**Group work**

**PHS 306: CARDIOLOGY AND GASTROENTEROLOGY.**

**300 Level**

**Department of Physiology**

**College of Medicine and Health Sciences**

**Group 9**

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*Topic:* **CARDIAC OUTPUT.**

*Submitted to:*

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**Cardiac Output**

This is the amount of blood pumped out by each side of the heart in one minute. It is calculated as *Heart rate* $×$ Stroke volume. It is about 5L per minute.

Definitions in cardiac output:

***Stroke volume****: This is the amount of blood pumped out by each ventricle with each heartbeat. When the heart rate is normal (72 beats per minute), stroke volume is 60-80 mL.*

***Cardiac index:*** *This is the cardiac output in relation square meter of body surface area.*

***Ejection fraction:*** *The fraction of end diastolic volume ejected out of each ventricle. It is about 60 to 65%.*

***Cardiac reserve:*** *This is the maximum amount of blood pumped out of the heart above normal value. It varies with age and is nil to minimum in disease conditions.*

**Variations in Cardiac Output**

Cardiac output can be varied physiologically and pathologically.

1. Physiological variations
2. Age: Cardiac output is less in children than in adults due to lower blood volume.
3. Sex: It is less in females than in males, also due to less blood volume.
4. Sleep: It is slightly decreased in sleep. Sometimes, it is unaltered.
5. Diurnal variation: It is low in early morning and increases in day time, depending on the basal conditions of the individuals.
6. Exercise: It increases during exercise due to an increase in the heart rate and force of the heart’s contraction.
7. Posture: The cardiac output decreases while changing from recumbent to upright position.
8. Pathological variations

Cardiac output can be increased or decreased pathologically.

*Increase in Cardiac Output*

1. Anemia: This is due to hypoxia.
2. Fever.
3. Hyperthyroidism.

 *Decrease in Cardiac Output*

1. Hypothyroidism.
2. Hemorrhage: this is due to low blood volume.
3. Shock: due to poor pumping and circulation.
4. Atrial fibrillation: due to incomplete filling of ventricles.
5. Cardiac failure: due to weak contractions of the heart.

**Factors maintaining Cardiac output**

1. ***Venous return***: This is the amount of blood returned to the heart from other parts of the body. An increase in the venous return increases cardiac output. This can be due to certain factors;
2. Respiratory pump- The activity of the respiratory organs to return blood to the heart. It is stronger in forced respiration and severe muscular exercise.
3. Muscle pump- The activity of the muscles to return blood to the heart.
4. Gravity- This force decreases venous return thereby decreasing the cardiac output. It occurs due to venous pooling i.e. the pooling of blood in the legs.
5. ***Force of contraction:*** This is alsodirectly proportional to cardiac output. It depends on **Preload** (stretching of the cardiac muscle fibers just before contraction at the end of diastole, making it directly proportional to the force of contraction) and **Afterload** ( the force against which the ventricles must contract and eject blood, which is inversely proportional to the force).
6. ***Heart rate:*** It is directly proportional to the cardiac output. A moderate change in this factor however has no effect on the cardiac output.
7. ***Peripheral resistance:*** It is the resistance to blood flow at the peripheral blood vessels i.e. load against which the heart has to pump blood. It is inversely proportional to the cardiac output. It occurs at the arterioles (resistance vessels) rather than the venules (capacitance vessels).

**Measurement of Cardiac output**

It can be measured directly and indirectly.

1. Direct method: This method is via Cardiometer and Flowmeter. The disadvantage of this method is because a blood vessel has to be open hence, it can be only used in animals.
2. Indirect method: here, safety and accuracy is considered.
3. Fick’s principle: This is calculated as;

Amount of substance taken or given= Amount of blood flow per minute × Arteriovenous difference.

1. Indicator dilution technique: Dye is used as the indicator.
2. Doppler echocardiography.
3. Thermodilution technique.