

What are the factors affecting central venous pressure?

A central venous pressure is the pressure in the thoracic vena cava near the right atrium. This means that central venous pressure and right atrial pressure are essentially the same.

A change in central venous pressure (ΔCVP) can be determined by the change in volume of blood within the thoracic veins (ΔV) divided by the compliance of these veins (C_v):

The formula to calculate this is;

$$\Delta CVP = \Delta V / C_v$$

From this formula, we find out that, central venous pressure can be increased by an increase in venous blood volume or by a decrease in venous compliance.

It is important to note for a proper conceptual understanding that the compliance of the large thoracic veins (especially the vena cava) does not undergo large changes. Instead, the major site for venous compliance changes is smaller veins located outside of the thorax.

These smaller veins can undergo significant compliance changes. When the compliance of these veins decreases (e.g., by sympathetic nerve stimulation), constriction of these veins and the resulting increased pressure is transmitted up to the thoracic veins, which increases their volume and therefore pressure.

A central venous pressure plays a very important role in cardiac filling and ventricular stroke volume (via the Frank-Starling mechanism).

Conditions that increase central venous pressure increase cardiac output in return, whereas the ones that decrease the central venous pressure decrease cardiac output in return.

Elevation in CVP can lead to peripheral edema.

What factors affect central venous pressure?

Therefore, it is important to understand how the following different conditions influence the central venous pressure.

1. A **decrease in cardiac output**, that is either because of a decreased heart rate (e.g., bradycardia) or a decreased stroke volume (ie., ventricular failure), leads to blood to back up into the venous circulation (increased venous volume) as less blood is pumped into the arterial circulation. With this, the resultant increase in thoracic blood volume elevates the central venous pressure. *A decreased cardiac output causes a primary decrease in volume.*

2. A **decrease in systemic vascular resistance** by selective arterial dilation increases blood flow from the arterial into the venous compartments, thereby increasing venous volume and CVP, while at the same time reducing arterial volume and pressure. *The primary change in a decreased systemic vascular resistance is volume.*
3. An **increase in total blood volume** is known as hypervolemia. This occurs in renal failure or with activation of the renin-angiotensin-aldosterone system, increases thoracic blood volume and therefore increased central venous pressure. *A decreased total blood volume causes a primary decrease in volume.*
4. **Constriction of peripheral veins** or a reduced venous compliance that may be elicited by sympathetic activation or circulating vasoconstrictor substances (e.g., catecholamines, angiotensin II) causes blood volume to be translocated from peripheral veins into the thoracic compartment, thereby increasing central venous pressure. *Venous constriction causes a primary change in compliance.*
5. **Postural changes** such as moving from a standing to a reclining or squatting position diminishes venous pooling in the legs caused by gravity, which increases thoracic volume and CVP. *Postural changes cause a primary change in volume.*
6. A **forceful expiration** against a high resistance such as in the case of Valsalva maneuver causes external compression of the thoracic vena cava (decrease in functional compliance), which increases central venous pressure. *A forceful expiration causes a primary change in volume.*
7. **Increased respiratory activity** (abdomino-thoracic pump) facilitates venous return into the thorax, thereby helping to maintain central venous pressure when cardiac output is elevated during exercise.
8. **Rhythmic muscular contraction** (muscle pump), particularly of the limbs during exercise, compresses the veins and facilitates venous return into the thoracic compartment, which increases CV