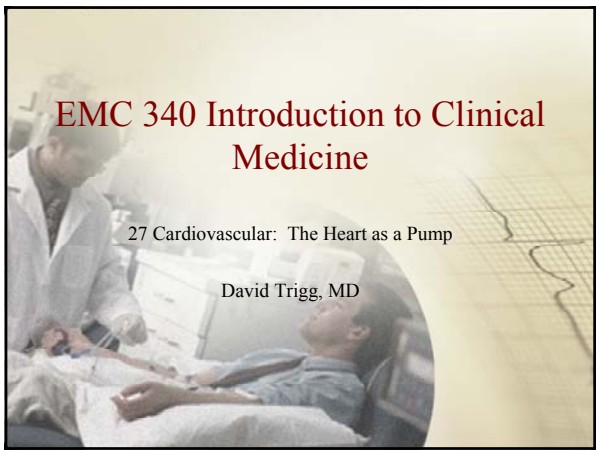
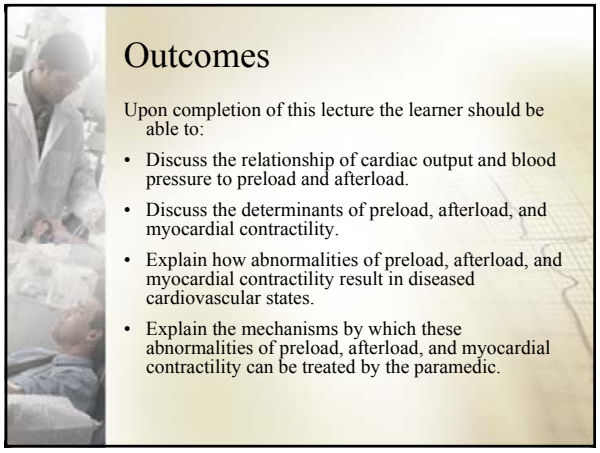


EMC 340 Introduction to Clinical Medicine

27 Cardiovascular: The Heart as a Pump

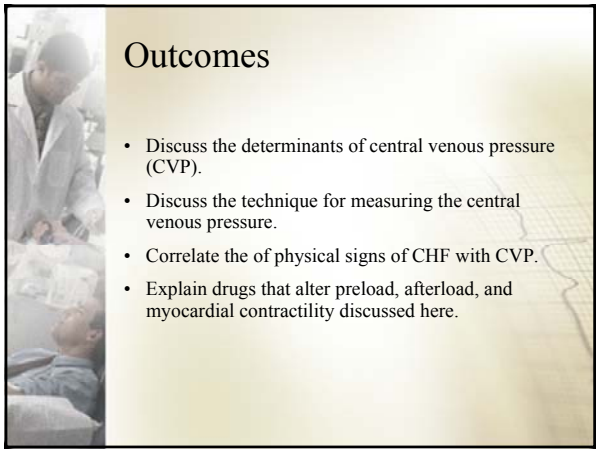
David Trigg, MD



Outcomes

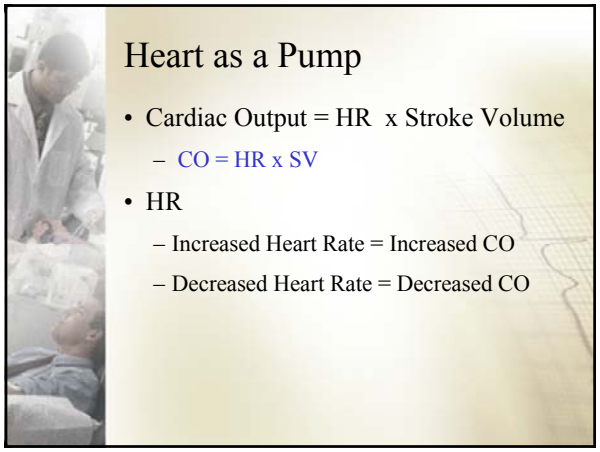
Upon completion of this lecture the learner should be able to:

- Discuss the relationship of cardiac output and blood pressure to preload and afterload.
- Discuss the determinants of preload, afterload, and myocardial contractility.
- Explain how abnormalities of preload, afterload, and myocardial contractility result in diseased cardiovascular states.
- Explain the mechanisms by which these abnormalities of preload, afterload, and myocardial contractility can be treated by the paramedic.



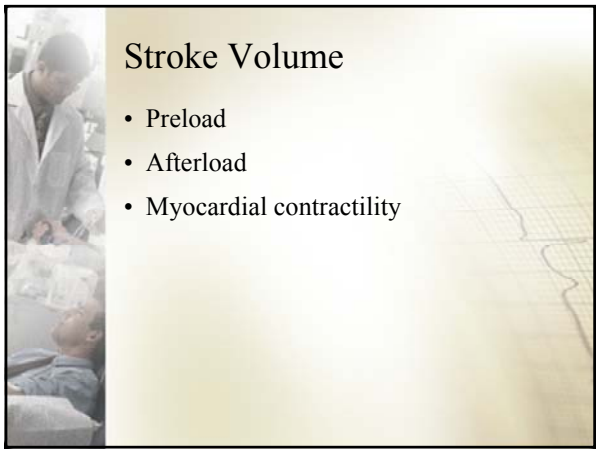
Outcomes

- Discuss the determinants of central venous pressure (CVP).
- Discuss the technique for measuring the central venous pressure.
- Correlate the of physical signs of CHF with CVP.
- Explain drugs that alter preload, afterload, and myocardial contractility discussed here.



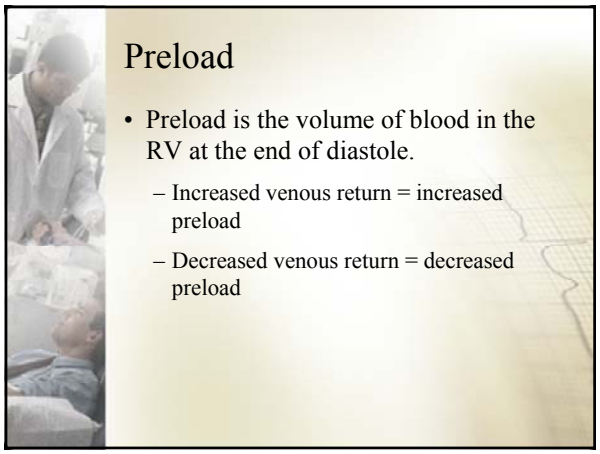
Heart as a Pump

- Cardiac Output = HR x Stroke Volume
  - CO = HR x SV
- HR
  - Increased Heart Rate = Increased CO
  - Decreased Heart Rate = Decreased CO



Stroke Volume

- Preload
- Afterload
- Myocardial contractility



Preload

- Preload is the volume of blood in the RV at the end of diastole.
  - Increased venous return = increased preload
  - Decreased venous return = decreased preload

Decrease of Venous Return

- Volume depletion
- Valsalva
- Exhalation / positive pressure
- Decreased stroke volume
- Vasodilator drugs

Increase in Venous Return

- Volume expansion
- Inhalation (negative pressure)
- Increased stroke volume
- CV hormones
  - ADH
  - ANP (Atrial Natriuretic Peptide)
  - renin-angiotensin-aldosterone

Afterload

- Afterload is the pressure against which LV works to empty.
  - Increased peripheral vesicular resistance = increased afterload
  - Decreased peripheral vesicular resistance = decreased afterload

Myocardial Contractility

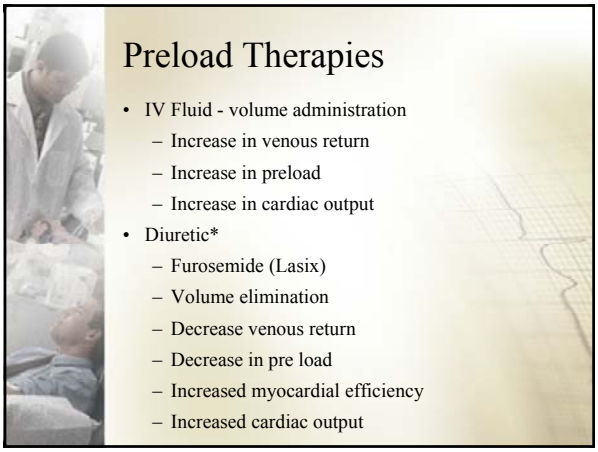
- Frank - Starling mechanism
  - Force of recoil proportional to length of stretch
- Adrenergic receptor activation
  - Sympathetic innervation (B1)
  - Circulating catecholamines (B1)
- Cardiac drugs

Preload (Volume) Problems

- Dehydration
  - Decrease of venous return
  - Decreased preload
  - Decreased cardiac output
  - Shock
- CHF
  - Volume overload
  - Increased venous return
  - Increased preload
  - Increased myocardial work
  - Declining myocardial efficiency
  - Decreased cardiac output

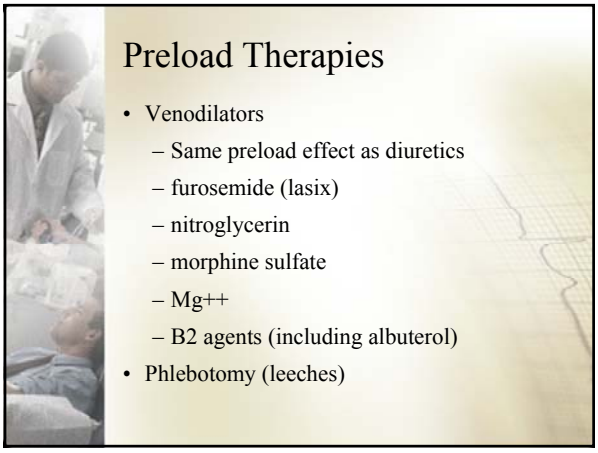
Afterload (Pressure) Problems

- Septic shock
  - Decreased PVR
  - Decreased afterload
  - Shock
- MAST
  - Increase in PVR
  - Increased afterload
  - Increased myocardial work
  - Declining myocardial efficiency
  - Decreased cardiac output



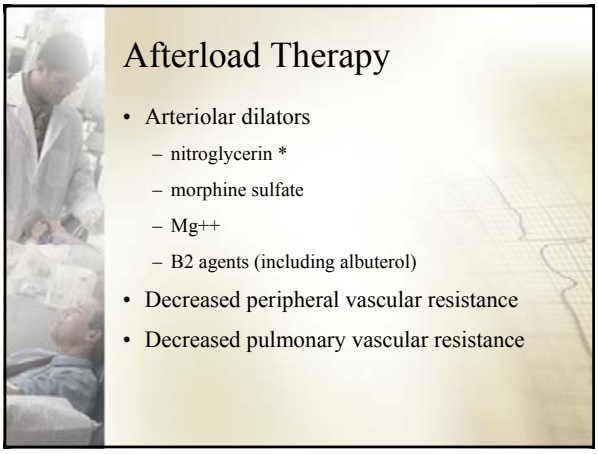
Preload Therapies

- IV Fluid - volume administration
  - Increase in venous return
  - Increase in preload
  - Increase in cardiac output
- Diuretic*
  - Furosemide (Lasix)
  - Volume elimination
  - Decrease venous return
  - Decrease in pre load
  - Increased myocardial efficiency
  - Increased cardiac output



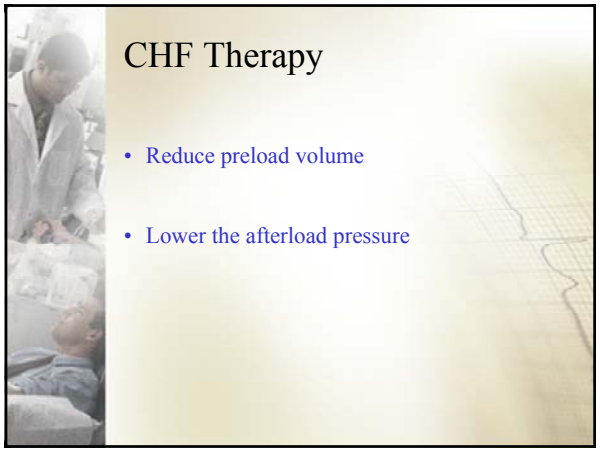
Preload Therapies

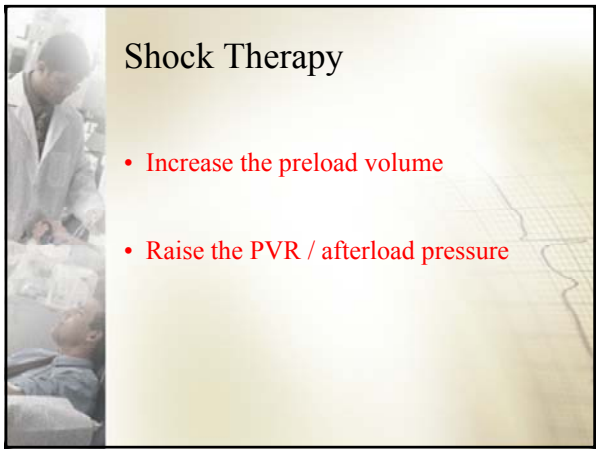
- Venodilators
  - Same preload effect as diuretics
  - furosemide (lasix)
  - nitroglycerin
  - morphine sulfate
  - Mg++
  - B2 agents (including albuterol)
- Phlebotomy (leeches)

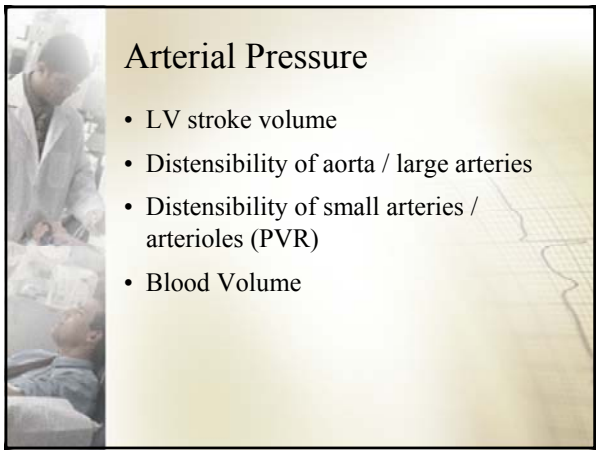


Afterload Therapy

- Arteriolar dilators
  - nitroglycerin *
  - morphine sulfate
  - Mg++
  - B2 agents (including albuterol)
- Decreased peripheral vascular resistance
- Decreased pulmonary vascular resistance


CHF Therapy
• Reduce preload volume
• Lower the afterload pressure


Shock Therapy
• Increase the preload volume
• Raise the PVR / afterload pressure

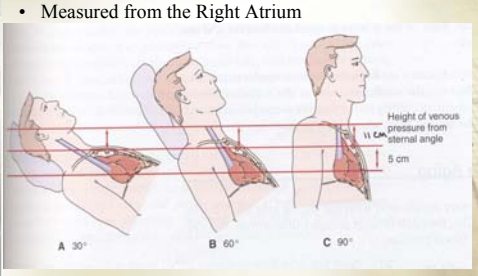

Arterial Pressure
• LV stroke volume
• Distensibility of aorta / large arteries
• Distensibility of small arteries / arterioles (PVR)
• Blood Volume

Central Venous Pressure

- Right Ventricular receptivity
- Distensibility of lungs / pulmonary vasculature
- Intrathoracic pressure
- Blood Volume

Central Venous Pressure

- 5 - 10 cm H_2O is considered normal
- Measured from the Right Atrium



Central Venous Pressure

- 5 - 10 cm H_2O - Normal
- < 5 - Volume deficit (dehydration)
- 11 - Mild elevation (mild CHF)
- 15 - Moderate (moderate CHF)
- >20 - Severe (severe CHF)

Signs of CHF with CVP's

Symptoms	Signs	CVP	Class	Mortality
DOE	Bibasilar rales; NVD: mild	11	I	1%
SOB at rest; cough	Diffuse rales; NVD: midneck	15	II	10%
Wet cough	Wheezing; pink sputum; NVD: to jaw	20	III	20%
Shock, low BP	Cyanosis	25	IV	60%

CVP Findings

- NVD: 11cm
  - If NVD barely visible above clavicle, then SVC is "backed-up" 11cm above the right atrium (Visible neck veins = CVP of at least 11 cm H_2O)
- NVD: Mid neck
  - If NVD visible at a point midway up the neck,then CVP of approx. 15 cm H_2O
- NVD: To the ear
  - If NVD visible all the way up the neck, to the angle of the jaw, then CVP of approx. 20 cm H_2O

Summary

- We have discussed cardiac output, arterial and venous pressures, preload and afterload, and myocardial contractility.
- We have discussed how abnormalities of preload, afterload, myocardial contractility, and central venous pressure can result in cardiovascular disease and the therapeutic benefit of altering these.