Shock

More than just low blood pressure

What is Shock?

- Inadequate perfusion of body tissue
  - begins at the cellular level
  - if left untreated results in death of tissue, organs, organ systems
  - and ultimately the death of the entire organism
- *It is not (just) low blood pressure*

What is adequate perfusion?

- Constant and necessary passage of blood through the body's tissue
- Delivery of nutrients and oxygen
- Removal of CO_2 and the waste byproducts of metabolism

Perfusion is dependent on a functioning and intact circulatory system

Components of circulatory system

- The pump (heart)
- The fluid (blood)
- The container (blood vessels)

Stroke Volume

- The amount of blood ejected by the heart in one contraction
- Factors affecting SV
  - Preload
  - Force and Rate of Contraction
  - Afterload

Preload

- Amount of blood delivered to the heart during ventricular diastole

- Includes everything available for next systole
  - Passive filling
  - "Atrial kick"

Inotropy and Chronotropy

- It is affected by circulating hormones called catecholamines
  - epinepherine
  - norepinepherine
- The strength of contraction of the heart

- The rate per minute of cardiac contractions

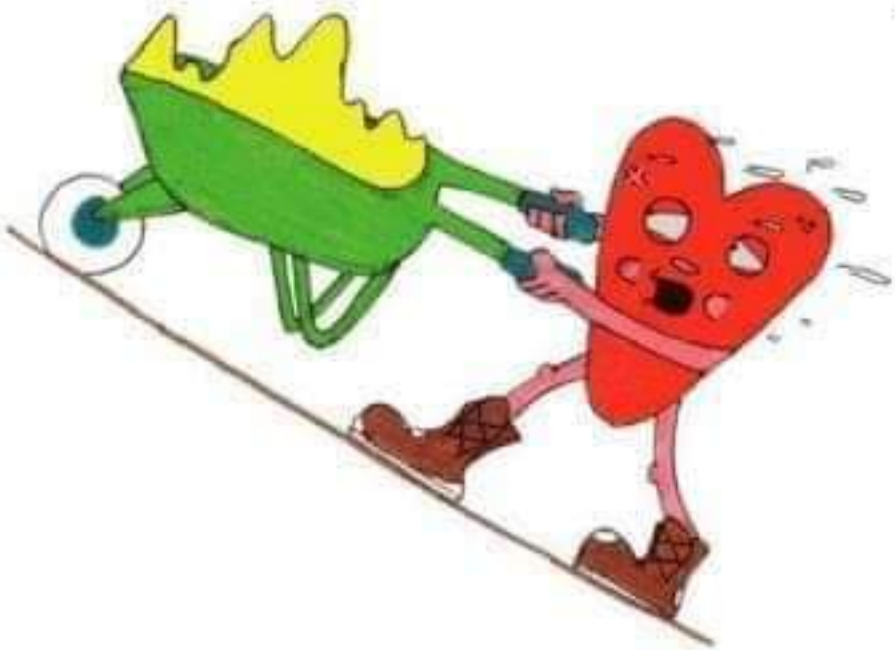
Frank Starling Mechanism

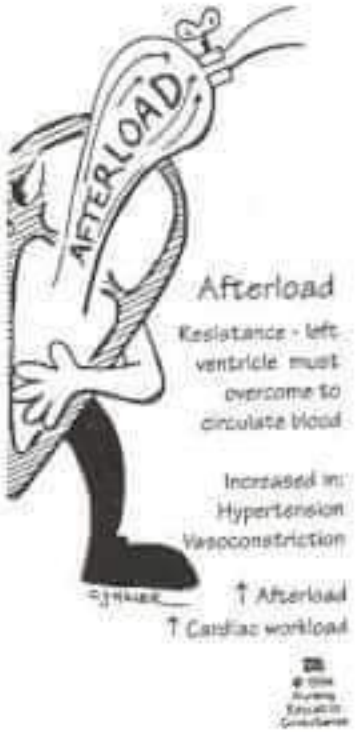
- The greater the stretch of the cardiac muscle, up to a certain point, the greater the force of cardiac contraction (ie: the rubber band effect)

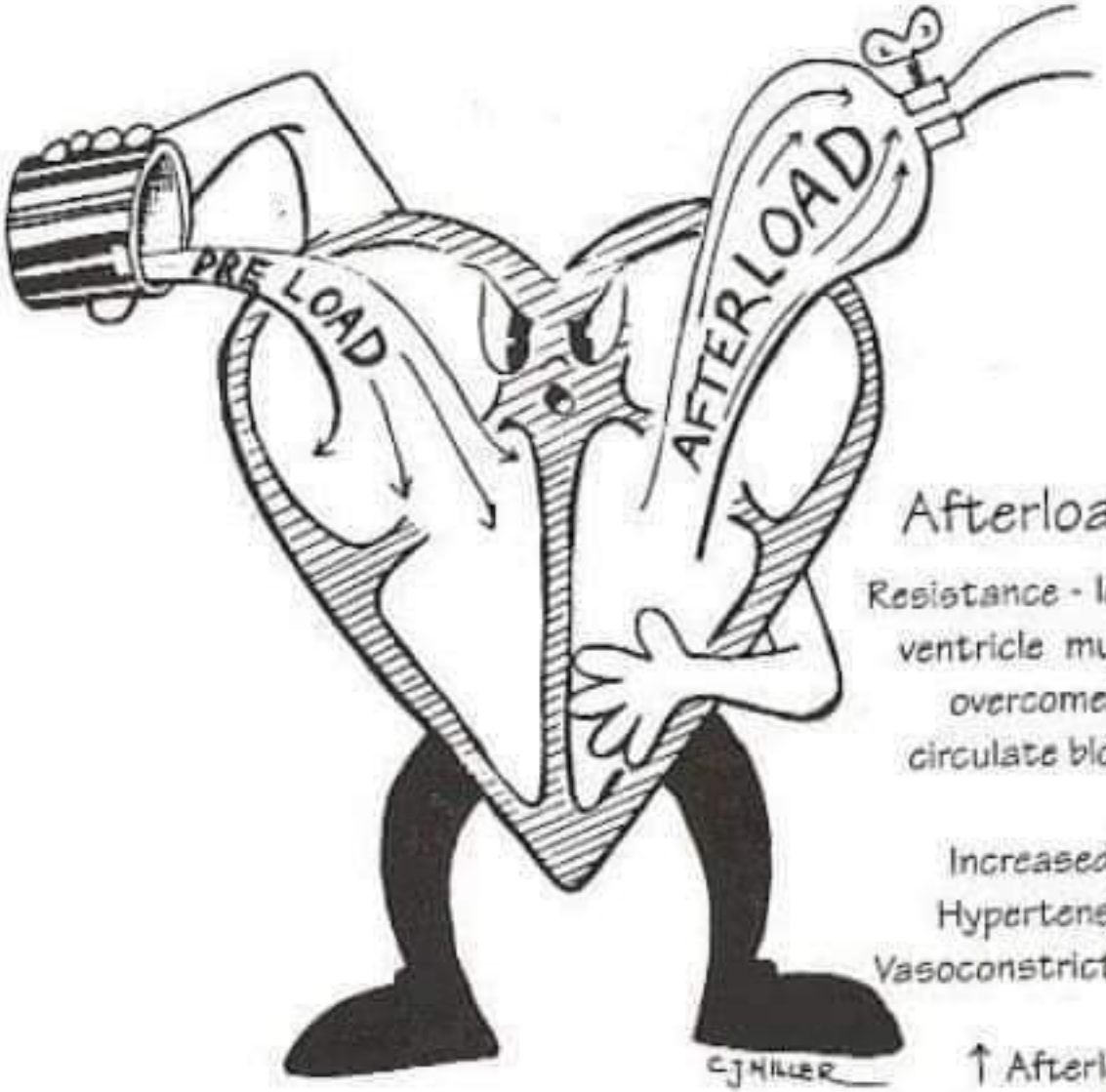
Which one of these has optimal athletic stretch?

Afterload

- Resistance against which the ventricle must contract
- Determined by the degree of peripheral vascular resistance







Afterload

Resistance - left ventricle must overcome to circulate blood

Increased in:
Hypertension
Vasoconstriction

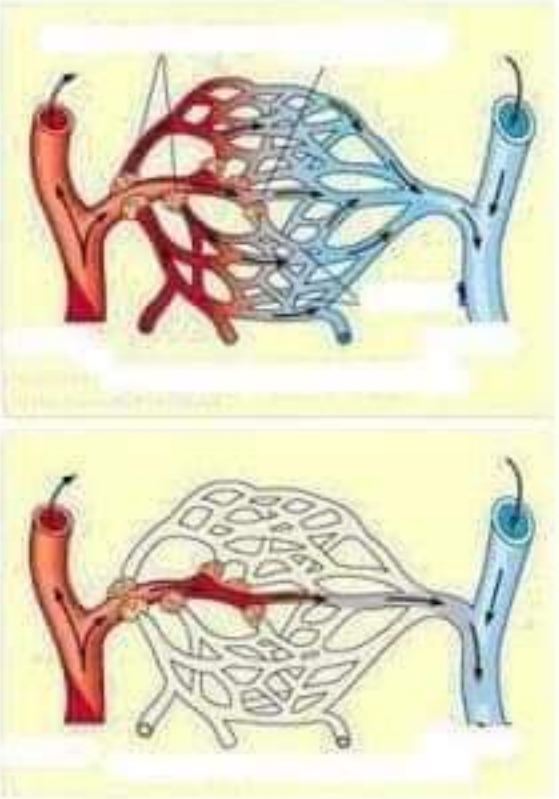
↑ Afterload
↑ Cardiac workload

Container

- Blood vessels serve as the container
- Under control of the autonomic nervous system
- They can adjust size and selectively reroute blood through microcirculation
- Microcirculation is comprised of the small vessels:
  - Arterioles, Capillaries, and Venules

Rerouting (shunting) blood

- Capillaries have a pre-capillary sphincter between the arteriole and capillary that responds to local tissue demands such as acidosis, hypoxia, and opens as more blood is needed
- At the end of the capillary between the capillary and venule is a post-capillary sphincter that opens when blood is needed to be emptied into the venous system



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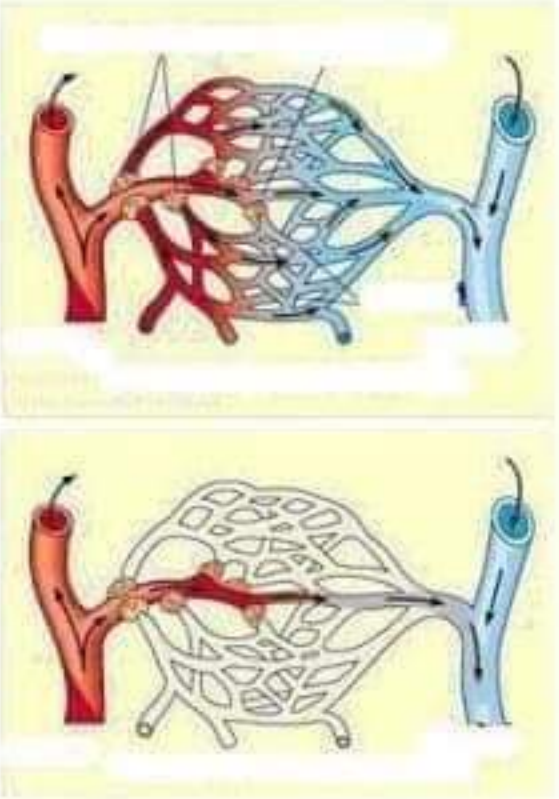


Causes of Hypoperfusion

Hose

Pump

Fluid

Inadequate Pump

- cardiac contractile strength
- heart rate (too slow or too fast)

Inadequate Fluid

- ***Hypovolemia (abnormally low circulating blood volume)***
- ***Not enough preload***

Container Problems

- Dilated container without change in fluid volume
- Normal container with low levels of fluid
- Leak in container
- Afterload too high – causes?

Result of hypoperfusion

- Shock at the cellular level
- Causes vary, however the ultimate outcome is impairment of cellular metabolism
- Can be localized (AMI, CVA, compartment syndrome) or generalized

Types of shock commonly seen by EMS

- Cardiogenic shock (pump)
- Hypovolemic shock (fluid)
- Neurogenic shock (container)
- Anaphylactic shock (container and fluid)
- Septic shock (all three?)

Cardiogenic Shock

- Pump fails to act as an effective forward pump
- Usually the result of left ventricular failure secondary to acute MI or CHF

Signs / Symptoms

- Pulmonary Edema – wheezes and crackles are heard as fluid levels increase
- Difficulty breathing
- Rarely - productive cough with white or pink-tinged foamy sputum
- Cyanosis
- Altered mental status
- Oliguria (decreased urination – take a good history)

ADULT CARDIOGENIC SHOCK

ALS

1. **Initial Medical Care** with **HIGH FiO_2 OXYGEN or VENTILATION**
   - If hypovolemic and/or dehydrated and lungs are clear: **IV FLUID CHALLENGE IN 200 mL INCREMENTS x 2**
   - Reassess breath sounds after each 200 mL increment

2. Treat underlying dysrhythmias per appropriate SOP

3. **DOPAMINE DRIP, dose dependent on clinical condition**
   - If P > 60, begin at 5 mcg/kg/min and increase q 3 min to achieve SBP ≥ 90 mmHg to a maximum of 20 mcg/kg/min

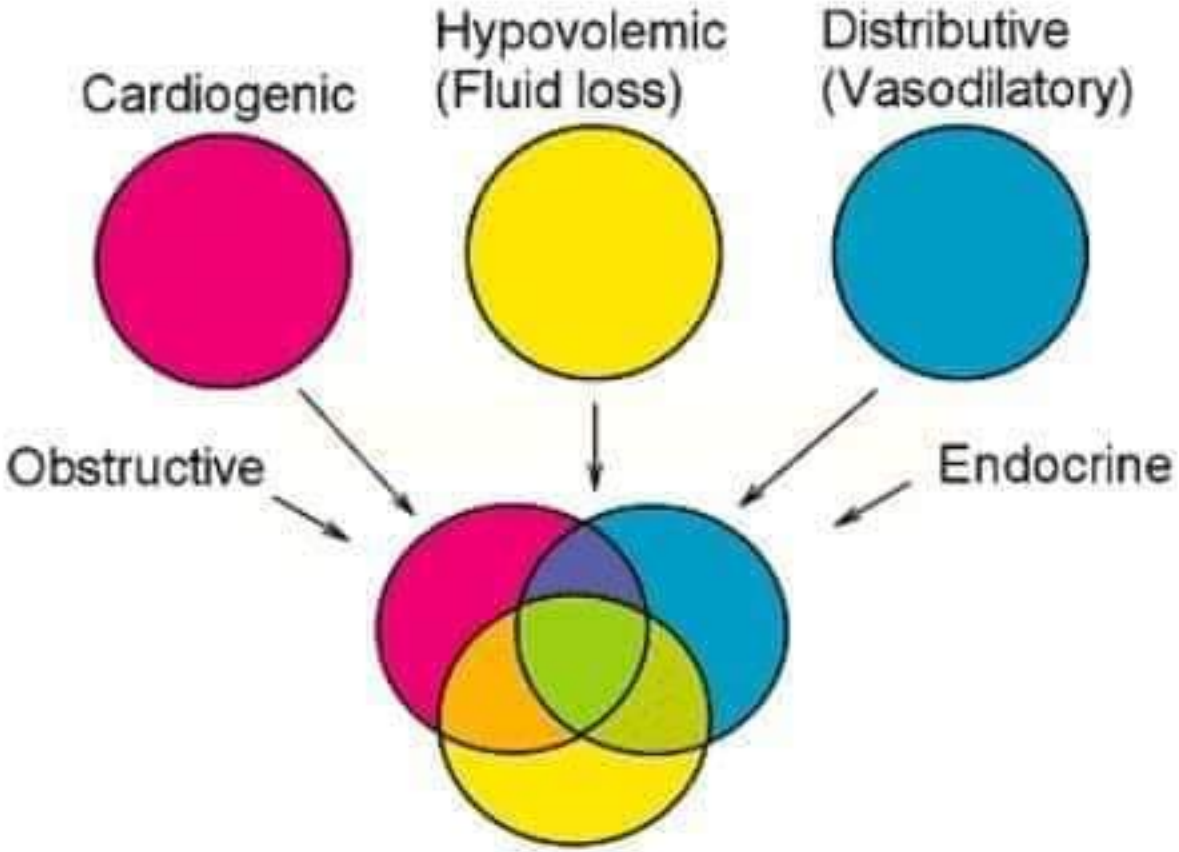
Calculation Chart

Body Weight		mcg / kg / min			
		5	10	15	20
Pounds	Kilograms	mcgtts/min	mcgtts/min	mcgtts/min	mcgtts/min
80	36	7	14	20	27
100	45	9	17	26	34
120	55	10	20	31	41
140	64	12	24	36	48
160	73	14	27	41	55
180	82	15	31	46	61
200	91	17	34	51	68
220	100	19	38	56	75
240	109	20	41	61	82
260	118	22	44	66	89
280	127	24	48	72	95
300	136	26	51	77	102

Individual dosage requirements may vary widely. The above drip rates cover a dosage range of 5 – 20 mcgm/kg/min. This chart applies to a concentration of 1600 mcgm/mL (typically 800 mg / 500 mL or 400 mg / 250 mL D5W)

Shock "combo"

(you don't want this "supersized")



FYI

All patients with sepsis require supplemental fluids. Assessment of the patient's volume and cardiovascular status guides the amount and rate of infusion. For adult patients who are hypotensive, administer an isotonic crystalloid solution (sodium chloride 0.9% or Ringer lactate) in boluses of 500 mL (10 mL/kg in children), with repeat clinical assessments after each bolus.

Administer repeat boluses until signs of adequate perfusion are restored. **A total of 4-6 L may be required.** Monitor patients for signs of volume overload, such as dyspnea, pulmonary crackles, and pulmonary edema, on chest radiograph. Improvement, stabilization, and normalization of the patient's mental status, heart rate, BP, capillary refill, and urine output indicate adequate volume resuscitation.

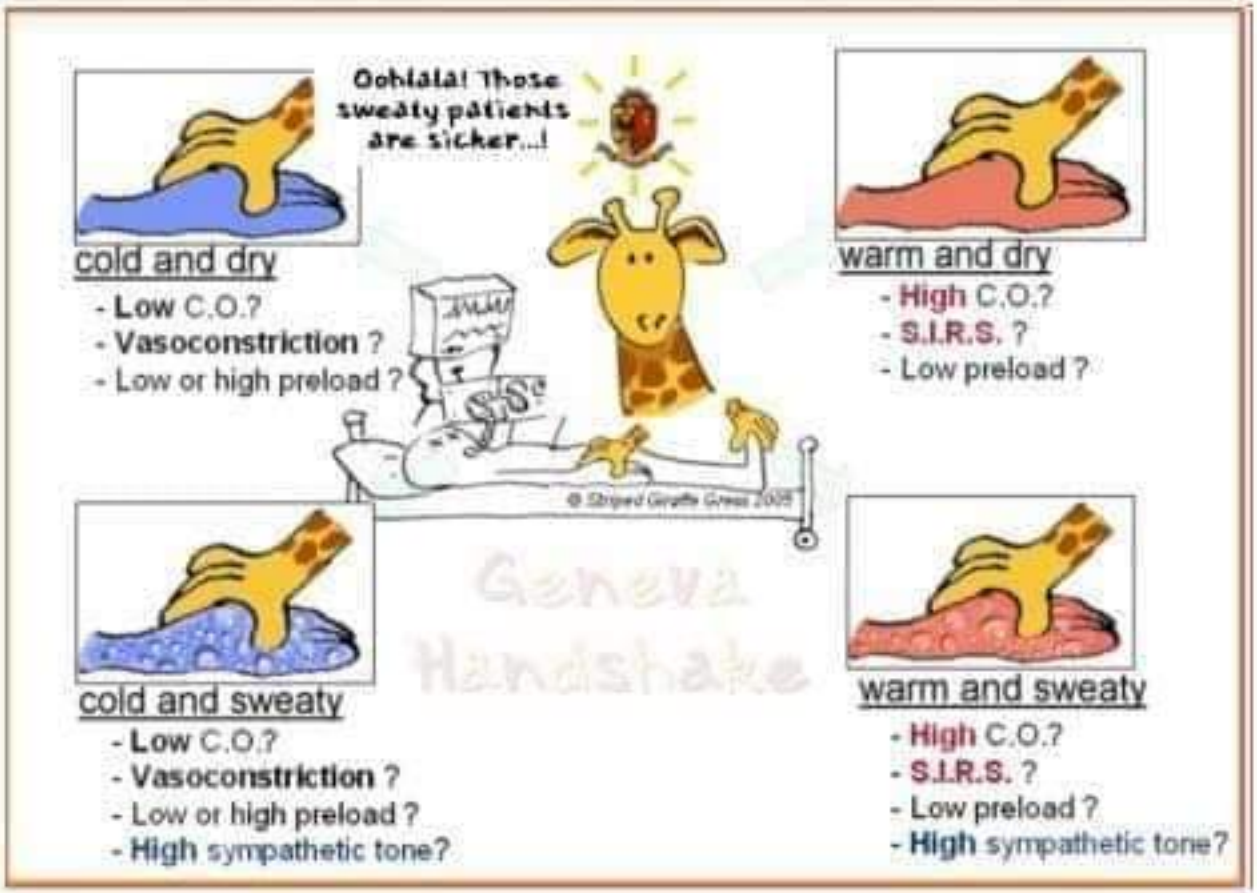
Multiple Organ Dysfunction Syndrome

- MODS is the progressive impairment of two or more systems from and uncontrolled inflammatory response to a severe illness or injury
- Mortality in MODS, secondary to SIRS is 60-98%

FYI – MODS timeline

- 24 hours
  - Low grade fever
  - Tachycardia
  - Dyspnea
  - Altered mental status
- 24-72 hours
  - Pulmonary failure begins
- 7-10 days
  - Hepatic failure begins
  - Intestinal failure begins
  - Renal failure begins
- 14-21 days
  - Renal and Hepatic failure intensify
  - Gastrointestinal collapse
  - Immune system collapse
- After 21 days
  - Hematologic failure begins
  - Myocardial failure begins
  - Altered Mental status resulting from encephalopathy
  - Death

The Geneva Handshake



Dopamine

- A naturally occurring substance that acts as a neurotransmitter
  - At low doses it causes dilation of renal, mesenteric and renal arteries which can stimulate urine output
  - At moderate doses it causes positive chronotropic and inotropic effects on the heart
  - At high doses it acts as a vasopressor, causing vasoconstriction and increased peripheral vascular resistance

Primary Use

- Cardiogenic shock
  - At 5-10 mcgm/kg/min, positive inotropic (stroke volume) and chronotropic (heart rate) effects can cause increased cardiac output (CO = HR x SV)
  - At > 10 mcgm/kg/min, vasopressor effect can raise blood pressure to increase perfusion of coronary arteries and improve inotropic function

Desired Dopamine Effect

- + inotropic effect
- ↑ mean arterial pressure
- ↑ coronary artery perfusion
- ↑ stroke volume
- ↑ forward pumping action of heart

Caution

- Intravenous fluids should be provided to maintain adequate preload (ie: **fill the tank**). Use caution to prevent fluid overload and worsen the pump failure (pulmonary edema or a decrease in BP are your warning signs)
- Extreme heart rates should be avoided because they may increase myocardial oxygen consumption, increase infarct size, and further impair the pumping ability of the heart. With higher doses, (the positive chronotropic effect of) dopamine has the disadvantage of increasing the heart rate and myocardial oxygen consumption.

Desired Outcome

- Used properly, at the right dose and with the right patient (adequate preload):

↑ Heart Rate

+

↑ Stroke Volume

=

↑ Cardiac Output

Secondary Use

- Bradycardia refractory to other therapy

Dopamine may be considered in the treatment of symptomatic bradycardia unresponsive to atropine, as a temporizing measure while awaiting availability of a pacemaker, or if pacing is ineffective

Bradycardia

UNSTABLE: altered mental status, signs of hypoperfusion

1. **Initial Medical Care**

Supraventricular Bradycardia, Second Degree Type-I AV blocks

2. **ATROPINE 0.5 mg rapid IV/IO or 1 mg ET;** may **repeat ATROPINE** q 3-5 minutes up to 3 mg until pacing available.
3. If patient remains hypotensive and pulse < 60: initiate **TRANSCUTANEOUS PACING (TCP)** at an initial rate of 70 bpm per System procedure. Consider sedation with **VERSED in 2 mg increments IV/IO** to a maximum of 10 mg.
4. If patient remains symptomatic, **DOPAMINE 5 – 10 mcg/kg/min IVPB**

IVR, Second Degree Type II or Third Degree AV block

2. Initiate **TRANSCUTANEOUS PACING (TCP)** at an initial rate of 70 bpm per system procedure. Consider sedation with **VERSED in 2 mg increments IV/IO** to a maximum of 10 mg.
3. If patient remains symptomatic, **DOPAMINE 5 – 10 mcg/kg/min IVPB**

Anaphylaxis

ALS

Anaphylaxis: multisystem reaction with signs of hypoperfusion; altered mental status or severe respiratory distress/wheezing/hypoxia

4. If signs of hypoperfusion, **IV/IO fluid challenges in 200 mL increments**
5. **EPINEPHRINE 1:10,000 0.5 mg slow IV/IO** or **1 mg ET**
   or **EPINEPHRINE 1:1000 0.5 mg injected sublingual** or **IM**
   - May repeat q 3 minutes
6. **BENADRYL 50 mg slow IV/IO.** If no IV, give IM. Max dose 50 mg.
7. Consider **ALBUTEROL** or **XOPENEX** per Acute Asthma SOP
8. Consider **DOPAMINE** per Cardiogenic Shock SOP for refractory hypotension

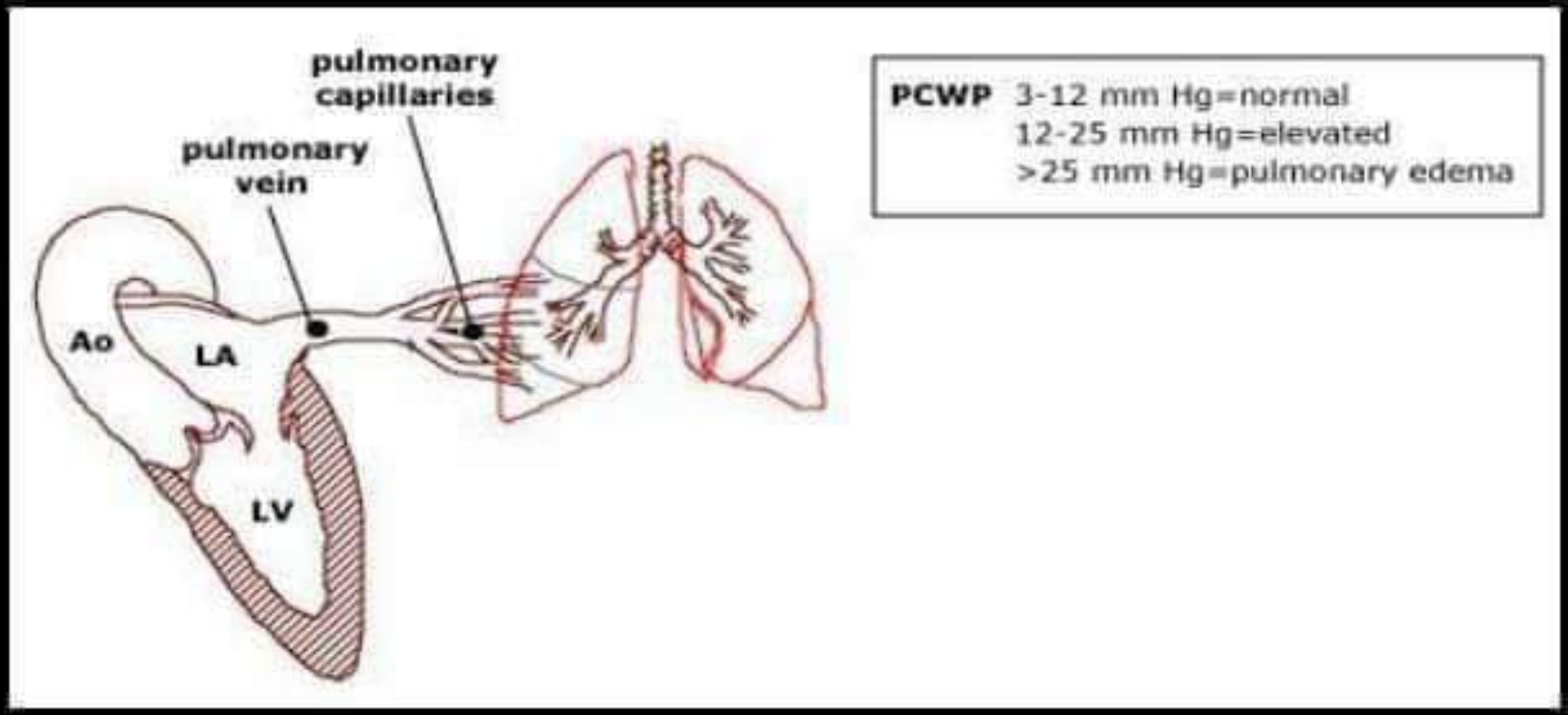
How does the body maintain normal blood pressure?

- The body has mechanisms to alter or maintain blood pressure and blood flow. There are sensors that sense blood pressure in the walls of the arteries and send signals to the heart, the arterioles, the veins, and the kidneys that cause them to make changes that lower or increase blood pressure. **There are several ways in which blood pressure can be adjusted** - by adjusting the amount of blood pumped by the heart into the arteries (cardiac output), the amount of blood contained in the veins, the arteriolar resistance, and the volume of blood.

Systolic and Diastolic

- Systolic blood pressure for most healthy adults falls between 90 and 120 millimeters of mercury (mm Hg). Normal diastolic blood pressure falls between 60 and 80 mm Hg. Current guidelines define normal blood pressure as lower than 120/80. Blood pressures over 130/80 are considered high.

Elevated Left Ventricular Diastolic Pressure Causes Pulmonary Congestion



Dr.Myron Prinzmetal

(1908-1987)

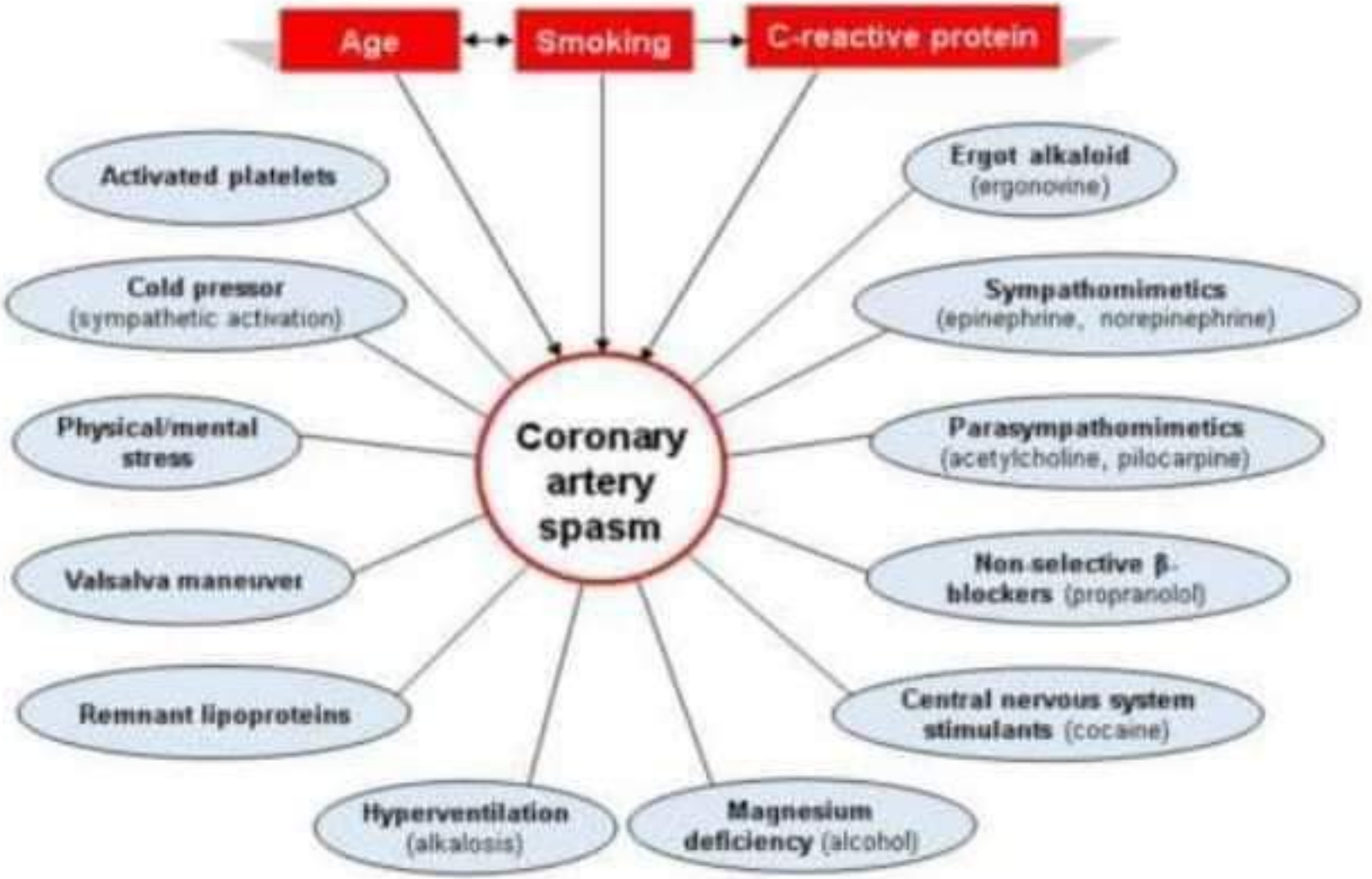


Figure 3. Risk factors and precipitating factors for the development of coronary artery spasm (CAS). While risk factors, which often coexist and interact with one another, increase a person's susceptibility to developing CAS, precipitating factors may contribute to the onset of CAS and act in the same patient to cause angina in different conditions. The risk factors and precipitating factors are represented by rectangles and circles, respectively.

SCAD = Spontaneous Coronary Artery Dissection

- Coronary arteries have 3 layers
- A dissection is when one or more inner layers tears away from the outer layer
- The torn flap of arterial wall sags and creates a blockage in blood flow to the heart, leading to angina, heart attack, or death

TYPES OF LIPOPROTEINS

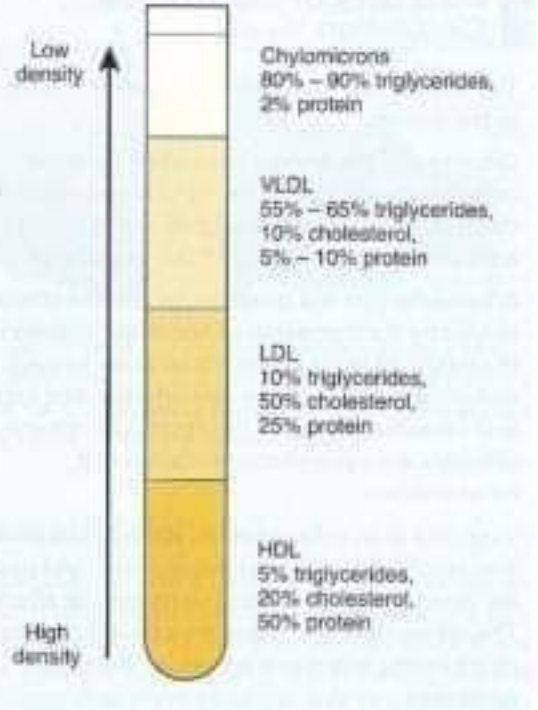
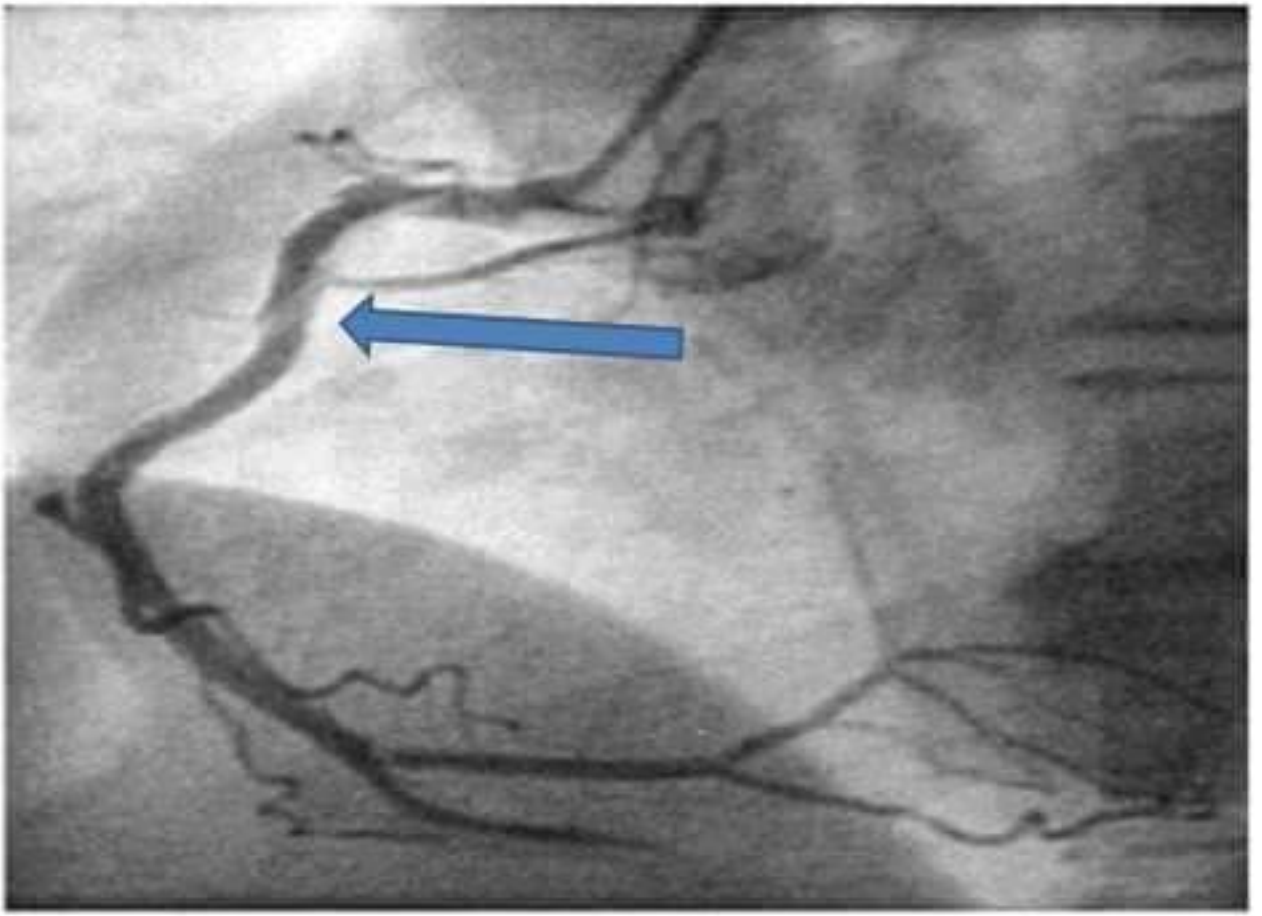


FIGURE 18-2. Lipoproteins are named based on their protein content, which is measured in density. Because fats are less dense than proteins, as the proportion of triglycerides decreases, the density increases. HDL, high-density lipoprotein; LDL, low-density lipoprotein; VLDL, very-low-density lipoprotein.

What does it mean?



Natural history

- Survival rates of SCAD is 70-90% survival
- Outcomes being more favourable should the acute phase be survived
- 1- and 10- year mortality 1.1% and 7.7%
- Men tend to have better survival rates
- Peri- or postpartum period have an even better prognosis than not pregnant

- Must be individualized
- Rx like ACS(+UFH)
- GP IIB-IIIA/TLT is a either edged sword-choose it carefully
- Angioplasty/surgery to the need
- Close F/U must

Follow me up

- Progression of the dissection and formation of pseudoaneurysms
- Any symptoms of recurrent ischemia
- Stress testing with nuclear perfusion imaging is preferred over coronary angiography as a means of surveillance

Conclusion

- Any young woman
- Nil risk factors for coronary artery disease and acute myocardial infarction
- Propensity for extension of dissection with or without mechanical revascularization
- Spontaneous healing
- Medical ℞ a is rational
- Therapy must be individualized