and helps them relax. This relaxation lowers blood pressure and increases the supply of blood and oxygen to the heart.
- **Angiotensin II receptor blockers (ARBs)**. ARBs work similarly to ACE inhibitors. However, instead of inhibiting the production of the angiotensin enzyme in the kidneys, they block the effects of angiotensin on cell receptor membranes. They are more effective than ACE inhibitors in treating some people who have high blood pressure. They are particularly useful for treating high blood pressure in individuals who cannot tolerate ACE inhibitors well. Adverse effects of ARBs can include headache, drowsiness, diarrhea, and a metallic or salty taste in the mouth.
- **Calcium channel blockers (CCBs)**. CCBs affect the transport of calcium into the cells of the heart and blood vessels, causing blood vessels to relax. This relaxation increases the blood and oxygen supply to the heart, lowers blood pressure, and reduces the heart’s workload. Physicians often recommend CCBs to treat high blood pressure in women who have pregnancy-induced high blood pressure, elderly patients, patients who have a history of angina (restriction of blood flow in the coronary arteries), or patients of African or Caribbean descent. CCBs are not a good choice for patients who have had a heart attack or who have congestive heart failure. Adverse effects of CCBs include constipation, swelling of the lower part of the legs, flushing, or headache.
- **Alpha blockers**. Alpha blockers block alpha receptors in vascular smooth muscle, preventing the uptake of catecholamines, which are produced in response to stress. This blocking mechanism permits blood vessel dilation and allows blood to flow more freely. Alpha blockers are not advised for those who have a history of (or are at risk for) congestive heart failure. Alpha blockers tend to interfere with the hemodynamic adjustments the body has to make when a person goes from sitting or lying down to standing. People using alpha blockers may experience a drop in blood pressure (called orthostatic hypotension) when they go from sitting or lying down to standing. Other common adverse effects include stuffy nose and dizziness.

Lifestyle Management of High Blood Pressure

If you have high blood pressure, it is important to understand the standard medical treatment, so that you and your physician can make the best decisions for your health.

Men and women with prehypertension (120-139/80-89 mm Hg) should have a goal of lowering their blood pressure to 115/75 mm Hg, unless they have chronic kidney disease or diabetes, in which case the goal should be less than 130/80 mm Hg (Chobanian AV et

al 2003). Prehypertension can be treated with lifestyle modifications, unless the individual has chronic kidney disease or diabetes, in which case antihypertensive drugs are often recommended (Chobanian AV et al 2003).

People with high blood pressure or those who are prehypertensive can lower their blood pressure by losing weight and increasing physical activity (especially by doing aerobic activity for at least 30 minutes every day). The following major dietary modifications can also be helpful:

1. Initiate the DASH (Dietary Approaches to Stop Hypertension) eating plan, which increases dietary potassium, fiber, and calcium intake through a diet rich in fruits, vegetables, low-fat dairy products, whole grains, and foods with reduced saturated fat and reduced total fat content (Chobanian AV et al 2003). The DASH plan is also rich in magnesium, a crucial mineral that may help promote optimal blood pressure levels (Geleijnse JM et al 2004).
2. Limit alcohol consumption to no more than two drinks a day for men and no more than one drink a day for women (Chobanian AV et al 2003).
3. Reduce salt intake to no more than 2.4 grams (g) of sodium or 6 g of sodium chloride each day.

NATURAL WEAPONS AGAINST HIGH BLOOD PRESSURE: A TRINITY OF NUTRIENTS

Blood pressure is controlled by a complex interplay of factors such as diet, genetics, response to stress, medications, and other underlying health conditions. Enlightened health care practitioners and their patients are discovering that inadequately controlled blood pressure requires a multifactorial strategy. An optimal strategy employs a combination of nutritional and pharmaceutical options to offer a comprehensive approach for normalizing blood pressure. This makes more sense considering that a large number of Americans do not achieve adequate blood pressure control on blood pressure medication alone.

In recent years, researchers have discovered a trio of nutrients that work together to help lower blood pressure. The following nutrients contain antioxidants and compounds that help reduce oxidative damage and relax the arteries:

Casein peptide. While searching for a natural agent to help optimize blood pressure, researchers hydrolyzed (or split) the milk protein known as casein and isolated the C12 peptide. Clinical studies now show that the C12 peptide is a natural ACE inhibitor that has specific blood pressure–lowering effects (Karaki H et al 1990).

A small study conducted in the United States demonstrated C12 peptide's effectiveness in helping to normalize high blood pressure. This randomized, double-blind, placebo-controlled, crossover study examined 10 men and women (average age, 50 years) who had an average blood pressure of 152/98 mm Hg and were not taking antihypertensive medications. Each subject took a placebo for 6 days and then a single dose of either 200 mg or 400 mg C12 peptide. Blood pressure was monitored via a small blood pressure unit that each subject wore throughout the day. In the 200-mg and 400-mg treatment groups, systolic pressure declined significantly by an average of 2.4 mm Hg and 4.5 mm Hg, respectively, while diastolic pressure dropped by an average of 4.4 mm Hg and 6.5 mm Hg, respectively (Townsend RR et al 2004). The study results demonstrate that the C12 peptide has a notable impact on blood pressure after only a single dose.

A Japanese study sought to evaluate the longer-term benefits of supplementing with the C12 peptide. Eighteen mildly hypertensive subjects, with a mean blood pressure of 141/99 mm Hg, received 200 mg/day of the C12 peptide for 4 weeks. The researchers recorded significant reductions—4.6 mm Hg in systolic blood pressure and 6.6 mm Hg in diastolic blood pressure. Blood pressure declined gradually over the 4-week study period. A gradual decline is indicative of a healthy decline, as opposed to a dramatic drop that could cause dizziness or fainting. When treatment was halted, the subjects' blood pressure began to return to the baseline levels that were recorded prior to treatment. The researchers also observed that the C12 peptide appears to have long-lasting effects. Even 2 weeks after treatment ended, diastolic blood pressure levels were still significantly lower than at baseline levels (Sekiya S et al 1992). No unfavorable side effects were reported.

The C12 peptide is not recommended for people who are allergic to dairy products and, like other ACE inhibitors, pregnant women should not take the C12 peptide.

Grape seed extract. The C12 peptide is not the only natural agent that effectively supports healthy blood pressure levels. Grape seed extract, which is already known to have a wealth of health benefits, contains high concentrations of polyphenols, potent antioxidants that naturally increase the dilation (widening) of blood vessels. This dilation naturally increases blood flow while decreasing blood pressure (Siva B et al 2006).

A recent study sought to ascertain the effects of administering grape seed extract to prehypertensive subjects. For 4 weeks, 24 patients who had a mean blood pressure of 130/79 mm Hg were given placebo or 150 mg or 300 mg of a standardized, polyphenol-rich grape seed extract. Both doses of grape seed extract significantly reduced the subjects' blood pressure compared to baseline levels. The researchers concluded that grape seed extract may be beneficial in lowering the blood pressure of people who are prehypertensive (Siva B et al 2006).

In addition to benefiting individuals who are prehypertensive, grape seed extract may help improve impaired endothelial function, an initiating factor in heart disease. In an important laboratory study, grape seed extract helped to inhibit the synthesis of a protein associated with endothelial dysfunction and mortality, while promoting the dilation of blood vessels (Corder R et al 2004). These findings led the researchers to propose that grape seed extract may be a critical nutrient for restoring impaired endothelial function, protecting against cardiovascular disease, America's number-one killer.

Grape seed extract is considered safe and is well tolerated. A formal toxicity assessment that evaluated the impact of chronic high doses of grape seed extract in rats found no adverse treatment-related changes (Bentivegna SS et al 2002).

Pomegranate extract. Pomegranates are fast becoming known as one of the healthiest foods we can eat, largely because of their beneficial effects on cardiovascular health (Aviram M et al 2001). While many people drink pomegranate juice, pomegranate extract may hold even greater benefits.

The benefit of supplementing with pomegranate extract (rather than drinking the juice or eating the fruit) is that the extract, unlike the juice, contains virtually no sugar or calories, and requires no refrigeration to maintain optimal quality. Interestingly, commercial pomegranate juice and whole fruit extracts contain beneficial phytonutrients that are not obtained from eating the pomegranate fruit itself (Gil MI et al 2000). In particular, punicalagins, the primary antioxidant found in pomegranates, are concentrated in the husk and in the juice of the whole fruit (Gil MI et al 2000).

While some pomegranate products are standardized to contain high levels of ellagic acid (an antioxidant and phytonutrient that has anticancer potential), focusing on ellagic acid alone is unlikely to provide optimal synergy among the phytonutrients found within pomegranates (Lansky EP 2006). Emerging research suggests that products standardized in punicalagins confer the greatest benefit by providing the highest levels of pomegranate antioxidants.

Scientists are now studying pomegranate extract to uncover the many advantages it may have for human health. Pomegranates contain an array of beneficial phytonutrients such as phenolic compounds and tannins, including punicalagins, which are unique to pomegranates. Several compounds in pomegranates are potent antioxidants and ACE inhibitors (Aviram M et al 2001). Researchers have determined that oxidative stress can disrupt the balance of vasoconstricting and vasodilating biochemicals in the endothelium, contributing to high blood pressure and endothelial dysfunction. By quenching oxidative stress, antioxidants may help prevent vasoconstriction, lower blood pressure, and promote healthy endothelial function (Kitiyakara C et al 1998). Scientists believe that pomegranates, a potent source of antioxidants, may promote healthy blood pressure levels by enhancing the activity and preventing the degradation of an important vasodilating agent. These benefits may also lead to improvements in endothelial function (Ignarro LJ et al 2006).

ADDITIONAL NUTRITIONAL SUPPORT

While the three nutrients discussed can form the backbone of a natural approach to lowering blood pressure (and may work in conjunction with blood pressure–lowering medication), there are many other nutrients that may also help lower blood pressure.

Minerals. Magnesium works in conjunction with calcium, potassium, vitamin D, and other nutrients to control the contraction and relaxation of muscles. It is very important to maintain the correct balance for proper blood pressure maintenance. A Canadian study concluded that daily intake of calcium, potassium, and magnesium is essential in the management of high blood pressure (Touyz RM et al 2004). The study recommended calcium, potassium, and magnesium supplementation for people who don't currently have high blood pressure but are at risk of developing it.

Based on a large body of evidence, the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure also recommends increasing your intake of potassium, calcium, and magnesium to control blood pressure (National Institutes of Health 2006). Calcium supplementation should always be complemented with magnesium because calcium stimulates muscle contraction, and magnesium is needed for relaxation. Supplemental potassium should only be taken on the advice of a physician because proper potassium balance is based on individual blood test values. For more information, see the Safety Caveats section of this chapter.

Magnesium seems especially beneficial for heart patients. Low levels of magnesium are associated with an improper balance of sodium, potassium, and calcium. Magnesium deficiency is frequently documented in alcoholics, in patients who have high blood pressure or congestive heart failure, and in people who have had a heart attack (Kurabayashi M 2005). Multiple studies recommend that people who have high blood pressure (or who are at risk of developing it) maintain an adequate intake of magnesium (Touyz RM et al 2004). In recent years, researchers in Japan have been focusing on the benefits of magnesium because magnesium intake has diminished in Japan as the traditional Japanese diet of seafood and vegetables is being replaced by a diet high in fat and animal products (Kumeda Y et al 2005).

Researchers have found that:

- Magnesium is necessary for the activity of chemicals that lower cholesterol in the body, which contributes to its ability to fight atherosclerosis and endothelial dysfunction (Inoue I 2005).
- Women taking magnesium supplements have a significantly lower risk of developing metabolic syndrome (Song Y et al 2005).
- A diet low in magnesium is associated with a potassium deficiency, which alters the balance of sodium and potassium in favor of sodium. Also, a low magnesium level is associated with high intracellular calcium levels, which contributes to vasoconstriction and high blood pressure (Rosanoff A 2005). The author of this study recommended long-term, adequate intake of magnesium to ensure a healthy balance of potassium to sodium and of magnesium to calcium.

For people who are taking diuretics or have kidney problems, retaining an adequate amount of magnesium in the body is more difficult. Most Americans get far less magnesium from their diets than they need, so supplementation is a good option. There is some evidence that magnesium improves insulin sensitivity, which decreases the risk of developing high blood pressure (Guerrero-Romero F et al 2004). Another study showed that taking magnesium along with beta blockers significantly reduced blood pressure compared to taking beta blockers alone (Wirell MP et al 1994).

Vitamin E. Vitamin E is an antioxidant that detoxifies (reduces) strong oxidants in the body. It stabilizes cell membranes and regulates oxidation reactions, as well as protects polyunsaturated fatty acids and vitamin A. Meta-analyses have suggested that vitamin E may be particularly beneficial for patients who have high blood pressure or cardiovascular problems (Taber M 2006). Small studies have shown that vitamin E, even when taken at fairly low doses, increases nitric oxide synthase activity, which leads to vessel dilation and lowered blood pressure. A larger study reported a significant reduction in systolic blood pressure when subjects took 600 mg/day of vitamin E (Galley HF et al 1997). A study of 895 participants reported that vitamin E supplementation might have an antihypertensive effect even among those who get an adequate supply from their diets (Mayer-Davis EJ et al 2002).

Vitamin C. Vitamin C, also known as ascorbic acid, is an antioxidant that protects other biochemicals from oxidation by being oxidized itself. A small, well-controlled study of 39 participants showed that treatment with vitamin C significantly lowered blood pressure after 30 days, while placebo had no effect (Duffy SJ et al 1999). Although specific mechanisms have not been identified for vitamin C, it may be that it can help promote vessel dilation. As an antioxidant, it may also enhance the synthesis or prevent the destruction of nitric oxide, which directly helps blood vessels dilate and lower blood pressure (Khosh F et al 2001).

Omega-3 fatty acids. Omega-3 fatty acids are essential fatty acids, which means the body needs these substances but is unable to manufacture them. They must come from food, such as cold-water fish or flaxseed. Studies that have looked at the incidence of high blood pressure and omega-3 fatty acids in large populations suggest that diets high in omega-3 fatty acids or dietary

supplementation with omega-3 fatty acids can reduce blood pressure (Hirafuji M et al 2003). It appears that omega-3 fatty acids have a direct widening effect on blood vessels (Din JN et al 2004).

Coenzyme Q10 (CoQ10). CoQ10 is found in the mitochondria, which is the energy-producing center of cells. It is involved in making the molecule known as adenosine triphosphate (ATP). ATP is the cell's major energy source. CoQ10 also serves as an antioxidant. Some studies have suggested that CoQ10 may stimulate the immune system and increase resistance to disease (Folkers K et al 1988), as well as lower blood pressure (Hodgson JM et al 2002). One theory to explain the effectiveness of CoQ10 on blood pressure concerns its role as an antioxidant. Studies of diabetics have found that increased oxidative stress may underlie endothelial dysfunction by decreasing production and increasing consumption of nitric oxide, as well as generating free radicals. CoQ10 has been found to mitigate this effect by reducing oxidative stress, thereby normalizing nitric oxide production and consumption (Chew GT et al 2004; Watts GF et al 2002).

CoQ10 has been widely studied in patients who have congestive heart failure and take hypertensive medications. One study of 109 patients with essential hypertension who supplemented their diets with 225 mg/day of CoQ10 in addition to their hypertensive medication, found that participants gradually were able to decrease the need for drug therapy during the first 1 to 6 months. Fifty-one percent of the participants were able to completely discontinue some of their medications an average of 4.4 months after they began CoQ10 supplementation (Langsjoen P et al 1994).

Another study evaluating CoQ10 as a dietary supplement found that it significantly lowered blood pressure by a mean of 17.8 mm Hg in participants. It was also well tolerated and safe. The study broadly concluded that CoQ10 has a beneficial therapeutic effect as an alternative or complementary treatment of high blood pressure (Burke BE et al 2001). Studies indicate it may take 4 to 12 weeks before the blood pressure–lowering benefit is seen (Khosh F et al 2001).

L-arginine. L-arginine is a basic amino acid found in many proteins and is essential to growth and health maintenance in all vertebrates. There is abundant evidence that it also plays an important role in maintaining endothelial function and blood vessel dilation and in reducing blood pressure. L-arginine is a precursor to nitric oxide, which is essential for the proper function of the endothelium. L-arginine has been shown to boost levels of nitric oxide, which reduces endothelial dysfunction (Boger RH et al 2005; Rasmussen C et al 2005). This helps maintain vascular integrity (Boger RH et al 2005).

Animal studies that reported L-arginine lowers blood pressure provided a launching pad for human studies of L-arginine. One human study found that diets naturally rich in foods containing L-arginine (and diets supplemented with L-arginine) lead to a decrease in blood pressure (Siani A et al 2000).

Taurine. Taurine is a sulfur-containing amino acid that is classified as conditionally essential, since the body can produce it from other amino acids, such as cysteine, based on the body's needs. A study was performed on 10 young adults who were borderline hypertensive and took 6 g/day of taurine. Their average systolic blood pressure decreased 9 mm Hg (Fujita T et al 1987). Researchers speculate that taurine may modulate an overactive sympathetic nervous system (Militante JD et al 2002).

Soy protein. Soy is a high-protein, low-fat food derived from soybean. Protein comprises nearly half its calories, and carbohydrate and fat roughly equal the other half. Soy holds only a trace amount of saturated fat and no cholesterol. In search of a natural approach to treating high blood pressure, a recent study addressed the effects of increased dietary soy protein on blood pressure. Researchers confirmed previous studies that showed higher intake of vegetable protein lowers blood pressure (He J et al 2005).

Data from the Shanghai Women's Health Study found higher intake of soy was associated with lower levels of blood pressure (Yang G et al 2005). The mechanism responsible for the reduction of blood pressure is not well understood. One plausible explanation concludes that soy protein (or an overall increase in protein) may lead to dietary arginine-induced increases in nitric oxide, which helps dilate blood vessels and improve endothelial function (Cuevas AM et al 2004).

Garlic. Many patients who have high blood pressure use garlic to lower high blood pressure or help prevent fatty plaque buildup in the arteries and blockages that can lead to heart attack or stroke. The sulfur compounds, especially allicin, are the active ingredients in garlic (Tattelman E 2005). More medical research is underway to assess the usefulness of garlic to prevent heart disease, stroke, and high blood pressure (Edwards QT et al 2005).

Hawthorn (Crataegus oxyacantha; Crataegus monogyna). Hawthorn berries have been used traditionally for cardiovascular health. Hawthorn appears to mildly reduce blood pressure, possibly via blood vessel dilation (Chang WT et al 2005; Schussler M et al 1995; Leuchtgens H 1993). One study examined the effects of varying doses of hawthorn (500 mg, 600 mg, and a combination of both dosages) on essential hypertension. Researchers found a promising reduction in the resting diastolic blood pressure of (as well as a reduction in anxiety in) the patients who were taking hawthorn (Walker AF et al 2002).

Hawthorn's beneficial effects may be caused by its antioxidant flavonoid components (Chang WT et al 2005). In a study of patients who had congestive heart failure, a dosage of 30 drops of hawthorn extract three times a day was well tolerated and safe. In another study, patients who were taking digoxin (an anticoagulant) were also administered 450 mg of hawthorn twice a day. The study found

that it was safe to coadminister hawthorn and digoxin (Tankanow R et al 2003).

Arjuna. Arjuna bark from the Terminalia arjuna tree has been used in traditional Indian ayurvedic medicine for more than three centuries, often to treat cardiovascular disorders. A recent trial showed that arjuna was capable of improving endothelial function in smokers (Bharani A et al 2004). In another study, patients whose angina was stable had a 50 percent reduction in angina episodes and a significant decrease in systolic blood pressure (Dwivedi S et al 1994). Prolonged treatment with 500 mg of arjuna showed no adverse effects on the kidneys, liver, or blood (Dwivedi S et al 1994).

Olive leaf (*Olea europaea*) extract. One of the primary active constituents of olive leaf extract is oleuropein, a complex of flavonoids, esters, and iridoid glycosides, which may have vasodilative properties. Research on the hypotensive effects of this plant found that, when an extract was given for 3 months, blood pressure was reduced in all patients and there were no adverse effects (Cherif S et al 1996).

HORMONE MODULATION

The risk of developing essential hypertension is significantly higher in a postmenopausal woman, as well as in men older than 55 years of age. As hormone levels decline, the risk of high blood pressure and heart disease rise. One study used progesterone to reduce blood pressure in pregnant women who had preeclampsia, pregnancy induced hypertension (Sammour MB et al 2005).

Vascular endothelium and smooth muscle cells have sex steroid receptors (Natoli AK et al 2005). Research has supported bioidentical hormone restoration of estrogen, progesterone, and testosterone for use in the management of blood pressure and overall cardiac health. Sex hormones stimulate endothelial cell growth, inhibit smooth muscle proliferation and contraction, and relax the vascular endothelium via nitric oxide, prostacyclin, and hyperpolarization pathways (Khalil RA 2005). When hormones are present at youthful concentrations, vascular function in patients who have high blood pressure may be modulated (Khalil RA 2005).

LIFE EXTENSION FOUNDATION RECOMMENDATIONS

Endothelial dysfunction is closely linked to high blood pressure, atherosclerosis, and cardiovascular risk. Management of high blood pressure, a critical factor in endothelial risk, requires frequent self-monitoring and a multifaceted approach, including taking blood pressure–lowering medications, making lifestyle changes, and watching your diet and nutritional intake. Life Extension recommends people strive for an optimal blood pressure of 115/75 mm Hg.

Because many of the nutrients that lower blood pressure act along the same metabolic pathways as blood pressure–lowering medications, it is important to let your physician know which supplements you are taking before beginning conventional blood pressure medication.

Nutrients that may help lower blood pressure include:

- **C12 casein peptide**—200 to 400 milligrams (mg)/day
- **Grape seed extract**—150 to 300 mg/day
- **Pomegranate extract**—50 to 100 mg/day
- **Arjuna bark extract**—250 to 500 mg twice a day
- **Calcium**—1200 to 1500 mg/day
- **CoQ10**—100 to 300 mg/day
- **Garlic**—1200 mg/day
- **Hawthorn berry extract**—240 mg twice a day between meals
- **L-arginine**—2000 mg three times a day between meals
- **Magnesium**—500 mg/day (or more), based on maximum bowel tolerance and hypotensive effect; take the most at night before bed
- **Olive leaf extract**—500 mg/day
- **Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA)**—1400 mg/day of EPA and 1000 mg/day of DHA
- **Potassium**—99 mg/day (or more) when instructed to do so by a health care professional, based on blood test results
- **Soy protein**—17 to 34 grams (g)/day
- **Taurine**—1000 to 6000 mg/day
- **Vitamin C**—1 to 3 g/day
- **Vitamin E (alpha-tocopherol succinate)**—400 International Units (IU)/day with about 200 mg of gamma-tocopherol

Hormone modulation can be achieved with blood testing to determine appropriate doses of dehydroepiandrosterone (DHEA), pregnenolone, and bioidentical topical preparations of estrogen, testosterone, and progesterone. See the chapters on Female Hormone Modulation and Male Hormone Modulation for more details.

PRODUCT AVAILABILITY

All the nutrients and supplements discussed in this section are available through the Life Extension Foundation Buyers Club, Inc. For ordering information, call anytime toll-free 1-800-544-4440, or visit us online at www.LifeExtension.com.

The blood tests discussed in this section are available through Life Extension National Diagnostics, Inc. For ordering information, call anytime toll-free 1-800-208-3444, or visit us online at www.LifeExtension.com.

High Blood Pressure Safety Caveats

An aggressive program of dietary supplementation should not be launched without the supervision of a qualified physician. Several of the nutrients suggested in this protocol may have adverse effects. These include:

Coenzyme Q10

- See your doctor and monitor your blood glucose level frequently if you take CoQ10 and have diabetes. Several clinical reports suggest that taking CoQ10 may improve glycemic control and the function of beta cells in people who have type 2 diabetes.
- Statin drugs (such as lovastatin, simvastatin, and pravastatin) are known to decrease CoQ10 levels.

Calcium

- Do not take calcium if you have hypercalcemia.
- Do not take calcium if you form calcium-containing kidney stones.
- Ingesting calcium without food can increase the risk of kidney stones in women and possibly men.
- Calcium can cause gastrointestinal symptoms such as constipation, bloating, gas, and flatulence.
- Large doses of calcium carbonate (12 grams or more daily or 5 grams or more of elemental calcium daily) can cause milk-alkali syndrome, nephrocalcinosis, or renal insufficiency.

EPA/DHA

- Consult your doctor before taking EPA/DHA if you take warfarin (Coumadin). Taking EPA/DHA with warfarin may increase the risk of bleeding.
- Discontinue using EPA/DHA 2 weeks before any surgical procedure.

Garlic

- Garlic has blood-thinning, anticlotting properties.
- Discontinue using garlic before any surgical procedure.
- Garlic can cause headache, muscle pain, fatigue, vertigo, watery eyes, asthma, and gastrointestinal symptoms such as nausea and diarrhea.
- Ingesting large amounts of garlic can cause bad breath and body odor.

Hawthorn

- High doses of hawthorn are toxic and may induce sedation and abnormally low blood pressure.
- Do not take hawthorn if you take digoxin. Hawthorn can interfere with the effects of digoxin.

L-Arginine

- Do not take L-arginine if you have the rare genetic disorder argininemia.
- Consult your doctor before taking L-arginine if you have cancer. L-arginine can stimulate growth hormone.
- Consult your doctor before taking L-arginine if you have kidney failure or liver failure.
- Consult your doctor before taking L-arginine if you have herpes simplex. L-arginine may increase the possibility of recurrence.

Magnesium

- Do not take magnesium if you have kidney failure or myasthenia gravis.

Olive Leaf Oil

- Do not take olive leaf oil if you have a history of gallstones.

Potassium

- Do not take potassium if you have hyperkalemia (a greater-than-normal concentration of potassium in the blood).
- Consult your doctor before taking potassium for potassium deficiency.
- Potassium can cause rash and gastrointestinal symptoms such as nausea, vomiting, and diarrhea.

Soy

- Do not take soy if you have an estrogen receptor-positive tumor.
- Soy has been associated with hypothyroidism.

Vitamin C

- Do not take vitamin C if you have a history of kidney stones or of kidney insufficiency (defined as having a serum creatine level greater than 2 milligrams per deciliter and/or a creatinine clearance less than 30 milliliters per minute.
- Consult your doctor before taking large amounts of vitamin C if you have hemochromatosis, thalassemia, sideroblastic anemia, sickle cell anemia, or erythrocyte glucose-6-phosphate dehydrogenase (G6PD) deficiency. You can experience iron overload if you have one of these conditions and use large amounts of vitamin C.

Vitamin D

- Do not take vitamin D if you have hypercalcemia.
- Consult your doctor before taking vitamin D if you are taking digoxin or any cardiac glycoside.
- Only take large doses of vitamin D (2000 international units or 50 micrograms or more daily) if prescribed by your doctor.
- See your doctor frequently if you take vitamin D and thiazides or if you take large doses of vitamin D. You may develop hypercalcemia.
- Chronic large doses (95 micrograms or 3800 international units or more daily) of vitamin D can cause hypercalcemia.

For more information see the Safety Appendix