

**Blood pressure (BP)** is the force of arterial blood pushing against the vessel wall in response to the cardiac cycle during **ventricular systole** (when ventricles are contracting) versus **ventricular diastole** (when ventricles are relaxed and filling with blood). Blood pressure can fluctuate moderately throughout the day due to activity and even body posture. When blood pressure changes outside of its **normal range (80 – 160mmHg)**, the body senses these changes and initiates a negative feedback response to bring blood pressure back to normal. **When blood pressure drops below normal**, pressure **baroreceptors within the aortic arch and carotid arteries** sense it and transmit information to the medulla oblongata. The **medulla's cardiac center** responds by stimulating a **sympathetic increase in heart rate**, which will increase blood pressure. The **medulla's vasomotor center also stimulates arterial vasoconstriction** to increase blood pressure. **When blood pressure is too high**, the aortic arch and carotid artery baroreceptors signal the **medulla's cardiac center to respond by stimulating a parasympathetic decrease in heart rate**, which decreases blood pressure. Simultaneously, the **vasomotor center stimulates arterial vasodilation** to decrease blood pressure.

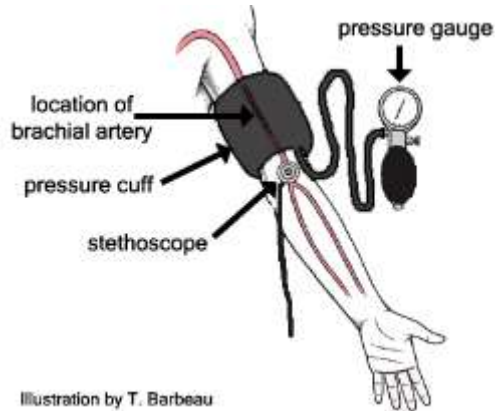
### The Effect of Changing Body Posture on Blood Pressure

Gravity is a constant force that influences nearly every aspect of biological activity. There are gravitational forces acting on physiological systems, such as the cardiovascular and circulatory systems. Any fluid columns, like blood vessels, are subjected to large pressure gradients when faced with sudden changes in body posture. There are physiological adaptations in the cardiovascular system designed to counteract the effects of gravity on the circulatory system under postural changes, such as when in a standing, sitting, or **lying down (supine)** position. When you have lain down for a long time and stand up suddenly, you might experience a brief feeling of faintness or dizziness that passes quickly. This sudden posture change from a supine to an upright posture creates a strong vertical gradient of gravitational pull on the blood in our circulatory system. The heart is now below the head and neck, and the heart is approximately 2-4 ft above the legs. Blood pressure decreases briefly in the head and neck while pressure increases in the legs. The sudden decrease in arterial blood pressure within your head and neck can cause feelings of dizziness or light-headedness, and might even lead to fainting (**syncope**). Several things will happen in the body to increase blood pressure and pooling of blood in the veins to counteract the force gravity upon standing. **(1)** The medulla's cardiac center stimulates a sympathetic increase in heart rate, which increases blood pressure. It also stimulates systemic arterial vasoconstriction, which also increases blood pressure. **(2)** The valves in your veins maintain a one-way flow of blood to the heart, which aids venous return of blood to the heart. Increased venous return allows the ventricles to fill maximally during diastole, which allows more blood to leave the heart during ventricular systole. **(3)** Your skeletal muscles contract and help compress the veins providing resistance to pooling of blood. These muscle twitches act much like a flight suit of jet pilots, which squeeze the body and provide resistance to the elastic-walled veins.

### Measuring Blood Pressure

A **sphygmomanometer**, or a blood pressure cuff, is a device used to measure blood pressure. In humans the blood is pumped through two separate circuits in the heart: the pulmonary circuit and the systemic circuit. During the **pulmonary circuit** the right ventricle of the heart pumps deoxygenated blood through the **pulmonary arteries** to the lungs in order to release CO<sub>2</sub> waste and take up O<sub>2</sub>. Oxygenated blood returns to the heart through **pulmonary veins**, and this is technically the end of the pulmonary circuit. Once oxygenated blood enters the left atrium this is the start of the **systemic circuit**. Blood then enters the left ventricle, and during ventricular systole the blood is pumped into the aorta and oxygenated blood travels through the arteries away from the heart towards body tissues. Deoxygenated blood travels through veins towards the heart away from body tissues.

Blood pressure is measured in millimeters of mercury (mmHg), and is recorded as two separate values: systolic blood pressure and diastolic blood pressure. The **systolic BP occurs when the ventricles contract and eject blood into arteries**; and the **diastolic BP occurs when the ventricles relax and fill with blood from the atria**. The average blood pressure of healthy young adults (about 20 yrs old) is 120 / 80 mmHg. The first value (120) represents systolic and the second value (80) represents the diastolic BP. In this lab you will use a **sphygmomanometer** placed over the **brachial artery** of the arm to measure blood pressure.



Pressure gauge of a sphygmomanometer



When the pressure in the blood pressure cuff is increased to greater than the systolic pressure, the brachial artery will be temporarily occluded. As the pressure in the cuff is gradually decreased it will reach a stage where it is just below the systolic pressure. At this time blood will push through the artery in spurts at the end of ventricular contraction. At this time the blood can be heard rushing through the artery by auscultation distal to the blood pressure cuff. These sounds being heard through the stethoscope are called **Korotkoff sounds**. As the cuff pressure is reduced sounds of blood being pushed through the constricted artery will be heard until its pressure falls below the diastolic blood pressure. When Korotkoff sounds in the artery can no longer be heard, the pressure in the cuff approximates the diastolic blood pressure. The average blood pressure of healthy young adults (about 20 yrs old) is 120/80 mmHg. The first value (120) represents systolic and the second value (80) represents the diastolic BP.

### Part 1: Measuring Heart Rate

Use two fingers (index and second finger) and lightly press them against the wrist below the thumb. Do not press too hard or you will block blood flow in the **radial artery**. Once you detect the pulse, record the number of beats in 15 seconds. Then multiply that number by 4 to get the beats per minute. The pulse can also be palpated in the **carotid artery** on the side of your neck.

### Locating and Detecting the Radial Pulse



### Part 2: Procedure for Measuring Blood Pressure:

1. Work with your lab partner and have them roll up their sleeve exposing their arm. Place the cuff of the BP cuff snugly around the biceps of the arm (not too tight!). Keep the chords of the BP cuff on the upper arm surface pointing towards the elbow. The arm should be resting comfortably on the lab table, palm up. Have the person hold the pulse monitor in the hand of the arm not having the BP cuff. Try and record resting heart rate at the same time as you perform the following steps.
2. Attach the BP cuff with the Velcro strap and keep the gauge where you can read it easily.
3. Use a stethoscope placed underneath the cuff to listen through the ear pieces for the sound of blood in the arteries of your partner. You will not hear anything until you perform step 5.
4. Close the valve on the BP cuff by turning it clockwise. Pump air into the cuff by squeezing the rubber bulb until the pressure reading reaches about 150 – 180 mmHg. **Please listen to your partner** and stop if this hurts. The pressure will collapse the brachial artery, so do not keep this pressure on the arm for more than 30 seconds!
5. Open the bulb **SLOWLY**. The needle on the pressure gauge should fall at a rate of 2-3 mmHg per second. You need to listen carefully as you observe pressure falling.
6. At the **FIRST SOUND** in the stethoscope, record the pressure. This is the systolic BP or the pressure at which the heart's ventricular contraction can again force blood through the brachial artery in the upper arm. You might also see the dial on the pressure gauge begin to jump with each heartbeat.
7. You will hear the sound of the blood pressure increase, and then fade. When the **SOUNDS STOP**, record the diastolic pressure.
8. Trade places with your partner and repeat the process.

### Part 3: Comparing Heart Rate and Blood Pressure Between Supine and Standing Postures.

Now you will examine blood pressure and heart rate while in a supine position followed by a sudden change to an upright posture. This will require your use of both the pulse monitor to record heart rate and the blood pressure cuff to record systolic and diastolic blood pressure.

1. Have your partner rest comfortably with sleeves rolled up on their arm. Place the BP cuff on their arm and secure gently with the Velcro strap. Place the stethoscope in position over the arm, under the cuff. Have a finger placed on the pulse monitor using the hand of the arm not wearing the BP cuff. Let the person lie quietly for 5 minutes without moving or raising the limbs.

2. After 5 minutes of resting, record the supine heart rate.

**Supine Heart rate = \_\_\_\_\_ bpm**

3. Now pump up the cuff (making sure the valve is closed) to about 150 – 200 mmHg and then slowly release the pressure. Record the Systolic BP and Diastolic BP.

**Supine Systolic BP = \_\_\_\_\_ mmHg**

**Supine Diastolic BP = \_\_\_\_\_ mmHg**

4. Keep the blood pressure cuff (with pressure released), stethoscope, and pulse monitor in position and let the person rest in the supine position for 5 more minutes.

5. You are now going to have the person get up quickly to an upright posture (standing). Please watch your partner for any sign of fainting! Within 10 seconds of standing you must repeat the above procedure and record the following:

**Standing Heart Rate = \_\_\_\_\_ bpm**

**Standing Systolic BP = \_\_\_\_\_ mmHg**

**Standing Diastolic BP = \_\_\_\_\_ mmHg**

6. Switch places with your partner and repeat the supine and standing measurements of heart rate and blood pressure. When you are finished put BP cuffs, stethoscopes, and pulse monitors away at front desk. Compile class data on the table and record them in Tables 1 and 2.

#### Analyses:

Your instructor might have a computer available with an **Excel spread sheet open for you to enter your data** there also. Excel will calculate average class supine and standing heart rate, as well as use a paired T-test to compare supine versus standing heart rate. Excel will also calculate average supine and standing blood pressure (systolic BP and diastolic BP), and then compare supine versus standing systolic blood pressure, and supine versus standing diastolic blood pressure.

**Table 1. Class Summary Data: Heart Rate With Posture Change**

<b>Heart Rate After Fast Postural Change</b>		
<b>Student</b>	<b>Supine Heart Rate (bpm)</b>	<b>Standing Heart Rate (bpm)</b>
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		
17.		
18.		
19.		
20.		
21.		
22.		
23.		
24.		
<b>AVG BPM</b>		

**Table 2. Class Summary: Blood Pressure With Posture Change**

Table 2: Class Blood Pressure Student	Blood Pressure While in Supine Position (Lying Down)		Blood Pressure After Fast Postural Change (Standing Up <10 sec)	
	Supine SBP	Supine DBP	Standing SBP	Standing DBP
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				
20.				
21.				
22.				
23.				
24.				
AVG BP				