Venous Return & Cardiac Output

Index:

Red: important Grey: extra information Green: doctor's notes yellow: numbers

Purple: only in female slides Blue: only in male slides

Physiology 437 teamwork

OBJECTIVES

by the end of this lecture you will be able to:

- Define stroke volume, end-systolic volume, and end-diastolic volume
- Define cardiac output, its normal values and factors affecting it
- Understand the determinants of CO and how CO is regulated
- Understand the factors affecting the EDV (the venous return)
- Understand the factors affecting the ESV (cardiac contractility & afterload)
- Know how heart rate changes affect CO
- Identify the factors that affect heart rate
- Know the method for measurement of CO (The direct Fick's method)
- Discuss functions of the veins as blood reservoirs.
- Describe measurement of central venous pressure (CVP) and state its physiological and clinical significance.
- State determinants of venous return and explain how they influence venous return.
- Define mean systemic filling pressure, give its normal value and describe the factors which affect it.
- Explain the effect of gravity on venous pressure and explain pathophysiology of varicose veins.
- Describe vascular and cardiac function curves under physiological and pathophysiological conditions.

Stroke volume

Stroke volume is the amount of blood ejected from ventricles during systole (per beat) = The stroke volume

What determines the stroke volume?

End-diastolic volume and End-systolic volume

- End-diastolic volume is the Volume of blood in ventricles at the end of diastole and is about 110-130 ml.
- End-systolic volume is the Amount of blood left in ventricles at the end of systole and is about 40-60 ml.

So End-diastolic volume - End-systolic volume = stroke volume 70-80 ml.

Ejection fraction (EF): Fraction of end-diastolic volume ejected during a heart beat =stroke volume/end diastolic volume = 60-65 %.

Cardiac output

Cardiac output is the amount of blood pumped by the each ventricle per minute.

- Cardiac output(CO) = stroke volume(SV) x heart rate(HR) = 5L/min
- Since the normal adult blood volume is about 5L, the entire blood supply passes through the body once each minute.

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Normal Values of Cardiac Output at Rest

Resting cardiac output:
are:

- The average cardiac output for the resting adult is 5L/min.
- CO vary with size of individual.
- Children have smaller CO than adults.
- Women have smaller CO than men.
- For men, CO 5.6L/min.
- For women, 4.9L/min.

The factors affecting cardiac output

1. Body metabolism
2. Exercise
3. Hyperthyroidism
4. Pregnancy
5. Increase body temperature.

What is the Cardiac index ?

- It relates the cardiac output to body surface area. (CO/min/m2 of body surface area Thus relating heart performance to the size of the individual. Normal Cardiac index= (3.2 Liters/min/m2 body surface area)

What is the Cardiac reserve ?

- It is the difference between cardiac output at rest and the maximum volume of blood that the heart can pump per minute.

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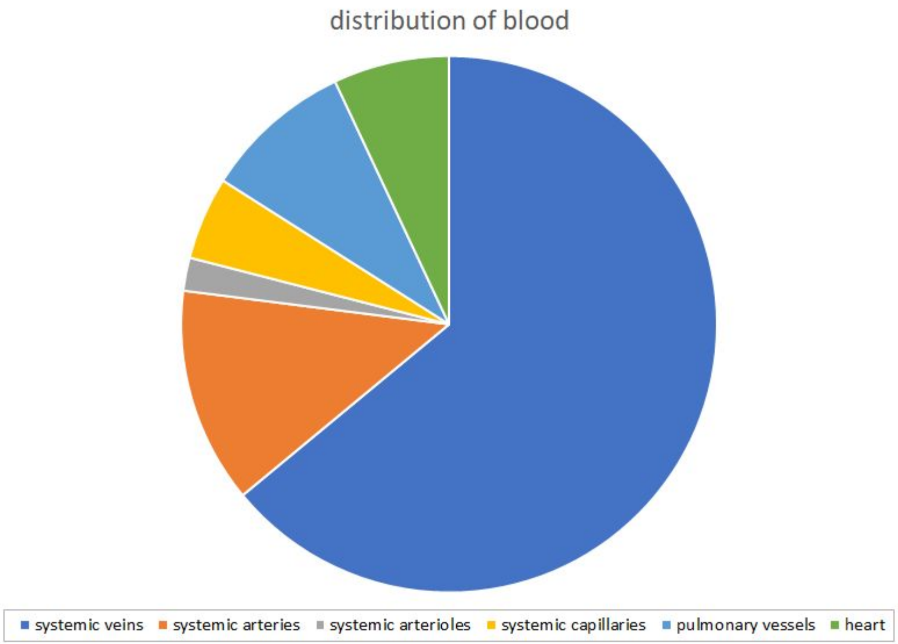
Regulation of CO

- CO is crucial since it is also the amount of blood that flows into the circulation and is responsible for transporting substances to and from the tissues. Thus, the body has strict control mechanisms that maintain adequate CO. There are 2 major factors which determine CO. These are the SV and HR .

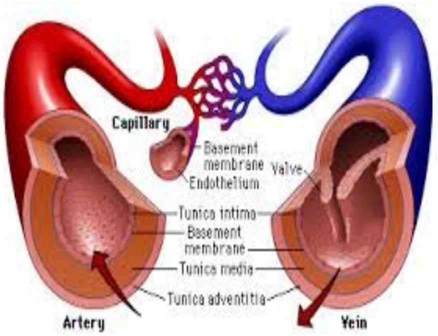
Distribution of blood

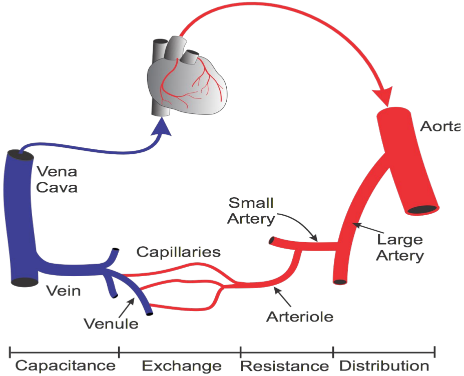


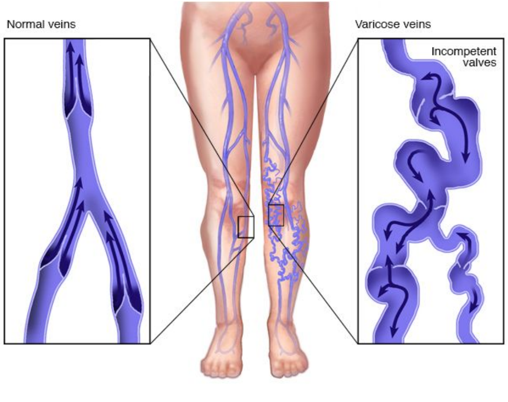
Systemic circulation 84%	Systemic veins 64%
	Systemic arteries 13%
	Systemic capillaries 7%
Pulmonary circulation 9%	Pulmonary veins 4%
	Pulmonary capillaries 2%
	Pulmonary arteries 3%
Heart 7%	

Vascular circuit

- In veins all three layers are present, but thinner than in arteries of same size (external diameter).
- Veins have paired semilunar, bicuspid valves to restrict backflow in lower extremities.
- In varicose veins, blood pools because valves fail causing venous walls to expand.
- Venules are called capacitance vessels.
- Arterioles are called resistance vessels.
- Capillaries are called exchange vessels.







Vascular compliance (vascular capacitance)

- Vascular compliance is the total quantity of blood that can be stored in a given portion of circulation for each mmHg pressure rise.
- Vascular compliance = increase in volume / increase in pressure.
- Compliance = distensibility x volume.
- The compliance of systemic veins is about 24 times that of its corresponding artery because it is about 8 times as distensible and it has a volume about 3 times as great (8 x 3 = 24).

Pressure volume curve in arterial and venous system

Volume-pressure curves

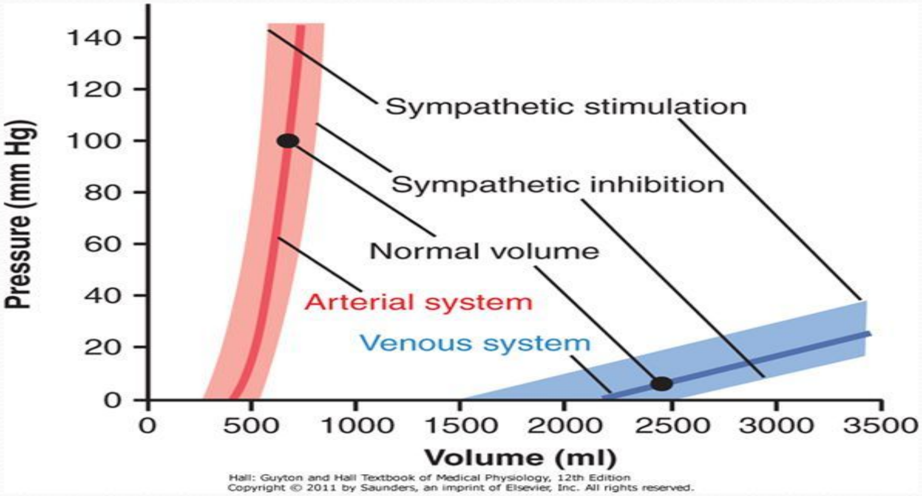


Fig. 15.1 "Volume-pressure curves" of the systemic arterial and venous systems, showing the effects of stimulation or inhibition of the sympathetic nerves to the CV system

Veins Are Blood Reservoirs

When the body is at rest and many of the capillaries are closed, the capacity of the venous reservoir is increased as extra blood bypasses the capillaries and enters the veins.When this extra volume of blood stretches the veins, the blood moves forward through the veins more slowly because the total cross sectional area of the veins has increased as a result of the stretching. Therefore, blood spends more time in the veins.

When the stored blood is needed, such as during exercise, extrinsic factors reduce the capacity of the venous reservoir and drive the extra blood from the veins to the heart so that it can be pumped to the tissues.

* اذا كنت مرتاح نسبة من الشعيرات الدموية تكون مسكره فيكبر حجم الأوردة وتزيد كمية الدم فيها فتصير الاوردة كانها مخزن للدم اذا احتجت هذا الدم في عندما تتمرن مثلا تكون فيه عوامل تخليك تستفيد من هذا الدم توزعه على خلايا الجسم

Veins are blood reservoirs...Cont.

Arterial blood pressure:

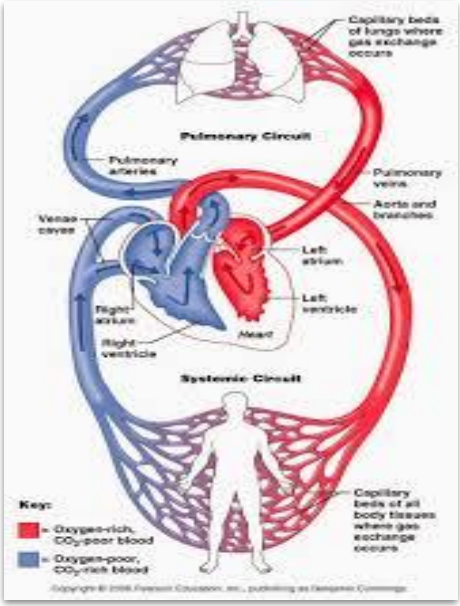
Blood pressure is the force the blood exerts against the walls of the blood vessels.

Systolic pressure	Maximum pressure during systole	120 mmHg
Diastolic pressure	Minimum pressure during diastole	80 mmHg
Pulse pressure	Systolic pressure – diastolic pressure	40 mmHg
Mean pressure	Diastolic pressure + (1/3 pulse pressure)	93 mmHg

VENOUS RETURN

Normally venous return must equal cardiac output (CO) when averaged over time because the cardiovascular system is essentially a closed loop. Otherwise, blood would accumulate in either the systemic or pulmonary circulations.

Venous return is determined by the difference in pressure between the venous pressure nearest to the tissues (mean systemic filling pressure; mean circulatory pressure; MCP)
And the venous pressure nearest to the heart (CVP).



VENOUS RETURN...Cont.

Central venous pressure (CVP): is the venous pressure in the right atrium and the big veins of the thorax
(right atrial pressure (RAP) = jugular venous pressure).

- Venous pressure is measured with a catheter inserted in the central venous system, usually SVC.
- The normal range of the CVP = 0 - 4 mmHg.
- It is the force responsible for cardiac filling.
- CVP is used clinically to assess hypovolemia and during IV transfusion to avoid volume overloading.
- CVP is raised in right-sided failure.

Central venous pressure (CVP)

From guyton: page 184

Right atrial pressure is regulated by a balance between

(1) the ability of the heart to pump blood out of the right atrium and ventricle into the lungs

(2) the tendency for blood to flow from the peripheral veins into the right atrium. If the right heart is pumping strongly, the right atrial pressure decreases. Conversely, weakness of the heart elevates the right atrial pressure. Also, any effect that causes rapid inflow of blood into the right atrium from the peripheral veins elevates the right atrial pressure.

Some of the factors that can increase this venous return and thereby increase the right atrial pressure are:

(1) increased blood volume

(2) increased large vessel tone throughout the body with resultant increased peripheral venous pressures

(3) dilation of the arterioles, which decreases the peripheral resistance and allows rapid flow of blood from the arteries into the veins.

The normal right atrial pressure is about 0 mm Hg, which is equal to the atmospheric pressure around the body. It can increase to 20 to 30 mm Hg under very abnormal conditions, such as

(1) serious heart failure

(2) after massive transfusion of blood, which greatly increases the total blood volume and causes excessive quantities of blood to attempt to flow into the heart from the peripheral vessels.

Mean Systemic Filling Pressure Or Mean Circulatory Pressure (MCP)

Is the pressure nearest to the tissues and is about 7 mmHg.

The value for right atrial pressure at which venous return is zero is called the mean systemic filling pressure. It is the point at which the vascular function curve intersects the X-axis (i.e., where venous return is zero and right atrial pressure is at its highest value).

MCP is affected by :

1. Blood volume (MCP is directly proportional to blood volume).
2. Venous capacity (MCP is inversely proportional to the venous capacity).

So if blood volume increases MCP will increase and if it decreases MCP will decrease
Venoconstriction will increase MCP and venodilatation will decrease it

Factors affecting the EDV

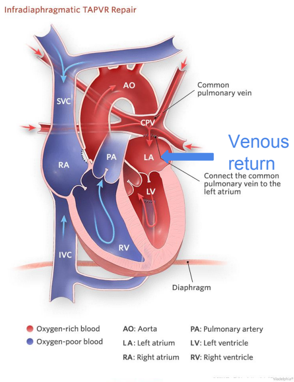
What determines the EDV (End-Diastolic Volume)?

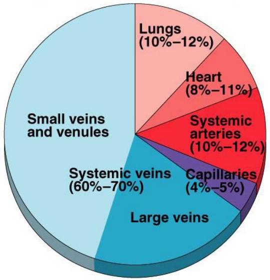
The venous return (VD).

Venous return is the quantity of venous blood flowing from large veins into the right atrium each minute.

Facts about the veins:

- Veins hold most of the blood in the body (70%).
- They are called capacitance vessels.
- They have thin walls & stretch easily to accommodate more blood without increasing pressure (= higher compliance)
- They have only 0-10 mm Hg pressure.





Frank-Starling Law

The Frank Starling principle is based on the length-tension relationship within the ventricle. If EDV (preload) is increased, the ventricular fiber length is also increased, resulting in an increased 'tension' of the muscle (i.e the stroke volume increases in response to increase of the end diastolic volume). This is called the Frank-Starling mechanism (or Starling's Law of the heart) Within physiological limits, the heart pump all blood comes to it without allowing stasis of blood in veins.

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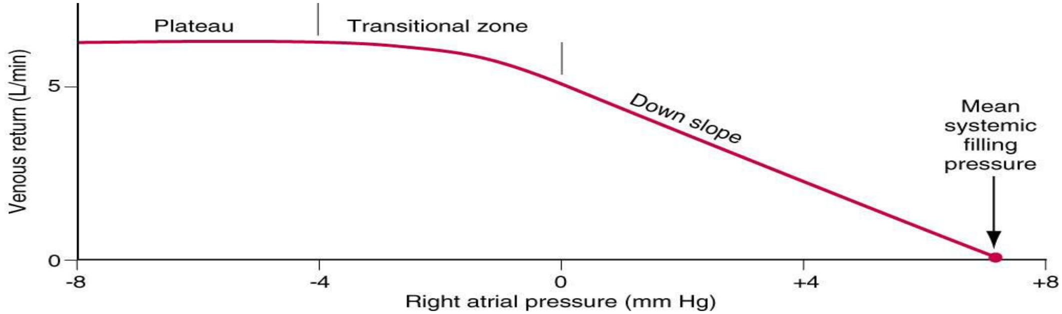
Venous Return Curve

Venous return (VR) curve relates VR to right atrial pressure. VR is decreased when:

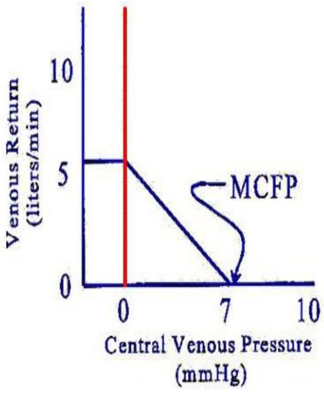
1- The right atrial pressure (RAP) is increased,
2- Pumping capability becomes diminished.
3- The nervous circulatory reflexes are absent.

- When the RAP falls below zero, no further increase in VR and a plateau is reached.
- Cause: collapse of the veins entering the chest.



Venous Return Curve,,,Cont.

- Mean circulatory filling pressure (MCFP) or mean circulatory pressure (MCP) is the value for right atrial pressure at which venous return is zero.
- when the heart is stopped by shocking the heart with electricity or any reason, flow of blood cease in the circulation.
- without blood flow, the pressures everywhere in the circulation become equal and is called: MEAN CIRCULATORY FILLING PRESSURE (which is pressure of +7 mmHg).



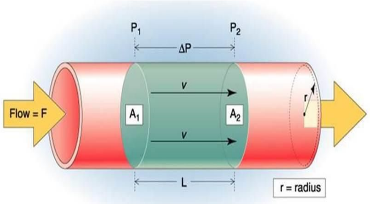
↑ Volume => ↑ MCP
↓ Volume=> ↓ MCP
Venoconstriction => ↑ MCP
Venodiltation => ↓ MCP

Basic principles :

Flow of any fluid (blood) through a tube (vessel) depends on:

1- The pressure difference between the two ends (pressure gradient), Blood flows from high pressure to low pressure.

2- The resistance to blood flow through the vessel, and it is controlled by the diameter of the vessel.



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Factors affecting the venous return:

1- Blood volume & pressure gradient

2- Gravity

3- Venoconstriction caused by sympathetic NS (nervous system)

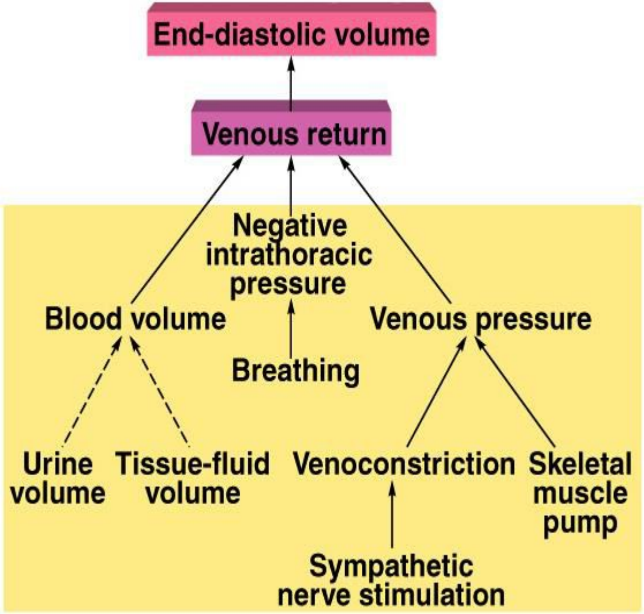
4- Skeletal muscle activity

5- Respiratory activity and thoracic pump

6- The presence of valves in the large veins

7- Cardiac suction effect

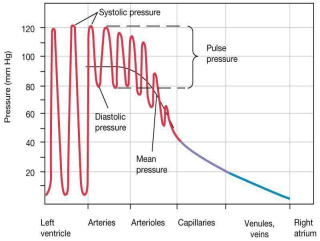
8- venous capacity



Factors affecting the venous return,,,cont.

1- PRESSURE GRADIENT:

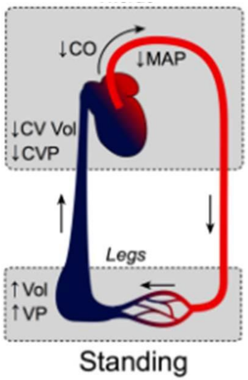
- ↑ (increase) Pressure gradient → ↑ (increase) venous return.
- Since the Rt (right) atrium is the site of the venous blood collection from all around the body → the pressure inside the Rt atrium i.e. (that is) right atrial pressure (RAP) is called central venous pressure (CVP)
- The pressure is highest in large arteries and continue to drop throughout the pathway, Reaching almost ZERO at right atrium.
- The high pressure in the arteries force the blood to continually move to areas where pressure is lower.



2- GRAVITY: → ↓ Venous Return (الجاذبية الأرضية تقلل الدم الراجع)

#Standing:

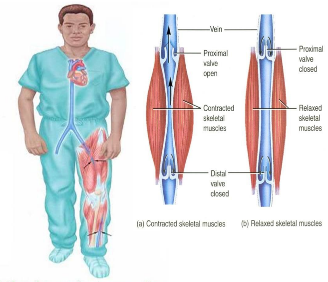
- When a person initially stands, right atrial pressure and ventricular EDV falls, which decreases stroke volume by the Frank-Starling mechanism. So, cardiac output and arterial pressure decrease.
- The flow through the entire systemic circulation falls because arterial pressure falls, therefore the pressure gradient driving flow throughout the entire circulatory system is decreased.



Factors affecting the venous return,,,cont.

3- Venoconstriction: (the constriction of the venules)
By sympathetic stimulation ↑ (increases) venous return.

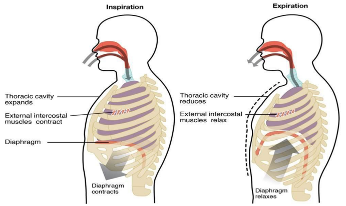
4- The skeletal muscle pump:
Rhythmical contraction of limb muscles (as occurs during walking. Running or swimming) → ↑ venous return by the muscle pump mechanism that squeeze the blood vessels between muscle fibers.



Skeletal muscle pump enhancing venous return

5- Respiratory activity:
- Inspiration → ↑ venous return because of a decrease in right atrial pressure.
- In Valsalva Maneuver (forceful expiration against a closed glottis), intrapleural pressure become positive which is transmitted to the large veins in the chest → ↓ venous return.

Valsalva maneuver = اذا سديت خشمك وفمك وطلعت الهواء مع اذانك يساعد كثير في تقييم وظائف القلب وبعض الاحيان يستخدم للتحكم في تنظيم نبضات القلب



6- Blood volume (directly proportional to venous return)**:**
- At constant venous capacity, as the blood volume increases, the MCP increases, leading to an increase in VR
- At constant venous capacity as the blood volume decreases, the MCP decreases, leading to a decrease in VR

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Factors affecting the venous return,,,cont.

6- The presence of valves in the large veins:

- These valves permit blood to move forward towards the heart but prevent it from moving back toward the tissues.
- These valves also play a role in counteracting the gravitational effects of the upright posture.
- Skeletal muscle pump is ineffective when the venous valves are incompetent.
- Chronically raised pressure in the veins leads to pathological distention of the veins (varicose veins).
- Increased capillary filtration leads to swelling (edema) with trophic skin changes and ulceration (venous ulcers).

7- cardiac suction effect

8- venous capacity:

- is the volume of the blood that the veins can accommodate.

At a constant blood volume, as the venous capacity → the MCP ↓ → ↓ VR.

- As the venous capacity ↓ → VR.

Varicose veins

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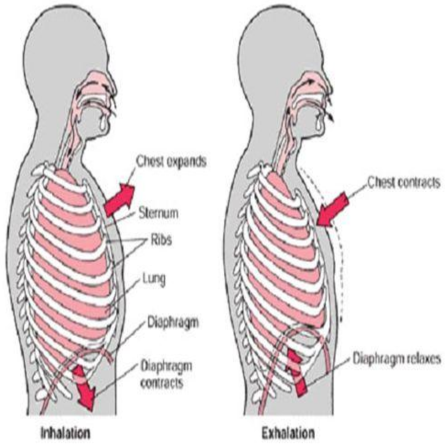
Factors affecting the venous return,,,cont.

Respiratory activity (respiratory pump; thoracic pump):

- As the venous system returns blood to the heart from the lower regions of the body, it travels through the chest cavity. The pressure in the chest cavity is 5 mm Hg less than atmospheric pressure.
- The venous system in the limbs and abdomen is subjected to normal atmospheric pressure.
- Thus, an externally applied pressure gradient exists between the lower veins and the chest veins, promoting venous return (this is known as the respiratory pump).



Physiological changes in Cardiac Output

- During the first 3 hours after meals, the CO is increased by ≈ 30% to enhance blood flow in the intestinal circulation.
- Later months of pregnancy are accompanied by > 30% increase in CO due to increased uterine blood flow.
- At environmental temperature above 30°C, the CO is increased due to increased skin blood flow.
- Also at low environmental temperature CO is increased due to shivering that increases blood flow to the muscles.
- Increased sympathetic activity during anxiety and excitement enhances the CO up to 50%-100%. Sitting or standing from the lying position deceases the CO by 20%-30%
- Exercise:

Type	Moderate	Intense/severe
Heart rate (HR)	200% (140 BPM)	300% (200 BPM)
Stroke volume (SV)	120% (85ml)	175% (125ml)
Cardiac output (CO)	240% (12l)	500%-700% (25-35l)

In athletes maximum CO may pass 35l, but HR can’t pass 200 BPM, so the increase occurs in SV which may reach 175 ml

Determines of CO….Cont.

CO = **SV** X HR

⬇

{End-diastolic volume (EDV) – end-systolic volume (ESV)}

⬇

CO = {EDV-ESV} X HR

Any factor that affects these parameters will affect the CO

End-Systolic Volume (ESV)

ESV = The volume of blood remaining in the ventricle at the end of systole.

↑ End-Systolic Volume (ESV) → ↓ stroke volume

↓ End-Systolic Volume (ESV) → ↑ stroke volume

ESV is determined by:

1. Cardiac contractility
2. Afterload

Determinants of ESV

1- Cardiac contractility:

- **↑↑ contractility → ↓↓ ESV → ↑↑ SV**
- **↓↓ contractility → ↑↑ ESV → ↓↓ SV**

2- Afterload:

It is expressed as tension which must be developed in the wall of ventricles during systole, i.e the load the heart needs to overcome to open the semilunar valves and eject blood to aorta /pulmonary artery.

As afterload increases, stroke volume decreases.

Afterload increases by any factor that restricts arterial blood flow like:

1- Increased arterial blood pressure.

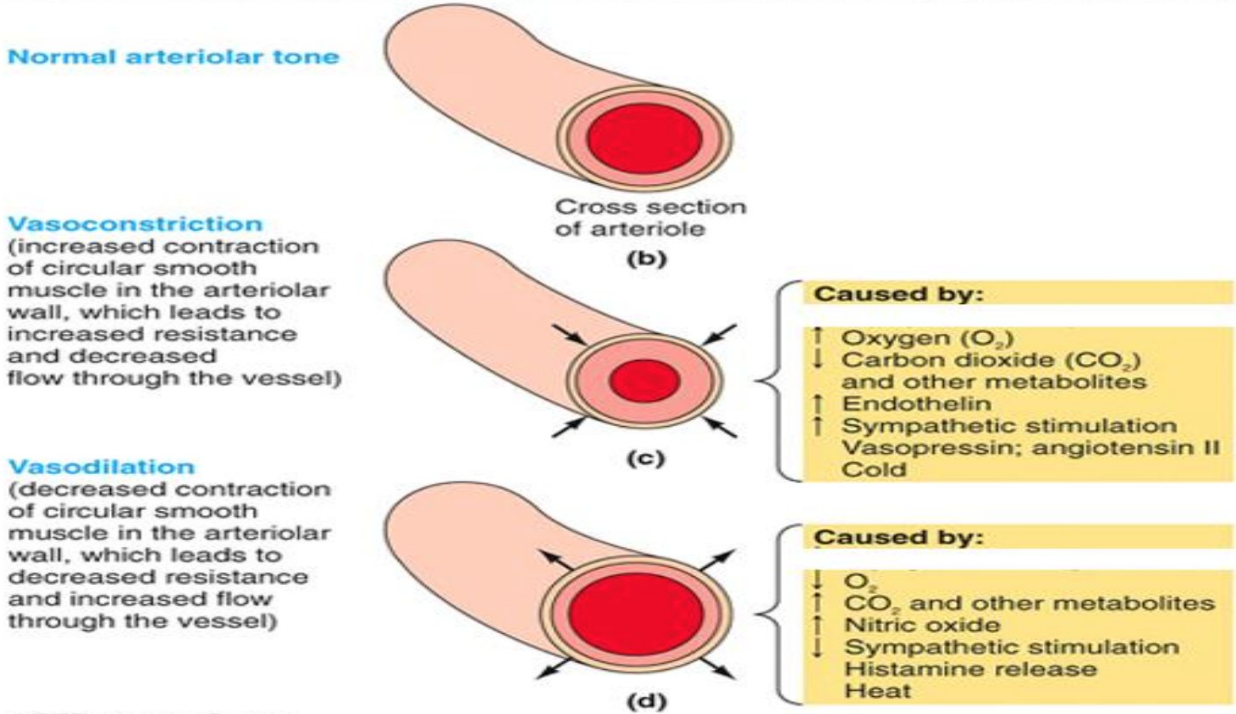
2- Vasoconstriction (the peripheral vascular resistance).

↑↑ resistance → ↑↑ ESV

↓↓ resistance → ↓↓ ESV

Determinants of ESV

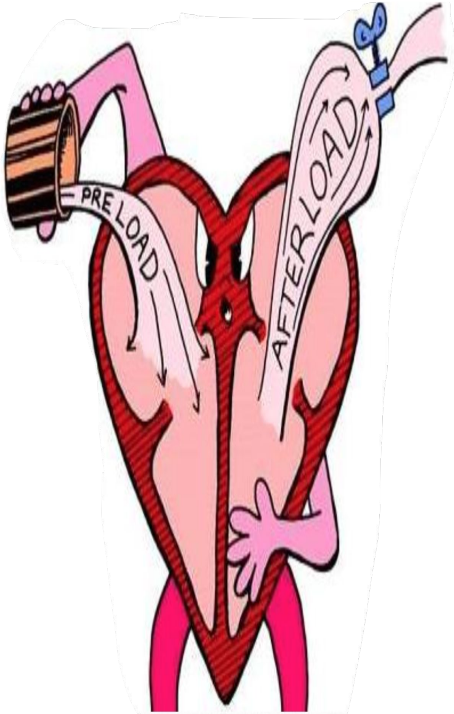
Afterload and hence ESV is determined by the peripheral vascular resistance



What Are Preload and Afterload

Preload:
Volume of blood in the ventricle at the end of diastole
(end diastolic pressure)

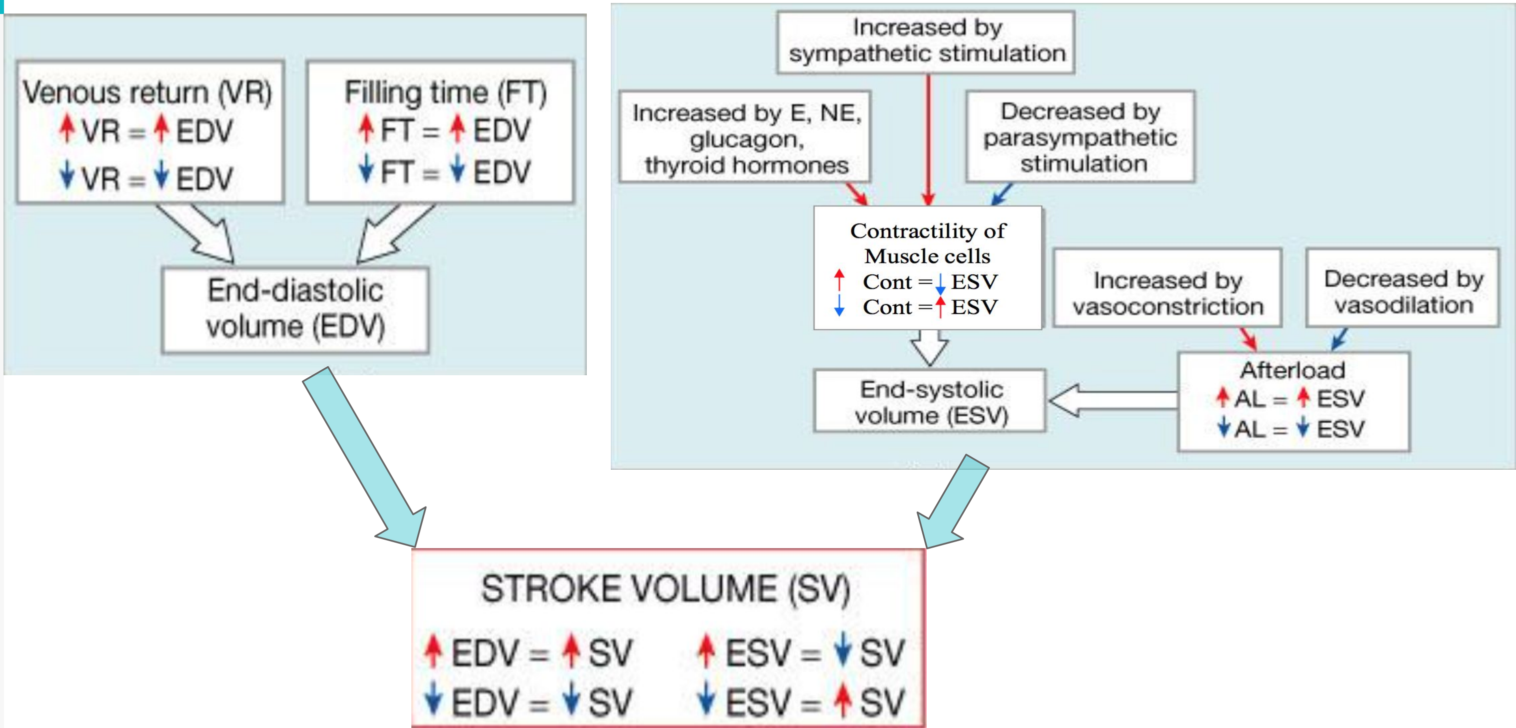
Increased in:
- Hypervolemia
- Heart failure



Afterload
Resistance left ventricle must overcome to circulate blood.
Increased afterload=Increased cardiac workload

Increased in:
- Hypertension
- Vasoconstriction

Summary of the Factors Affecting Stroke Volume



Heart Rate (HR)

Normal heart rate = 60-100 beats/min

> 100 beats/min → Tachycardia

< 60 beats/min → Bradycardia

Normal heart rate is regular sinus rhythm.

Regulation of heart rate

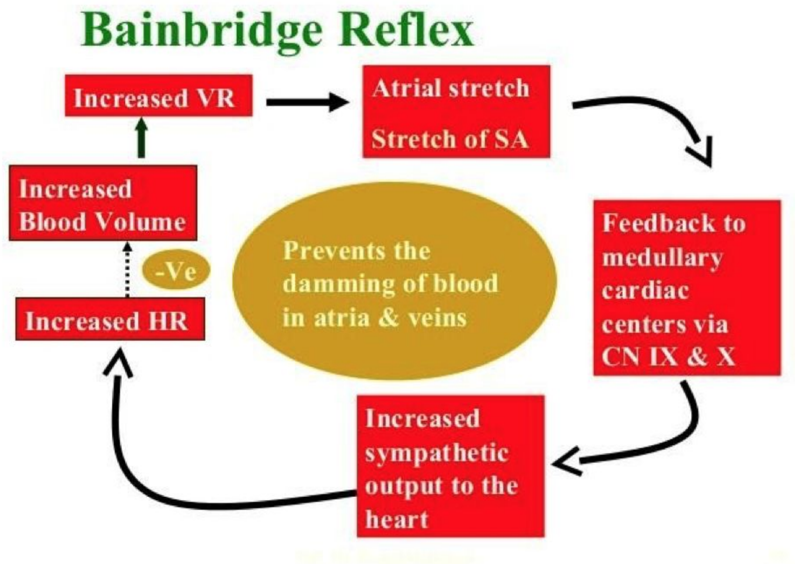
1- Autonomic nervous system	2-Physical activity	3-Hormones and drugs
Sympathetic nerves: *increase* HR as occurs during stress, crisis or low blood pressure	**Age**: Resting HR is *faster in fetus* and then *gradually decreases* throughout life.	Epinephrine and thyroxine *increase* HR.
	Gender: HR is *faster in females* (72-80 bpm) than in males (64-72 bpm).	
Parasympathetic nerves (vagus nerve)**:** *slow* HR.	**Temperature:** *Heat increases* HR as occurs in high fever. Cold has the opposite effect.	Increased calcium level in blood causes prolonged contraction
	Exercise: *Increases HR* through sympathetic nervous system.	Reduced calcium level in blood *depress* the heart.

Regulation of heart rate...cont

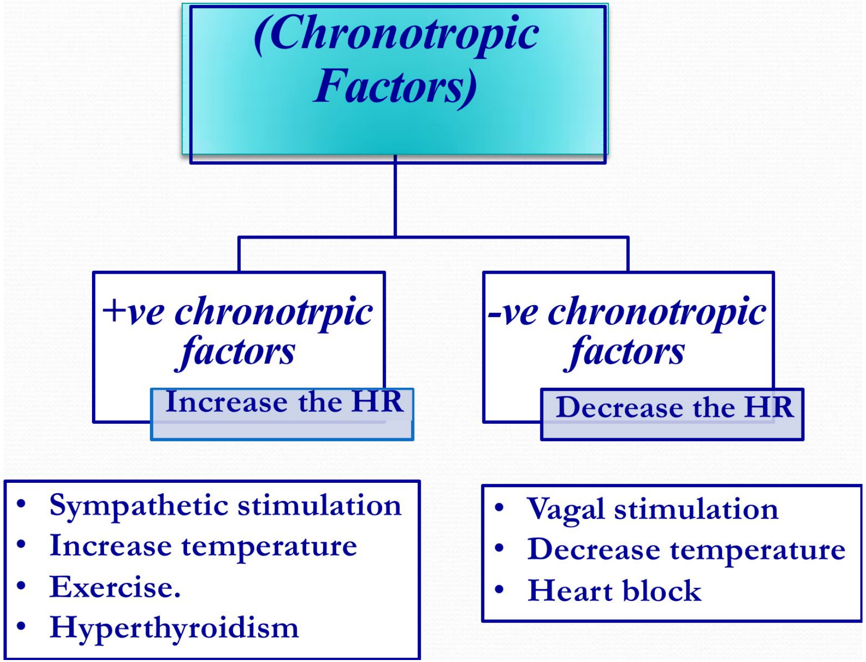
4-blood volume

Atrial Reflex (bainbridge reflex)

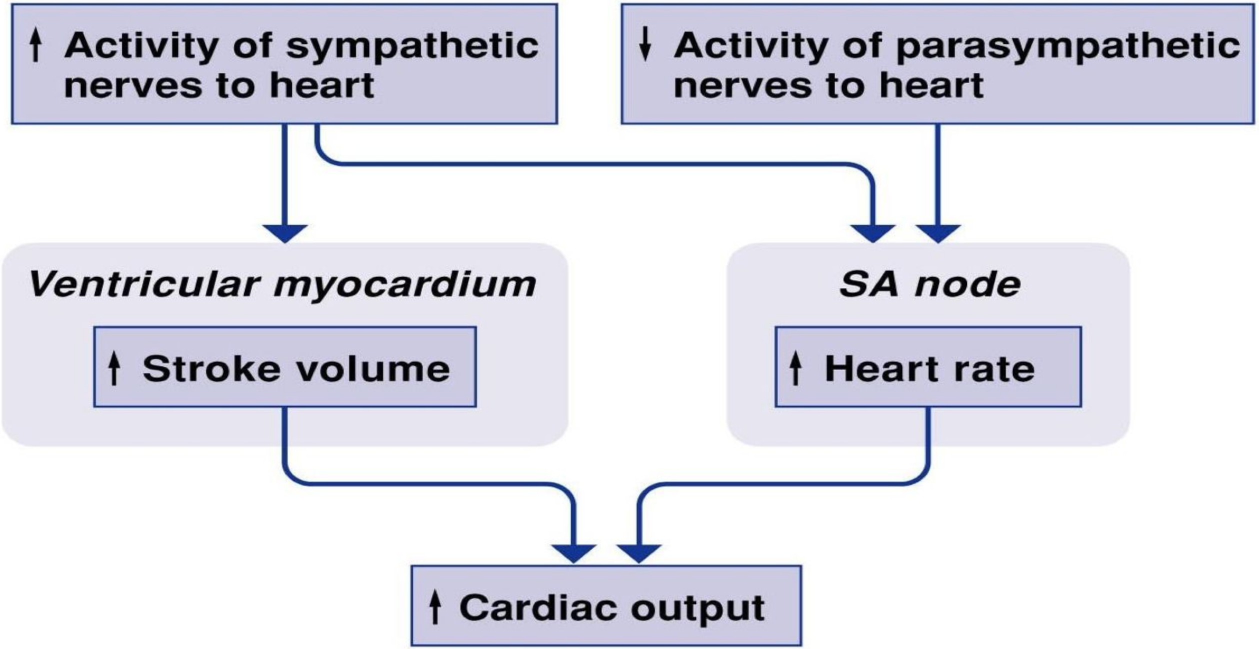
- This reflex adjusts heart rate in response to venous return.
- Increase blood volume, stimulates stretch receptors in right atrium.
- This triggers increase in heart rate through increased sympathetic activity.



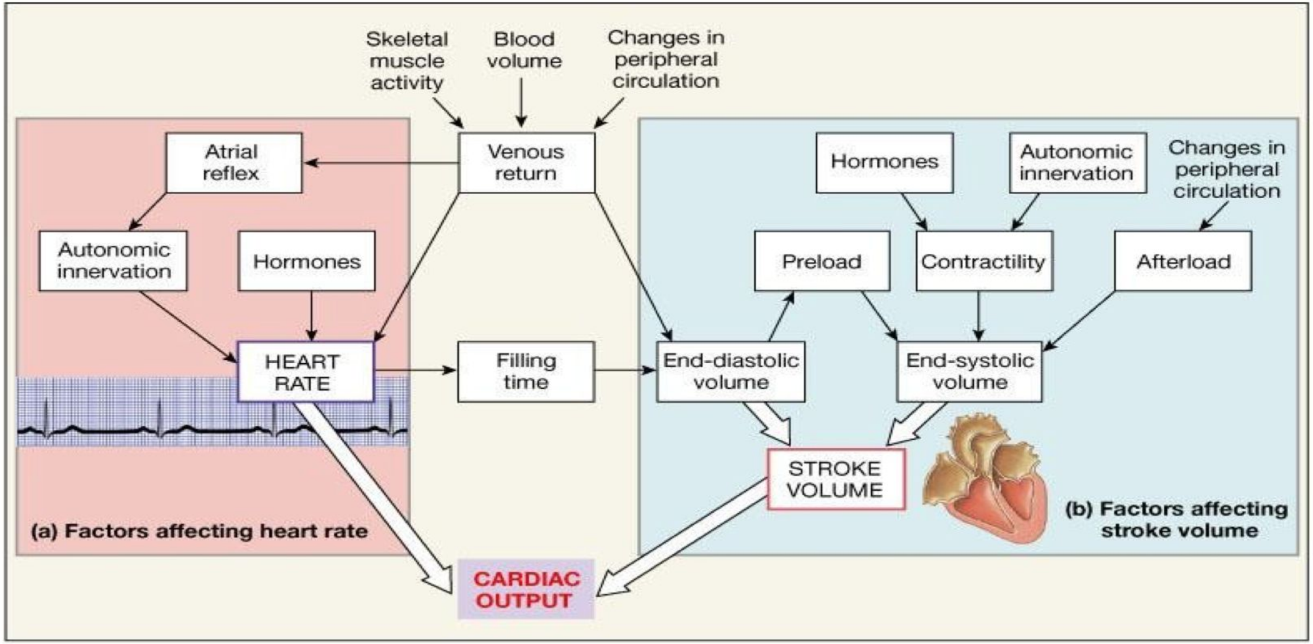
Factors Affecting the HR (Chronotropic Factors)



Regulation of Cardiac Output by autonomic nerves



Summary of the Factors Affecting Cardiac Output



Measurement of Cardiac Output

It can be measured mainly through 3 methods:

- Ultra-fast computer tomography: It measures changes in ventricular diameter at several depths to estimate changes in ventricular volume
- Fick's Principle
- 2 dimensional cardiography: Records real-time changes in ventricular dimensions during systole and diastole. It thus computes stroke volume, which when multiplied by heart rate gives the cardiac output.

Measurement of C.O.

The direct Fick's Method:

It states that, the amount or volume of any substance (oxygen) taken up by an organ or by the whole body is equal to:

(The arterial level of the substance — its the venous level) x blood flow.

$$\textbf{Blood Flow (CO) (L)} = \frac{\text{Amount of the substance } (O_2 \text{ consumption ml/min})}{\text{(Arteriovenous O2 difference ml/L)}}$$

Dr notes:
الطريقة هذي ما تستخدم إكلينيكيا والدكتور قال ما راح نسألكم عنها

Methods for measuring cardiac output (The Fick's principle)

- In the steady state, the rate of O_2 consumption by the body must equal the amount of O_2 leaving the lungs in the pulmonary vein minus the amount of O_2 returning to the lungs in the pulmonary artery.
- The total O_2 consumption, is simply the difference between the inspired and expired O_2. It can be measured with an exhaled gas collection bag using any oxygen meter.
- The amount of O_2 in the pulmonary veins = pulmonary blood flow (CO) x the O_2 content of pulmonary venous blood.
- Likewise, the amount of O_2 returned to the lungs via the pulmonary artery = pulmonary blood flow (CO) x the O_2 content of pulmonary arterial blood.
- O_2 consumption = CO x [O_2] pulmonary vein - CO x [O_2] pulmonary artery
- O_2 consumption = CO x [O_2] pulmonary vein - [O_2] pulmonary artery
- CO = O_2 consumption per minute/arteriovenous O_2 difference

Summary

Some important concepts

Cardiac output ”CO” is the amount of blood pumped by the each ventricle per minute. CO = SV * Heart beats per min (5L)
Stroke volume “SV” is the amount of blood ejected from ventricles during systole (per beat). SV=EDV - ESV(70ml/one beat)
End Systolic Volume “ESV” is the volume of blood remaining in the ventricle at the end of systole. (40 - 50ml)
End Diastolic Volume “EDV” is the volume of blood in each ventricles at the end of systole. (110-120ml)
Venous return ”VR” is the quantity of venous blood flowing into the right atrium each minute. VR = CO
Preload: Volume of blood in the ventricle at the end of diastole (end diastolic pressure)
Afterload: Resistance left ventricle must overcome to circulate blood.

Blood Pressure

is the force that the blood exerts against the walls of the blood vessels.

Systolic Pressure: maximum pressure during systole =120.
Diastolic Pressure: maximum pressure during diastole =80.
Pulse Pressure: Systolic Pressure- Diastolic Pressure = 40.
Mean Pressure: Diastolic Pressure + ⅓ Pulse Pressure = 93.
Mean Arterial Pressure is the main driving force for blood flow.

Summary

Factors Affecting Venous Return

1- Pressure gradient
2- Gravity
3- Venoconstriction
4- Skeletal muscle activity
5- Respiratory activity and thoracic pump
6- The presence of valves in large veins
7- Cardiac suction effect
8- Venous capacity

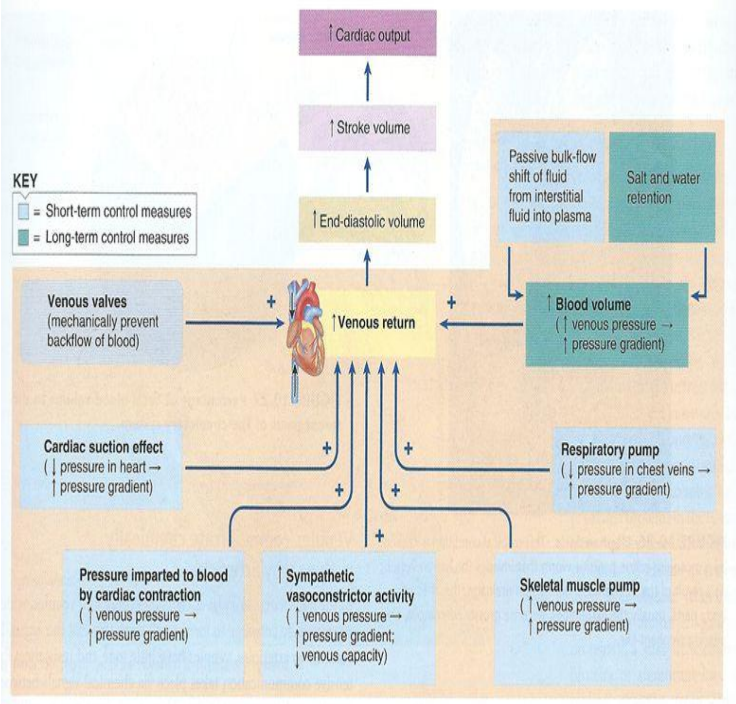
Regulation of Heart Rate

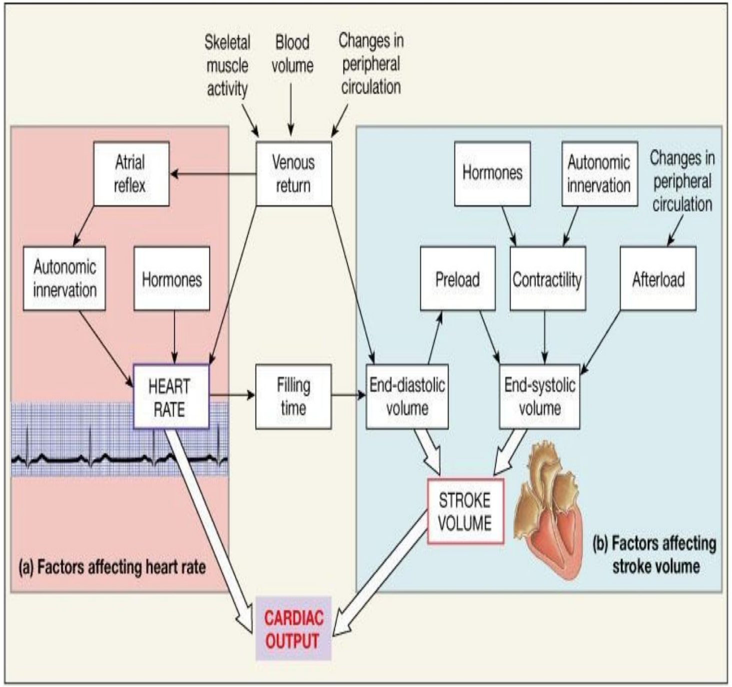
1-Autonomic nervous system (Sympathetic / Parasympathetic)
2- Physical activity (Age , Gender, Temp and exercise)
3- Hormone and drugs (Norepinephrine ,Calcium level)
4-Blood volume

Normal heart rate = 60-100 beats/min
higher than 100 beats/min → Tachycardia
lower than 60 beats/min → Bradycardia

Vascular compliance is the total quantity of blood that can be stored in a given portion of circulation for each mmHg pressure rise.
The compliance of systemic veins is about 24 times that of its corresponding artery because it is about 8 times as distensible and it has a volume about 3 times as great (8 x 3 = 24).

Summary


↑ Cardiac output
↑ Stroke volume
↑ End-diastolic volume
KEY
= Short-term control measures
= Long-term control measures
Passive bulk-flow shift of fluid from interstitial fluid into plasma
Salt and water retention
Venous valves (mechanically prevent backflow of blood)
↑ Venous return
↑ Blood volume (↑ venous pressure → ↑ pressure gradient)
Cardiac suction effect (↓ pressure in heart → ↑ pressure gradient)
Respiratory pump (↓ pressure in chest veins → ↑ pressure gradient)
Pressure imparted to blood by cardiac contraction (↑ venous pressure → ↑ pressure gradient)
↑ Sympathetic vasoconstrictor activity (↑ venous pressure → ↑ pressure gradient; ↓ venous capacity)
Skeletal muscle pump (↑ venous pressure → ↑ pressure gradient)


Skeletal muscle activity
Blood volume
Changes in peripheral circulation
Atrial reflex
Venous return
Autonomic innervation
Hormones
HEART RATE
Filling time
Hormones
Autonomic innervation
Changes in peripheral circulation
Preload
Contractility
Afterload
End-diastolic volume
End-systolic volume
STROKE VOLUME
(a) Factors affecting heart rate
(b) Factors affecting stroke volume
CARDIAC OUTPUT

Quiz

1. Which of the follow is considered as the blood reservoir?
   A:arteries B:Veins
   C:Heart D:Capillaries

2. Minimum resistance in the circulation Is located in the?
   A:Arteries B:arterioles
   C:large Veins D:Capillaries

3. The compliance of systemic Veins in comparison with its corresponding Arteries is ?
   A:Veins are 8 times greater
   B:Arteries are 8 times greater
   C:Veins are 24 times greater
   D:Arteries are 24 times greater

4. If the systolic pressure of a person is 115 mmHg And diastolic pressure is 90 the pulse pressure will be?
   A:25 mmHg B:40 mmHg C:98 mmHg D:123 mmHg

5. Which of the following pressures is the main Driving force of the blood flow
   A:systolic B:diastolic pressure
   C:mean arterial pressure D: pulse pressure

6. Central Venous Pressure refers to the pressure in the ?
   A:Right atrium B:Right ventricle
   C:left atrium D:left ventricle

7. Hyperthyroidism affects the Cardiac Output By
   A:increasing it B:Decreasing it
   C:it has no effect

1.B 2.D 3.C 4.A 5.C 6.A 7.A
2.Capillaries are small but they have the least resistance due to their huge number allowing them to have the maximum surface area

Thank you for checking our work

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العنود سلمان

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روان مشعل
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ليلى الصباغ
فلوة السعوي
نورة بن حسن
نورة الحربي
نورة العثيم
مجد البراك

لينا العوهلي
عهد القرين
مها النهدي
مها بركة
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