CORONARY ARTERY DISEASE

INTRODUCTION

Coronary artery disease (CAD) is a chronic heart condition that affects millions of Americans. It is considered to be the number one cause of death in the United States, and it is also very common worldwide.

At times, the terminology surrounding CAD can be confusing. You may hear people talk of heart disease, hardening of the arteries, atherosclerosis, hypertensive heart disease, heart failure, etc. It can be difficult to separate one from another.

However, although these conditions are closely connected and one may cause another, they are different diseases. This module will be about CAD, and CAD is actually a consequence of one of these diseases, atherosclerosis.

For people with CAD, the arteries that bring oxygen and nutrients to the heart have become stiff and narrowed and sometimes these blood vessels can become completely blocked. CAD can cause many serious health problems. To a certain degree CAD is caused by a genetic susceptibility to the development of the disease. However, in most cases CAD is a disease that is primarily caused by lifestyle factors.

OBJECTIVES

When the student has finished this module, he/she will be able to:

1. Identify a definition of coronary artery disease.
2. Identify the basic cause of coronary artery disease.
3. Identify three specific factors that can cause coronary artery disease.
4. Identify the basic cause of the signs and symptoms of coronary artery disease.
5. Identify the medical term for chest pain associated with coronary artery disease.
6. Identify three signs and symptoms of an angina attack.
7. Identify the medical term for a heart attack
8. Identify the three major complications of coronary artery disease
9. Identify a disease that makes evaluating a patient with coronary artery disease difficult.
10. Identify signs/symptoms that should be brought to a supervisor’s immediate attention.
WHAT IS CORONARY ARTERY DISEASE?

Coronary artery disease is a medical condition that affects the circulatory system of the heart. In CAD, the arteries and vein that supply the heart muscle with blood are slowly and progressively blocked. These blood vessels can also become weak, fragile, and susceptible to rupturing.

Coronary artery disease is the result of a process called atherosclerosis. Atherosclerosis is a chronic disease that causes blockages of the arteries and veins. Atherosclerosis can affect almost any blood vessel anywhere in the body, but some parts of the circulation are more likely to develop atherosclerosis than others. The circulation in the heart and the brain are areas that are commonly affected by atherosclerosis.

The heart is responsible for circulating the blood to the body. But the heart also pumps blood to itself through the coronary circulation, and it is the arteries and veins of the coronary circulation that become blocked by CAD. Because the heart is such a vital organ and because it is so metabolically active, any disruption to its blood flow can be very damaging. If CAD progresses to a certain point, the heart muscle can become irreversibly damaged and other very serious complications can develop.

Coronary artery disease is defined as narrowed and/or blocked arteries in the heart.

HOW COMMON IS CORONARY ARTERY DISEASE? WHO IS AT RISK?

The exact number of people who have CAD is impossible to determine, but a recent (2013) estimate that there are approximately 14 million Americans who have CAD clearly shows that the disease is widespread. Coronary artery disease is the number one cause of death in the United States, and the complications of coronary artery disease such as angina, arrhythmias, and myocardial infarction are a significant public health problem.

Coronary artery disease is more common in men than women, it affects African Americans differently than it does other ethnic groups, and it is more common in the elderly. However, simply saying that women, African Americans, and the elderly are more likely to have CAD, or that it affects certain ethnic groups in a particular way leaves out some important information.

**Women and CAD**

Men are more likely than women to have CAD, but this is true only before a certain age - usually around 65 or so - and this phenomenon is probably due to hormones such as estrogen. It thought that prior to menopause, female hormones have a protective effect that prevents the development of CAD. It is not known why this is so, but estrogen may decrease serum cholesterol levels. After menopause, when estrogen levels drop, the incidence of CAD in women begins to rise and eventually a post-menopausal woman who has risk factors for the development of CAD will get CAD.

So, after menopause, the incidence of CAD in women rapidly becomes equal to that of men, and CAD is the leading cause of death for women in the United States. Women who have CAD also have more symptoms such as chest pain, and they have a higher mortality rate associated with CAD. Other aspects of CAD that are different for women are the
way that plaque is deposited and the signs and symptoms of CAD. That last point is very important and will be discussed later in the module.

**Learning Break:** Coronary artery disease is the leading cause of death in women. But many studies have shown that the majority of women are unaware of the risk, and this has obvious implications for the way women manage their health and life style.

### African Americans and CAD

African Americans may actually have *less* obstructive CAD than other ethnic groups, but the incidence of complications caused by CAD is higher among African Americans than it is among other ethnic groups. African Americans are also more likely than other ethnic groups to die from CAD, even when certain life style factors are accounted for. Unfortunately, the presence of medical condition and life style factors such as diabetes, hypertension, and obesity that increase the risk of developing CAD is disproportionately high among African Americans.

### The Elderly and CAD

Because CAD is a chronic, progressive disease, not surprisingly the older someone is the more likely he/she will have pre-existing medical problems such as diabetes and hypertension. These can increase the development of CAD, and they can also make management of the disease more difficult. The great majority of people who die from CAD are over age 65, and this population group suffers more complications from CAD, as well.

### Risk Factors and CAD

The risk factors that increase the chances of developing CAD will be discussed in detail later in the module. However, a quick and simple assessment of what these risk factors are and what they mean can be done by answering these questions.

1. Gender
2. Age: Are you over 45?
3. Blood cholesterol: Is your total serum cholesterol > 200?
4. Blood pressure: Do you have hypertension?
5. Diabetes: Do you have Type I or type II diabetes?
6. Tobacco: Do you smoke?
7. Family history of CAD?
8. Weight: Are you overweight or obese?
9. Exercise: Are you sedentary or active?

It has clearly been shown that men who are older than 45 are at a higher risk for developing CAD than women or than younger men. And anyone who has the presence of these other risk factors, aside from the family history of CAD which obviously can’t be changed, should definitely make life style changes. Someone who has these specific medical problems - an elevated serum cholesterol, high blood pressure - and these life
style issues - a history of smoking, obesity and being sedentary - and has a family history of CAD has a very high risk for developing CAD.

There are many assessment tools available that can help someone determine what his/her risk is for developing CAD or developing complications from CAD. One of the more commonly used ones is The Framingham Risk Score. This assessment estimates the risk of having a heart attack within the next 10 years. Age, gender, total cholesterol, HDL cholesterol, tobacco use, systolic blood pressure, and the use/non-use of anti-hypertensives are evaluated, and a risk percentage is determined.

Example: A 65-year-old male has a total serum cholesterol of 240 mg/dL and his HDL cholesterol is 65 mg/dL. He does not smoke, his systolic blood pressure is 142 mm Hg, but he does not take anti-hypertensives. It is estimated that within the next 10 years he has a 12% chance of having a heart attack.

The Framingham Risk Score can be found on the website of the National Heart, Blood, and Lung Institute - http://www.nhlbi.nih.gov/ - and then search under Risk Assessment Tool for Estimating Your 10-year Risk of Having a Heart Attack. You can also use this link to connect to it directly. http://cvdrisk.nhlbi.nih.gov/calculator.asp.

HOW DOES CORONARY ARTERY DISEASE HAPPEN?

Coronary artery disease is a complication of atherosclerosis. Atherosclerosis causes the arteries (the blood vessels that bring oxygen and nutrients to the body) to become very narrow, stiff, and occasionally, completely blocked. Atherosclerosis can affect the arteries supplying the brain and cause stroke. It can also affect the arteries in the extremities and cause a condition called peripheral vascular disease. When it affects the arteries in the heart, it causes CAD.

What is Atherosclerosis? How does Atherosclerosis Happen?

Atherosclerosis is a chronic disease characterized by arteries that are stiff, rigid, and occluded by plaques. The plaques are deposits of cholesterol and fats.

Atherosclerosis is the cause of CAD, and the development of atherosclerosis happens in a complex way. Over a period of time, usually starting in the late childhood and perhaps earlier, the arteries in the heart develop plaques. These plaques are deposits of fats, cholesterol, and other material. It is not known why these plaques begin to form, especially early in life when many of the risk factors for CAD are not present.

Later in life, the development of these plaques continues, and the initial plaques become larger and more widespread. The risk factors that were discussed in the previous section, e.g., elevated serum cholesterol, high blood pressure, smoking, etc., all contribute at this point to plaque development. Each of these risk factors damages the arteries in a specific way, and most experts feel that each of them is necessary for atherosclerosis to happen. For example, hypertension places a constant pressure on the walls of the arteries. Over time this causes physical damage to the arteries that allows the elevated levels of
cholesterol and lipids to become deposited on and in these blood vessels, forming plaques. Smoking appears to cause inflammation in the walls of the arteries; this contributes to the physical damage caused by hypertension and makes it easier for cholesterol and fats to form plaques.

**Learning Break:** Coronary artery disease caused by atherosclerosis is a chronic condition that takes years and years to develop. Because CAD develops so slowly, the disease can be widespread and serious before signs and symptoms are noticed.

Other factors such as genetics, age, ethnic background, obesity, sedentary lifestyle, diet, alcohol abuse, and medical conditions such as diabetes all contribute to the development of the atherosclerosis that causes CAD. How and why these other risk factors contribute to the development of CAD is not known, and they appear to be less significant as risk factors than “the big three” of hypertension, elevated serum cholesterol, and cigarette smoking. However, although they appear to be less important there is no doubt that being overweight, sedentary, having diabetes, etc. increase the chances of developing CAD.

**Can CAD be Inherited?**

The role of genetics and CAD is not completely understood, but it is clear that to some degree CAD - or the tendency to develop CAD - can be inherited. Studies have shown that if someone in your family, especially a parent or a sibling, developed CAD at a relatively young age then the chances that you will develop CAD are increased. This tendency to “inherit” CAD may be due to a genetic susceptibility to accumulate serum cholesterol that is part of the family history. This risk factor can’t be eliminated, and it is not known how much it contributes to the development of CAD: compared to risk factors such as hypertension and smoking, genetics probably play a relatively minor role.

**What is the Significance of Atherosclerosis and CAD?**

Atherosclerotic plaques that form on the walls of the arteries narrow the arterial passages and block blood flow. Atherosclerosis also causes the arteries to become stiff and rigid, and they cannot open properly. The plaques can also become fragile and rupture. Because there is less room for blood to flow through the arteries and because atherosclerotic arteries are far less elastic than normal arteries, the tissues and organs are deprived of blood and deprived of oxygen and nutrients.

The significance of atherosclerosis and CAD depend on three things: 1) Where the plaques are; 2) How much they interfere with blood flow, and; 3) How stable the plaques are. If the plaques are in relatively minor arteries, if they are not very large, and they are stable, atherosclerosis and/or CAD may not be a serious problem - yet.

But if the plaques are in a major artery that supplies an area of the body that is very dependent on a high amount of blood flow - an artery such as the left anterior artery in the heart - than a blockage of that artery can cause a heart attack, a.k.a., a myocardial infarction. Of course, just the presence of a plaque, even in a very important artery, does not necessarily mean that the plaque is dangerous. The plaque has to be large enough to
interfere with blood flow and it has to be fragile, as well. Atherosclerotic plaques cause
damage by blocking blood flow, but they also cause damage by becoming fragile and
rupturing. When this happens, a plug is formed in the artery that completely blocks the
flow of blood; this is how most heart attacks happen.

The heart is one of the most active organs of the body. It needs a constant supply of
oxygen and nutrients and for oxygen and nutrients to reach the heart muscle, the coronary
artery must be open and clean. If the blood supply to the heart is decreased, there are
compensatory mechanisms that can, for a while, keep blood flowing to the heart.

But CAD is a progressive disease. Unless the risk factors are tightly controlled the
plaques keep growing, they become more fragile, and the blockages of blood flow to the
heart become worse and worse. Eventually, someone with widespread CAD will develop
one of the serious complications associated with the disease, and when that happens the
disease cannot effectively be reversed and that person must live with the consequences.

Summary

Coronary artery disease is defined as narrowed and/or blocked arteries in the heart.
Coronary artery disease is caused by atherosclerosis. Atherosclerosis is defined as a
chronic disease characterized by arteries that are stiff, rigid, and occluded by plaques.
The plaques are deposits of cholesterol and fats. These plaques are caused by life style
factors and certain medical conditions called risk factors. The most important risk factors
for developing atherosclerosis and CAD are elevated serum cholesterol, hypertension,
and cigarette smoking. Coronary artery disease interferes with blood flow to the heart. It
is a progressive disease, and the plaques become large enough, if they become very
fragile and rupture, and if they occlude a significant artery, the heart can suffer serious
damage.

SIGNS AND SYMPTOMS OF CORONARY ARTERY DISEASE

Coronary artery disease is a chronic condition and for most people it progresses very
slowly. The plaques build up over decades and although there can be times when they
stop increasing in size, there are also times when they progress quickly. If the plaques are
relatively small and stable and the arteries don’t become too rigid, someone with CAD
may not be aware they have the disease. The body can also compensate by actually
growing new blood vessels around the damaged arteries.

However, when the plaques become large enough to obstruct blood flow and the
arteries become very stiff, the heart muscle is deprived of oxygen. When that happens,
the person with CAD may experience:

• Chest pain (also known as angina)
• Heart attack
• Shortness of breath
• Rapid heart rate
• Irregular heart rate
• Inability to tolerate exercise
• Inability to tolerate cold
• Inability to tolerate heat
• Inability to tolerate stress
• Dizziness
• Sweating

All of these signs and symptoms can happen when someone is resting. However, they are more likely to happen during exercise, when it’s cold, or during stress. These are times when the body needs more blood and oxygen, and the heart has to beat stronger and faster to supply it.

If the heart has to work harder and faster, the heart itself needs more blood and oxygen. And if the blood vessels in the heart are narrowed, stiff, or blocked, the required amount of blood won’t get through and several things are likely to happen.

1. That person will likely have chest pain because the heart muscle is not receiving enough oxygen. If this continues, the heart can actually become damaged.
2. Shortness of breath and tachypnea would be very common in these situations. The heart cannot pump blood out to the body very effectively, so the muscles, tissues, and organs are deprived of oxygen, and that person feels short of breath. In order to compensate, the rate of breathing is increased.
3. A rapid heart rate - tachycardia - is another compensatory mechanism. The heart is not pumping effectively with each beat - so the heart rate is increased to make up.

Learning Break: *The basic cause of the signs and symptoms of CAD is a lack of oxygen reaching the heart.*

At times, these signs and symptoms may start slowly and gradually, offering warnings that someone has developed CAD. Unfortunately, mild chest pain, a little bit of shortness of breath once in a while, an occasional rapid or irregular heart beat can be easy to dismiss or ignore. Even worse, there are times in which there may not be any noticeable signs and symptoms of CAD until the person suffers a cardiac disaster. This is especially true for people with certain medical conditions; the damage is being done and they are unaware.

Learning Break: People who have diabetes and CAD may *not* have any signs and symptoms of CAD until they suffer a serious cardiac event such as a myocardial infarction (heart attack)

**COMPLICATIONS OF CORONARY ARTERY DISEASE**

Coronary artery disease can be managed with proper attention to diet, exercise, monitoring the blood pressure, and avoiding alcohol and tobacco. Many people with CAD can adjust and live without any serious restrictions to their life.

However, in many cases, the disease is progressive; slowly but surely it gets worse. Managing CAD requires people to make changes - stop smoking, lose weight, change their diet, take up an exercise program that many people find difficult to do. And if the
disease progresses and is not managed well, CAD can cause some serious complications. Three of these are common enough and serious enough that they will be discussed separately.

**Angina**

*Angina* is the medical term for the chest pain that occurs in people with CAD. It is caused by lack of oxygen to the heart. The heart is alike any other organ or tissue of the body. It needs oxygen to function and if it deprived of oxygen, the person with CAD will experience may experience an attack of angina (Imagine holding your breath for a long period of time; it can be very painful). Angina can happen when someone is resting or when they are exercising or under stress.

Many people describe angina as a pain in the chest. It is also frequently described as pressure in the chest: people who are having an angina attack frequently say it feels as if there is a very heavy weight on the chest. The pain or pressure often radiates down the left arm or up into the neck. Someone who is having an attack of angina will often be sweaty, feel dizzy, feel weak, feel nauseated, and have shortness of breath. Some times, the person who is having an attack of angina will not experience any chest pain, pressure or discomfort. He/she may simply feel a little anxious or restless, perhaps a little sweaty, a little short of breath. However, the most common signs and symptoms of an attack of angina are:

- Chest pain or chest pressure
- Pain or pressure that radiates down the left arm
- Pain or pressure that radiates up into the neck or the jaw
- Shortness or breath
- Rapid heart beat
- Nausea
- Dizziness
- Sweating

Although there are common signs and symptoms of angina, everyone experiences an attack of angina in his/her own unique way. It was mentioned earlier that the signs and symptoms of CAD are different for women. Women who are having angina or a myocardial infarction (This will be discussed in the next section) are less likely than men to have chest pain or chest pressure. For women, dizziness, feeling lightheaded, nausea, pressure in the abdomen, and shortness of breath are more common.

**Learning Break**: Another group that experiences complications of CAD in their own way is people who have diabetes. Diabetes can, over a period of years, alter and decrease the ability to sense pain. Someone who has diabetes *and* who has CAD *and* who is having angina or a myocardial infarction may not appear very ill and have minimal signs and symptoms.

Angina attacks may be brief (a few seconds) or they may last for a few minutes. They may go away spontaneously, they may require treatment, or they may progress to actual
damage to the heart. People who suffer from angina often carry a medication called nitroglycerin that can be placed under the tongue to relieve the pain. These people should also have received instructions from their physician about how to handle an angina attack. Example: If the patient considers the angina pain to be a 3 on the 1-10 scale, there are no other symptom such as shortness of breath, and the pain is relieved by one nitroglycerin, it is safe to stay home. If the pain is 8 on a 1-10 scale, and there is no relief after one nitroglycerin, go to the hospital.

Myocardial Infarction

Myocardial infarction is the medical term for a heart attack. A myocardial infarction is very similar to angina. They both happen to people with CAD. They both happen when the oxygen supply to the heart is disrupted. And they both cause many of the same signs and symptoms.

However, myocardial infarction is far more dangerous than angina. When a person with CAD has a myocardial infarction, the oxygen supply to the heart has been blocked so much that part of the heart muscle dies. Certainly, that is serious in and of itself. The heart and the patient may recover, but because part of the muscle is no longer functioning, the heart is now much weaker. However, a myocardial infarction can also cause other dire complications:

- Arrhythmias: If the heart muscle has been permanently damaged during a myocardial infarction, there may be changes in the rhythm of the heart. Some of these, such as ventricular fibrillation, may be fatal. Some may be survivable, but the person may require a permanent pacemaker or defibrillator to shock the heart back into a normal rhythm.
- Shock: A strong heart is required in order to maintain a normal blood pressure. A myocardial infarction can damage the heart so seriously that the blood pressure becomes dangerously low and the person can develop shock.
- Pulmonary edema: If a large amount of the pumping action of the heart is lost, blood and fluid will back up into the lungs. This condition is called pulmonary edema, and he/she will be unable to breathe.
- Sudden death.

The signs and symptoms of a myocardial infarction are essentially the same as those of an attack of angina. How can the two be distinguished? Many times, someone with angina knows when he/she is having angina, and if that person is having a myocardial infarction, he/she will know the difference. Many times, the signs and symptoms - the chest pain/pressure, shortness of breath, etc. - will be much worse if a myocardial infarction is happening.

But remember: it may be very difficult to tell the difference between an attack of angina and a myocardial infarction. At times, an exam by a physician, an electrocardiogram (ECG) and blood tests are the only ways to know for sure if someone with CAD and chest pain is having angina or a myocardial infarction.
ARRHYTHMIAS

When coronary artery disease disrupts the oxygen supply to the heart, the cardiac muscle often becomes unstable. There is also a specialized conduction system in the heart that acts very much like a system of electrical wires. This conduction system makes sure that each heartbeat starts normally and progresses normally. Coronary artery disease can also damage this specialized conduction system.

If either of these two circumstances occurs - damage to the heart muscle or the conducting system — the heart can develop erratic rhythms. At the best, these might merely require medication. At the worst, they can be fatal.

WHAT IS THE TREATMENT FOR CORONARY ARTERY DISEASE?

Treating coronary artery disease focuses on two areas: 1) Life style changes, and; 2) Preventing and treating complications.

Life Style Changes

Cigarette smoking, an elevated serum cholesterol, and hypertension greatly increase the risk of developing CAD. For most people, having or not having hypertension is not a choice: 95% of all adults who have high blood pressure were destined to develop the disease. However, management of high blood pressure depends on the patient complying with the treatment plan. And smoking cessation and eating a diet that lowers serum cholesterol can only be done through individual effort.

Many people find those life style changes difficult to introduce into their lives. Making other changes that can decrease the risk of developing CAD, changes such starting a daily exercise program, can also be challenging. But the evidence is clear that living a healthier life style can not only reduce the risk of developing CAD, it can also reduce the degree of CAD in people who already have the disease.

Preventing and Treating Complications: Drugs

The line between treating and preventing and the major complications of CAD is very narrow because many of the therapies that do one essentially do the other, as well. Preventing complications is primarily done by having the patient make life style changes, but if this is not possible then medications therapy is necessary.

Medications for preventing and treating CAD complications include:

- Anti-anginal drugs: Drugs such as the beta blockers (e.g., atenolol, metoprolol), the calcium channel blockers (e.g., diltiazem, verapamil), and long-acting nitrates can be used to prevent angina attacks. Short-acting nitrates such as sublingual nitroglycerin are used to treat an acute angina attack.
- Anti-hypertensives
- Anti-arrhythmic drugs: Atrial fibrillation is a common arrhythmia that is caused by CAD. It causes the heart to beat very rapidly and very irregularly, and this can...
have serious consequences. Digoxin is drug that is used to treat atrial fibrillation by slowing the heart rate.

- **Cholesterol lowering drugs:** These drugs are called statins, and Crestor® and Lipitor® are commonly used brands.
- **Clot prevention:** Drugs that prevent the formation of clots can prevent and decrease the number of angina attacks and prevent the occurrence of myocardial infarctions. Aspirin and Plavix® are drugs that are used to prevent clots. Some patients who have CAD and other types of cardiovascular disease may need to be on more powerful clot preventing medications such as warfarin, a.k.a., Coumadin®.
- **Clot dissolving drugs:** Patient who are having an acute myocardial infarction are typically treated with IV medications that dissolve the clot

**Preventing and Treating Complications: Surgery**

The two surgical procedures that that are used to prevent and/or treat CAD complications are:

1. **Coronary artery bypass graft surgery,** commonly know as a “cabbage procedure” or CABG involves replacing the blocked coronary arteries with new blood vessels
2. **Angioplasty:** Angioplasty is as procedure that either physically removes plaques in the coronary arteries or use an inflatable balloon that is inserted into the coronary arteries in the areas where the plaques are. The balloon is expanded, the plaques are compressed, and the blood vessel is opened up. In either procedure, a tube called a stent may be placed in the newly opened arteries in order to keep them open and maintain blood flow.

**CARING FOR THE PATIENT WITH CORONARY ARTERY DISEASE**

Caring for the patient with CAD involves close monitoring of the patient’s pulse and blood pressure. It also involves being aware of the conditions and situations that can aggravate CAD. And it involves knowing the major complications of CAD, these signs and symptoms of these complications, and what to do if they occur.

- **Monitoring the pulse and blood pressure:** If a patient with CAD has a pulse that is abnormally slow or fast, this can be a sign of a serious problem. If the patient with CAD has a blood pressure that is abnormally low or high, this can also be dangerous. Any of these changes should be reported to your supervisor immediately.
- **Dangerous situations for a patient with CAD:** Anything that makes the body work harder increases the need for oxygen and makes the heart work more intensely. This is always risky for a patient with CAD. Emotional stress, physical exertion, a fever, intense heat or cold, pain, or a sudden illness are all situations that could be dangerous for a patient with CAD.
- **Major complications of CAD:** These have already been discussed, as have the signs and symptoms associated with them. *You must know these.* If the patient
with CAD has any of those signs or symptoms, you must notify your supervisor immediately. It is also important to remember that although most people with CAD who are having angina, a myocardial infarction, or an arrhythmia will have some of the common signs and symptoms that were mentioned, some will not. Each person experiences these complications in his/her own unique way. You need to know your patients. Often, it is best to simply ask them what happens when their CAD gets worse.

If a patient with CAD has an abnormal heart rate, an abnormal blood pressure, chest pain or pressure, pain or pressure in the left arm, the neck or the jaw, or difficulty breathing, you must notify your supervisor immediately.

Some people with CAD may be suffering from angina, having shortness of breath, etc. and they will deny that anything is wrong. This is not uncommon. As a medical professional, you have to know your patients. You have to know who has CAD, and you have to be a keen observer. The patient with CAD may deny he/she is in pain or can’t breathe, but you must learn to trust what you can see and measure.