4.1.3

Hypertension

Blood Pressure Category	Systolic mmHg (upper number)		Diastolic mmHg (lower number)
Hypotension	Less than 90	and/or	Less than 60
Normal	Less than 120	and	Less than 80
Elevated	120-129	and	Less than 80
High BP (Hypertension Stage 1)	130-139	or	80-89
High BP (Hypertension Stage 2)	140 or Higher	or	90 or Higher
Hypertensive Crisis	Higher than 180	and/or	Higher than 120

Table by Kaylie S. BYU-I S-21

Hypertension (HTN) is high blood pressure. A normal blood pressure level is less than 120/80 mmHg. There are various degrees of HTN, but if a patient's BP is consistently over 130 for systolic or 80 for diastolic, they are said to have HTN. Hypertension is the leading risk factor for cardiovascular disorders, but it does negatively affect many other areas of the body. Hypertension is normally asymptomatic, but when symptoms do occur they are often caused by long-term effects of HTN on organ systems such as the blood vessels, heart, kidneys, eyes, and brain. The extra pressure on blood vessels due to HTN can damage the vessels themselves and thus increase the rate of atherosclerosis and put an individual at risk for developing thrombi. For the heart, systemic hypertension can lead to left ventricular hypertrophy, heart failure, an increased rate of atherosclerosis in the coronary arteries, and an overall increase in the risk for myocardial infarction. HTN can negatively affect the kidneys because the added pressure on the renal blood vessels and glomerulus can lead to nephrosclerosis and chronic kidney disease. Kidneys damaged by HTN do not filter blood well and they also fail to regulate blood pressure, further compounding the hypertension problem. Hypertension can be particularly detrimental to kidneys already compromised by damage due to elevated blood sugar levels (called diabetic nephropathy). HTN can damage the eyes over time because the elevated pressure causes the vessels of the retina to weaken and become leaky in what is known as retinopathy. The brain is also affected by hypertension; cognitive impairment and dementia occur more often in those with hypertension. The risk for both hemorrhagic (intracerebral hemorrhage) and ischemic stroke also increases for those with hypertension.

Primary Hypertension

Hypertension can be divided into two categories: primary and secondary hypertension. **Primary hypertension** accounts for 90-95% of all cases of HTN. It is the chronic elevation of blood pressure without evidence of other disease conditions. Primary hypertension is also called **essential hypertension**. It is not generally possible to discover the cause of essential hypertension. Risk factors for primary hypertension include family history, race, elevation of blood pressure at a young age, high salt intake, and obesity.

Secondary Hypertension

Secondary hypertension is elevation of blood pressure due to another condition/cause that has been determined. We will discuss various causes of secondary hypertension below.

Drug-Induced Hypertension

Many drugs taken for medical conditions or other reasons can influence blood pressure. There are too many to list them all here, but we will mention a few.

Cocaine, amphetamines, alcohol, nicotine and even caffeine can all cause an increase in blood pressure and result in secondary hypertension.

Another type of secondary hypertension involves estrogen/progesterone intake. Women on birth control medication should have their blood pressure assessed regularly. It is not known why these drugs can increase blood pressure, but it may have something to do with the known effect that these hormones cause the body to retain sodium.

Hormone-Induced Hypertension

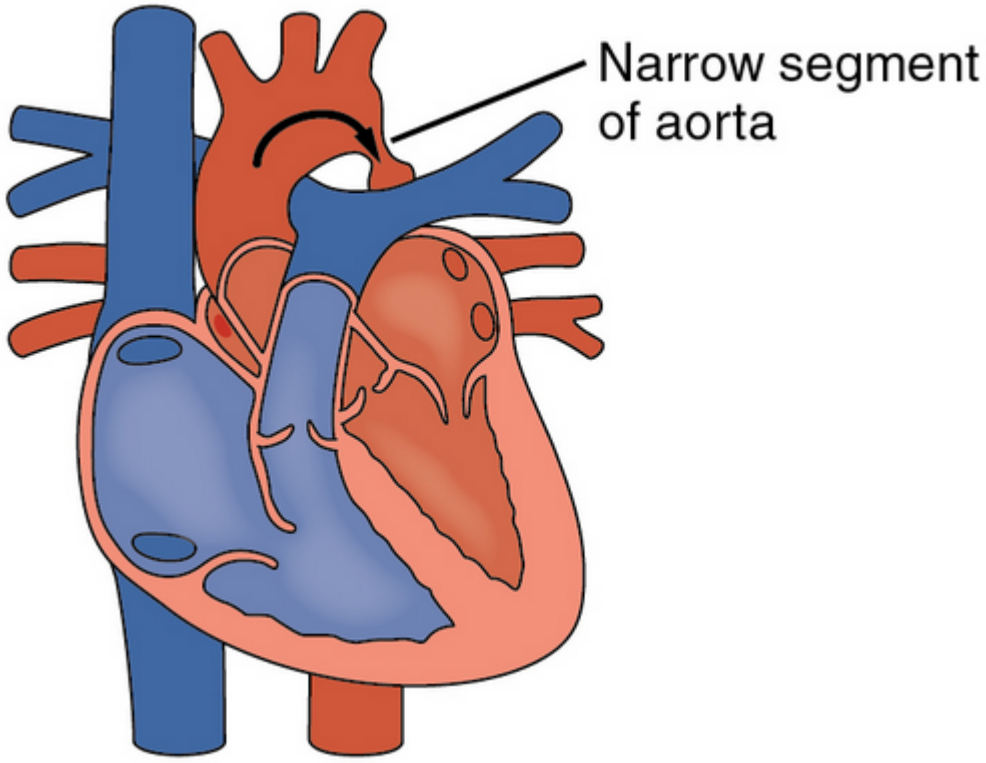
Many hormones influence blood pressure through different means. Any hormones that cause increased sodium and water retention in the kidneys can cause hypertension if their levels are too high. As you've learned in your previous physiology classes, the adrenal gland has several layers, some of which release hormones that influence BP. The cortex is divided into three layers. From superficial to deep we have the zona glomerulosa (responsible for the production of mineralocorticoids like aldosterone), zona fasciculata (responsible for the production of glucocorticoids like cortisol), and the zona reticularis (responsible for the production of androgens). Hyperaldosteronism and hypercortisolism due to pathological conditions can cause hypertension due to excessive sodium and water (follows sodium) retention in the kidneys. Due to the way transporters in the kidneys work, when Na^+ is retained, K^+ is lost in the urine. Because of the increased sodium retention caused by aldosterone, patients with hyperaldosteronism often have decreased potassium levels (hypokalemia). It is interesting to note that cortisol can also bind aldosterone receptors and cause similar hypokalemic effects. However, this does not generally happen because cells with aldosterone receptors also have an enzyme that quickly breaks down cortisol. However, if cortisol levels are very high (like in Cushing's syndrome), then the enzyme that breaks down cortisol can be overwhelmed and cortisol can activate more aldosterone receptors. This results in more sodium retention, potassium loss, and HTN.

Beneath the cortex of the adrenal gland is the medulla, which is responsible for the production of catecholamines like epinephrine and norepinephrine. A **pheochromocytoma** is a catecholamine secreting tumor of the adrenal chromaffin cells. As you have previously learned, epinephrine is an important effector of the SNS and can cause an increased heart rate and vasoconstriction. If levels of epinephrine are uncontrolled and too high in the body, a pheochromocytoma can lead to hypertension. This condition can be diagnosed by urine and blood tests for high levels of catecholamines and their metabolites.

Erythropoietin can elevate blood pressure as well because it causes an increase in peripheral resistance by increasing blood viscosity.

Coarctation of the Aorta

Coarctation of the aorta is a congenital disorder in which the lumen of the aorta narrows. This narrowing most commonly occurs just distal to the origin of the left subclavian artery. The ejection of a bolus of blood into the narrowed artery increases the systolic blood pressure. Because the blood can't flow to the lower body as easily, the narrowed artery increases blood flow to the upper part of the body. Blood pressure in the lower part of the body is usually within normal range, but is occasionally low. This possibly low BP can be regulated by the RAAS in response to decrease renal blood flow. Treatment for this coarctation is surgery or balloon angioplasty.



Coarctation of Aorta Distal to Origin of Left Subclavian Artery *artery File:2009 Congenital Heart Defects.jpg; OpenStax College; https://commons.wikimedia.org/wiki/File:2009_Congenital_Heart_Defects.jpg; Creative Commons Attribution 3.0 Unported*

Renovascular Hypertension

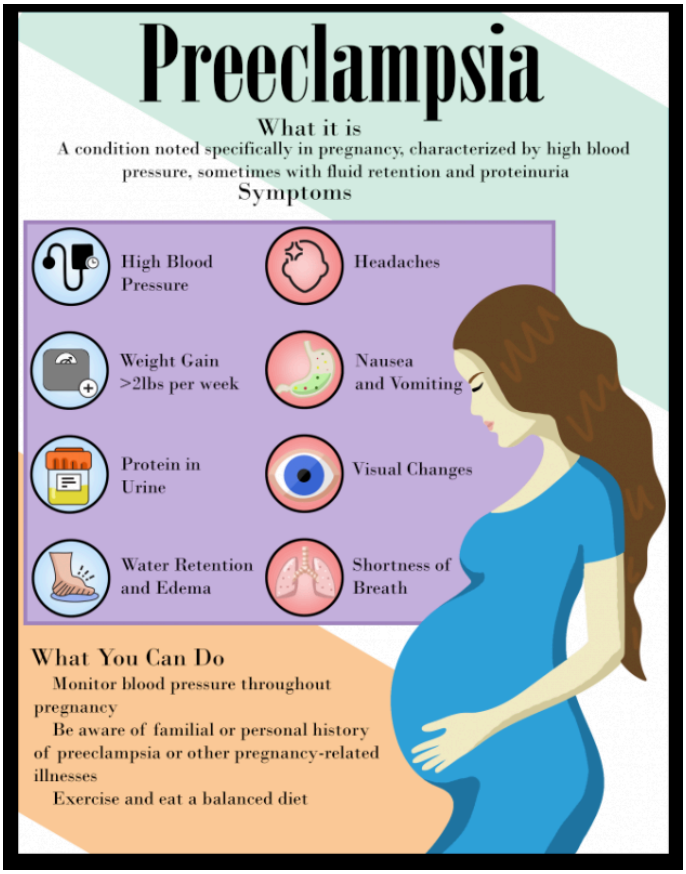
Renovascular hypertension is the most common cause for secondary hypertension. The general definition of renovascular hypertension is an increased release of renin due to decreased renal blood flow. This decreased renal blood flow is usually caused by two different pathologies:

1. Atherosclerosis of the proximal renal artery is the most common reason for renovascular hypertension and is seen more often in older patients. The atherosclerosis can lead to decreased renal blood flow, and as a result the kidneys will release more renin in an effort to increase BP. This reaction is normally desirable, but in this case the BP can often be normal and the increased renin can lead to HTN.
2. Fibromuscular dysplasia is a noninflammatory vascular disease that affects the renal arteries and branch vessels. Fibromuscular dysplasia is an abnormal growth of cells and tissue in the walls of arteries that can cause a vessel to bulge and narrow the lumen. The cause of this condition is not well understood, but the restricted blood flow to the kidneys will result in superfluous renin release and HTN.

High Blood Pressure in Pregnancy

High blood pressure in pregnancy is referred to as **preeclampsia**. It is generally diagnosed after elevation of blood pressure (systolic blood pressure > 140 mm Hg and diastolic > 90 mm Hg) and proteinuria have developed after 20 weeks of pregnancy. Preeclampsia occurs the most in first pregnancies and subsequent pregnancies of women with diabetes mellitus, multiple fetuses, collagen vascular disease, and underlying kidney disease. Chronic primary hypertension is also a risk factor for developing preeclampsia. **Eclampsia** is the development of seizures in a woman with preeclampsia.

It appears that in some women, the placenta develops with slight errors in the way spiral arteries feed the placental tissue. This leads to an environment of hypoxia in the placenta that triggers the release of cytokines and chemical mediators that strive to increase BP and blood perfusion to the placenta to support the fetus. These cytokines can have undesirable systemic effects on the mother's circulation by causing vasoconstriction and increased BP. They also cause endothelial dysfunction and endothelial retraction which both lead to edema and water retention in various parts of the body. Swelling of the limbs and face are common. Patients may also get a cough due to pulmonary edema that can develop as well. Endothelial retraction in the kidney also leads to proteinuria and in the retinal vessels it leads to visual disturbances. In the brain, cerebral edema due to endothelial cell compromise is manifested by headaches and the cerebral edema can even cause seizures. If a pregnant woman with preeclampsia gets seizures, then the condition is termed eclampsia. The vasoconstriction can become severe enough that it can cause hypoperfusion and ischemia of organs like the kidney, brain, liver, and heart. Endothelial cells also play an important role in inhibiting clotting and any endothelial dysfunction can increase the risk for disseminated intravascular coagulation (DIC).



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