**End diastolic volume (EDV):**

It is the volume of blood present in the ventricles at the end of ventricular diastole. It is about 110 to120 ml.

Factors affecting EDV:

1. Filling time
2. Effective filling pressure
3. Distensibility of ventricle
4. Atrial contraction

a)Filling time: EDV is directly proportional to filling time.

↑HR ↓Filling time ↓EDV

b)Effective filling pressure: EDV is directly proportional to effective filling pressure. *(Effective filling pressure is the pressure gradient between inside & outside of the ventricle.)*

↑Effective filling pressure ↑VR ↑EDV

c)Distensibility of ventricle: EDV is directly proportional to distensibility of ventricle .

↓Distensibility of ventricle ↓ventricular filling ↓EDV

d)Atrial contraction: EDV is directly proportional to atrial contraction.

Stronger atrial contraction ↑EDV

**End systolic volume (ESV):**

It is the volume of blood remaining in the ventricles at the end of ventricular systole. It is about 40 to 50 ml.

Factors affecting ESV:

1. Pressure load
2. Vigor of myocardial contraction

a)Pressure load: It is the pressure within aorta, against which ventricle is pumping.

↑BP ↑ESV unless force of contraction is increased

↓BP ↓ESV

b)Vigor of myocardial contraction:

It depends on –

1. Metabolic condition of the cell
2. Heterometric autoregulation
3. CNS action
4. Homeometric autoregulation
5. Interval between beats

Heterometric autoregulation: Force of contraction depends on change in cardiac muscle fibre length.

Homeometric autoregulation: Regulation due to changes in contractility independent of length. Example- Ionotropic agents such as digitalis, catecholamine.

**Stroke volume (SV):**

The volume of blood ejected from each ventricle in each beat. It is about 60 to 70 ml.

SV = EDV – ESV

Factors affecting SV:

a) Venous return: SV is directly proportional to VR.

↑VR ↑EDV ↑SV (due to Frank- Starling mechanism)

*Frank- Starling mechanism: Greater the heart muscle is stretched during filling, the greater is the force of contraction ,greater is the quantity of blood pumped into aorta.*

b) Heart rate: SV is inversely proportional to HR

↑HR ↓Filling time ↓EDV ↓SV

c) Force of contraction of heart: SV is directly proportional to force of contraction.

↑Force of contraction (due to sympathetic stimulation) ↑Ejection fraction ↑SV

d) Total peripheral resistance: SV is inversely proportional to TPR.

**Ejection fraction:**The fraction of the end-diastolic volume that is ejected is called the ejection fraction. It is usually about 0.6 (or 60 percent).

**Venous return (VR):**

The amount of blood that returns to the heart per minute is called venous return.

It is about 5-6 L/min (equal to cardiac output).

**Factors affecting venous return:**

1. Pressure gradient in vessels: ↑Pressure gradient ↑VR

(Pressure gradient: Mean systemic filling pressure - right atrial pressure.

↑Mean systemic filling pressure ↑VR

↑ Right atrial pressure ↓VR)

1. Resistance to blood flow between the peripheral vessels and the right atrium.

↑ Resistance to blood flow ↓VR

1. ↑Skeletal muscle pump: ↑VR

Contraction of skeletal muscle compress underlying veins ↑VR

1. Negative intrathoracic pressure: During inspiration, more negative intrathoracic pressure ↑VR
2. Positive intra-abdominal pressure: During inspiration, ↑intra-abdominal pressure ↑VR

(In expiration: ↑intrathoracic pressure & ↓intra-abdominal pressure ↓VR

1. Position of body (Effect of gravity): ↑ Gravity ↓VR

In standing position, venous pooling in the legs occur due to gravity, so ↓VR.

1. ↑Blood volume ↑VR

Venous return can be calculated by the following formula:

Psf – PRA

Venous return =

RVR

Here, Psf= Mean systemic filling pressure, PRA= Right atrial pressure &

RVR = Resistance to VR

In the healthy human adult, the values for these are as follows: venous return equals 5 L/min, Psf equals 7 mm Hg, right atrial pressure equals 0 mm Hg, and resistance to venous return equals 1.4 mm Hg per L/min of blood flow.

**Central venous pressure:** Blood from all the systemic veins flows into the right atrium of the heart. Therefore, the pressure in the right atrium is called the central venous pressure.

The normal right atrial pressureis about 0 mm Hg (same as atmospheric pressure).

It can increase to 20 to 30 mm Hg in serious heart failure or after massive transfusion of blood.

In condition like severe hemorrhage, the right atrial pressure falls to about −3 to −5 mm Hg.

**Mean Circulatory Filling Pressure:** When heart pumping is stopped by shocking the heart with electricity, flow of blood everywhere in the circulation ceases a few seconds later. Without blood flow, the pressures everywhere in the circulation become equal. This equilibrated pressure level is called mean circula­tory filling pressure.

Mean Systemic Filling Pressure: It is the pressure measured everywhere *in the systemic circulation* after blood flow has been stopped by clamping the large blood vessels at the heart. The mean systemic filling pressure is impossible to measure in the living animal & is almost always nearly equal to the mean circulatory filling pressure.