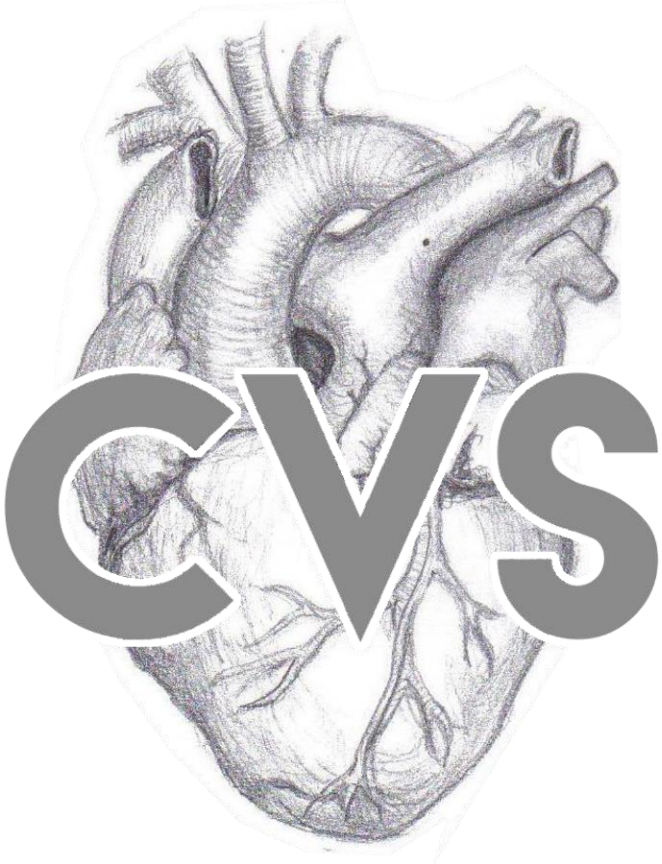

PHYSIOLOGY

☑ Sheet ○ Slide ○ Handout

Number

13

Subject

Venous Return

Done By

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Doctor

Faisal M.

Date: 00/00/2016

Price:

بسم الله الرحمن الرحيم

- This sheet was written according to section 2 record

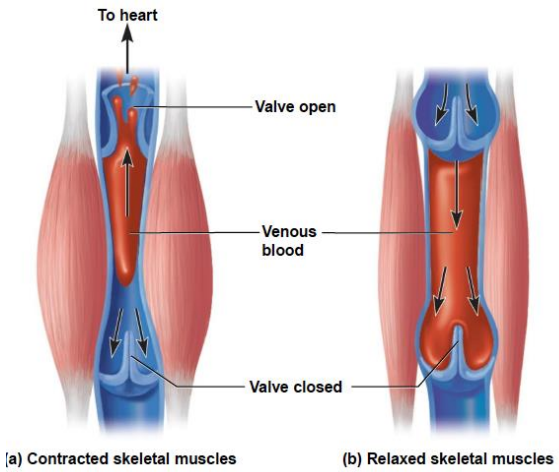
VENOUS RETURN

Definition: venous return is the volume of blood returns to either the left side or the right side of the heart per minute.

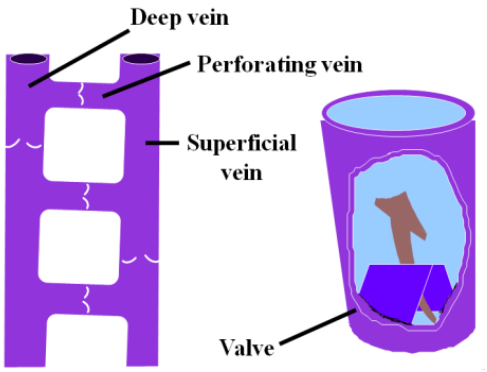
VR= CO = P/R

VR = (Venous pressure –Rt. Atrial pressure)/ resistance to venous return

- the veins contain **Valves** which maintain the unidirectionality of blood towards the heart.



- The **deep veins** lie between the skeletal muscles, so when these muscles contract blood goes up "pumped" to the heart, after that "when muscles are relaxed" the blood won't come down due to the presence of the valves. "unidirectional"



- Exercise increases the venous return due to contraction of these muscles that surround the veins, low amount of blood stays in the veins which keeps the venous pressure low. *"Notice the figure above"*

- if venous pressure becomes high, veins will dilate and valves will become <u>incompetent</u>

- these veins will become tortuous, engorged, bluish in color and called **<u>Varicose veins</u>**

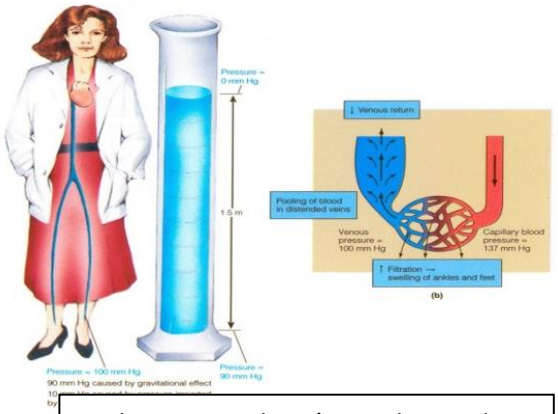
- They are "tortuous" because of the high amount of blood in them, "bluish" because this blood contains low oxygen concentration.

- collection of blood in varicose veins reduces venous return ➔ reduced CO

- Reduced venous return may compromise blood flowing to the brain and consequently patient may comatose "faint or coma"!

- Varicose veins also causes <u>Stasis</u> of blood which is a risk factor of thrombosis! Like DVT "most common thrombosis in veins! ➔ thrombus might dislodge "embolus"! ➔ goes from right side of the heart to the lungs and causes pulmonary embolism and infarction !

(if embolus occurs in the left side it will cause CVA "cerebrovascular accident" and/or cardiac infraction)



In this picture there's a Lady standing still, blood normally collects in lower limb veins

If she stays standing still for long time blood will collect more & more and veins will become larger and dilated, valves will become incompetent due to high pressure against them, this accumulation of blood will cause Varicose veins. ☹

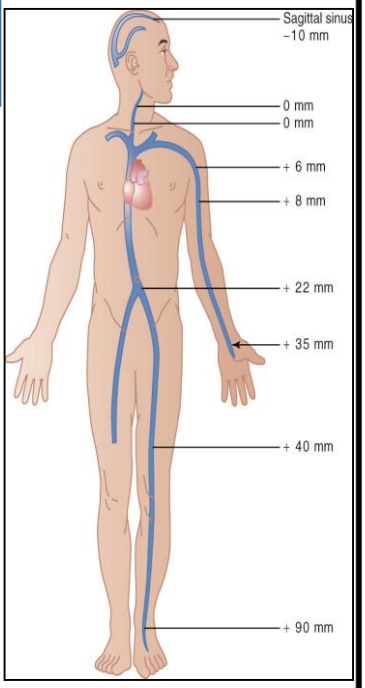
*Pressure inside the leg is the column of water from her heart to her leg,

If the length from her heart to her feet is for example 136 cm pressure will be 10cmhg "or100mmhg"

$136 cmH_2O / 13.6 g/cm^3 Hg = 10 cmHg$
"somehow don't ask why"

Remember: "exercise → muscle contract → blood from vein to heart"

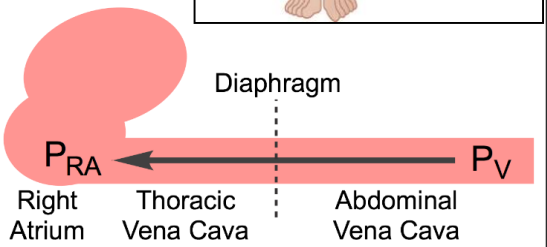
Venous pressure in the body:



Central venous pressure "CVP":

- pressure in the right atrium is called central venous pressure
- Usually it is around 0mmhg around the heart while it is about 90-100mmhg near the feet (lowest point in the body).
- increased right atrial pressure reduces venous return, because pressure gradient is reduced
- this will force the blood to return to the peripheral circulation which will cause edema "pitting edema"

"while left atrial pressure increment causes pulmonary edema"
**LHF : pulmonary edema /RHF : peripheral edema*



$$VR = \frac{P_V - P_{RA}}{R_V}$$

RK '15

- This edema is different from the edema caused by hypothyroidism which is called myxedema
  - Myxedema → skin itself is thick
  - Pitting edema → skin is soft and can be depressed by pressure "pressing the skin leaves a groove"

Right atrial pressure (RAP) is regulated by a balance between the ability of the heart to pump blood out of the atrium and the rate of blood flowing into the atrium from peripheral veins.

Factors that increase RAP:

-increased blood volume

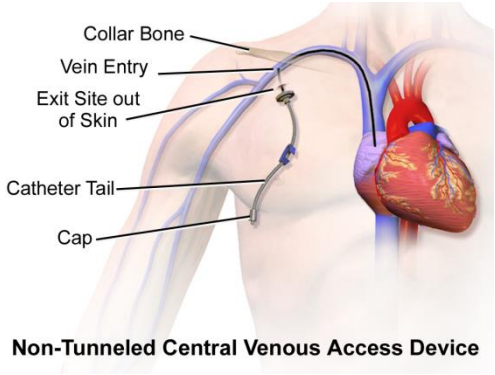
-increased venous tone

- dilation of arterioles

-decreased cardiac function

*Increased abdominal pressure might increase pressure in veins which increases venous return! *"Abdominal pressures tend to increase venous pressures in the legs."* *from the slide*

- CVP “central venous pressure” in the right atrium is usually 0mmhg, but it might reach 20mmhg *“maybe 30 sometimes!”*
- to monitor the right atrial pressure we use a <u>Catheter</u> “central venous line”



- CVP should be monitored in heart failure patients because increased CVP may lead to sudden death, especially when giving IVF! (Could be lethal!)

venous tone: more venoconstriction ➔ increased pressure in right atrium and right ventricle too

Dilation of arterioles ➔ less resistance ➔ more blood flow ➔ decreased cardiac function! ”arterioles are the main resistant vessels“

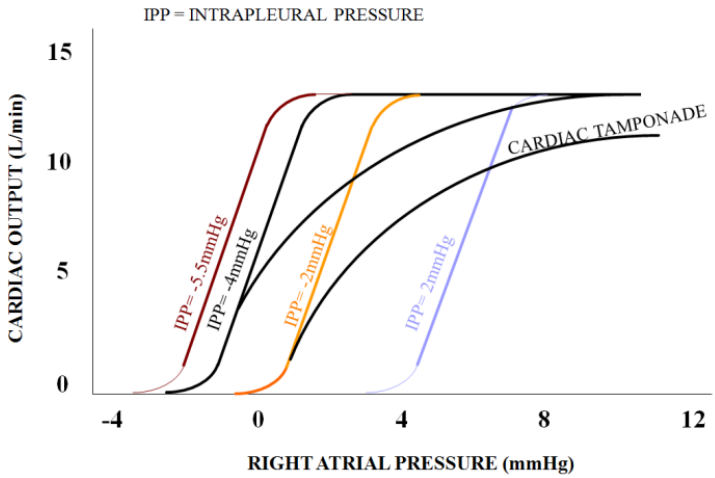
increased contractility “+ve inotropes” reduces ESV, which helps in heart failure”” 21:00

if there is increase in venous return there is increase in EDV ➔ frank starling law, increased stroke volume and cardiac output “within physiological limit”

Note: information from this page till the end will be written again with more details in the next sheet, so it will be like an introduction 😊

Factors affecting the CVP:

1. skeletal muscle contraction: increased venous pressure ➔ increased gradient between the veins and right atrium ➔ increased venous return ➔ increased cardiac output
2. Blood volume: increased blood volume means more pressure ➔ increased venous pressure ➔ more gradient ➔ more venous return ➔ more cardiac output
3. **Veno**-constriction & Arterio-constrction "sympathetic!": main volume of blood is collected in veins, so arterio-constriction has less "negative" effect on the venous return (negligible), but **vasoconstriction** as a whole increases venous return due to veno-constriction although arteries are constricted too!



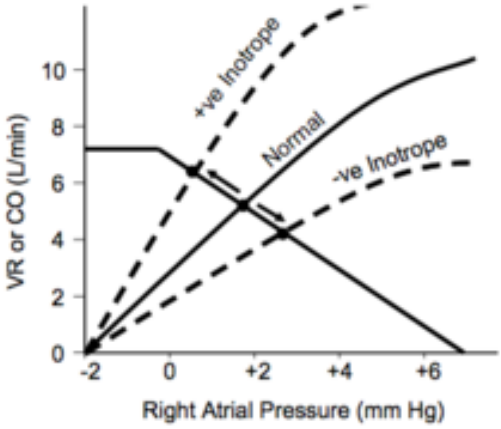
4. Respiration:

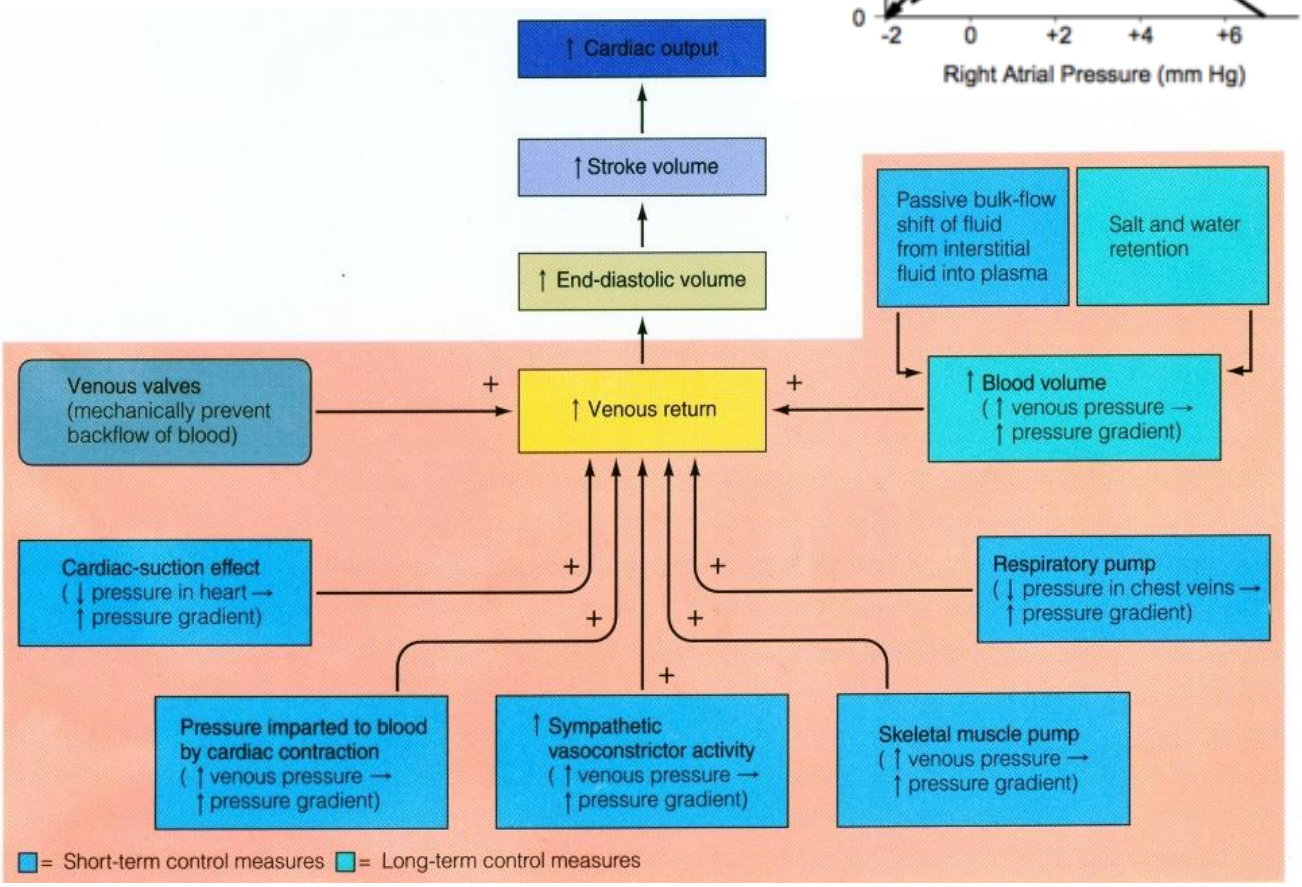
inspiration ➔ pressure inside alveoli is less than pressure outside "atmosphere" ➔ less pleural pressure ➔ less atrial pressure ➔ more return, normally pressure in pleura is -4, during inspiration it becomes -6 instead of -4!, pressure in right atrium becomes -2 instead of 0 "gradient increased" ⇨ more venous return!

Expiration: IPP returns to -4 , CO back to normal *"CO and venous return are related to each other"*

5. Venous Return is decreased if valves are incompetent, "blood flows back"

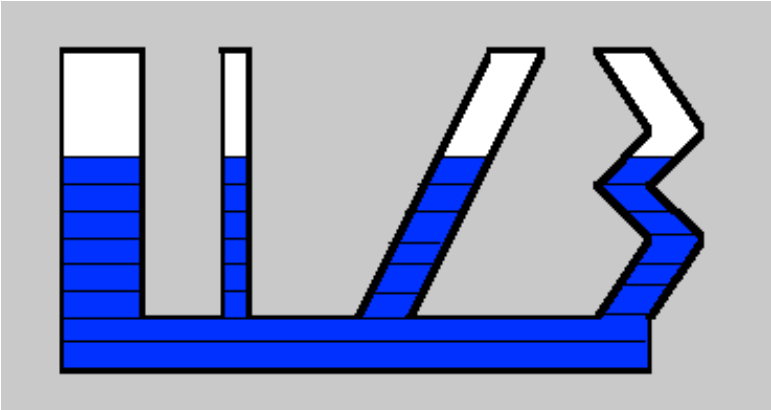
6. **Cardiac contractility:** more +ve inotrope ➔ more contractilité ➔ decreased ESD ➔ less pressure in right atrium ➔ increased gradient ➔ more venous return <u>(Cardiac Suction)</u>



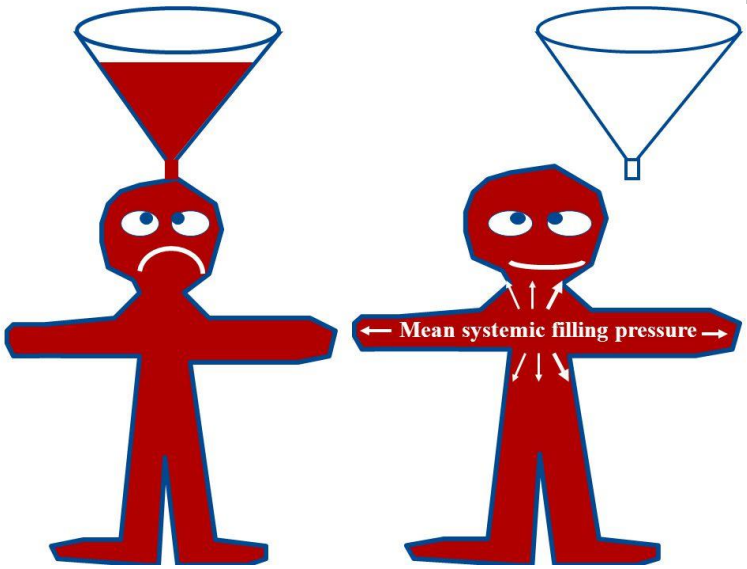


Mean Systemic Filling Pressure "MSFP":

The concept of Communicating vessels « الاواني المستطرقة » :



- ☆ if we stop the heart and equilibrate the blood in the vessels, the level of blood will be parallel in all these vessels (just like the figure)
- ☆ if we add more blood the level will rise in all vessels!



- ☆ So the idea here is "same level means same pressure", this is called <u>mean pressure</u>
- ☆ mean systemic pressure: is the mean pressure in <u>systemic circulation</u>
- ☆ mean circulatory pressure: is the mean pressure in both <u>systemic and pulmonary circulation</u>
- ☆ we care about the mean systemic pressure!

"first person to measure mean systemic pressure was guyton, he first measured it in goats, then tried to do so in humans and found it was 7-8 mmhg"

F. M. Khateeb

- mean systemic pressure = mean systemic filling pressure MSFP = **7- 8**mmhg
- If the pressure in the right atrium equals to MSFP, this means that there is no venous return "**Gradient is 0!**"
  (there must be a gradient between the right atrium and the pressure in veins "MSFP" in order to create a blood flow *"from high to low"*)

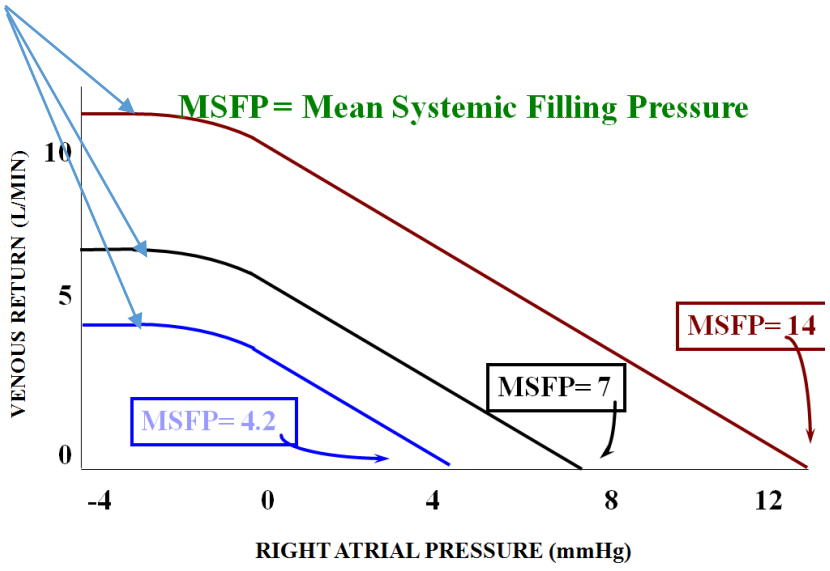
- if pressure in rt atrium is 6mmHg there's a little flow
- When it's 5mmHg, flow will increase "more" and so on…
- that's why it's called **filling "MSFP - right atrial P = filling or gradient"**

- when pressure in the right atrium becomes **negative** vessels will collapse "theoretically" but blood collecting behind them will put pressure on their walls so they won't collapse ⇨ plateau in the figure below

What increases MSFP?

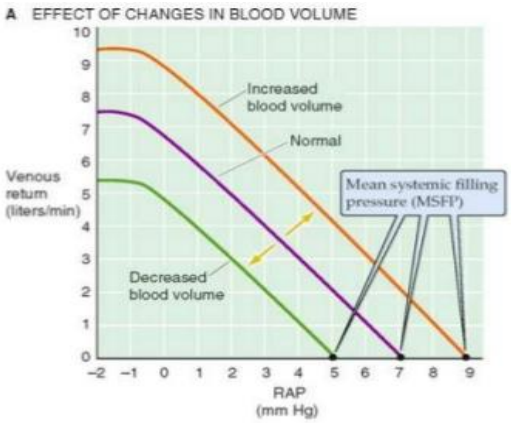
- Transfusion ➔ increased fluid "blood volume" increases venous return, shift the curve to right and upward =14

- Hemorrhage ➔ means low blood volume shift the curve to left and downward =4.2 "dehydration also decreases blood volume ➔ low MSFP"



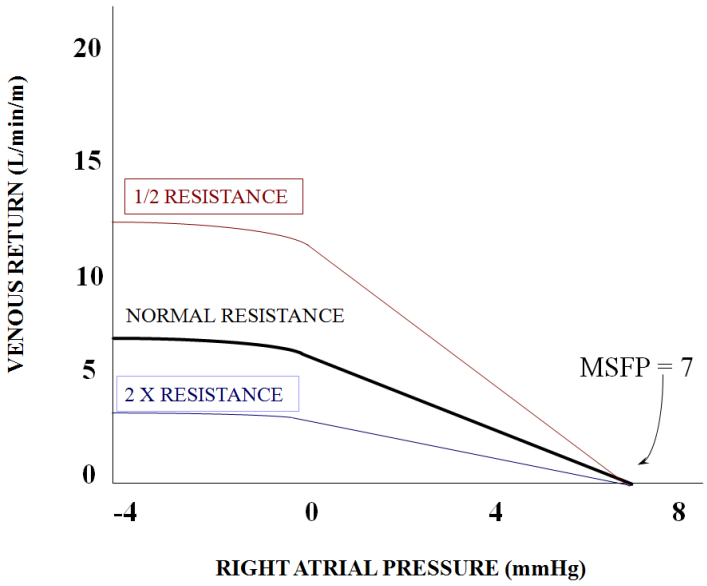
Cardiac & vascular function curves

- Mean systemic filling pressure (MSFP) is at the point where venous return curve intersects the x axis (normally ~7 mmHg)



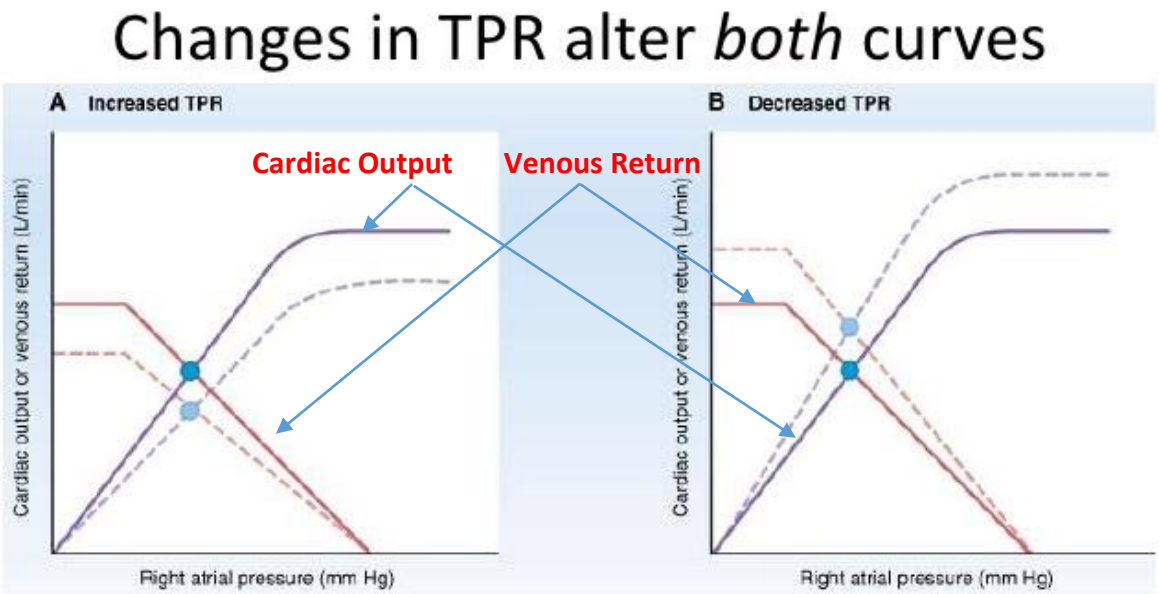
- MSFP is increased by – increased blood volume or decreased venous compliance
- MSFP is decreased by – decreased blood volume or increased venous compliance

⌘ **Important note:** "increasing or decreasing TPR has no effect on MSFP! because arteries contain little amount of blood, while veno-constrction or dilation affects the MSFP!"



TPR increment has no effect on venous return! yet decrement in TPR means more flow which also has no effect on MSFP but increases venous return "TPR is mainly done by arterioles"

while change in **venous** pressure "increased or decreased resistance" affects venous return because most of the blood volume is in the veins!



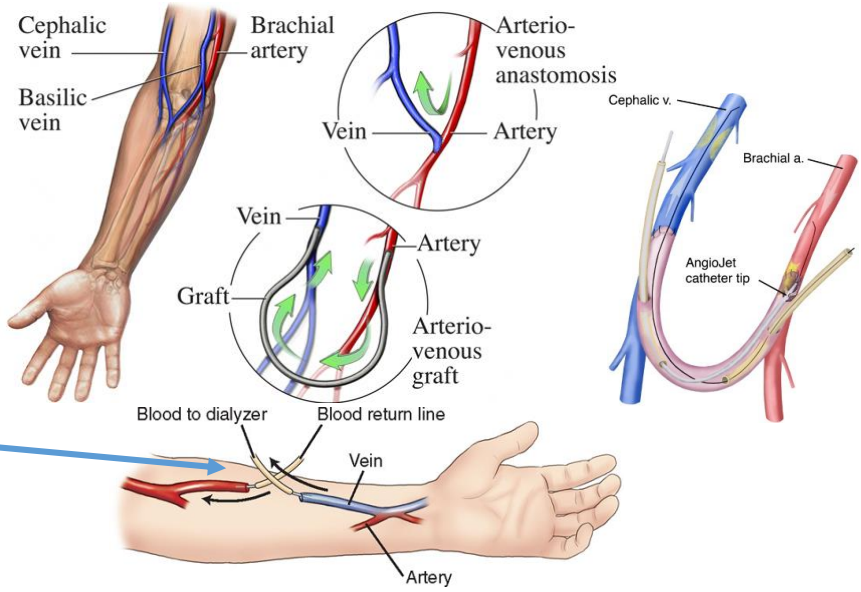
Diseases that affect venous return:

- Beriberi - thiamine deficiency (vitamin B1 deficiency)

"this disease affects elastin, which will make elastic fibers less elastic ⇨ arteriolar dilation!"

- causes venous return to increase due to arteriolar dilation (less RVR resistance to venous return) → cardiac output increases too

VR = (MSFP - RAP) /RVR



- AV fistula (Arterio-venular Shunt) ➔ less RVR,
  - Hemodialysis AV-shunt for kidney failure patients

- C. hyperthyroidism ➔ less RVR

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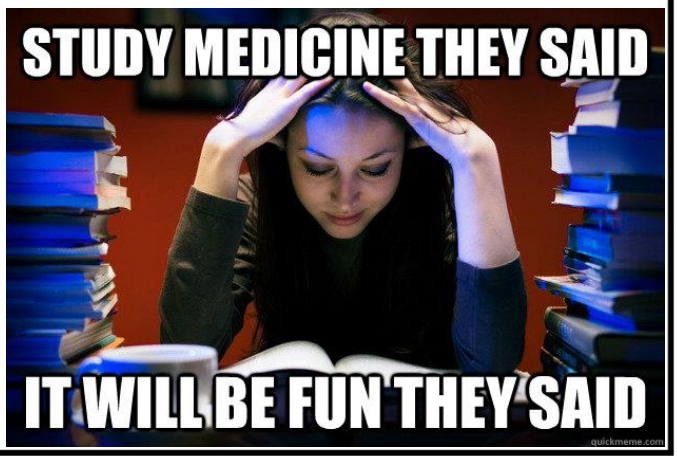

Omar Saffar