

VASCULAR DISORDERS

Abstract:

Atherosclerosis is a chronic, long-term process in which the walls of the arteries become hardened and abnormally narrowed by atherosclerotic plaques. Hardening of the arteries and the development of atherosclerotic plaques compromise the vascular system. Atherosclerosis develops due to fat and cholesterol accumulation, inflammation, and calcification. Preventative measures that stop or slow atherosclerosis is considered the best approach to good vascular health. While some risk factors for vascular disease are nonmodifiable, such as inherited characteristics, other risk factors may be controlled, such as blood lipid levels, obesity, a sedentary lifestyle, and smoking, to reduce the risk of vascular disorders. Lifestyle changes are very effective at lowering blood pressure and risk associated with vascular disease but they are a lifelong commitment that many people find difficult. Half of the people who know they have hypertension and vascular disease are not receiving treatment, or not being adequately treated. All health clinicians and health care professionals have a valuable role to assist patients in a health prevention plan to control the development of vascular disease.

Learning Objectives:

1. Identify risk factors for atherosclerosis, deep vein thrombosis, and hypertension.
2. Identify common complications of these conditions.
3. Identify how these conditions are prevented and treated.
4. Describe how to care for a patient with a vascular disorder.

Introduction

The World Health Organization (WHO) confirms Cardiovascular diseases (CVDs) as the number 1 cause of death globally, taking an estimated 17.9 million lives each year. Cardiovascular diseases are a group of disorders of the heart and blood vessels and include coronary heart disease, cerebrovascular disease, rheumatic heart disease, and other vascular conditions. The most common form of heart disease in the United States is coronary artery disease which limits blood flow to the heart. Hundreds of thousands of Americans die or are disabled each year by a vascular disorder. These disorders can result in arrhythmias, blood clots, cardiac arrest, myocardial infarction (heart attack), stroke, and many other serious diseases. The development of vascular disorders depends in part on genetic factors but in most cases, lifestyle issues are the most prevalent cause. Most vascular disorders, especially those related to atherosclerosis, could be prevented by decreasing body weight, blood pressure control, through treatment or lifestyle change, a healthy diet, and other non-medication-based interventions. This module will cover atherosclerosis, deep vein thrombosis, and hypertension, three vascular disorders that every health care professional should be familiar with. They are all in some way related but each has its own causes, signs and symptoms, and treatments.

Atherosclerosis

Atherosclerosis, which is commonly called hardening of the arteries, is a chronic, long-term process in which:

1. The walls of the arteries become hardened.
2. The lumen of the artery (the open, interior section through which blood flows) becomes abnormally narrowed by atherosclerotic plaques.

Hardening of the arteries and the development of atherosclerotic plaques compromise the vascular system. Instead of having flexible and pliant arteries with open lumens, the body must try and adapt to a circulatory system that is rigid and narrowed.

Causes of Atherosclerosis

The basic components of atherosclerosis development are fat and cholesterol accumulation, inflammation, and calcification.

Fat and cholesterol accumulation:

Risk factors for the accumulation of fat and cholesterol include a variety of things and are listed below.

1. Age: Your cholesterol levels tend to rise as you get older. Even though it is less common, younger people, including children and teens, can also have high cholesterol.
2. Heredity: High blood cholesterol can run in families.
3. Weight: Being overweight or having obesity raises your cholesterol level.
4. Race: Certain races may have an increased risk of high cholesterol. For example, African Americans typically have higher HDL and LDL cholesterol levels than whites.

To help with an understanding of HDL, LDL cholesterol an explanation has been included below:

1. HDL stands for high-density lipoprotein. It is sometimes called "good" cholesterol because it carries cholesterol from other parts of your body back to your liver. Your liver then removes the cholesterol from your body.
2. LDL stands for low-density lipoprotein. It is sometimes called "bad" cholesterol because a high LDL level leads to the buildup of plaque in your arteries.

The most common cause of high cholesterol is an unhealthy lifestyle. This can include:

1. Unhealthy eating habits, such as eating lots of bad fats. One type, saturated fat, is found in some meats, dairy products, chocolate, baked goods, and deep-fried and processed foods. Another type, trans fat, is in some fried and processed foods. Eating these fats can raise your LDL (bad) cholesterol.
2. Lack of physical activity, with lots of sitting and little exercise. This lowers your HDL (good) cholesterol.
3. Smoking, which lowers HDL cholesterol, especially in women. It also raises your LDL cholesterol.

Inflammation:

Inflammation is a major contributing factor to many vascular events, including atherosclerotic plaque development. Inflammation can cause the walls of the blood vessels to thicken, which reduces the width of the passageway through the vessel. When low levels of inflammation are sustained, irritation can occur within your blood vessels. When the walls of the blood vessels become irritated or inflamed the smooth surface can become rough allowing for fats/cholesterol to adhere to the vessel wall forming plaques. Inflammation may promote the growth of plaques, loosen existing plaque in your arteries, trigger blood clots, which are the primary cause of heart attacks and strokes. Although it is not proven that inflammation causes cardiovascular disease, inflammation is common for heart disease and stroke patients.

Calcification:

Calcification is defined as a buildup of plaques consisting of fat, cholesterol, calcium, and fibrous tissues that form on the walls of the vessels. These calcifications cause the vessels to become frigid and non-flexible. The prevalence of coronary artery calcification (CAC) is age and gender-dependent, occurring in over 90% of men and 67% of women older than 70 years of age. According to the Division of Cardiology at UCLA School of

Medicine, most adults older than 60 have calcium deposits in their blood vessels.

These inflamed deposits in the vessels extend from inside the wall of the artery to inside the lumen of a blood vessel and it becomes a *plaque*, a deposit that protrudes into the lumen and interferes with blood flow. The plaque itself is made up of fat, cholesterol, calcium, fibrous tissues, and other material. Its outside surface, the part of the plaque that extends into the lumen, is a fibrous cap that can be thick and stable or thin and fragile.

Atherosclerosis is a chronic disease, and the damage to a person's circulation develops slowly, over decades. In addition, atherosclerosis does not progress in a straightforward fashion but with periods of rapid growth and periods of decreased activity. Atherosclerosis does not typically cause signs or symptoms. Most individuals become aware that they have the disease when the damage is already extensive and its symptoms are severe.

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Consequences of Atherosclerosis

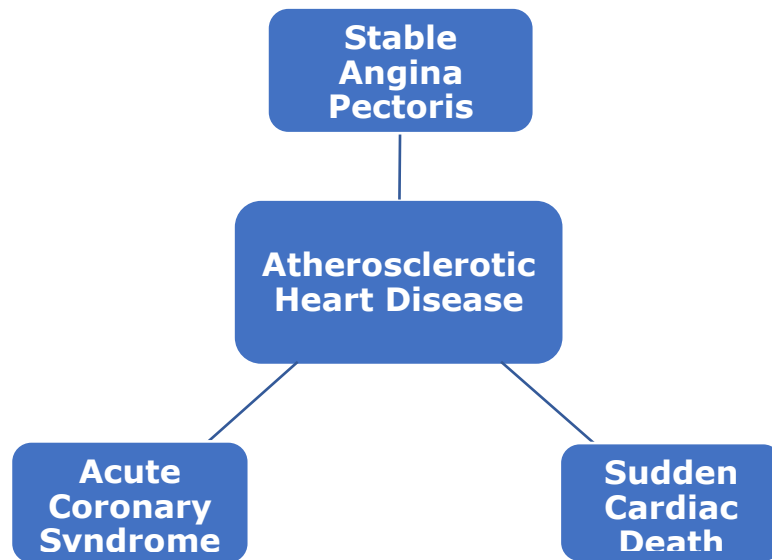
Atherosclerosis is commonly thought of as a disease that affects the heart but atherosclerosis affects the circulation of other organs as well. Most importantly, atherosclerosis may affect the circulation of the arteries that supply blood to the brain and the arteries within the brain, the arteries that provide blood to the kidneys, and the arteries that supply the periphery, for example, the arms and legs. Peripheral vascular disease (PVD) is atherosclerosis that causes the blood vessels outside of your heart and brain to narrow, block, or spasm. Peripheral vascular disease includes any blood vessel including, veins and lymphatic vessels. PVD typically causes pain and fatigue, often in your legs, and especially during exercise.

The Heart and Atherosclerosis

Atherosclerotic heart disease, also called coronary artery disease (CAD), has three major complications:

1. Stable Angina Pectoris
2. Acute Coronary Syndrome
3. Sudden Cardiac Death

These are all caused by, or the result of, the formation of atherosclerotic plaques.



Stable Angina Pectoris:

The word angina means pain and pectoris refers to the chest. Angina pectoris is chest pain that is caused by ischemia (inadequate blood supply) of the myocardium (heart muscle). Stable angina pectoris occurs when the myocardium is stressed and working hard. During those times the heart needs more blood but because of atherosclerotic plaques, the coronary circulation cannot deliver enough. The other defining characteristic of stable angina pectoris is that the pain is relieved by rest. When physical stress has been removed, the pain resolves.

People who have stable angina will have chest pain (sometimes described as chest pressure) that may radiate to the jaw or the left arm. Aside from pain, the patient is usually asymptomatic. Stable angina does not cause damage to the heart.

Acute Coronary Syndrome:

Acute coronary syndrome consists of two conditions known as unstable angina pectoris and myocardial infarction. Unstable angina pectoris occurs while at rest compared to stable angina, and it is relatively long-lasting > 10 minutes. Unstable episodes of angina tend to get worse over time. Unstable angina pectoris does not cause any damage to the heart muscle. Symptoms of unstable angina are:

1. Mild or severe chest discomfort/pain/tightness/dull ache/heaviness
2. Radiation of discomfort/pain/tightness/dull ache/heaviness in the chest to arms (especially left arm), neck, shoulder, or jaw
3. Shortness of breath
4. Nausea
5. Sweating
6. Weakness
7. Pallor
8. Tachycardia (rapid heart rate)

Myocardial infarction (MI), commonly called a heart attack, is one of the most serious complications of atherosclerotic heart disease. A myocardial infarction occurs when an atherosclerotic plaque in a coronary artery ruptures. When this occurs, coagulation mechanisms are activated and a blood clot is formed that completely blocks the artery. The myocardium receives no blood or oxygen to that portion of the heart and part of the heart muscle may die. Depending on the size and location of the infarction and if the patient is quickly treated, he or she may survive but deaths from myocardial infarction are not uncommon.

Sudden Cardiac Death:

Sudden cardiac death, also known as cardiac arrest, can occur during a myocardial infarction when plaque ruptures causing a blockage in a coronary artery. But, sudden cardiac death primarily occurs as a result of a fatal arrhythmia such as ventricular fibrillation or ventricular tachycardia. During these arrhythmias, the heart no longer pumps out blood but instead the heart beats so irregularly, rapidly, and weakly that there is no circulation to the brain or heart at all. The patient may feel dizzy and weak but typically there is simply a sudden loss of consciousness.

Most sudden cardiac deaths are caused by a fatal arrhythmia. Automated external defibrillators (AEDs) can shock a heart back to a normal rhythm if they are applied quickly enough, and that is why AEDs are now found in many public areas.

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The Brain and Atherosclerosis

Atherosclerosis affects both the brain and the carotid arteries, the blood vessels that supply oxygenated blood to the brain. The presence of atherosclerosis in these areas has many effects; one of the most serious is *ischemic stroke*.

Ischemic stroke also called a cerebrovascular accident or CVA, occurs when the blood supply to an area of the brain is suddenly stopped or significantly impaired. The brain is metabolically active and must have oxygen and glucose (sugar) to function and survive. The brain accounts for approximately 2.5% of total body weight but it requires 15% of the blood pumped by the heart each minute to function and survive. When the blood supply to the brain is interrupted, the consequences can be devastating. If the cerebral blood flow is cut off for as little as 4 minutes, brain tissue can die. An ischemic stroke can be mild and the patient can fully recover, or he or she

may suffer permanent brain damage and may never speak or walk again. Many ischemic strokes are caused by atherosclerosis. Quick evaluation of a patient with possible stroke symptoms is imperative to prevent brain tissue damage or possible death.

A quick way to evaluate someone for the presence of a stroke is to use the mnemonic FAST.

F = Face: Ask the patient to smile and show his or her teeth.

A = Arms: Ask the patient to hold his or her arms out in front and parallel to the floor.

S = Speech: Have the patient say a short, simple sentence.

T = Time: Time is critical as the sooner treatment is delivered the more brain tissue can be saved.

Facial drooping, inability to hold the arms parallel and/or one

Peripheral Circulation and Atherosclerosis

Atherosclerosis is one of the primary causes of *peripheral arterial disease* (PAD). Peripheral arterial disease is a chronic condition in which atherosclerosis decreases the *arterial* circulation in the extremities, most often the legs.

Peripheral arterial disease typically happens to older adults who have the following risk factors:

1. Cigarette Smoking
2. Diabetes
3. Family History (peripheral arterial disease)
4. Hypertension
5. High Blood Lipids
6. Obesity

The signs and symptoms vary from person to person, and some people may have PAD and not know it; however, it is more common for someone who has PAD to have some evidence of poor circulation. Table 1 is a list of signs and symptoms of PAD.

Table 1: Signs and Symptoms of PAD

- **Cold or pale feet or legs**
- **Cramping in the feet or legs**
- **Cuts or sores that do not heal properly**
- **Pain in the feet or legs when walking, which is relieved by rest**

The last of these, pain while walking that is relieved by rest, is called *intermittent claudication* and it is a very important diagnostic sign of PAD. Intermittent claudication is common in PAD, and patients who have intermittent claudication may also complain that their legs ache, cramp, or feel numb and tired while walking. Peripheral arterial disease is treated with anti-clotting drugs such as aspirin or clopidogrel, exercise, reduction of risk factors, for example, smoking cessation, statin drugs, drugs like cilostazol that relieve the pain of intermittent claudication, and if needed, angioplasty or surgery.

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Who Develops Atherosclerosis?

Atherosclerosis develops from a complex interaction between risk factors and genetics. Having a family history of atherosclerosis increases an individual's risk for the disease; however, it is not known how atherosclerosis or the tendency to develop it is inherited. The contribution of non-modifiable risk factors and of modifiable risk factors, such as lifestyle factors, is much better understood.

Table 2: Modifiable Risk Factors of Atherosclerosis

- **Elevated Blood Lipids**
- **Obesity**
- **Sedentary Lifestyle**
- **Smoking**

Elevated blood lipids (also known as fats), including cholesterol, have been clearly associated with an increased risk for atherosclerosis. Obesity increases the risk for atherosclerosis in several ways. It increases blood pressure; it increases the chances of developing diabetes, which itself is a risk factor for atherosclerosis; and, it increases blood lipid levels.

A sedentary lifestyle affects the development of atherosclerosis by the absence of the protective effects of exercise. Studies have shown that exercise can actually improve both symptoms related to as well as the progression of PAD. When you exercise blood circulation can improve and new collateral vessels can develop. Smoking increases blood pressure and it also directly damages the blood vessels, making them more likely to develop atherosclerotic plaques. Nicotine causes your blood vessels to constrict or narrow, which limits the amount of blood that flows to your organs. Over time, the constant constriction results in blood vessels that are stiff and less elastic.

Table 3: Non-Modifiable Risk Factors for Atherosclerosis

- **Age**
- **Diabetes**
- **Family History**
- **Hypertension**

Age:

Age is an important risk factor for atherosclerosis; the incidence of the disease is higher in men \geq age 45 and women \geq age 55. **As you get older, so do your blood vessels, and your risk for atherosclerosis increases.** Aging causes your vessels to become less flexible, making it harder for blood to move through them easily. Genetic or lifestyle factors can cause plaque to build up in your vessels as you age and by the time you're middle-aged or older, enough plaque has built up to cause signs or symptoms.

Diabetes:

Diabetes, if it is not well controlled, results in consistent abnormally high blood sugar. This is thought to cause the walls of the arteries to become inflamed, making them susceptible to the growth of fatty deposits (plaques). Also, diabetes may cause a change in blood chemistry leading to narrowing of the blood vessels.

Family History:

When members of a family pass traits from one generation to another through genes, the process is called heredity. WebMD published The Framingham Heart Study done in July of 2003 concluding that if one or both parents have early atherosclerosis then their children will suffer from

atherosclerosis or thickening of arteries. During the study, both parents and the children underwent regular screening for heart disease, including imaging that detects thickened arteries in the neck before symptoms occur. It was concluded that the average wall thickness of the arteries was greater in children who had at least one parent who had had a heart attack or atherosclerosis before age 60. Family history of atherosclerosis modifies future atherosclerosis risk depending on the number and age of affected first-degree relatives. Siblings of patients with atherosclerosis have about a 40% risk increase, while offspring of parents with premature atherosclerosis have a 60% to 75% risk increase.

Hypertension:

High blood pressure can damage your vessels by making them less elastic, which decreases the flow of blood and oxygen. Over time this increased pressure damages the arterial walls and this increases the development of plaques, leading to atherosclerosis.

Age and family history cannot be changed but it is important to remember that diabetes and hypertension, although they are classified as non-modifiable risk factors, are diseases that *can* be managed and controlled. If blood sugar levels and blood pressure can be kept within normal limits the risk of developing atherosclerosis drops dramatically. It has been estimated that approximately 90% of all complications associated with atherosclerosis could be prevented by lifestyle changes.

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Treatment of Atherosclerosis

The best approach to atherosclerosis is prevention. Lifestyle changes can help prevent or slow the progression of atherosclerosis.

- Stop Smoking
- Exercise
- Lose Weight (maintain a healthy weight)
- Eat Healthy

- Manage Stress

Existing diagnosis of atherosclerosis can be managed through medications for increased cholesterol such as statins and fibrates, anti-coagulants for prevention of blood clots, medications for diagnosis contributing to atherosclerosis such as hypertension (Angiotensin-converting enzymes-ACE, beta-blockers or calcium channel blockers), and preventive measures mentioned above. With continued management utilizing preventative measures atherosclerosis can be a disease you can live with for many years.

Medical procedures to treat atherosclerosis are listed below:

1. Angiography and stenting: Your doctor puts a thin tube into an artery in your leg or arm to get to diseased arteries. Blockages are visible on a live X-ray screen. Angioplasty (using a catheter with a balloon tip) and stenting can often open a blocked artery. Stenting helps ease symptoms, but it does not prevent heart attacks.
2. Bypass surgery: Your doctor takes a healthy blood vessel, often from your leg or chest, and uses it to go around a blocked segment.
3. Endarterectomy: Your doctor goes into the arteries in your neck to remove plaque and restore blood flow.

Changes in Lifestyle

Lifestyle changes were listed above under preventative measures and it's an important reminder that these changes have been shown to prevent atherosclerosis. They can also reduce the risk of the complications of atherosclerosis. The American College of Cardiology/American Heart Association's Guidelines on Lifestyle Management to Reduce Cardiovascular Risk provides useful guidance. Examples of the guidelines are shown below:

The diet should emphasize, fruits, vegetables, and whole grains.

Limit the intake of sodium sweets, sugar-sweetened beverages and red meat.

Low-fat dairy products, poultry, and fish are preferred sources of protein.

Managing Pre-existing Diseases

Management and control of pre-existing conditions can prevent further injuries and complications. Managing diabetes by managing and controlling blood sugar levels through the use of medication, dietary adjustments, and frequent monitoring is imperative. Hypertension control with medications, reduction in weight with dietary changes and exercise, and dietary changes to closely monitor sodium intake and management of cholesterol levels.

Managing pre-existing conditions can reduce the incidence of atherosclerotic complications.

Medications

The statin drugs like atorvastatin and lovastatin lower serum lipids. They have been shown to prevent atherosclerosis and in people who have atherosclerosis, statins can reduce the incidence of mortality, myocardial infarction, and stroke.

Deep Vein Thrombosis

Deep vein thrombosis (DVT) is one of the most common vascular disorders in the United States. Approximately 900,000 people each year in the United States develop DVT or pulmonary embolism and tens of thousands die.

Deep vein thrombosis and pulmonary embolism are often grouped together as a single disease and called venous thromboembolism. In this module DVT will be discussed as the primary disease and pulmonary embolism as a complication of DVT.

A thrombus is a blood clot that forms in a vein. An embolus is anything that moves through the blood vessels until it reaches a vessel that is too small to let it pass. When this happens, the blood flow is stopped by the embolus. An embolus is often a small piece of a blood clot that breaks off the thrombus and many times goes to the lung, referred to as a pulmonary embolism. If untreated, acute pulmonary embolism is associated with a significant mortality rate (as high as 30%), whereas the death rate of diagnosed and treated pulmonary embolism is 8%. DVT will be discussed below.

Causes of DVT

A thrombosis is a medical term for a blood clot, and a DVT is a thrombosis that forms in a deep vein. As with many of the body's functions, blood clotting is a process of balance. The body must form clots so that bleeding can be stopped but the body must also be able to break down clots

so that proper circulation can be maintained. In the case of DVT, this balance is upset, clots are formed, and they cannot be removed by natural processes. Three primary ways that DVTs form include:

1. Damage to the blood vessels
2. Interruption of blood flow
3. Abnormal clotting process

Examples of DVTs are listed here.

Damage to the blood vessels:

If one of the deep veins is injured by minor and major traumas, this predisposes that blood vessel to clot formation. Prolonged IV use, surgery, or injury from trauma are a few examples of how a deep vein thrombosis can occur.

Interruption of blood flow:

Obesity, inactivity, or any other factor that interrupts blood flow can lead to the pooling of blood in the extremities, particularly the lower extremities, and blood that is not circulating will naturally clot. Muscle contractions in the limbs help push blood through veins back to the heart. Long periods of immobility, like sitting at a job, increase the chance that a clot will form.

Abnormal clotting:

Some patients who have DVT have an inherited condition that abnormally increases the natural clotting tendency of the blood. These basic causes of DVT combine with many risk factors for DVT that increase the chance of developing the disease.

Table 4: Deep Vein Thrombosis Risk Factors

- **Cancer**
- **Central IV catheters**
- **Family history of DVT**
- **Immobility**
- **Obesity**
- **Oral contraceptives**
- **Pregnancy**
- **Smoking**
- **Stroke**
- **Surgery**
- **Trauma**

Signs, Symptoms, and Diagnosis of DVT

Signs and symptoms of DVT:

A DVT often does not cause any significant signs and symptoms and the first indication that a patient has a DVT may be a pulmonary embolism (PE). However, some patients may have:

1. Noticeable Leg Swelling
2. Pain
3. Pale or Discolored Skin
4. Edema
5. Surface Veins are Distended

Diagnosis:

The diagnosis of DVT is made by determining the patient's risk profile:

1. Physical examination (tenderness, warmth, erythema, cyanosis, edema, palpable cord (a palpable thrombotic vein), superficial venous dilation, or + Homan's sign (pain in calf with dorsiflexion))
2. Blood tests (A D-dimer test to identify any blood clotting disorder)

3. Specific diagnostic tests Venography is an x-ray examination with contrast material to visualize blood flows through your veins
4. Ultrasound examination Sound waves to produce images of the veins to search for blood clots

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Complications of DVT

The most serious complication of DVT is *pulmonary embolism* (PE). An embolism is defined as a clot or a foreign body that blocks a blood vessel, and a PE is a portion of a DVT that has broken off from the primary clot. Once a portion of the DVT breaks off it travels through the circulation and becomes lodged in one of the blood vessels of the pulmonary circulation. Pulmonary embolism is a common complication of DVT. One study found that more than one-third of patients with DVT had a PE.

Many PEs are small and do not cause symptoms. In most cases, they are broken down and removed through the body's natural processes. A PE can also be a medical emergency. If a PE is large enough to block a major blood vessel of the pulmonary circulation, it can cause arrhythmias, heart failure, pulmonary hypertension, shock, and death. Fortunately, massive PEs are not common. The risk factors for PE are essentially the same as for DVT.

Venous insufficiency is a chronic condition caused by damage to the veins in the legs. It is a common complication, occurring in one-third to one-half of all people who have DVT. Blood pressure in the venous system is relatively low, and blood flow from the lower extremities back to the heart depends on normal functioning veins. With venous insufficiency, the integrity of the vasculature of the legs may be disrupted. Blood flow may be obstructed or the veins may be damaged, causing blood to pool in the lower extremities. The most common signs of venous insufficiency are:

1. Discoloration of the Skin
2. Edema
3. Pain
4. Feeling of Heaviness in the Legs

5. Leg Ulcers
6. Nocturnal Leg Cramps
7. Varicose Veins

Venous insufficiency is uncomfortable and can significantly interfere with activities of daily living but it is not by itself a dangerous condition that causes serious complications.

Deep vein thrombosis can also cause an *ischemic stroke* by either a local DVT in the brain *or* because a small portion of a DVT broke off and traveled to the cerebral circulation, blocking blood flow to the brain. This is an emergency situation and must be treated immediately.

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Treatment of Deep Vein Thrombosis

The primary treatment for DVT is anticoagulation. Anticoagulation will help to break down the existing DVTs, prevent new DVTs from forming, and decrease the risk for PE.

Anticoagulation is recommended for all patients who have a documented DVT unless there is a significant contraindication such as a bleeding disorder. This will be determined with the D-dimer blood test. The standard protocol is to start anticoagulation as soon as the presence of a DVT has been confirmed, continue therapy for three months, and then, depending on the response and the requirements of the patient, continue anticoagulation therapy for up to a year and occasionally, indefinitely.

Initial anticoagulant therapy can be done with intravenous or subcutaneous heparin then once the patient is released home subcutaneous or oral may be continued.

A low-molecular-weight subcutaneous heparin such as enoxaparin may be administered. Fondaparinux, a Factor Xa inhibitor anticoagulant may be given subcutaneously, or one of the newer oral anticoagulants like apixaban or rivaroxaban.

Patients who cannot tolerate anticoagulant therapy or who have a massive DVT can be treated by using mechanical clot removal; a filter placed in the inferior vena cava that will prevent DVTs from becoming PEs; or, thrombolytic therapy that

Treatment for venous insufficiency includes leg elevation, compression stockings, vein stripping, and other types of surgery.

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Hypertension

Hypertension often referred to as high blood pressure, is one of the most common vascular disorders. Approximately one in three adult Americans has hypertension, and hypertension contributes to the development of many other chronic diseases like atherosclerosis and diabetes mellitus.

Classifying Hypertension

There are 2 classes of hypertension, *primary* or *secondary* hypertension. Hypertension that doesn't have a known cause is called essential or primary hypertension. In contrast, secondary hypertension has a known cause.

Primary (essential) Hypertension:

Primary hypertension accounts for approximately 90%-95% of all cases of hypertension. Primary hypertension may be in part inherited but the cause of primary hypertension is unknown. There are risk factors that can contribute to the development of primary hypertension and this will be covered in this section.

Secondary Hypertension:

Secondary hypertension is much less common and in secondary hypertension, there is an identifiable cause. Mayo Clinic has identified a complete list of these possible causes. Several kidney diseases that may cause secondary hypertension, including:

1. Diabetes complications (diabetic nephropathy). Diabetes can damage your kidneys' filtering system.
2. Polycystic kidney disease. In this inherited condition, cysts in your kidneys prevent the kidneys from working normally.
3. Glomerular disease. Your kidneys filter waste and sodium using microscopic filters called glomeruli that can sometimes become swollen. If the swollen glomeruli can't work normally hypertension can occur.
4. Renovascular hypertension. This type of high blood pressure is caused by narrowing (stenosis) of one or both arteries leading to your kidneys.

Medical conditions affecting hormone levels also may cause secondary hypertension. When there is an imbalance in hormones the body has a difficult time maintaining homeostasis. These conditions may include:

1. Cushing syndrome. May be caused by a pituitary tumor or other factors that cause the adrenal glands to produce too much of the hormone cortisol.
2. Aldosteronism. The adrenal glands produce too much of the hormone aldosterone. This makes your kidneys retain salt and water.
3. Pheochromocytoma. This rare tumor, usually found in an adrenal gland, produces too much of the hormones adrenaline and noradrenaline.

4. Thyroid problems. When the thyroid gland doesn't produce enough thyroid hormone (hypothyroidism) or produces too much thyroid hormone (hyperthyroidism), high blood pressure can result.
5. Hyperparathyroidism. The parathyroid glands control levels of calcium and phosphorus in your body. If the glands release too much parathyroid hormone, the amount of calcium in your blood rises, which triggers a rise in blood pressure.

Other possible causes of secondary hypertension include:

1. Coarctation of the aorta. In this condition, present at birth, the body's main artery (aorta) is narrowed (coarctation). This forces the heart to pump harder to get blood through the aorta and to the rest of your body.
2. Sleep apnea. This condition is often marked by severe snoring, breathing repeatedly stops and starts during sleep, causing you to not get enough oxygen (hypoxia). Not getting enough oxygen may damage the lining of the blood vessel walls, which may make it harder for your blood vessels to control your blood pressure.
3. Obesity. As you gain weight, the amount of blood flowing through your body increases. This puts added pressure on your artery walls, increasing your blood pressure.
4. Pregnancy. Pregnancy can make existing high blood pressure worse or cause high blood pressure to develop (pregnancy-induced hypertension or preeclampsia).
5. Some prescription medications can cause or worsen high blood pressure in some people.
6. Over-the-counter decongestants and certain herbal supplements may have the same effect.
7. Many illegal drugs, such as cocaine and methamphetamine, also increase blood pressure.

Determining the underlying cause of secondary hypertension may take testing and routine follow-up with your provider to determine but diagnosis and treatment could lead to a better or well-controlled blood pressure and decrease complications in the future.

Normal blood pressure is a systolic pressure ≤ 120 mm Hg and a diastolic blood pressure ≤ 80 mm Hg. In addition to primary and secondary, hypertension can also be classified as pre-hypertension, Stage I and Stage II hypertension, and diastolic and systolic hypertension. In the table below, SBP is referred to as systolic blood pressure and DBP is referred to as diastolic blood pressure.

Table 5: Definitions of Hypertension

- Pre-hypertension: SBP 120-139 mm Hg, DBP 80-89 mm Hg
- Stage I hypertension: SBP ≥ 140 mm Hg or DBP ≥ 90 mm Hg
- Stage II hypertension: SBP ≥ 160 mm Hg or DBP ≥ 100 mm Hg
- Isolated diastolic hypertension: DBP ≥ 90 mm Hg and SBP < 160 mm Hg
- Isolated systolic hypertension: SBP ≥ 140 mm Hg and DBP < 90 mm Hg

Pre-hypertension is a condition in which the blood pressure is above normal but not to the level that defines hypertension; the condition increases the risk of developing hypertension and the complications of hypertension.

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Risk Factors for Primary Hypertension

The cause of primary hypertension is not known but risk factors for the disease have been identified. Risk Factors for Hypertension are:

1. Age
2. Alcohol
3. Genetics/Family History

4. Obesity
5. Race
6. Sedentary Lifestyle
7. Smoking
8. High Sodium Diet
9. Low Potassium Diet

Age:

Hypertension is not an inevitable part of aging, but the likelihood of developing hypertension increases as we get older. It has been estimated that the probability of a middle-aged or elderly person developing hypertension in his or her lifetime is 90%.

Alcohol:

Excessive use of alcohol increases the risk of developing hypertension. Excessive alcohol use includes binge drinking and heavy drinking. Binge drinking is defined as consuming 4 or more drinks on an occasion for a woman or 5 or more drinks on an occasion for a man.

Genetics/Family History:

Studies that have controlled environmental factors have estimated that genetics may account for 15%-35% of the risk of developing hypertension. However, those individuals not living in a controlled environment with a family history of high blood pressure share common environments and other potential factors that increase their risk.

Obesity:

Being overweight can increase the likelihood of developing high blood pressure than if you are at your desirable weight. About 70% of adults in the

United States are overweight. By decreasing your weight you can reduce your risk of high blood pressure.

Race:

The incidence and severity of hypertension are higher in African Americans than in other ethnic groups in the United States. African Americans develop hypertension at an earlier age and the rate of progression from pre-hypertension to hypertension is faster than it is for other ethnic groups. In addition, African Americans suffer disproportionately from the cardiovascular and renal complications associated with hypertension and optimal control of blood pressure is more difficult for African Americans.

Even when income, body mass, and diet are considered, hypertension is a specific problem for African Americans and the reasons for this are not clear. High rates of high blood pressure in African Americans may be due to the genetic make-up of people of African descent. Researchers have uncovered that in general, African Americans respond differently to high blood pressure drugs than do other ethnic groups of people.

Sedentary Lifestyle:

Physical inactivity and a sedentary lifestyle increase the risk for developing hypertension, and a high level of fitness and physical activity can prevent the development of hypertension.

Smoking:

The relationship between cigarette smoking and hypertension is complex. Smoking increases the risk of developing atherosclerosis and atherosclerosis can contribute to hypertension. Not only does smoking or chewing tobacco immediately raise your blood pressure temporarily, but the chemicals in tobacco can damage the lining of your artery walls.

Sodium Intake:

An excess of dietary sodium can lead to water retention and increases the risk of developing hypertension. Dietary Guidelines for Americans recommends limiting sodium intake to less than 2,300 mg per day, which is equal to about 1 teaspoon of salt. Most Americans consume 3,400 mg per day, well above the recommended amount.

Potassium Intake:

Potassium and sodium have an inverse relationship, meaning when potassium levels fall sodium levels rise. Consuming a diet low in potassium could inversely increase sodium in your body. Most people do not consume the recommended 3,500–4,700 mg daily from foods. To increase your intake, incorporate a few potassium-rich foods into your diet such as spinach, yams, avocados, bananas, and fish.

Complications of Hypertension

Hypertension is often called the silent killer. Hypertension does not produce signs and symptoms until the disease has been present for many years or unless there is a hypertensive emergency. Each year, however, the increased pressure in the vascular system causes slow, progressive damage to vulnerable tissues and organs and contributes to the development of many serious, chronic diseases. The primary complications of hypertension are listed in Table 7.

Table 7: Complications of Hypertension

- **Aneurysm**
- **Atherosclerosis**
- **Heart Disease**
- **Kidney Disease**

- **Retinal (eye) Damage**
- **Stroke**

Aneurysm:

An aneurysm is an abnormal bulge that forms on a blood vessel. Hypertension increases the risk for aneurysms, and aneurysms in the brain can cause a stroke.

Atherosclerosis:

Hypertension is one of the major risk factors for atherosclerosis because of the damage it causes to blood vessels.

Heart Disease:

Heart disease is the most common cause of death in people who have hypertension.

Kidney Disease:

Hypertension is a major risk factor for the development of chronic kidney disease and is the second leading cause of kidney failure in the U.S.

Retinal Damage:

The retina transmits the optical images from the eye to the brain, and a healthy, functioning retina is essential for normal vision. The cells and tissues that make up the retina are extremely sensitive to pressure, and retinal damage has been reported in up to 80% of the population that has hypertension.

Stroke:

Hypertension is one of the major risk factors for stroke, and the higher the blood pressure the greater the risk for a stroke.

[9]

Screening for Hypertension

The diagnosis of hypertension cannot be confirmed until an elevated blood pressure is present on at least three occasions, each one separated by at least one week. Every health care professional needs to be proficient in measuring blood pressure but a short review is shown in the following table.

- 1. Blood pressure should be measured in a quiet, warm environment.**
- 2. Patients should not drink coffee or ingest caffeine-containing products within 1 hour of the blood pressure measurement and not smoke within 30 minutes.**
- 3. The patient should be seated and the arm should be at the level of the heart.**
- 4. During the first visit, check postural blood pressure and check the blood pressure on both arms. If there is a difference in the readings between arms, use the higher reading of the two.**
- 5. Take at least two readings during each evaluation. The readings should be separated by as much time as is practical.**
- 6. The length of the blood pressure cuff should be 80% of the length of the arm and the width of the cuff should be at least 40% of the upper arm circumference.**
- 7. Inflate the cuff 20 mm Hg above the systolic pressure.**
- 8. Deflate the cuff 3 mm Hg per second.**

The United States Preventive Services Task Force recommends that people who have a systolic and diastolic blood pressure < 120 mm Hg and < 80 mm Hg have their blood pressure measured every two years. Anyone who has a systolic blood pressure of 120-139 mm Hg or a diastolic blood pressure of 80-89 mm Hg should be screened yearly.

Treating Primary Hypertension

The benefits of treating primary hypertension are clear and unequivocal. Lowering blood pressure significantly reduces the risk of developing complications of diseases like congestive heart failure, kidney disease, and stroke. The first step in treating hypertension is to establish a goal for blood pressure. Table 8 lists current recommendations for goal blood pressures.

Table 8: Blood Pressure Goals

General population, age \geq 60:

- Systolic pressure < 150 mm Hg; diastolic pressure < 90 mm Hg

General population, age < 60, and patients of any age who have chronic kidney disease (CKD) and/or diabetes:

- Systolic pressure < 140 mm Hg, diastolic pressure < 90 mm Hg

Lifestyle Modifications

Lifestyle modifications should be the first intervention when treating and controlling hypertension. These should be considered lifelong commitments.

Decreased Alcohol Consumption:

When heavy drinkers decrease the amount of alcohol consumed, blood pressure is significantly reduced.

Diet:

Patients who have hypertension should be instructed to follow the Dietary Approaches to Stop Hypertension (DASH) eating pattern. The DASH program diet stresses eating fruits, vegetables, whole grains, low-fat dairy products, reducing intake of saturated fats and total fats, and restricting sodium intake. The DASH program has been shown to reduce systolic blood pressure and to a lesser degree, diastolic blood pressure.

Exercise:

Aerobic exercise has been shown to reduce blood pressure for 24 hours post-exercise and to reduce resting blood pressure, as well. According to the American College of Sports Medicine (ACSM) patients who have hypertension are recommended to engage in moderate-intensity, aerobic exercise 5-7 days a week, supplemented by resistance exercise 2-3 days a week. Resistance training makes your muscles work against a weight or force. Resistant exercises could utilize weights or your own body weight, such as squats or pushups.

Before starting an exercise program, patients should consult with a physician, especially if he or she is > 40 years of age, has chest pain at rest or during activity, has bone or joint pain, has a balance disorder, or is taking medications for hypertension or a cardiac disorder. The American College of Sports Medicine has published exercise program recommendations for people who have hypertension and these can be viewed at:

<http://www.acsm.org/docs/brochures/exercising-your-way-to-lower-blood-pressure.pdf>.

Smoking Cessation:

Smoking cessation has been shown to reduce systolic blood pressure, arterial stiffness, and 24-hour ambulatory blood pressure. The American Heart Association (AHA) reported that in as little as 1 day after quitting smoking, a person's blood pressure begins to drop, decreasing the risk of heart disease from smoking-induced high blood pressure. In this short time, a

person's oxygen levels will have risen, making physical activity and exercise easier to do, promoting heart-healthy habits.

Weight Loss:

Weight loss has been shown to significantly lower blood pressure. Losing even 10 pounds can lower your blood pressure and losing weight has the biggest effect on those who are overweight and already have hypertension.

Antihypertensive Therapy

Lifestyle changes are very effective at lowering blood pressure but they are a lifelong commitment that many people find difficult. It has often been said that half of the people who have hypertension do not know it; half of the people who know they have hypertension are not receiving treatment; and, half of the people who are being treated are not being adequately treated.

If the patient is unable to make lifestyle changes or if these changes do not help reach blood pressure goals, antihypertensive therapy should be started. There are standard guidelines for who should be treated and what drugs should be used in treatment. Most patients who have hypertension will eventually require more than one type of drug to reach the blood pressure goal.

Several examples from the 2014 report by the Eighth National Joint Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure include:

1. African American patients who do not have diabetes or chronic kidney disease; start therapy with a thiazide diuretic like hydrochlorothiazide (HCTZ) or a calcium channel blocker like amlodipine.
2. Non-black patients who do not have diabetes or chronic kidney disease; a thiazide diuretic, an angiotensin-converting enzyme inhibitor (ACEI) like lisinopril, an angiotensin II receptor blocker (ARB) like valsartan, or a calcium channel blocker (CCB), may be given alone or in combination.

After a patient has been started on an antihypertensive, the medications can be adjusted using one of these strategies:

1. Maximize the first medication dose before adding a second.
2. Add a second medication before reaching the maximum dose of the first medication.
3. Start with 2 medication classes separately or as a fixed-dose combination.

[10]

Case Study: Hypertension

The health care professional was scheduled to visit a 70-year-old male at his home for post-operative vital sign checks and to assist with bathing. He was reported to have a history of hypertension and was newly placed on antihypertensive blood pressure medications. His last average blood pressures were recorded to be 190/110 and had been consistently elevated. Recently, the home support registered nurse had delivered the new blood pressure medication ordered by his cardiologist and requested that the health care professional do vital sign checks during every home visit.

The patient had been asked to do his own blood pressure monitoring between home visits with the registered nurse. He had been shown how to do this with an ambulatory blood pressure monitor, however had been reluctant to do so. After returning home following his surgery, the registered nurse noted that there were very few entries in his vital sign diary between nursing visits. The health care professional was informed of the patient's non-compliance with home blood pressure monitoring and asked to document entries in the patient's vital sign diary. The hope was that over time the patient would observe what the health care professional was doing when supporting data entries and daily vital sign trends and would begin to enter self-acquired readings. This could help with medical decision-making at the home care level.

The health care professional was assigned 1-hour visits every day for the first 30-days of in-home care. The primary duties of the health care professional were to support the patient to maintain daily hygiene, assist with nutrition and fluid intake, and to aid with minor needs related to the cleanliness of the patient's immediate living space. The health care professional provided ongoing reporting to the home care interdisciplinary health team, which included the registered nurse, physical therapist, and the medical clinician. Additionally, the patient's medications were delivered to the home by the community pharmacy through the mail. The health care professional was the primary support person seeing the patient on a daily basis and integral to the patient's long-term recovery plan.

Over time, the health care professional was able to model for the patient how routine blood pressure checks should be done. After the first week, the health care professional discovered that the patient was very frightened to witness such high blood pressure readings. On a daily basis, the health care professional was able to show the patient how routine vital sign checks could help inform the health team on whether the antihypertensive medication was being effective or not. By week 2 of entering vital sign entries into the patient's diary, the health care professional was able to show how the blood pressure was trending down to a healthier level and noticed the patient showed relief when the blood pressure reached 140/86. Although this blood pressure calculation was not at the target level preferred by the patient's cardiologist, it did show progress and the patient became more motivated to take over his own blood pressure monitoring. By week 3, the health care professional began to document the progress of the patient to record his own vital signs and reported to the home care interdisciplinary team that the patient's ability to manage independent health needs had advanced to the point that by week 4 the health care professional could reduce visits to 2-3 times weekly.

Also, the registered nurse discovered that the patient's home blood pressure readings were consistently less at home than those obtained in the clinic at the current increased dose of his antihypertensive medication. There was often a discrepancy of 40/20 mmHg between clinic and average home blood pressure readings. She also noted that the patient appeared more

anxious when arriving at the medical clinic for check-ins than when visited at home. A nursing diagnosis of anxiety and difficulty coping with external stressors was added to the patient's treatment plan, and an intervention proposed to extend health care professional home support as needed after the home visits by the registered nurse ended. In light of this older man's apparent white-coat syndrome (a fear of medical clinicians and clinic visits), the health care professional suggested that the patient could now take his own vital signs and self-report blood pressure trends taken at home during his medical clinic visits.

The role of the health care professional supported medical treatment by assisting the patient to maintain average vital sign trends and to document good blood pressure response to antihypertensive medication. This also helped the patient to avoid unneeded blood pressure medication increases as part of his medical clinic review where blood pressures consistently appeared higher due to the anxiety during medical clinic visits. The health care professional was also very instrumental to assist the patient by helping to alleviate his anxieties about being diagnosed with hypertension in the first place, modeling how routine documentation in his health diary could support quality health outcomes and motivating him to take an active part in his own health prevention plan. In future medical appointments, the patient may also now feel more reassured that the prescribed medication is working and that his risk of having a stroke are less.

Summary

The three vascular disorders and their complications include atherosclerosis, deep vein thrombosis, and hypertension; these conditions cause hundreds of thousands of deaths every year. They are among the most important causes of morbidity and disability and the associated costs of treatment are enormous. Prevention is the best approach when confronting the risk of atherosclerosis, DVT, and hypertension.

Atherosclerosis, DVT, and hypertension are three distinct diseases but they frequently occur together. The presence of one can influence the

development and progression of another. The risk factors for all three are essentially the same, and each disorder can be a risk factor for the other two.

These vascular disorders can be treated, however, they are chronic and progressive diseases and unfortunately often do not cause signs or symptoms until after they are well-established. Some individuals will develop all three conditions together. Once someone has atherosclerosis, DVT, or hypertension it takes diligent, conscientious effort by the patient and members of the interdisciplinary health teams to prevent serious complications. Treatment of these vascular disorders is difficult but it can be successful.

POST-TEST

- 1) Fat accumulation occurs inside the walls of the arteries beginning**
 - a) in middle age and thereafter.**
 - b) after hypertension is diagnosed.**
 - c) as early as childhood.**
 - d) once the arteries have hardened.**

- 2) Pain associated with stable angina pectoris relieved by**
 - a) rest.**
 - b) angioplasty.**
 - c) use of medications such as nitroglycerin.**
 - d) use of anticoagulants.**

- 3) Peripheral arterial disease is a chronic condition in which atherosclerosis most often decreases arterial circulation to the**
 - a) brain.**
 - b) heart.**
 - c) liver.**
 - d) legs.**

4) Which of the following is a non-modifiable risk factor for atherosclerosis?

- a)** Hypertension
- b)** Elevated blood lipids
- c)** Obesity
- d)** Sedentary lifestyle

5) One of the primary ways that a deep vein thrombosis (DVT) forms are from

- a)** an interruption of blood flow.
- b)** open lumens.
- c)** elevated blood lipids.
- d)** a myocardial infarction.

6) The most serious complication of deep vein thrombosis (DVT) is

- a)** endocrine disease.
- b)** hypertension.
- c)** a bleeding disorder.
- d)** pulmonary embolism.

7) _____ is defined as a clot or a foreign body that blocks a blood vessel.

- a)** A thrombus
- b)** An aneurysm
- c)** An embolism
- d)** A stroke

8) A patient with systolic and diastolic blood pressure readings of SBP 120-139 mm Hg, and DBP 80-89 mm Hg would be classified as having

- a)** stage II hypertension.
- b)** pre-hypertension.
- c)** primary hypertension.

d) isolated systolic hypertension.

9) Complications of hypertension include

a) aneurysm.

b) atherosclerosis.

c) stroke.

d) All of the above

10) _____ should be the first intervention when treating and controlling hypertension.

a) Diuretics

b) Anti-hypertensive medications

c) Lifestyle modifications

d) Anti-diuretics