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HOW TO KEEP YOUR HEART BEATING . . .

until we come up with better ways to move your blood along!

"I feel better today at 50 than I did 10 years ago at 40. Your diet, supplements, and advice are helping me feel younger and more confident as the days go by. I have restored my cholesterol levels to normal after having them extremely high."

OSVALDO (50), SPAIN

Your heart is a seemingly tireless organ that has beat about a billion times by the time you're 30 years old. When healthy, its rhythm is more like a delicate dance than just a repetitive mechanical pump. It responds, of course, to our physical need for greater bloodflow when we exert ourselves, but its patterns are also affected by our moods and emotions, hence its reputation as the organ of love and affection.

As we discussed in the Introduction, our bodies evolved in an era when it was not in the interest of our species for people to live much past their twenties. In addition, our modern diets, which are high in saturated and other unhealthy fats, sugars, and starches, and our often sedentary lifestyles exacerbate the processes that lead to heart disease. Both of the authors have intensely studied the process of heart disease—and how to thwart it—for most of our lives. Ray was 15 when his father had his first heart attack at only 51; his father then died of heart disease at the age of 58. Ray's paternal

grandfather also died from heart disease in his fifties. Because of this strong family history of premature heart disease, Ray has taken aggressive steps to overcome his own genetic legacy and has counseled hundreds of others to do the same. Terry has treated thousands of patients for heart disease and, being a male baby boomer over 45 himself, is also personally concerned about this disease—just being male is a risk factor, and so is being over 45 for males and over 55 for females. We should all be concerned about heart disease—it is the number one killer of both men and women, taking 600,000 Americans each year, and is the leading cause of death in the developed world.

Yet, the authors are convinced that almost no one needs to die of a heart attack. Every time we hear of someone who has died of a heart attack, we are filled with regret that the message of how to avoid this circumstance did not reach that person in time. One-third of first attacks are fatal, and another third result in permanent damage to the heart. However, the good news is that if you follow the simple guidelines in this chapter, and throughout this book, you can gain the comfort and security of substantially protecting yourself from this devastating disease.

Like many goals in life, our strategy doesn't rely on a single magic bullet. Rather, by persistently and aggressively chipping away at the risk factors underlying heart disease from multiple directions, we show how you can reduce your likelihood of a destructive event to extremely low levels. This is possible because we now have the knowledge to reduce heart attack rates by more than 90 percent. Although it may be difficult to move the entire society to healthier patterns of nutrition and lifestyle, you can drastically reduce your own risk in just a few weeks.

THE NEW UNDERSTANDING OF HEART ATTACKS

Before discussing how you can dramatically reduce your risk of a heart attack, it is important to understand the process of heart disease. Recent large-scale follow-up studies of patients, as well as new scanning technologies that provide an unprecedented clear view of what is actually going on in the coronary

arteries, have completely changed our understanding of the disease. Recent studies of the most popular form of heart surgery have shown that the long-held model of heart disease as basically a plumbing problem in which the coronary arteries that supply blood to the heart become increasingly filled with cholesterol-laden sludge is fatally flawed. A major study of 2,300 heart patients, both men and women, published in 2007 in the prestigious *New England Journal of Medicine*, examined the effectiveness of angioplasty, the most common form of heart surgery. This surgery involves smashing the deposits blocking the coronary arteries—the arteries that provide blood to the heart itself—up against the arterial walls and inserting a "stent" (a wire mesh tube to keep the artery open). All of the patients in this study were considered candidates for angioplasty according to the standard surgical criteria and were divided into two groups. One group underwent angioplasty surgery plus standard medical care, which included lifestyle recommendations and standard-of-care cardiac medications such as aspirin (to reduce blood clots), beta-blockers (to reduce strain on the heart), and statin drugs (to lower "bad" cholesterol levels and inflammation). The control group received the same standard medical care but no surgery. After 4½ years, no benefit was seen from the surgery in reducing heart attacks or deaths.

According to the numerous studies that have been done, the primary circumstance in which angioplasty aids survival is immediate administration after a heart attack. Proponents of angioplasty and stenting countered that even though the patients who underwent these procedures had no reduction in heart attacks or deaths, the surgery was still worth doing because these patients would have less angina or chest pain. Some studies have shown a reduction in angina, but this new study also found that patients who underwent angioplasty did not have less chest pain either. Angioplasty procedures are still done more than 1.2 million times a year. At an average cost of about $44,000, the American public is spending more than $50 billion a year on a procedure that has never been shown to prolong life.

The second most common type of heart surgery is coronary artery bypass grafting (CABG). With this very invasive surgery, occluded arteries are bypassed with grafted veins or mammary arteries. The surgery involves stopping

the heart, maintaining the patient on a heart–lung machine during surgery, and then restarting the heart when the bypass surgery is completed.

Studies of the effectiveness of bypass surgery show it to be more effective than angioplasty. Unlike angioplasty, CABG does bypass both the hard, calcified plaque and the soft plaque in the treated occluded arteries. If postoperative patients are aggressive in preventing the bypassed arteries from becoming diseased again, the surgery can be successful in "resetting" these arteries from both types of plaque.

If the primary objective is reducing angina pain, less expensive and safer, noninvasive ways are available to accomplish the same thing, such as judicious use of cardiac medications and a noninvasive procedure known as enhanced external counterpulsation (EECP), discussed below.

The old scientifically discredited theory of heart disease—that it is a plumbing problem that can be fixed by unclogging a stopped-up pipe—explains why angioplasty is relatively ineffective at preventing subsequent heart attacks. Angioplasty burrows through calcified plaque but does not eliminate the soft vulnerable plaque that causes most heart attacks. Bypass surgery does "bypass" both forms of plaque and, under the right circumstances, can reduce subsequent heart attacks and death. Bypass is a major operation and requires over a month of recovery and obviously should be considered a last resort.

Let's compare the old plumbing model with our new understanding, because all of our recommendations stem from a proper understanding of the real causes of heart attacks. The old model works like this: Hard, calcified plaque builds up in your arteries, gradually occluding them. Then, when an artery becomes sufficiently blocked—75 percent or more—there is a risk that a clot will get stuck in the narrowed opening. When that happens, the artery becomes completely blocked, no blood can get through to the heart muscle—and that's a heart attack.

We now know that most heart attacks do not result from arteries blocked with the hard calcified deposits, or *calcified plaque*, that patients are shown by their surgeons. In fact, this type of hard plaque is rarely the cause of heart attacks; rather, it appears to be the *result* of the body's attempt to wall off the real culprit, which is soft, noncalcified, or *vulnerable*, plaque. Soft or vulnerable

plaque is flexible and dynamic. It rarely produces symptoms, does not appreciably block arteries, and is difficult to see on angiograms. Yet, vulnerable plaque is the real villain in the story.

This new understanding replaces the old model of heart disease and looks at it instead as a dynamic multistep process in which *inflammation* (the overactivation of the immune system) works first to create vulnerable plaque and then to lead it through an intricate and insidious cascade of events that ultimately ends in a heart attack. It is worthwhile to review the steps in the process that leads up to a heart attack because it guides our thinking on how to thwart this process at every stage.

The story begins with LDL (low-density lipoprotein) cholesterol particles—the aptly named "bad" cholesterol. We should note that LDL is not all bad; indeed we could not survive without it. LDL transports cholesterol from the liver to the body's tissues, where it is needed to keep cell membranes healthy. It is also a precursor of our sex hormones. But when levels of LDL are higher than we need for these vital life processes, it accumulates inside the artery walls, where it can undergo pathological changes. LDL can react with oxygen to become oxidized and with excess glucose in a process called glycation (binding with sugar molecules). Once modified in this way, the LDL particles take on a different appearance. They no longer look friendly to the immune system and are easily mistaken for foreign invaders. The immune system responds by sending in different types of white blood cells, including monocytes and T lymphocytes, in an attempt to destroy the pathological LDL molecules.

After the monocytes encounter the LDL deposits, they become *macrophages* and begin to gobble up these deposits. These macrophages (from the Latin *macro* for big and *phage* for eater) have such big appetites, they eventually become stuffed with the LDL particles and become "foam cells," so named because they look like bubbles of foam. This is the beginning of vulnerable plaque, which at this stage is called a fatty streak. Autopsies of soldiers killed in battle have shown that this early form of vulnerable plaque is quite common in 20-year-olds, and can even be found in children.

Note that the entire process above is associated with inflammation, basically an overactivation of the immune system. Inflammation, in fact, underlies

every stage of this process. In the next step, inflammation causes the blood vessel's smooth muscle cells to grow over the foam cells and form a fibrous cap. This is now a mature vulnerable plaque, which typically does not restrict bloodflow but just appears as a slight bulge in the outer diameter of the blood vessel. Vulnerable plaque has been notoriously difficult to visualize, but we have recently begun to be able to see images of it in the arteries of a beating heart using a new generation of noninvasive scanners, which are emerging as promising diagnostic tools.

The stage is now set for the coup de grâce event of a heart attack, and is again fueled by inflammation. Prompted by substances produced by an overactive immune system, the fibrous cap can rupture, spilling the contents of the foam cells and other dangerous chemicals that they have produced. Specific elements in the bloodstream respond by forming a blood clot or thrombus to keep the contents of the foam cells from entering the bloodstream. If the thrombus that forms is large enough to completely block the coronary artery, that's a heart attack. The region of the heart normally supplied by this artery is now deprived of oxygen and other nutrients and will die if the blockage is not quickly reversed. It is important to note that, in most cases, until just moments before the heart attack, the artery was *not* significantly blocked by the vulnerable plaque. The thrombus formed suddenly after the rupture of the fibrous cap, with devastating consequences.

This new understanding motivates all of our recommendations for heart attack prevention. Since the process starts with excess LDL particles, keeping LDL at healthy low levels is our first recommendation. In addition to LDL, there is a form of cholesterol called HDL (high-density lipoprotein), the "good cholesterol," which clears LDL particles from the bloodstream and carries them back to the liver. So, keeping HDL levels high is another important approach.

Keeping in mind that every stage leading to a heart attack is fueled by inflammation, we see once again another way in which our evolutionary Stone Age heritage is not on our side when we get to middle age. Infections were the most common form of death tens of thousands of years ago, so having a strong and highly reactive immune system was critical to the survival

of the human species. At this earlier time in our evolution, very few people lived long enough to die from heart attacks, so there was little need to worry about the downsides of an overly active immune system that might cause a heart attack later in life. In addition, many aspects of our modern lifestyle, such as the wrong diet and excessive stress, increase the activation of the immune system and increase inflammation. So, our next and perhaps most important strategy in preventing heart attacks is keeping our immune system robust enough to combat infections but avoiding its overactivation and subsequent inflammation. Each of our recommendations below fits into one of these overarching themes.

A MULTIPRONGED STRATEGY TO AVOID HEART ATTACKS: COMBAT EVERY RISK FACTOR

Several other risk factors have been associated with higher levels of heart disease, and removing each such factor has been shown in extensive studies to lower heart attack risk. We will discuss how each risk factor fits into the new understanding of how heart attacks arise. In addition, a stroke results from the same set of steps except that it takes place in the arteries feeding the brain rather than the heart. So, an added benefit is that by reducing your risk of a heart attack, you will also be reducing your risk of strokes.

To start, we recommend that you get a basic set of heart-related blood tests, which should include:

- **A lipid panel,** which includes total cholesterol as well as LDL, HDL, and triglycerides (a measure of fat in the blood)
- **High-sensitivity C-reactive protein** (CRP, a measure of inflammation in the body)
- **Homocysteine** (a measure of an independent risk factor)

Then count the number of major risk factors you have based on the 11 we list below. If you have three or more major risk factors, we recommend that you also get an exercise stress test and ultrafast computed tomographic scan

of the heart, which will provide additional information on your risk of having a heart attack in the next several years.

Major Risk Factors for Heart Disease

1. **Genetic inheritance:** Did your father have a heart attack before the age of 55 and/or did your mother have a heart attack before the age of 65? Y/N
2. **Age:** If you are male, are you 45 or older? If female, 55 or older? Y/N
3. **Smoking:** Do you smoke cigarettes and/or have you been a smoker any time in the last 10 years? Y/N
4. **Weight:** Are you 20 percent or more over your optimal weight? (See Tables 13-2 and 13-3) Y/N
5. **Cholesterol and triglycerides:** Do you have any of the following:
   - Total cholesterol over 200
   - LDL over 130
   - HDL over 130 (in men over 40 and women over 50)
   - Ratio of total cholesterol to HDL over 4? Y/N
6. **Homocysteine:** Is your homocysteine more than 10.0? (See Chapter 5, page 118) Y/N
7. **High-sensitivity CRP:** Is your high-sensitivity CRP more than 5.0? (See Chapter 5, page 113) Y/N
8. **Fasting glucose:** Is your fasting glucose (blood sugar) under 110? (Fasting glucose >110 is a rish factor for metabolic syndrome, see Chapter 11, pages 211–13) Y/N
9. **Blood pressure:** Is your systolic 140 or higher and/or is your diastolic 90 or higher? Y/N
10. **Stress:** Are you a type A personality with a high level of anger and/or lack of social connectedness (type D)? (See Chapter 2, page 44) Y/N
11. **Exercise:** Are you sedentary? Y/N

Let's discuss some of the most important risk factors and what you can do to minimize them.

Genetic Inheritance

Your genetic profile affects your predisposition to many of the other risk factors, and many studies have shown that overall heart disease risk is inherited. However, it is our strongly held view that your genetic inheritance is not destiny. The conventional wisdom used to be that your risk of diseases such as heart disease was 80 percent genetic and 20 percent determined by your lifestyle. New research from the field of epigenetics, however, suggests that this thinking is completely backwards! It now appears that only 20 percent of risk comes from your genes and 80 percent from the lifestyle choices you make every day. Thinking that the opposite was the case was perhaps a reasonable perspective given how watered down public health recommendations for prevention of heart disease were up until fairly recently. If you are really diligent, we believe that you can reduce your risk of heart attacks significantly. New public health guidelines (such as keeping LDL below 70 if you are in a high-risk category) have been positively influenced by recent research. The bottom line is that we now have the knowledge to largely overcome most of the risks associated with our genetic heritage.

Ray: There is a new technique called RNA interference that essentially allows us to turn off genes in a mature human. This method is only a few years old, but has already been recognized with the Nobel Prize, another indication of the acceleration of progress. We also have new forms of gene therapy that allow new genes to be added. For example, I am involved with a company that takes lung cells out of the body, adds a new gene in a Petri dish, ensures that it has been inserted properly, replicates the cell a millionfold (using another brand-new technology), and then injects these million cells—with the added gene—back into the body, where they end up in the lungs. This has already been shown to cure a fatal disease called pulmonary hypertension in animals and is now undergoing human trials. There are now over 1,000 drugs and procedures in various stages of the development pipeline to either turn off or add genes.

Terry2023: Today in 2023, the first batch of drugs to turn off genes and methods to add new genes are now approved therapies. We now have a direct and elegant way to remove your genetic disposition to heart disease.

Reader: So I will be able to go back in time and pick new parents?

Ray2023: Well, as far as the "nature" side of the equation is concerned, that is exactly what you can do in 2023. As for changing the results of the "nurture" experiences you've had with your parents, I'm afraid you'll have to wait a little longer.

Reader: Well, changing my genes is a good place to start. I know that the concept of "designer babies" has been somewhat controversial, but I kind of like the idea of being a "designer baby boomer."

Gender and Age

The common wisdom used to be that only men need to be concerned about heart disease. A 2002 survey by the society for Women's Health Research showed that 60 percent of women fear cancer the most, compared with only 5 percent who were afraid of heart disease. So it may come as a surprise that heart disease is the number one killer of *both* men and women. Of the 1.1 million heart attacks each year, almost half occur in women.

It is true that women have some protection from heart disease while they are menstruating, but after menopause all bets are off. The statistics show that women's risk is delayed by about 10 years.

Iron in the blood can act as a catalyst for the process of oxidizing LDL, one of the first steps in the formation of vulnerable plaque. This is one reason that premenopausal women have some level of protection since menstruation helps keep iron levels low. Women also receive protection before menopause thanks to hormone levels that may inhibit these LDL changes.

If you are a man 45 years or older or a woman over 55, then you already have one major risk factor. If you have two additional major risk factors, then you should give a high priority to adopting all of the recommendations in this chapter.

Smoking

The risk of heart attack for smokers is 200 to 400 percent greater than that of nonsmokers. There are 4,000 poisons contained in tobacco and tobacco smoke, many of which greatly accelerate the processes that lead to a heart attack. Cigarette smoke significantly increases the overall level of inflammation in the body and dramatically increases free-radical activity, which accelerates the oxidation of LDL. Smoking also increases heart rate and blood pressure, which accelerate damage to the arteries. We could go on, but the recommendation is obvious: Don't smoke, and avoid secondhand smoke.

Weight

Being overweight contributes to a wide range of diseases and to several of the other risk factors. It is a major contributor to development of metabolic syndrome, type 2 diabetes, and hypertension. The Framingham study, a major study that has followed tens of thousands of individuals for several decades, found that obesity significantly increased risk of heart disease in both men and women. Excess weight is also a major risk factor for increasing the level of inflammation in the body.

Maintaining your optimal weight, as discussed in Chapter 13, is critical to heart disease avoidance, but even losing as little as 10 pounds can significantly decrease heart attack risk.

Cholesterol and Triglycerides

Cholesterol and its LDL and HDL components continue to play major roles in the new inflammation-based understanding of heart disease. We know that the inflammation process starts with excess LDL particles, which enter the coronary artery lining and become oxidized. HDL (good cholesterol) particles reduce heart disease risk by transporting excess LDL cholesterol back to the liver and also by keeping it from becoming inflamed and oxidized.

Based on the statistics for the general population, total cholesterol less

than 200 is considered optimal. However, we feel the optimal range for total cholesterol is 160 to 180. Ideally, LDL should be 80 or less, and, depending on the number of your risk factors, HDL should be 60 or higher. An ideal ratio of total cholesterol to HDL is under 2.5.

Recent research has confirmed that reducing LDL cholesterol to much lower levels than the standard recommendation (below 100) substantially reduces the risk of heart disease. A 2004 study by researchers at Harvard Medical School also published in the *New England Journal of Medicine* examined whether reducing LDL levels well below 100 would substantially reduce heart disease risk. The group that took the more aggressive LDL-lowering therapy had a median LDL level of 62, compared with 95 for the control group, who took a more moderate course of statin drug therapy. The group with lower LDL had substantially fewer heart attacks as well as fewer recommendations for bypass or angioplasty surgery. "This is really a big deal," commented Dr. David Waters, professor of medicine at the University of California, San Francisco. Dr. Waters, who was not involved in the research, added, "We have in our hands the power to reduce the risk of heart disease by a lot." On the basis of this and other corroborating research, we recommend that you keep your LDL levels at approximately 80 (if you have fewer than three major risk factors) or 70 or less (if you have three or more major risk factors). Another independent risk factor for heart disease is the level of triglycerides (free-floating fat) in the blood. Conventional recommendations are for the triglyceride level to be less than 150, but we feel that less than 100 is optimal. Excessive consumption of high-glycemic carbohydrates and alcohol are common causes of elevated triglycerides.

The first step toward improving cholesterol and triglyceride levels is to adopt a healthy diet by following the nutritional recommendations in Chapters 11 and 13. Most important, you should sharply reduce saturated fat, which is the most significant dietary influence. No other major dietary nutrient increases LDL levels more than does saturated fat.

There is some controversy regarding dietary cholesterol. Cholesterol levels in the blood are regulated by the liver, so a healthy system is able to

maintain healthy levels of cholesterol in the blood despite consumption of dietary cholesterol. However, if you have unhealthy lipid levels, these cholesterol-regulation mechanisms are probably not working optimally. If your blood cholesterol levels are not optimal, we recommend reducing dietary cholesterol to no more than 100 milligrams per day. One egg yolk has about 220 milligrams of cholesterol.

The most powerful method of lowering cholesterol levels is with the use of statin medications such as Zocor (now available as inexpensive generic simvastatin), Lipitor, and Crestor. Before you resort to statins, however, consider the many effective nonprescription supplements that can significantly improve cholesterol, LDL, HDL, and triglyceride levels. We recommend that you try these over-the-counter supplements first and then turn to prescription statin drugs as your second line of therapy if these prove insufficient. The supplements described here have mechanisms that are independent from the statins, so they can be used together with the drugs.

The most effective cholesterol-lowering over-the-counter supplements include the following:

- **Red yeast rice** is a supplement that naturally contains small amounts of lovastatin, the active ingredient in Mevacor, a prescription drug used to lower cholesterol. In a paper published in the July 2008 issue of *Mayo Clinic Proceedings*, researchers compared a group of patients who took red yeast rice and fish oil and followed a healthy diet with a group that took 40 milligrams (a large dose) of prescription-strength Zocor (simvastatin). Cholesterol fell in the red yeast rice group 42.4 percent compared with 39.6 percent in the group that took the drug. In addition to lowering cholesterol, red yeast rice also possesses other properties that appear to protect the heart. In a study reported in the June 15, 2008, issue of the *American Journal of Cardiology*, red yeast rice was found to lower the risk of subsequent heart attack in 5,000 patients with a history of heart attack by half and risk of death from any cause by one-third.

• **Plant sterols** can lower cholesterol levels significantly. They have been marketed in cholesterol-reducing margarines, but these products contain unhealthy fats, so we recommend taking plant sterols as a supplement in pill form.

• **Policosanol** is an effective supplement for improving lipid levels, with results similar to those seen with statin drugs. Studies have also demonstrated that combining policosanol with statins provides even greater effects. A study published in the *American Heart Journal* showed that at dosages of 10 to 20 milligrams per day, policosanol "lowers total cholesterol by 17 percent to 21 percent and LDL cholesterol by 21 to 29 percent. It also raises high-density lipoprotein cholesterol by 8 to 15 percent." Similar to lipid drugs, policosanol also inhibits the oxidation of LDL, a critical first step in the creation of deadly foam cells.

• **Vitamin E** may also be effective both in lowering cholesterol and dramatically reducing overall heart disease risk. In the 1996 Cambridge Heart Anti-Oxidant Study (CHAOS), 1,000 heart patients were given 400 or 800 international units of vitamin E, while a control group of another 1,000 patients (with the same health profile) was given a placebo. Eighteen months later, the vitamin E groups had 75 percent fewer heart attacks.

• **Phosphatidylcholine** (PC) is a major component of your cell membranes. As you age, the level of PC in the cell wall diminishes, which is an important aging process. By supplementing with PC, you can stop and even reverse this process. Research indicates that PC can stimulate reverse cholesterol transport—that is, removal of cholesterol from artery plaque—essentially the same process that HDL promotes. PC, both as an oral supplement and as an intravenous therapy, is widely used in Germany and approved by the German equivalent of the FDA. When taking oral PC, it is important to use one that is at least 50 percent pure. Many supplements labeled as phosphatidylcholine are actually only about 30 percent PC. Food-grade lecithin contains PC, but only about 20 to 25 percent is PC.

The following table lists doses of the supplements mentioned above as well as a few additional supplements that have been found of value in helping lower cholesterol to optimal levels. We recommend that you start with one or more of the supplements in the table below and measure your results 2 months later. A common regimen is to begin by taking red yeast rice and plant sterols as separate supplements and vitamin E as part of your daily multiple. If your heart lipid levels still need improvement, you can consider adding additional supplements from the list below or a statin drug in consultation with your physician.

TABLE 2-1: NATURAL SUPPLEMENTS TO IMPROVE HEART LIPID LEVELS

SUPPLEMENT	AMOUNT PER DOSE	TIMES PER DAY	TOTAL DOSE PER DAY
Red yeast rice	*600–900 millligrams*	*2*	*1,200–1,800 millligrams*
Plant sterols	*1,800 millligrams*	*2*	*3,600 millligrams*
Policosanol	*10 millligrams*	*2*	*20 millligrams*
Vitamin E (mixed tocopherols)	*200 international units*	*2*	*400 international units*
Garlic	*900 millligrams*	*3*	*2,700 millligrams*
Curcumin	*900 millligrams*	*1–2*	*900–1,800 millligrams*
*Niacin**	*100–500 millligrams*	*2*	*200–1,000 millligrams*
Phosphatidylcholine	*900–1,800 millligrams*	*2*	*1,800–3,600 millligrams*
*Soluble fiber***	*4–6 grams*	*2–3*	*8–18 grams*

**Dosages of up to 3,000 milligrams per day are often used, although we recommend starting with closer to 200 milligrams per day. Periodic monitoring of liver function is recommended when taking niacin.*
***Soluble fiber, such as pectin, guar gum, or psyllium, is recommended, especially before meals high in fat. If you take the prescription drugs nitrofurantoin or digitalis, do not take soluble fiber.*

Statin Drugs

If natural supplements fail to move your cholesterol, LDL, HDL, and triglyceride levels to an ideal range, you and your physician may wish to consider one of the HMG-CoA reductase enzyme inhibitors, also known as statin drugs. Statins slow down the creation of cholesterol by the liver and increase the rate at which LDL is cleared from the blood.

They also appear to inhibit the oxidation of LDL, thereby slowing down the first step of vulnerable plaque formation. Perhaps most important of all, statins reduce the likelihood that cholesterol in plaques will become inflamed.

Like all prescription medications, statin drugs are associated with side effects. They may have toxic effects on the liver, so your physician will want to monitor your liver enzymes periodically. The same enzyme that the body uses to make cholesterol, HMG-CoA reductase, is also used in the manufacture of coenzyme Q_{10}. Since taking statins depletes the body of coenzyme Q_{10}, which is needed to maintain the health of the mitochondria (the energy furnaces in every cell), *it is vital to take supplemental coenzyme Q_{10} when taking statin drugs*. You should take 50 to 150 milligrams of coenzyme Q_{10} twice a day or 50 milligrams of the activated form of coenzyme Q_{10} known as ubiquinol twice a day if you are receiving a statin drug. These are available over the counter without prescription.

A particularly effective statin drug is atorvastatin, also known as Lipitor. Unlike other lipid drugs, Lipitor is approved as a treatment to reduce triglycerides in addition to lowering cholesterol levels. Lipitor can reduce LDL by 40 to 60 percent and triglycerides by 20 to 40 percent. It also boosts HDL by 5 to 10 percent. Lipitor has been shown to significantly reduce heart attacks and deaths in people at high risk of heart disease.

There is clear research showing that statins lead to a reduction in heart attacks and deaths from heart attacks in men who are at high risk. Use of statins in other groups has become controversial within the medical community. The same types of beneficial results have not yet been shown in women. In addition, even though statin therapy has been shown to decrease heart attack risk, no studies have shown that statin therapy increases life expectancy for any group other than men with a history of heart attack. It should be noted, however, that studies demonstrating significant increases in life expectancy are hard to conduct because of the significant time periods required to see an effect.

The bottom line is that changing to a heart-healthy diet has been shown to be much more effective than taking statin drugs for preventing heart attacks.

In a French study conducted in the 1990s, people with prior heart attacks who ate a diet high in fruits and vegetables, replaced simple starches with whole grains, consumed more olive oil and fish, and avoided red meat, butter, cheese, and egg yolks—followed a prudent diet not unlike the one we outlined in *TRANSCEND*, in other words—had a substantially reduced risk of subsequent heart attacks and deaths. The benefit was two to three times greater than what was possible with taking statin drugs.

Thus, the most important first steps are to follow our recommendations for a healthy diet (see Chapters 11 and 13), regular exercise (see Chapter 14), and stress reduction (see Chapter 9). If your cholesterol and other lipid levels still remain above the optimal ranges, add one or more of the natural supplements shown in Table 2-1. If you have three or more major risk factors and your levels are still too high, you can discuss addition of a statin drug with your physician. Be sure to take coenzyme Q_{10} or ubiquinol if you are taking statin drugs—it is a valuable health supplement in any event.

Blood Pressure

Even under normal circumstances, blood pressure in the coronary arteries is quite high, which increases the inflammation that begins the process of plaque formation. Inflammation in the coronary arteries is worsened by elevated blood pressure. A study of 10,874 men reported in the *Archives of Internal Medicine* showed that people with mild hypertension—blood pressure of 140/90 to 160/105 mm Hg—had a 50 percent higher risk of dying of coronary heart disease. Even those with high-normal blood pressure (also known as *prehypertension* and defined as readings between 120/80 and 140/85 mm Hg) had a 34 percent higher risk of heart attack. Many other studies have demonstrated how high blood pressure can accelerate the build-up of plaque in the arteries and increase the likelihood of a heart attack. Hypertension is also a symptom of metabolic syndrome.

Optimal blood pressure is less than 120/80 mm Hg. If your blood pressure is higher than this, we recommend following a lifestyle and supplement program to get as close to this level as possible. The first step is to adopt our nutritional recommendations in Chapter 11 and attain your optimal weight.

Determine whether you have metabolic syndrome or type 2 diabetes and follow our program in Chapter 5. These steps, particularly adopting a low-carbohydrate, very-low-glycemic-index diet, are often adequate by themselves to resolve hypertension. If blood pressure remains elevated despite these measures, we will often recommend a traditional Chinese medicine formulation of six herbs known as Uncaria-6 (also called Gou Teng Jiang Ya Pian). This formulation will frequently lower blood pressure without the side effects of many blood pressure medications. Uncaria-6 is available from acupuncturists and practitioners of traditional Chinese medicine.

There are many other supplements that can help lower blood pressure. In addition to or in place of Uncaria-6, you might try a combination of magnesium, garlic, and arginine as shown in Table 2-2. If your blood pressure is still suboptimal, consider some of the other supplements listed below.

TABLE 2-2: NATURAL SUPPLEMENTS TO IMPROVE BLOOD PRESSURE

SUPPLEMENT	AMOUNT PER DOSE	TIMES PER DAY	TOTAL DOSE PER DAY
Magnesium	*200 milligrams*	*2*	*400 milligrams*
Garlic	*900 milligrams*	*3*	*2,700 milligrams*
*L-arginine **	*1–2 grams*	*3*	*3–6 grams*
Coenzyme Q_{10}	*100 milligrams*	*3*	*300 milligrams*
EPA/DHA (fish oil)	*EPA (500–1,500 milligrams) DHA (350–1,000 milligrams)*	*2*	*EPA (1,000–3,000 milligrams) DHA (700–2,000 milligrams)*
Vitamin C	*1,000 milligrams*	*2*	*2,000 milligrams*
Vitamin E	*200 international units*	*2*	*400 international units*
Calcium	*500 milligrams*	*1–2*	*500–1,000 milligrams*
*Alpha-lipoic acid (ALA)***	*250 milligrams*	*2*	*500 milligrams*
Potassium	*200 milligrams*	*1*	*400 milligrams*
Green tea extract	*500–1,000 milligrams*	*2*	*1,000–2,000 milligrams*
Hawthorn	*250 milligrams*	*2–3*	*500–750 milligrams*

**L-arginine has additional benefits in improving vessel health.*
***ALA is an important supplement for preventing and treating metabolic syndrome.*

If these recommendations prove insufficient and prescription drugs are considered, angiotensin II antagonists such as Cozaar or Hyzaar appear to be safer and more effective than other classes of blood pressure medications, such as calcium-channel blockers. Diuretics and beta-blockers appear to increase insulin resistance, which is counterproductive because it increases the risk of developing metabolic syndrome and type 2 diabetes.

Stress

Given the prominent role of inflammation at every step of the process leading up to a heart attack, it is not hard to understand why stress is a risk factor. Studies have demonstrated that feelings of aggression and rage increase levels of homocysteine. The continual self-imposed stress associated with the type A personality results in higher levels of adrenaline, which worsens inflammation. As we discuss in Chapter 9, not everyone with a type A personality is at risk. People with short tempers who are continually getting angry have the personality type with higher risk. The type D personality, characterized by a lack of social connectedness and inability to express emotion, also has increased heart disease risk.

Exercise

To put this in a positive context, adequate levels of exercise reduce all of the controllable risk factors, including improving insulin sensitivity, which contributes to weight loss and reduces blood pressure, stress, and inflammation. We discuss this key issue in Chapter 14.

SECONDARY RISK FACTORS FOR HEART DISEASE

Several other factors can contribute to heart attack risk. Let's look at a few of these secondary cardiac risk factors, as well as the tests you can do to assess whether you have these.

- **Obstructive sleep apnea** is a common condition in which the mouth opens widely during sleep, causing a blockage of air. Most people who

have it are unaware of the condition, and it has been shown to be a risk factor for heart disease. See our discussion of sleep in Chapter 1 for a description of how to diagnose and treat sleep apnea.

• **High levels of iron in the blood** (a hereditary condition called *hemochromatosis*), particularly combined with elevated LDL levels, promote the oxidation of LDL, which is the critical first step in creating deadly foam cells. The easiest way to test for the amount of iron in the blood is with two blood tests: the *serum ferritin* and the *iron binding capacity*. If you have elevations of either of these, the simplest treatment is regular phlebotomies, or donations of blood. Giving blood a few times a year can help lower your iron level, as well as help many patients in need of blood transfusions at the same time. Supplements that reduce iron levels include fiber, calcium, magnesium, garlic, vitamin E, green tea, and red wine. Unless you are anemic, you should not take supplements (particularly mineral supplements) that include iron, and you should avoid iron cookware.

• **Periodontal disease,** such as gingivitis, is characterized by chronic inflammation of the gums and has been linked to increased risk of heart disease. We do not yet know whether the existence of gum disease itself contributes to heart disease, or whether underlying inflammatory and infectious processes contribute to both gum disease and heart disease. It is also possible that the varied bacteria involved in gum disease may contribute to the process of atherosclerosis. Proper dental hygiene, including daily flossing and regular dental visits, can reduce the likelihood of gum disease, and, in turn, reduce the likelihood of coronary heart disease.

• **Hypothyroidism (low thyroid function)** has been linked to elevated cholesterol levels and increased heart disease risk. Half of hypothyroid patients have high levels of homocysteine, compared with 18 percent of the overall population. In addition, more than 90 percent of hypothyroid patients have excessive levels of cholesterol or homocysteine, compared with only about a third of the general population. Tests to check

thyroid function (free T_3 [triiodothyronine], free T_4 [thyroxine], and TSH [thyroid-stimulating hormone] levels) should be a routine part of your annual examination, and impaired thyroid function should be treated.

Ray2034: You can now replace a portion of your biological red blood with nanobots called respirocytes that perform the same function. These robotic red blood cells were designed more than 20 years ago by nanomedicine pioneer Robert Freitas, and are now approved methods to enhance the performance of your blood. Like most of our biological systems, red blood cells perform their oxygenating function very inefficiently, but these tiny respirocyte robots are a thousand times more capable. By replacing a portion of your blood with these devices, you can now do an Olympic sprint for 15 minutes without needing to take a breath.

Reader: So will I be able to sit at the bottom of my pool without oxygen or go underwater diving without scuba gear?

Ray2034: Yes, for about 4 hours.

Reader: "Honey, I'm in the pool" will take on a whole new meaning.

Terry2034: Indeed it will.

Reader: But what about our athletic competitions? Today we have controversies with injections of steroids and human growth hormone, but robotic red blood cells are going to blow that out of the water, so to speak.

Ray2034: Well, there will always be specific rules in athletic contests. For example, it was quite feasible back in 2008 to develop cars that go much faster than the winning cars in NASCAR competitions, but there were very detailed rules as to how you can soup up your car. We'll have to determine rules for how you can soup up your body.

Reader: Assuming these things can be detected.

Ray2034: Actually, they'll readily show up in a blood sample, but we do want to point out that there is a good reason not to ban them. Anabolic steroids and human growth hormone in the absence of specific medical conditions requiring their use (such as the condition of low levels of human growth hormone or other medical reasons) *should* be illegal because they are bad for your health. If we did not ban them, then athletes would be forced to harm their health in order to be competitive. Respirocytes, on the other hand, are good for your health. They provide better oxygenation of your tissues and superior removal of carbon dioxide and toxins.

Reader: How about if I have a heart attack? Are these things going to get in the way?

Terry2034: Here in 2034, the incidence of heart attacks has been reduced by more than 95 percent because of the widespread use of effective medications and procedures that change your genes to be heart protective. But in the rare event that you do have a heart attack, you'll be glad you have these little robots. They'll keep your heart and brain and all your vital organs supplied with oxygen for at least 4 hours. You can walk into your doctor's office and calmly explain that you're having a heart attack. She'll inject you with more respirocytes and then deal with removing the clot and fixing the problem.

Reader: I suppose you have more nanobots for that too?

RayandTerry2034: Yes, we do. They travel through the bloodstream and destroy the clot that caused the heart attack.

Reader: What about the other parts of the blood?

Terry2034: We also have micron-size artificial platelets that are capable of achieving homeostasis (bleeding control) up to 1,000 times faster than biological platelets. Right now nanorobotic microbivores (white blood cell replacements), which can destroy specific infections and are effective against all bacterial, viral, and fungal infections, even cancer cells, and with no limitations of drug resistance, are being tested for human use. These robotic microbivores can destroy a pathological organism like a harmful bacterium or virus in 30 seconds. The pathogens are broken down into harmless amino acids and other nutrients rather than the often-toxic result from the action of our biological immune system.

Reader: That doesn't sound so impressive. I studied microbiology in college and I know that my own white blood cells can quickly destroy a pathogen right now.

Ray2034: Actually, back in your day I observed my own white blood cells destroy a bacterium through a special microscope at Terry's clinic. The white blood cells were indeed very clever at blocking the bacterium's escape, but they were very slow. It took over an hour. Our new nanorobotic microbivores can do that in seconds—they can also download software from the Internet so they'll know what germs are in the community at the moment, as well as be able to treat any engineered biological agents.

Enhanced External Counterpulsation

In addition to the noninvasive remedial procedures involving diet and supplements described above, an ingenious method for reducing angina pain

and improving cardiac function in patients with heart failure is enhanced external counterpulsation (EECP). This completely noninvasive treatment involves placing air-filled cuffs around the patient's calves, thighs, and buttocks. While the patient lies on a table, the cuffs are compressed with air in a specific rhythm controlled by a computer that receives input from the patient's real-time electrocardiogram. The inflation of the cuffs is timed to occur precisely during the resting phase of the heart rhythm, called *diastole*. As the computer inflates the cuffs, blood is propelled from the lower body back into the heart. This treatment, which is approved by the FDA for some cases of angina pectoris and heart failure, rapidly promotes the development of collateral coronary blood vessels (very small coronary arteries that augment the main coronary arteries). In other words, EECP causes the heart to grow its own natural bypasses.

EECP greatly accelerates the natural process of growing collateral bypass circulation. It also appears to provide the heart with a profound form of exercise. It is well known that elderly heart patients, who have had more time to grow collateral circulation, have a lower risk of dying from a heart attack for this reason. With EECP, however, people can grow effective collateral circulation at any age. It dramatically improves blood circulation and has been shown to improve a variety of conditions that benefit from improved circulation, such as Parkinson's disease. A typical course of EECP treatment is 1 hour per day, 5 days a week for 7 weeks. Although this involves a significant commitment of time and inconvenience, it is far preferable to invasive surgery and involves a healthy, healing process, rather than the risks and complications of surgery. EECP is both FDA- and Medicare-approved under certain circumstances, such as forms of congestive heart failure. It is the leading form of heart therapy in China.

Terry2034: Now that robotic red blood cells are in daily use, research is gearing up to replace the heart altogether. We expect this to happen later in the 2030s. The heart is a remarkable machine, but it has a number of severe problems. It is subject to a myriad of failure modes—as discussed at length in this chapter—and it represents a

fundamental weakness in our potential longevity. The heart usually breaks down long before the rest of the body, and often very prematurely.

Ray2034: Although artificial hearts have come a long way in the past 30 years and the new models work quite well, a more effective approach is to get rid of the heart altogether. We can do this by using robotic blood cells that provide their own mobility. If the blood system moves on its own, the engineering issues of the extreme pressures required for centralized pumping by the heart can be eliminated. With the self-propelled respirocytes providing greatly enhanced access to oxygenation, we will be in a position to eliminate the lungs, too, since the nanobots can also provide oxygen and remove carbon dioxide.

Reader: Okay, now hold your horses, I kind of like breathing. Going into the great outdoors and taking a deep breath is one of the great pleasures of life. And for that matter, I like the feeling of my heart beating also.

Ray2034: The therapies that are now being developed are intended to augment our heart and lungs, so we'll have the best of both worlds.

Reader: Yes, but from the way you are talking, it sounds like the heart and lungs, eventually, won't be needed at all.

Ray2034: If you like breathing that much, we are also developing virtual ways of having this sensual experience.

Reader: Well, for some things, I kind of like real reality.

Terry2034: You can keep your biological heart and lungs as long as you like. But, I hope you'll come talk to us about this in a quarter century. It will be comforting to know that you have a backup if something goes wrong.

EARLY DETECTION: CARDIOVASCULAR DISEASE

Finding out that you have some type of vascular disease before a catastrophe occurs—early detection, in other words, can be lifesaving. More people die of cardiovascular disease than from any other cause, and, in 2005, one American died of cardiovascular (heart and blood vessel) disease on average every 96 seconds, for a total of 151,671 fatal heart attacks and 143,948 fatal strokes.

In more than half of these cases, the people who died had no prior warning symptoms. There was neither chest pain nor skipped heartbeats to let them know something was wrong with their hearts—right up to the very day they suffered the heart attack that killed them. Most didn't have any strokelike symptoms before the day of their fatal stroke. Sadly, in the majority of cases, there was nothing to suggest that there was anything wrong with these folks, which would have brought them to the doctor so that something could be done in time.

This is an unnecessary tragedy since several simple, safe, and inexpensive screening tests can easily detect cardiovascular disease long before a heart attack or stroke occurs. Yet, the overwhelming majority of practicing physicians still do not routinely order these tests on their patients, leading to hundreds of thousands of unnecessary deaths.

Part of the reason is too much emphasis on measuring and aggressively treating blood lipids, such as cholesterol, while not directing enough attention toward other critically important risk factors, such as homocysteine and CRP. In addition, only a small fraction of the population has had their coronary calcium score measured or undergone carotid intima-media thickness measurement, two simple screening tests discussed below that can detect the presence of cholesterol build-ups in the arteries and alert people to potential problems that can be corrected long before heart attacks or strokes occur.

An effective program for the early detection of cardiovascular disease relies on a combination of blood tests and imaging studies, such as the coronary calcium score and ultrasound examination of the arteries. We'll outline for you a very effective program that will enable you to discover whether you have any problems early on—at a time when almost all of the damage can be avoided. Luckily, you don't need to be independently wealthy or have a doctor's orders or permission to have any of the testing we recommend done. Hopefully, you have a forward-thinking physician who is already using these tests. If not, talk with your doctor (one of the *TRANSCEND* principles) to see whether you can arrange to have them done on your own.

Blood Tests for Early Detection of Cardiovascular Disease

Lipid Panel

The lipid panel tests for four major cardiovascular risk factors: **total cholesterol, LDL cholesterol, HDL cholesterol, and triglycerides**. This is one test for the detection of cardiovascular disease that is routinely done by all practicing physicians. We agree with the National Cholesterol Education Program (NCEP) and the American Heart Association recommendations that everyone get a lipid panel beginning at age 20, and, if results are normal, every 5 years thereafter.

This test should be done in the morning after you have been fasting for at least 10 hours. If your lipid levels are not within the goal ranges, you should have testing done more often—say, every 4 to 6 months—until you get your numbers into the desirable ranges. In addition, if you do the imaging studies recommended below and find that you have either early heart disease because of a positive coronary calcium score or early cerebrovascular disease as a result of ultrasound testing of the carotid arteries in your neck, then the optimal values below are not merely desirable—they are mandatory.

TOTAL CHOLESTEROL

NCEP recommendations are for total cholesterol to be less than 200 mg/dL. Readings between 200 and 239 are considered borderline high, while levels above 240 are associated with twice the risk of heart attack compared with levels less than 200. On the basis of the most recent evidence, we believe that the optimal range for total cholesterol should be 160 to 180. This range is supported by research suggesting that these lower levels can reduce risk of cardiovascular disease even further. People who have positive results on their coronary artery calcium scans or carotid ultrasounds need to achieve this optimal level.

LDL CHOLESTEROL

To determine your optimal goal for LDL cholesterol, you need to count how many of the following types of risk factors you have:

Severe Risk Factors:

- Established coronary heart disease
- Diabetes
- Metabolic syndrome
- Coronary artery calcium score is below 75th percentile for your age (our recommendation—not included in the NCEP list)

If you have one or more of these severe risk factors, you are considered very high risk and need to lower your LDL cholesterol very aggressively. NCEP suggests 100 as the upper limit for LDL in this group.

Major Risk Factors:

- Age—male older than 45 years of age or female older than 55 years of age
- Cigarette smoking
- Family history of premature heart or blood vessel disease (age older than 55 in a first-degree male relative or older than 65 in a first-degree female relative; a first-degree relative is a parent, sibling, or child)
- High blood pressure (140/90 or higher, or on blood pressure medication)
- HDL cholesterol < 40
- Coronary artery calcium score > 25th percentile (our recommendation—not included in the NCEP list)

According to NCEP, if you have zero or one major risk factor, your LDL goal is less than 160. If you have two or more major risk factors, NCEP suggests an LDL goal of less than 130, with an optimal goal of less than 100. If you are in the severe risk group for heart attack or stroke, NCEP feels your LDL goal is less than 100. Although we agree with the NCEP categories, we feel LDL should be treated more aggressively in people in the high- or severe-risk categories. For the severe-risk group, we recommend that the LDL level

be less than 70 (rather than 100); for the high-risk group, we feel it should be less than 100 (rather than 130). Terry's clinic has set a goal of LDL less than 80 if there is any evidence of early coronary artery disease based on a positive calcium heart score (any calcium whatsoever) or of carotid artery disease because of ultrasound abnormalities on the intima-media thickness test. Reaching this goal should help prevent further disease progression even in the absence of any other risk factors.

HDL CHOLESTEROL

HDL cholesterol is the "good" cholesterol because it works to remove plaque from arteries. HDL levels less than 40 mg/dL are a major risk factor for cardiovascular disease. Levels above 60 mg/dL are protective, while levels below 40 mg/dL in men and below 50 mg/dL in women are a symptom of metabolic syndrome, which is another major risk factor for cardiovascular disease.

TRIGLYCERIDES

Triglycerides are a measure of fat in the blood. A high triglyceride level, along with a low HDL level, is classic for metabolic syndrome. High triglycerides are commonly the result of a diet high in sugary and high-glycemic-index foods. Triglyceride levels less than 150 mg/dL are considered normal, and the optimal values are less than 100.

The VAP Lipid Panel

The VAP, or Vertical Auto Profile, test provides more detailed information than a conventional lipid panel. In one study of families with premature coronary artery disease in Utah, Roger Williams, MD, found that only 25 percent of the cases of heart disease could be accounted for by elevated total cholesterol and LDL alone. At least 60 percent were the result of other lipid abnormalities, such as low HDL, elevated lipoprotein(a), intermediate-density lipoprotein (IDL), or very-low-density lipoprotein (VLDL).

When a standard lipid panel is run, the total cholesterol, HDL, and triglycerides are measured, while the LDL is calculated from the other results.

In the VAP test, LDL is measured directly, providing much more accurate information than a calculated value. In addition, the VAP provides information about the size and actual number of LDL particles, and tells how many of the less dangerous, larger, fluffy "A" LDL particles you have compared with the number of more dangerous, small, dense "B" particles. Because they are light and fluffy, "A" particles tend to bounce off the walls of the arteries. In contrast, the small, dense "B" particles act more like little bullets and penetrate the arterial wall more easily, where they deposit the cholesterol they contain. Higher numbers of small "B" particles are more common in patients with diabetes or metabolic syndrome.

VAP also measures lipoprotein(a), IDL, and VLDL, risk factors found to be more important than total cholesterol and LDL. Finally, VAP fractionates or splits HDL, the beneficial form of cholesterol, into HDL-2 and HDL-3 subunits. HDL-2 is much more protective than HDL-3. Low HDL-2 is a significant risk factor for cardiovascular disease.

IDL is a genetic risk factor and tends to be elevated in patients whose family tree includes diabetes. VLDL carries triglycerides in the blood and, if elevated, suggests the need to eat less sugar and high-glycemic-index carbohydrates. Elevated lipoprotein(a) is another hereditary factor that is associated with high risk and rarely responds to conventional cholesterol-lowering drugs. Elevated lipoprotein(a) levels can be lowered by taking 1 gram of vitamin C, 1 gram of lysine, and 1 gram of proline twice daily.

The Metabolic Factors—Glycation, Inflammation, and Methylation

In Chapter 5, we discuss how the metabolic factors—glycation, inflammation, and methylation (GIM)—can contribute to cardiovascular as well as other types of health risks. Three simple laboratory tests can provide a wealth of information on how well your body is performing these critical metabolic functions. You can assess your own GIM factors with three simple blood tests: *Hemoglobin* A_{1c} directly measures glycation, *CRP* measures inflammation, and *homocysteine* measures methylation status. These tests are also discussed at further length in Chapter 5.

Fasting Glucose and Insulin

Metabolic syndrome and its more serious cousin, type 2 diabetes, have far-ranging implications for heart disease risk. Patients with these conditions have insulin resistance, which results in high blood levels of insulin. Insulin is a growth promoter and accelerates coronary plaque formation. It also is associated with hypertension (high blood pressure), another risk factor for heart disease. High levels of glucose in the blood increase the glycation of LDL, a key step in turning macrophages and LDL into pathological foam cells. Fat metabolism is also likely to be disrupted by insulin resistance, causing excessive levels of triglycerides, another coronary risk factor.

We recommend having your fasting glucose and insulin levels checked and suggest that you follow the guidelines in Chapter 5 for fasting glucose less than 90 and fasting insulin less than 5.

TABLE 2-3: SUMMARY OF REFERENCE VERSUS OPTIMAL BLOOD LEVELS FOR HEART HEALTH

BLOOD TEST	STANDARD REFERENCE RANGE	OPTIMAL LEVEL
C-reactive protein (mg/L)	*< 5*	*< 1.3*
Homocysteine (μmol/L)	*< 15*	*< 7.5*
Cholesterol (mg/dL)	*100–199*	*160–180*
LDL (mg/dL)	*0–129*	*80 (if you have < 3 major risk factors)* *< 70 (if you have > 3 major risk factors)*
HDL (mg/dL)	*40–59*	*> 60*
Cholesterol-to-HDL ratio	*2.5–4.0*	*< 2.5*
Triglycerides	*0–149*	*< 100*

Imaging Tests

Coronary Artery Calcium Score

Even though most heart attacks are caused by soft or *vulnerable* plaque, the amount of hard, calcified plaque in your coronary arteries is important

because there is a direct correlation between the levels of hard and soft plaque in your arteries. Soft plaque still cannot be readily measured, while hard plaque is easier to detect. As we discussed earlier, our current understanding is that soft or vulnerable plaque in coronary arteries is the cause of most heart attacks. As noted, when inflammation is present, soft plaque might rupture, thereby stimulating local clot formation and downstream obstruction of bloodflow—also known as a heart attack.

The primary reason for the direct correlation between hard and soft plaque is that the body walls off vulnerable plaque with calcified deposits, so the rate at which calcified plaque is created also correlates to the amount of soft plaque. You can get an indirect measurement of how much of the more dangerous soft plaque you have by measuring your hard plaque with ultrafast or electron-beam computed tomography (EBCT), also known as the coronary artery calcium (CAC) score. The technique is fast, noninvasive, reasonably priced, and widely available.

Higher CAC scores relate to higher risks of a heart attack, but physicians differ about the usefulness of this method of risk assessment. In 2007, the American Heart Association's Consensus Document concluded that it "may be reasonable" to measure CAC in asymptomatic patients with intermediate risk (two or more major risk factors) of coronary disease, but not in low-risk patients (zero to one major risk factor) or in the general population. The American Heart Association document also advised against measuring CAC scores in asymptomatic high-risk patients because they already qualify for "intensive risk reducing therapies" regardless of the CAC results. We believe the CAC test is a useful measurement if you understand the different roles of calcified and soft plaque and if the results are properly interpreted. One caveat is that CAC cannot be used in patients who have undergone previous invasive cardiac procedures, such as bypass surgery, angioplasty, or stenting. The EBCT has been available for over 15 years, and it is unfortunate that it has taken this long for conventional medicine to begin to recognize its value.

Optimally, your CAC score will be zero, meaning you have no detectable plaque, but for any non-zero score, the higher the level, the greater your

risk of a heart attack. Your score should be compared to the range of scores observed in people of your age and gender, expressed as a percentile rating (see Table 2-4). If your score places you in the 75th percentile (meaning that 75 percent of people of your age and gender have scores lower than yours) or higher, we recommend that you address coronary plaque reduction urgently. It is actually the rate of increase in calcified plaque that indicates your level of vulnerable plaque. Without treatment, CAC

TABLE 2-4: CORONARY ARTERY CALCIUM SCORES (AVERAGE AND 75TH PERCENTILE)

MEN

AGE	AVERAGE (50TH PERCENTILE)	75TH PERCENTILE
40–45	*2*	*11*
46–50	*3*	*36*
51–55	*15*	*110*
56–60	*54*	*229*
61–65	*117*	*386*
66–70	*166*	*538*
70+	*350*	*844*

WOMEN

AGE	AVERAGE (50TH PERCENTILE)	75TH PERCENTILE
40–45	*0.1*	*1*
46–50	*0.1*	*2*
51–55	*1*	*6*
56–60	*1*	*22*
61–65	*3*	*68*
66–70	*25*	*148*
70+	*51*	*231*

scores can progress by 40 percent per year or more. With aggressive maneuvers, that rate of progression can be lowered to 10 percent or less and, as first demonstrated by Dr. Dean Ornish, even reversed by aggressive dietary manipulations.

Because the heart is imaged multiple times during this procedure, this test results in radiation exposure. In men, a single EBCT screening administers the equivalent amount of radiation as eight standard two-view chest x-rays. For women, because of the greater amount of radiation to the breast tissue, it is equivalent to about 15 chest x-rays (or five mammograms). Therefore, this procedure should not be repeated too frequently and should be done less often in women than men.

Intima-Media Thickness Measurement

Arteries have three layers; the intima and media are the two innermost layers. Increased thickness of these two layers is a sign of plaque build-up in the arteries. Measurement of intima-media thickness (IMT) is usually done on the carotid arteries, which are in the neck and carry blood to the brain. Carotid IMT is a diagnostic test that uses ultrasound waves and is a safe, noninvasive, inexpensive, and rapid method for determining carotid wall thickness and plaque. Carotid plaque appears on the ultrasound as an abnormal thickening between the intimal (innermost) and medial (midlevel) layers of the artery. Carotid IMT provides an estimate of a person's risk of stroke, the third leading cause of death.

Despite its many advantages and the amount of information it provides, use of this test is still not routine. In early 2007, a report in the journal *Circulation* found that carotid IMT is a strong predictor of both stroke and heart attack. Even so, a few months later, the U.S. Preventive Services Task Force recommended that asymptomatic adults *not* get routine carotid IMT screening.

Terry's clinic has been using the CAC score since 1996 and has recently added carotid IMT imaging to its testing panels. We feel these two tests provide critical information about a patient's risk of some of the leading causes of death and believe they should be included in the comprehensive health evaluations of any patient with two or more cardiovascular risk factors.

Peripheral Arterial Disease Screening

Peripheral artery disease (PAD) refers to plaque build-up in the peripheral arteries (the arteries in the arms and legs). The prevalence of asymptomatic PAD has been steadily increasing among American adults and is found in about 5 percent of adults 40 years and older, as reported at the 2007 Scientific Sessions of the American Heart Association. PAD occurs when plaque accumulates in the walls of arteries supplying blood to the limbs, especially the legs and feet. When PAD becomes more severe, individuals develop pain when they try to do routine tasks that involve use of the lower extremities, such as walking or climbing up stairs. Eventually, the pain becomes so severe that some type of bypass surgery or stenting must be done to restore blood circulation to the legs, although in some cases, amputation becomes necessary to prevent gangrene. PAD is also associated with increased risk of heart attack and stroke.

PAD can be easily diagnosed before symptoms develop by measuring the blood pressure at the ankles and comparing it to the blood pressure in the arms. The ratio between the two is referred to as the ankle–brachial index or ABI (*brachium* is Latin for "arm"). The blood pressure in the legs is normally higher than in the arms, so the ABI should always be greater than 1.0. When the ratio drops below 0.8, people often experience pain in their legs when walking. A person with an ABI less than 0.4 will typically have pain even at rest and often needs surgery.

A convenient and inexpensive way to get both carotid IMT and PAD screening is through mobile screening clinics, which are available several times each year in most cities. These tests are typically done in a van that travels to different locations each day.

Graded Exercise Testing

Graded exercise testing (GXT) is commonly known as a stress test or exercise tolerance test and evaluates how well an individual can tolerate the stress of exercise. During a GXT, the patient performs gradually increasing levels of exertion while the physician continuously monitors the electrocardiogram tracing, frequently checks the heart rate and blood pressure, and ensures that the patient feels well at each stage of the test. A GXT can be completed in less

than 30 minutes and can provide several important pieces of information about heart health. Exercise testing is not foolproof, however—it is better at detecting more advanced blockages of the coronary arteries, such as those that are occluding more than 75 percent of an artery, but is less sensitive at detecting smaller blockages. That's why we recommend checking your coronary artery calcium score with the ultra-fast CT scan because it's better at detecting smaller blockages. The GXT can also provide a good indication of a person's aerobic conditioning and exercise tolerance. A baseline GXT is recommended for individuals over 40 years of age who have not been exercising previously in order to ensure that it is safe for them to begin exercising.

A standard exercise test is recommended for healthy individuals without heart-related symptoms. For patients with known cardiovascular disease or for individuals who have been experiencing undiagnosed chest pain, a thallium treadmill test is preferred. In this test, as soon as the maximum level of exercise has been achieved, the patient receives an intravenous injection containing radioactive thallium. Using an imaging scanner, doctors can compare the amount of blood flowing to the heart muscle during maximum exercise to the amount flowing at rest. Patients with blockages in the arteries often have adequate bloodflow at rest, but inadequate bloodflow during maximal exertion.

Some risks are associated with this test. These risks are rare and include low blood pressure, chest pain, arrhythmia (abnormal heart rate or rhythm), heart attack, and stroke. Having a trained physician with appropriate resuscitation equipment immediately at hand increases the level of safety.

THE END OF HEART DISEASE

You already have the knowledge to dramatically reduce your risk of heart disease. If you adopt all of the methods we have described in this chapter, you can reduce your risk of having a heart attack almost to zero, regardless of your genes. Once the new therapies discussed by our future selves are fully developed over the next 20 years, we will have easily available means to reverse the damage already done by atherosclerosis, and even by previous heart attacks. We really do have the means to overcome our genetic legacy!