Introduction to Lesson 5 - Cardiovascular Disease

Cardiovascular disease (heart disease and stroke) is the leading cause of death of over one-third of Canadians. It not only affects the elderly but is also the third leading cause of premature death under age 75. Mortality (death) rates for heart disease and acute myocardial infarction (heart attack) continue to decrease, but mortality rates for stroke have not changed significantly during the past ten years.

The number of elderly in the Canadian population has been increasing in recent years. As a result of this trend, there has been an increase in the number of deaths due to stroke and heart disease. This trend is expected to continue for the next fifteen years.

Lesson 5 Outcomes

- By the end of this lesson, you should be able to:
  - Describe the effects an aneurysm may have on the body.
  - Explain the dangers of atherosclerosis and the risk factors that accelerate its development.
  - Describe angina and the factors that can cause this condition.
  - Explain 3 possible medical procedures used to rectify atherosclerosis (i.e., coronary bypass, angioplasty, drug therapy).
  - Distinguish between congenital heart defects and those related to lifestyle.
  - Discuss lifestyle factors which contribute to heart disease, i.e., smoking, obesity, diabetes, diet, kidney problems.

Lesson 5 Overview

Following is a list of topics covered in this lesson.

- Cardiovascular Disease
- Atherosclerosis
Cardiovascular Diseases and Deaths

Cardiovascular diseases are defined as diseases and injuries of the cardiovascular system: the heart, the blood vessels of the heart, and the system of blood vessels (veins and arteries) throughout the body and within the brain. Stroke is the result of a blood flow problem in the brain. It is considered a form of cardiovascular disease.

The exact number of Canadians who have cardiovascular disease is unknown. It is estimated that one in four Canadians has some form of heart disease, disease of the blood vessels or is at risk for stroke. If this estimate is accurate, approximately eight million Canadians have some sort of cardiovascular disease.

Cardiovascular disease deaths

Cardiovascular disease accounts for the death of more Canadians than any other disease. In 1999 (the latest year for which Statistics Canada has data), cardiovascular disease accounted for 78,942 Canadian deaths.

35% of all male deaths in Canada in 1999 were due to heart diseases, diseases of the blood vessels and stroke. For women, the toll was even higher – 37% of all female deaths in 1999 were due to cardiovascular disease.

54% of all cardiovascular deaths are due to coronary artery disease; 20% to stroke; 16% to other forms of heart disease such as problems with the electrical system of the heart, viral heart infections, and heart muscle disease, and the remaining 10% to vascular problems such as high blood pressure and hardening of the arteries.

Atherosclerosis
**Atherosclerosis** is a form of arteriosclerosis, a general term for the thickening and hardening of the arteries. Atherosclerosis comes from two Greek words: athero (meaning gruel or paste) and sclerosis (hardness). In atherosclerosis, the walls of the arteries have a build-up of **plaque**, a combination of cholesterol, cellular waste products, calcium and fibrin (a clotting material in the blood). Plaque rupture can trigger the formation of a blood clot.

Atherosclerosis affects large and medium-sized arteries. The type of artery involved and the location of the plaque varies with each person. Researchers are still trying to determine why plaque is "patchy" (i.e., why it doesn't occur consistently throughout the artery but is found only in certain locations). Atherosclerosis is a slow, progressive disease that may start as early as childhood. People's susceptibility to atherosclerosis varies with their genetic make-up and their lifestyles.

The causes of atherosclerosis are complex and still not entirely understood. Blood vessels have a thin lining composed of endothelial cells. Many scientists think atherosclerosis begins when this inner lining becomes damaged. The blood vessel wall reacts to this injury by stimulating various types of cells to grow and reproduce. The result is a progressive thickening of the blood vessel wall.

Risk factors for atherosclerosis include:

- High levels of LDL cholesterol and triglycerides in the blood;
- Lipoprotein oxidation, the process whereby cholesterol is modified by elements called "free radicals" and becomes more damaging to the blood vessels;
- High blood pressure;
- Smoking. Cigarette smoke greatly aggravates and speeds up the growth of atherosclerosis in the coronary arteries;
- Genetics. There appears to be a strong genetic component to atherosclerosis.

A person with atherosclerosis may remain symptom-free until the disease is far enough advanced to block a significant portion of some important blood vessel. If the blockage occurs in a coronary artery (one which supplies the heart muscle), the result is **angina**. Angina (angina pectoris is the full medical term) is chest pain. It is sometimes described as "pressure" or "discomfort" rather than pain; it may also radiate to the throat, jaw, back, or arms. Angina usually follows a predictable pattern. Pain generally occurs at about the same point when exercising and/or under emotional stress. The pain usually comes on with activity and/or emotional stress and goes away with rest and/or nitroglycerin within three to five minutes.
Angina is a warning signal. It is the heart muscle’s way of telling the body that it is being forced to work too hard and needs to slow down.

Atherosclerosis can cause a **heart attack** or **myocardial infarction** in one of two ways. First, it can block coronary arteries to such an extent that little or no blood can get through to the heart. Second, rupture of plaque can trigger the formation of blood clots, which may then block a coronary artery.

### Heart Attack Warning Signs

**Pain**
- sudden discomfort or pain that does not go away with rest
- pain that may be in the chest, neck, jaw, shoulder, arms or back
- pain that may feel like burning, squeezing, heaviness, tightness or pressure
- in women, pain may be more vague

**Shortness of Breath**
- difficulty breathing

**Nausea**
- indigestion
- vomiting

**Sweating**
- cool, clammy skin

**Fear**
- anxiety
- denial

Atherosclerosis can also cause a **stroke** by blocking cerebral blood vessels (those within the brain) or by triggering a clot which then blocks cerebral blood vessels.
Atherosclerosis can be diagnosed using angiography, arteriography or Doppler ultrasound testing. The progress of atherosclerosis can be significantly slowed by avoiding the risk factors for the disease. Keeping blood pressure within healthy limits, adopting a non-smoking lifestyle, exercising regularly and eating a balanced, low-fat diet will all help control atherosclerosis.

If atherosclerosis progresses to the point where it is seriously obstructing blood flow in one or more coronary arteries, **angioplasty** may be recommended. This catheter-based procedure unblocks arteries without major surgery. Traditionally, angioplasty has been used to widen narrowed blood vessels in the heart. The catheter is positioned where a blood vessel has been narrowed by the buildup of plaque (atherosclerosis). A balloon tip is inflated, which presses against the atherosclerotic plaque and widens the blood vessel.

**Stenting** is similar in many ways to angioplasty. In addition to using a balloon, a wire mesh tube (called a stent) is inserted into the narrowed artery. When the balloon tip is inflated, the stent pops open. The balloon is then removed, leaving the stent in place. The stent helps to prevent the blood vessel from collapsing and re-narrowing.

Another option is **bypass surgery**, which replaces "clogged" arteries with unblocked arteries taken from the patient’s own leg or chest.

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**Aneurysms and Thrombi**

A **thrombus** (plural - thrombi) is a blood clot that forms inside a blood vessel or cavity of the heart. The term "thrombosis" refers to the process by which blood clots form.

A thrombus is dangerous because it can block a blood vessel partially or entirely, cutting off blood flow to the area supplied by that vessel. A thrombus may form for a variety of reasons, including trauma (injury) or rupture of an atherosclerotic plaque. Risk
factors for thrombus formation include atherosclerosis or other cardiovascular disorders, blood disorders, obesity and heredity.

A thrombus will produce different symptoms depending on where it forms. A coronary thrombus will produce chest pain (angina) and may result in a heart attack. A thrombus in the brain will result in a temporary ischemic attack (TIA) or stroke. A thrombus in the limbs may produce a sharp pain in the affected area and a bluish tinge (associated with lack of circulation) below the clot.

A thrombus causing stroke or heart attack can be identified on the basis of a physical examination plus an electrocardiogram (ECG) or electroencephalogram (EEG). Doppler ultrasound tests might be used to detect a thrombus in the limbs.

**Aneurysm**

An **aneurysm** is a bulging out of part of the wall of a blood vessel. It forms where the wall has weakened, often due to the build-up of plaque. It may also be an inherited condition or a complication of high blood pressure (hypertension). Left untreated, aneurysms may tear or burst (a ruptured aneurysm). Ruptures are very painful events that cause massive internal bleeding. The patient must be treated within minutes in order to have a chance of survival. If an aneurysm bursts in the brain, it could cause a hemorrhagic stroke. If an aneurysm bursts in the chest, there is only a 20 percent chance of survival. Therefore, early diagnosis and treatment are critical. Because aneurysms often produce no symptoms or mild symptoms (e.g., back pain), routine physical examinations are strongly encouraged so that a physician can regularly test for warning signs.

There are a number of different types of aneurysms. The two most common are:

- **Aortic aneurysm.** A general condition characterized by the distention, or ballooning out, of part of the wall of the aorta. The aorta is the main artery carrying oxygen-rich blood from the heart to the rest of the body. Typically, the widened part of the aorta is considered to be an aneurysm when it is more than 1.5 times its normal size.
- **Cerebral aneurysm.** Also known as a berry aneurysm, this is a bulge in the wall of a blood vessel in the brain (one of the cerebral arteries). A cerebral aneurysm is typically found where the arteries branch at the base of the brain. Cerebral aneurysms occur more commonly in adults than in children and are slightly more common in women than in men, however they may occur at any age. Before an aneurysm ruptures, the individual may experience such symptoms as a sudden
and usually severe headache, nausea, vision impairment, vomiting, and loss of consciousness or the individual may be asymptomatic, experiencing no symptoms at all. Onset is usually sudden and without warning. Rupture of a cerebral aneurysm is dangerous and usually results in bleeding in the brain or in the area surrounding the brain, leading to an intracranial hematoma (a mass of blood—usually clotted—within the skull).

**Congenital Heart Diseases**

Congenital heart problems are those present at birth. They include defects in the valves and chambers and also circulatory problems. About eight of every 1,000 infants are born with one or more heart or circulatory problems, and about half these cases are serious enough to require treatment.

The good news is that congenital defects are being detected earlier than ever - sometimes in the womb - and are being treated with refined medical and surgical methods, including less invasive methods than those used in the past.
Causes of Congenital Heart Disease

The exact cause of a congenital heart defect is unknown. Although genetic factors seem to play a part, families should be aware that medical researchers cannot predict most cases. Therefore, there's no point in trying to assess genetic "blame" or determine which side of the family "caused" the problem.

In addition to genetic factors, certain environmental and behavioral factors have been identified as interfering with the development of the fetus's heart during the first 10 weeks of development. Some conditions that alert a physician to the possibility of congenital heart disease in an infant include:

- Congenital heart disease in the mother or father.
- Congenital heart disease in a previous child or other relative.
- Diabetes in the mother.
- Rubella (German measles), toxoplasmosis (a protozoa infection transmitted via cat feces), or HIV infection in the mother.
- The mother's excessive use of alcohol.
- The mother's use of cocaine or other drugs.
- The mother's exposure during pregnancy to certain anticonvulsant and dermatologic medications.

Types of Congenital Heart Disease

The most common congenital heart defects are:

- Abnormalities that impede the flow of blood through the vessels.
- Heart valves that are malformed, missing, or blocking blood flow.
- Problems with the structure of the heart that allow blood to flow from one side to the other outside the normal circulatory path.
- Problems with the connections between the main arteries or veins and the heart.

Even though there seem to be both genetic and environmental links to congenital heart disease, a pregnant woman's exposure to one or more of these environmental threats doesn't necessarily mean that her baby will be born with a heart defect. For example, not every mother who contracts rubella during pregnancy delivers a baby with a defective heart. Likewise, unless a specific chromosomal defect has been identified, the fact that an earlier child or close family member had a congenital heart defect does not guarantee that a baby will have a similar problem.
Other Heart Conditions

Congestive Heart Failure (CHF) usually develops gradually. It is a condition in which the heart does not pump as strongly as it should. The body does not get the right amount of blood and oxygen it needs to work properly. The weakened pumping action can cause a backup of fluid (congestion) in the lungs and other parts of the body. An abnormal buildup of fluid in the lungs is known as pulmonary edema. Without a proper oxygen supply and with congestion, you may feel tired and short of breath at times.

Causes
Congestive Heart Failure (CHF) has many causes:

- long-standing impaired blood flow to the heart for some time (this may or may not produce chest pain or angina);
- heart muscle damage from a previous heart attack;
- long-standing high blood pressure;
- a heart valve that is not working properly (heart valve disease);
- an infection causing inflammation of the heart muscle;
- excessive use of alcohol or drugs;
- a disease of the heart muscle itself from an unknown cause.

Valvular stenosis is the result of diseases such as rheumatic fever, which causes the opening through a valve in the heart to become so narrow that blood can flow through only with difficulty. The result can be blood damming up behind the valve. Valvular regurgitation occurs when the valves become so worn that they cannot close completely, and blood flows back into the atria or the ventricles. If the blood can flow backward, the efficiency of the cardiac stroke is drastically reduced.

A heart murmur is an abnormal heart sound. ("Normal" heart sounds, such as the familiar "LUB-DUB" noise made by the beating heart, are produced by the heart valves opening and shutting.

Heart murmurs may be caused by turbulent blood flow in the heart resulting from congenital (present at birth) heart defects. Some heart murmurs are caused by defective heart valves. Others may be the result of a heart attack.

Usually, there are no symptoms associated with a simple heart murmur. If a heart murmur is caused by a heart valve disorder, the patient may experience shortness of breath.
Heart murmurs are easily heard by a doctor, listening to heart sounds through a stethoscope. If a heart valve problem is suspected, the patient will be referred for more testing. Diagnostic tests for valve disorders can include a chest x-ray, electrocardiogram (ECG) testing, echocardiograms or cardiac catheterization.

Most heart murmurs are quite harmless. They tend to be common in children and disappear when the child grows up. If a heart murmur is the result of a problem with a heart valve, treatment may be necessary. Heart valve problems are often treated with medication. Sometimes, surgical repair or replacement of a damaged valve is required.

**Artificial Heart Valves**

Artificial heart valves are man-made or animal-derived valves which can be surgically implanted in a human heart to replace a damaged or diseased valve. Valve replacement surgery dramatically lowers the death rate from valvular disease. Mortality from the surgery is quite low, around 5%, depending upon the age of the patient and his/her overall health and functioning.

Each year, there are approximately 4,000 heart valve surgeries in Canada. Human heart valves can be replaced with mechanical valves, or with specially prepared heart valves from human or animal donors (known as bioprosthetic or tissue valves).

**Mechanical valves** (made of metal alloys, carbon and various plastics) are very durable, but can promote the formation of blood clots, which can lead to a heart attack or stroke. To prevent this, patients with mechanical valves must take blood-thinning medication every day for the rest of their lives.

**Bioprosthetic valves** come from two sources: human donors and animals. Valves from animal sources (usually cows or pigs) are very similar to those found in the human heart. They are well tolerated by the body, and do not promote clot formation to the same degree as mechanical valves. On the other hand, bioprosthetic valves from pigs or cows are usually not as durable as the mechanical kind. Human heart valves are well tolerated and tend to last longer than animal valves.

**Cardiovascular Disease Risk Factors**
Your blood pressure is the measure of the pressure or force of circulating blood against the walls of your blood vessels. In adults, high blood pressure or hypertension is defined as a blood pressure that is consistently greater than or equal to 140 mm Hg systolic pressure, or greater than or equal to 90 mm Hg diastolic pressure.

**Cholesterol and Triglycerides**
Cholesterol is a soft waxy substance manufactured by human and animal bodies. LDL cholesterol is often called the "bad" cholesterol. It doesn’t really deserve this name - our bodies need normal amounts of LDL cholesterol for cell growth and repair. However, if blood levels of LDL cholesterol are too high, they can cause the gradual build up of plaque on the walls of our blood vessels. This leads to a condition called atherosclerosis which is the main cause of heart disease and stroke.

The body contains another type of fat called triglyceride. While not a cholesterol, triglyceride is the most common form of fat found within our bodies. Research has shown that quite a large number of people who have heart disease also have high triglyceride levels. On the other hand, some people with very high triglyceride levels show no sign of plaque buildup. For this reason, experts can’t be sure that triglycerides are a direct cause of atherosclerosis. On the other hand, high triglyceride levels are often associated with low HDL ("good") cholesterol.

Unlike LDL cholesterol, triglycerides do not adhere to the walls of the blood vessels. Triglycerides are more like a "thick cream" in the blood and increase the tendency of the blood to clot. The greater the tendency to clot, the greater the risk of a heart attack or stroke. High triglyceride levels are often associated with excess alcohol consumption, excess weight or poorly controlled diabetes. Their presence may therefore be a signal that additional heart disease risk factors are present or that lifestyle changes are needed.

**Diabetes**
Diabetes is when the body can't process sugar properly. "Juvenile diabetes" (develops in childhood) must be treated with insulin. "Adult onset diabetes" often develops in overweight adults. Both forms of diabetes can increase the risk of high blood pressure, atherosclerosis, coronary heart disease and stroke, particularly if blood sugar levels are poorly controlled. Insulin resistant people also have an increased risk of developing cardiovascular problems. More than 80% of people with diabetes die from some form of heart or blood vessel disease.

**Obesity**
People who are overweight or obese are at risk of developing high blood pressure, high blood lipids and diabetes - all of which put them at high risk of cardiovascular or heart disease.
Smoking
Smoking is a dangerous health hazard for teenagers. It is the single most important cause of preventable illness and premature death for Canadians.

Coronary Heart Disease Risk Factors
Coronary heart disease risk factors are behaviours or medical conditions which make people more likely to develop coronary heart disease. Some risk factors are well known. Others are less well recognized.

Risk factors you CAN influence

- High blood cholesterol
- High blood pressure
- Lifestyle factors (lack of exercise, being overweight, smoking, drinking too much alcohol, stress)
- Diabetes

Risk factors you CAN'T change

- Age and gender (55+ for women, 45+ for men)
- Ethnic descent (African, South Asian, and First Nation populations are at higher risk)
- Family medical history - heart attack or stroke before age 65, angina, tendency to develop high blood cholesterol or blood pressure
Lesson 5 Exercise

1. Why is it important to learn about cardiovascular disease?

2. a) What is congenital heart disease?
   
   b) Can congenital heart disease be prevented?

3. a) What is atherosclerosis?
   
   b) Why is it potentially dangerous?
   
   c) Describe two common procedures used to relieve the symptoms of atherosclerosis of the coronary arteries.

4. a) What is the most common symptom of atherosclerosis?
   
   b) What are some common symptoms of a heart attack?

5. a) What are some common risk factors of cardiovascular disease?
   
   b) Which of these risk factors are considered congenital and which are considered lifestyle related?
6.  a) What is an aneurysm and why are they potentially fatal?

   b) Describe the two most common types of aneurysms.

7. Why is a thrombus a dangerous condition?

8. a) What is congestive heart failure?

9.  

   b) How does CHF lead to pulmonary edema?

10. Explain the statement "Most heart murmurs are quite harmless although some may be an indication of a serious heart disorder".

11. Differentiate between a mechanical and bioprosthetic valves.
Module 4 Project Assignment

Case Study - Wake-Up Call

The Module 4 Project Assignment is a Case Study related to cardiovascular disease. Please read the case study on the following page and answer the questions after each section. You may need to do research to answer some of the questions. Submit your work for assessment in the Assignments Tool — M4 L5 Case Study.

Read the following case study and answer the questions related to each part. Makes sure that you keep the structure of the case study and label the answers accordingly. You may need to research to find some of the answers. You could try the Heart and Stroke Foundation web site. Click on Web Links and select Heart and Stroke.

The case study questions are repeated in the Assignment M4 L5 section.

Wake-Up Call

Part 1 - "Panic!"

It was 4:36 a.m. She was in a cold sweat and having difficulty breathing. She felt as though she had run a marathon. Fear swept through her—something terrible was going to happen. Panic-stricken, she woke her husband, Jeremy.

"Denise, what is it? Is it a nightmare?"

"No, it's like I'm having an asthma attack. I feel lightheaded and I can't catch my breath. My heart feels like it's beating a thousand times a minute."

Afraid to upset her husband further, Denise didn't tell him that an immense feeling of apprehension suddenly overcame her. She got up to drink some water and waited for the anxiety to subside. Her mind was racing. Jeremy had a family history of heart disease. This couldn't be happening to her. It was his problem. A few months earlier Jeremy was diagnosed with coronary artery disease. He was only 48 years old, the same age as Denise. The scare had encouraged him to gradually end years of chain
smoking and adopt a healthier lifestyle. He was currently working on giving up the occasional cigarette for good.

"No," Denise thought to herself. "There's no way this was a sign of heart troubles. I didn't have a pain in my chest, I'm physically fit, and I have no family history. There's just no way."

After assuring herself of this, Denise was somehow able to fall back asleep.

Questions:

1. How likely is this to be a heart problem? Asthma? Panic attack? Or...?
2. Why do you say this? What are the symptoms that are consistent with your preliminary diagnosis? Is there anything unusual?

Part 2 - "A Voice from Within"

The next day at work, Denise was having a hard time focusing. Maybe the stress of her job was finally catching up with her. Managing a catering business was no easy task. On top of that, her only daughter, Emily, had left for college this fall and, being the overprotective parent that she was, Denise found herself constantly worrying about how her daughter was faring in a different city, away from the comforts of home. Also, Denise was starting to go through the early stages of menopause. The hormonal changes, combined with fatigue, stress, and her general worrisome nature, were catching up to her. Not only that, she couldn't get last night's scary episode out of her thoughts. Was it just part of the whole perimenopause thing or was it more? Her body was trying to tell her something, but Denise wasn't sure she was ready to hear.

"I wonder if Denise realizes how all those years of second-hand smoke have taken a toll on her lungs and on ME, her heart! All that tobacco inhalation has constricted her coronary arteries. Sure, Denise tries to stay physically active but genetics and her food choices have brought her blood cholesterol up pretty high to 245 mg/dl. She could be headed for heart disease. A person's total cholesterol level shouldn't get above 200 mg/dl. That's right. I ought to know! Denise has hypercholesterolemia, a major contributor to heart disease. Geesh. Get with it, Denise.

That was a major warning last night. I'm oxygen-starved! Luckily, only a small area of my left ventricle had a big decrease in blood flow and oxygen supply (cardiac ischemia). Thank goodness. If nothing else happens, my body will start growing some new collateral vessels (bypass channels) and I can get some repair work done. Denise didn't experience chest pain (angina pectoris). But her rapid heart beat and shortness of breath sure got her attention. She had better shape up because I don't know if I can handle much more oxygen deprivation. And, hey, all this unstable plaque lurking around is not a good sign either. No indeed. Who knows when it may rupture? I don't like the looks of this at all."
Questions:

1. Draw a sketch of the heart and show where the coronary blood vessels lie.
2. What are the characteristics of Denise's lifestyle that might lead to a heart problem?
3. Has Denise suffered a heart attack?

Wake-Up Call

Part 3- "Heart Attack Basics"

It appears that Denise has suffered mild heart trauma, which may lead to a more severe heart attack if not treated. But wait ... isn't a heart attack when the heart stops beating? Not exactly.

Cardiac arrest is the term used when the heart muscle literally stops pumping blood. A heart attack, also known as a myocardial infarction, may lead to cardiac arrest, but it's defined as a sudden event where at least one of the three major coronary arteries (right coronary artery, left anterior descending coronary artery, and left circumflex artery) becomes partially or totally blocked, usually by a blood clot (thrombus). A more rare cause of coronary artery blockage is an artery spasm that shuts down blood flow to the heart. This can occur with cocaine use and severe emotional stress. Other rare causes of heart attack include allergic reactions, carbon monoxide poisoning, extreme hypoxia (lack of oxygen), and an unmet increased need for blood flow to the heart such as may occur during extreme physical exertion, shock, or hemorrhage.

Heart cells can live for about 20 minutes without oxygen. The loss of oxygen-rich blood to the heart cells during a heart attack leads to cell damage, which may be permanent and lead to cell necrosis (death), depending on the severity of the attack and the amount of heart tissue that the blocked artery supplies. The area of infarction is where cell necrosis occurs, if it does. Surrounding it is the area of injury, which may or may not suffer permanent damage. The outermost affected area is the zone of cardiac ischemia, which is weakened but regains function within two to three weeks.

Besides the possibility of cardiac arrest, other possible complications include the following: cardiogenic shock (where the heart is too weak to adequately pump blood), pulmonary edema (where a weakened heart causes blood backup and leakage of plasma into the lungs), irregular heart rhythm (arrhythmia), rupture of a heart wall or valve, or death.

It is a misconception that having a heart attack leads to chronic coronary artery disease (CAD). In reality, CAD and accompanying atherosclerosis (hardened, narrowed arteries) is the number one cause of heart attacks. What causes CAD? The main culprit is arteriosclerosis, or plaque buildup in the coronary arteries. Plaque is a material composed mainly of lipids, cholesterol (lipoproteins), and calcium. Cholesterol (a type of lipid necessary for synthesis of hormones, vitamin D, and bile) is carried
through the bloodstream by two main types of lipoproteins: high-density lipoproteins (HDL’s) or "good" cholesterol, and low-density lipoproteins (LDL’s) or "bad" cholesterol. HDL’s help prevent heart disease by transporting lipids and cholesterol from the arteries to the liver. LDL’s, which contain more fat and less protein, are unstable and stick to artery walls to help contribute to plaque formation.

LDL’s (cholesterol-handling system) produce toxins that form tiny lesions on the inner walls of arteries. These lesions attract triglycerides and other substances in the bloodstream. White blood cells (inflammatory system) rush to the injury site, but cause the inner wall to become stickier and thus attract more LDL’s. Platelets (blood-clotting system) collect at the lesion site, only to trap more lipids and white blood cells. Plaque build-up slowly occurs. (Note that cholesterol is not the sole cause of plaque formation.) Over time, some of the plaque can develop a thick, hard, calcified fibrous cap and is called stable plaque, yet causes the arteries to become narrower and harder (atherosclerosis). Other plaque can develop a large lipid and macrophage core, decreased smooth muscle cell content, and a thinner, softer, more unpredictable fibrous cap (due to increased enzyme activity). This can rupture, producing a thrombosis (artery blockage), cardiac ischemia, and a heart attack can ensue.

Questions:

1. Define these terms: cardiac arrest, myocardial infarction, thrombus, necrosis, cardiac ischemia, cardiogenic shock, pulmonary edema, arrhythmia, plaque.
2. How long can heart cells live without oxygen?
3. What is the difference between HDL’s and LDL’s?
4. What does LDL have to do with heart attacks?

Wake-Up Call

Part 4 - "Call 911!"

It was March. Emily was home for spring break and Denise was enjoying having her 19-year-old daughter around. Unfortunately, it was going to be hard to spend much time with her because it was that time of the year when weddings and other catered events were picking up again after the post-New Year's lull. Denise was feeling the pressure pile up again. She constantly felt fatigued and out of breath, but she attributed these to perimenopause.

Emily could sense that her mother was tense and out of sorts, so she planned a relaxing evening for her parents and offered to cook mushroom lasagna, her mother's favorite dish. All was going well until dessert, when Emily noticed her mother's face growing paler by the minute. Suddenly, just like that night back in October, Denise
began to have severe trouble breathing and her heart began racing. The room began to spin and, without warning, she fainted on the dining room floor.

"Oh my God! Dad, call 911!"

"Uh oh. Oh! Oh no! Denise. Denise! Do you read me? I'm in the middle of a heart attack!! I know it. I can feel it! That plaque in your left anterior descending coronary artery just ruptured. Now everything is going crazy. Everyone in the whole body seems to be swimming by. BAD things are happening, Denise. Really, really BAD!

Plaque ruptures. Platelets stick to the exposed lipid core at the site of rupture. The blood clot grows...too big. Oh too big. Is it going to break? Say it isn't going to break. Not thrombosis, please....

.... It's been 10 minutes since my heart cells supplied by the blocked artery have been without oxygen. If something isn't done soon, my cells are going to die. Necrosis! I never thought I could say that word. They say a heart attack can take over four to six hours. This first hour is horrible—the most critical period. Parts of the blood clot may break loose, travel in the blood, and stick in some tiny little blood vessel. My God, it could get in a coronary artery or the brain! An embolism. I need help! Now...NOW. HELP!!

I've got to get my self in hand. It's the only way in a crisis. Right? Right! Why didn't Denise go to her doctor to complain about her chronic breathlessness, fatigue, and nausea? All this stress elevated her blood pressure and further increased her risk for a heart attack. Alright, so she didn't know that she had a mutation in her LDL receptor gene. How could she know that LDL was not being efficiently removed from her blood? Whatever. At least she should have known her LDL blood levels were very high. So were her levels of lipoprotein (LP a). This stuff increases heart disease risk. Why didn't anyone warn her?

Sure, I know I'm involved. I'm taking it personally. Wouldn't you? But maybe, just maybe, if Denise had been more aware of the symptoms of heart disease she would have sought help. I happen to know that heart attacks are the number one cause of death in Canada. More people die from cardiovascular disease (including heart attacks, atherosclerosis, and hypertension) each year than the next six leading causes of death combined, including cancer and automobile accidents. It's an epidemic that people need to be educated about. So get it. I'm here to tell you. Denise. If you won't listen to me, who will you listen to?

Questions:

1. Why is the first hour of a heart attack the most critical?
2. What is the cause of Denise's breathlessness, fatigue, and nausea?
3. What are platelets and what do they have to do with Denise's heart problem?
4. What is an embolism and what is its connection to thrombosis?
5. How does hypertension develop and what does it have to do with a high risk of heart attacks?

Wake-Up Call

Part 5 - "Emergency Room"

The doctor spoke calmly to Jeremy in the waiting room. "Mr. Belmore, your wife is in no immediate danger but she has suffered a heart attack to her left ventricle. She's in the emergency room right now, with the aid of an oxygen mask. We noticed some scar tissue, meaning that some prior heart trauma occurred as well. Is this your wife's first attack?"

"Yeah. I'm actually the one who has been diagnosed with heart disease in the house, and I'm the one with a family history. I don't understand. Where did this come from? Denise is conscious of her weight, and she's healthier than I am. She's the one who usually looks out for me and my daughter."

"Well, from her records, your wife hasn't had her blood pressure and cholesterol tested in a few years. Unfortunately, they were highly elevated, which greatly increased her risk of heart disease. Although she looked fit on the outside, blood work would have revealed hidden dangers. Tell me, had your wife been feeling out of sorts these past few months?"

"She has always been an on-the-go person and tends to worry a lot. Her job is pretty stressful. I did notice that these past few months she seemed more tired than usual and acted almost asthmatic. But, don't heart attack victims experience chest pain? Denise has never complained of that."

"That's a good question. The simple answer is that women's heart disease symptoms can be subtler than men's and are often overlooked. Take a look at the charts on the wall over there and you'll see what I mean. Patients may experience all, some, or none of those symptoms. It is even possible to have a silent heart attack."

**Women's Symptoms**
- Angina (chest pain may radiate into jaw and down left shoulder and arm)
- Breathlessness (especially at night)
- Chronic fatigue (usually overwhelming)
- Dizziness or even blackouts
- Edema or swelling, especially in the

**Men's Symptoms**
- 1. Sudden *immense* pressure or pain in the chest center (may persist or occur on and off)
- 2. Pain that radiates from chest center to neck, shoulders, and arms
- 3. Dizziness, nausea, sweating
- 4. Sudden onset of rapid heartbeat
The doctor continued, "This is a pamphlet that gives you some background on cardiovascular disease and the factors that go into them. You'll notice that some of these are things you can't change. We call them "non-modifiable." They include your gender, age and your hereditary background; we're all stuck with these. Then there are the "modifiable" factors, things like smoking, stress, and a high fat diet. When more than one factor is present, risk further increases. Once Denise is better I think you both need some time together to consider how you might change your lifestyle."

"Well, it's been four hours since the chaos began here in Denise's heart. I'm pooped! Here's the way I see it. A bunch of my cells are dead. So now there's an inflammatory response of neutrophils and monocytes and an elevated body temperature. Enzyme levels in the bloodstream are up. I don't know one enzyme from the other. They're all just proteins to me. But here's what I heard the doctors say—I mean it, they really use these big words: Creatine phosphokinase (CPK) has become elevated and will peak within 12 to 24 hours since the attack and with luck it'll return to normal within 48 to 72 hours. Its isoenzyme, CK-MB, is also elevated. CK-MB2 undergoes a change to CK-MB when released into the bloodstream. The ratio of CK-MB2 to CK-MB1 is more than 1.5 for heart attack patients, which is a benchmark doctors use to diagnose myocardial infarction within 6 hours of symptom onset. The blood level of aspartate aminotransferase (AST or GOT) has become elevated due to cell injury, will peak in 24 to 48 hours, and will return to normal in five days. In contrast to the rapid rise and decline of these enzymes, lactate dehydrogenase (LDH) will begin to elevate within a day of the attack onset and will persist at high levels for 10 to 20 days.

Cardiac troponins T and I (which help me contract) will remain elevated in the blood for 10 to 15 days after myocardial injury. This means that if the doctors find that the troponins levels are up, they can really be sure the heart has been injured. Well, that's sure to be what happened to me. So now what have I got to look forward to? Some rest and healing time. With luck, four to six weeks from now, Denise's body will have deposited collagen fibers and scar tissue at the plaque rupture site. Some more collateral vessels will have been built. But for me, things will never be the same. Any of my heart tissue that died from oxygen starvation will be lost and replaced with scar tissue ... unless doctors can find a way to regenerate it. Geesh, I never thought this would happen to me. Denise is so young...."
Assignment:

Denise is back home and on cholesterol-lowering medication and is learning how to better handle stress. Your assignment is to help Denise and her family research the key measures in preventing heart disease, or in Denise’s case, another heart attack. Try the Heart and Stroke Foundation at http://www.heartandstroke.ca. Answer the following questions briefly and directly. You may include a table if desired.

1. Heart-Healthy Diet
   a. What foods/nutrients should be limited and specifically what foods/nutrients are beneficial and why? (Example: what are the benefits of folic acid, monounsaturated fats, omega 3 fats, etc? Why are saturated fats bad?)

1. Lifestyle Changes
   a. What activities are hazardous to heart health and what are some solutions? (Example: handle stress with stress management, not overeating.)
   b. What are the benefits of exercise concerning heart health?

2. Aspirin
   a. How can aspirin help in preventing heart disease?

3. Create a pamphlet that the doctor could give to Denise about altering her lifestyle. It should include information on smoking, cholesterol, blood pressure, obesity, diabetes, physical activity, diet, and stress.

Lesson 5 Summary

In this lesson, you have studied some of the most common cardiovascular diseases.