

CARDIAC OUTPUT

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CARDIAC output is one of the important aspects of cardiac function and its increase or decrease would cause disturbance in its function, resulting in serious forms or cardiac diseases. It is responsible for transport of substances to and from tissues.

"The volume of circulation", "The minute volume" and "The rate of circulation" all these terms are used interchangeably.

Cardiac output is defined as "The amount of blood discharged from the left or right ventricle per minute." For an average adult at rest the cardiac output is approximately 3.0 liter/square meter body surface area each minute or 5 liter/minute in male and in female it is 10 per cent less than male.

Another author defines cardiac output as "Effective volume of blood expelled by either ventricles of the heart in a unit of time, which is expressed in cubic centimeter or liter per minute."

It is appropriate to define the word—STROKE VOLUME. "It is the amount of blood ejected by each ventricle per beat." This ranges from 50 to 90 ml. Cardiac output therefore, can be summarized as "CARDIAC OUTPUT = STROKE VOLUME × CARDIAC RATE."

Normally, output of both ventricles are identical. If there is regurgitation of blood due to aortic valvular insufficiency or shunting of blood due to congenital defects or pathological ruptures, the actual output of the ventricles may differ.

Cardiac output is a function of body size, age and sex. It

may vary in physical exercise, physical training, emotional state and changes in body posture. In order to maintain the normal homeostasis of the body it is necessary to have a cardiac output which meets the metabolic demands of the body tissues. When the heart "fails", the mechanical efficiency of the heart is reduced and these demands are no longer met.

The factors which determine the cardiac output are: Heart rate, stroke volume, end diastolic volume, end systolic volume; Rate of venous return; peripheral resistance; arterial pressure; needs of the tissues; local tissue metabolism; Degree of filling of the circulation (systemic filling pressure) or quantity of blood in circulatory system. (blood volume).

Measurements of Cardiac Output

It can be measured in three ways and they are: Direct application of Fick Principles, dilution method, including use of foreign gases and dyes and physical method.

Direct application of Fick Principles

Determining arterio venous O_2 differences: If the O_2 concentration of arterial blood is 190 ml./liter and that of venous blood 150 ml./liter then each liter of blood absorbs 40 ml. of O_2 when it passes through the lungs. If 200 ml. of O_2 is absorbed by subject in one minute, 200/40 or 5 litres of blood must have flowed through the lung in a minute. This pulmonary blood flow is right ventricle output, which is equal to that of left ventricle which is cardiac output.

O_2 absorption

$$\text{The Fick Principle} = \frac{\text{ml. per min.}}{\text{(ml. per liter)}} = \frac{\text{arterial } O_2 - \text{mixed venous } O_2}{\text{ml. per liter}}$$

O_2 elimination

$$\text{Cardiac Output} = \frac{\text{ml. per min.}}{\text{(liters per min.)}} = \frac{\text{venous } CO_2 - \text{arterial } CO_2}{\text{(ml. per liter)}}$$

Dilution Method

A measured amount of foreign gas is inhaled or a dye is injected. The amount of blood flow in a unit of time required to absorb the measured uptake of gas or I.V. dye represents cardiac output.

Physical method

These are: X-ray measurements; Pulse pressure and pulse wave measurement; Balistocardiography. Mechanism for measuring the impact caused by the discharge of blood from the heart at each beat with the determination made by right heart catheterization.

It is essential to know the results of increase or decrease in cardiac output and how it affects our body system.

Diminished Cardiac Output

Under normal conditions cardiac output is less in upright position than in recumbent position because of pooling of blood in lower extremities, because of gravity. It thus diminishes the venous return, and then cardiac output is decreased.

It is also diminished after prolonged standing, on holding breath in inspiration and in an advanced age.

Pathological conditions associated with diminished cardiac output are

Myxoedema; Constrictive pericarditis; Paroxysmal arial tachycardia and atrial fibrillation; Heart block; Shock; Valvular heart disease; Cardiac heart failure (C.H.F.) and Rapid heart rate tend to reduce cardiac output resulting L.V.F.

Whenever the left ventricle is affected, due to lack of blood supply to its muscles, as seen in coronary arterial disease, and anterior myocardial infarction the pumping action of the ventricle decreases. With the result the cardiac output is decreased. This would lead to cardiogenic shock.

In some other conditions where heart rate is beating faster, it tends to reduce cardiac output because of decrease in stroke volume, as a result of short ventricular filling time, which would lead to L.V.F.

In the same manner whenever there is atrial flutter and fibrillation, associated with rapid ventricular response, the cardiac output is decreased because there is not enough time for ventricular filling.

The reduced cardiac output, eventually causes lack of tissue perfusion, leading into shock.

Treatment of low cardiac output associated with patients having Myocardial infarction:

The treatment is directed towards correcting underlying causes as listed above, e.g. pericarditis and should be treated with appropriate antibiotics. To correct cardiac arrhythmias, e.g.

extreme bradycardia is treated with atropine or isupril, if drugs fail then transvenous pacing is the remedy. Extreme sinus tachycardia is controlled by treating the cause of tachycardia and sedating the patient. Atrial flutter and fibrillation is treated by intravenous digitals and precordial shock. Various type of blocks are treated with atropine, isupril and transvenous pacemaker. Valvular defects are corrected by means of mechanical and surgical means and cases of cardiac heart failure are treated by means of agents like digitalis. Decreased tissue O_2 requirement which will reduce the cardiac load and this is achieved by: complete bed rest; hypothermia; normal and regular bowel movement and regular eating habits with little at a time. The new concept has emerged that giving inderal helps to reduce cardiac rate which in turn reduces the cardiac output which eventually reduces the O_2 requirement of tissue.

Pathological conditions associated with increase in Cardiac Output are: hyperthyroidism; fever; anemia; arterio venous fistula; beriberi; and severe pulmonary emphysema. Since cardiac output in other ways affects the functioning of heart and causing disturbance in body function, it is essential to maintain an equilibrium. This is done by: maintaining good health by adequate and proper diet; regular exercise; adequate rest; regular good habits; emotional tranquility; personal hygiene and regular medical checkup.

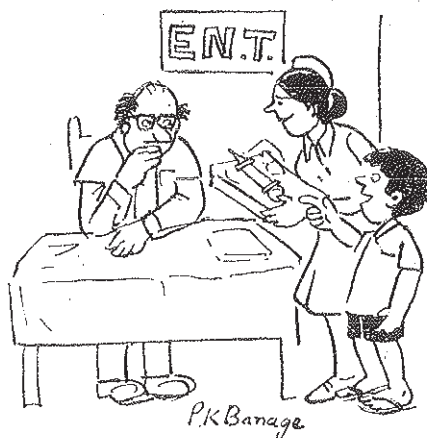
If we follow this, chances are increased that our heart remains

healthy, our body remains healthy and thus we remain productive to society.

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"SIR ! PLEASE REMEMBER THE EAR OF THE CHILD"



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