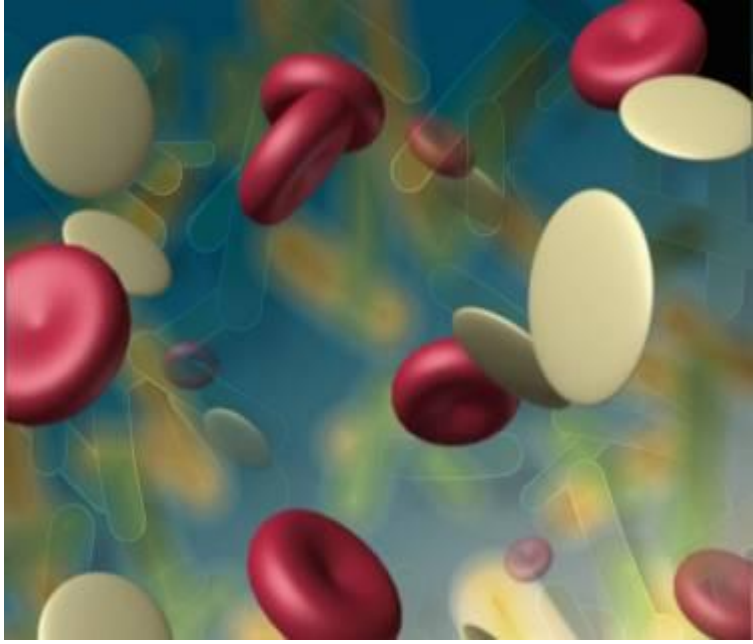
Shock



Prof. Abdelwahab Saleh

Intensive care medicine

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Critical cases

Objectives

- Definition
- Classification
- Types
- Specific treatments for each type
- High lights on inotropic
- Complications of shock
- Decision of blood transfusion

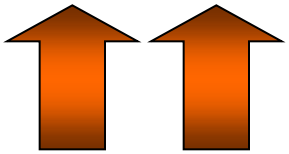
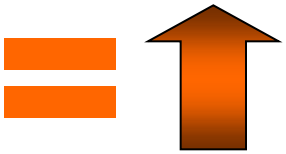
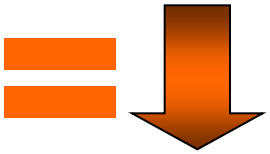
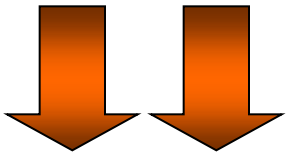
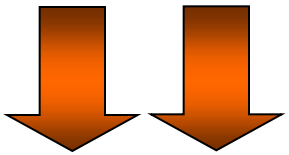
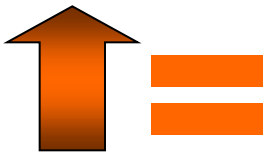
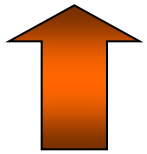
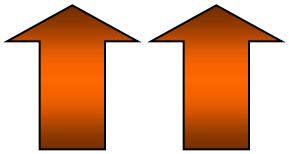
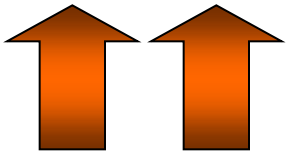
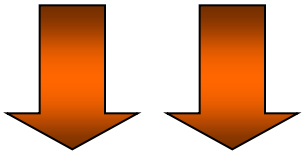
Definition of Shock

- Inadequate oxygen delivery to meet metabolic demands
- Results in global tissue hypoperfusion and metabolic acidosis
- Shock can occur with a normal blood pressure and hypotension can occur without shock
- In early signs of shock blood pressure normal or elevated due to cmpensatory hormone release

Types of Shock

- Hypovolemic
- Cardiogenic
- Septic
- Anaphylactic
- Neurogenic
- Obstructive

Classification of Shock

	Hypovolemic (hemorrhage)	Cardiogenic (myocardial infarction)	Obstructive (pulmonary embolism)	Distributive (septic shock)
PAOP				
CO				
SVR				

Hypovolumic Shock Classification

- Hemorrhagic
  - Trauma, GI
- Non hemorrhagic
  - Dehydration
    - vomiting, diarrhea,fistulas, burns, polyuric (eg, DKA, DI)
  - Third spacing
    - post-op, pancreatitis, ascites, nephrosis

Cardiogenic Shock Classification

- Myocardial
  - Infarction, contusion, myocarditis, cardiomyopathy, pharmacologic,depressant factors
- Mechanical
  - Valvular stenosis, regrurgitation
  - Septal Defects
- Arrhythmogenic

Obstructive Shock Classification

- Extrinsic Vascular Compression
  - tumors, fibrosis
- Increased Intrathoracic Pressure
  - Tension pneumo , high auto peep in PPV
- Flow obstruction
  - PE, Air embolism, tumors, Ao dissection, Ao coarctation, acute pulmonary HTN, tamponade.

Distributive Shock Classification

- SIRS-related (any shock can end up w/SIRS)
  - Sepsis (infectious); pancreatitis; trauma; burns.
- Anaphylactic/anaphylactoid
- Spinal Trauma (low pulse, SVR low)
- Toxic, pharmacologic
- Endocrine (thyroid, adrenal crisis)

Diagnosis of shock

- History
  - Recent illness
  - Fever
  - Chest pain, SOB
  - Abdominal pain
  - Comorbidities
  - Medications
  - Toxins/Ingestions
  - Recent hospitalization or surgery
  - Baseline mental status
- Physical examination
  - Vital Signs
  - CNS – mental status
  - Skin – color, temp, rashes, sores
  - CV – JVD, heart sounds
  - Resp – lung sounds, RR, oxygen sat, ABG
  - GI – abd pain, rigidity, guarding, rebound
  - Renal – urine output

Diagnosis

- Physical exam (VS, mental status, skin color, temperature, pulses, etc)
- Infectious source
- Labs:
  - CBC
  - Chemistries
  - Lactate
  - Coagulation studies
  - Cultures
  - ABG

Further diagnosis

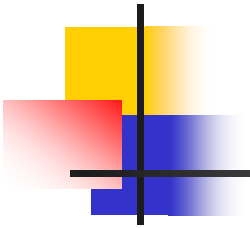
- CT of head/sinuses
- Lumbar puncture
- Wound cultures
- Acute abdominal series
- Abdominal/pelvic CT or US
- Cortisol level
- Fibrinogen, FDPs, D-dimer

Suggested Shock Clinical Criteria*

SBP <90 mm Hg for >30 min:
a. Or mean BP <60 mm Hg for >30 min
b. Or requirement of vasopressors to maintain systolic BP ≥90 mm Hg or mean BP ≥60 mm Hg
Hypoperfusion defined by:
c. Decreased mentation
d. Cold extremities, livedo reticularis
e. Urine output <30 mL/h
f. Lactate >2 mmol/L

Suggested Shock Hemodynamic Criteria*

1. SBP <90 mm Hg or mean BP <60 mm Hg
2. Cardiac index <2.2 L/min/m^2
3. Pulmonary capillary wedge pressure >15 mm Hg
4. Other hemodynamic considerations
a. Cardiac power output ([CO x MAP]/451) <0.6 W
b. Shock index (HR/systolic BP) >1.0
c. RV shock
i. Pulmonary artery pulse index [(PASP-PADP)/CVP] <1.0
i. CVP >15 mm Hg
i. CVP-PCW >0.6



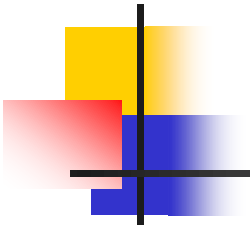
SHOCK COMPLICATIONS

Complications of shock

- Endothelial inflammation and disruption
- Inability of O2 delivery to meet demand
- Result:
  - Lactic acidosis
  - Cardiovascular insufficiency
  - Increased metabolic demands

Complications of shock

- Progression of physiologic effects as shock ensues
  - Cardiac depression
  - Respiratory distress
  - Renal failure
  - DIC
- Result is end organ failure
- Multible organ dysfunction (MODS)



TREATMENT OF SHOCK

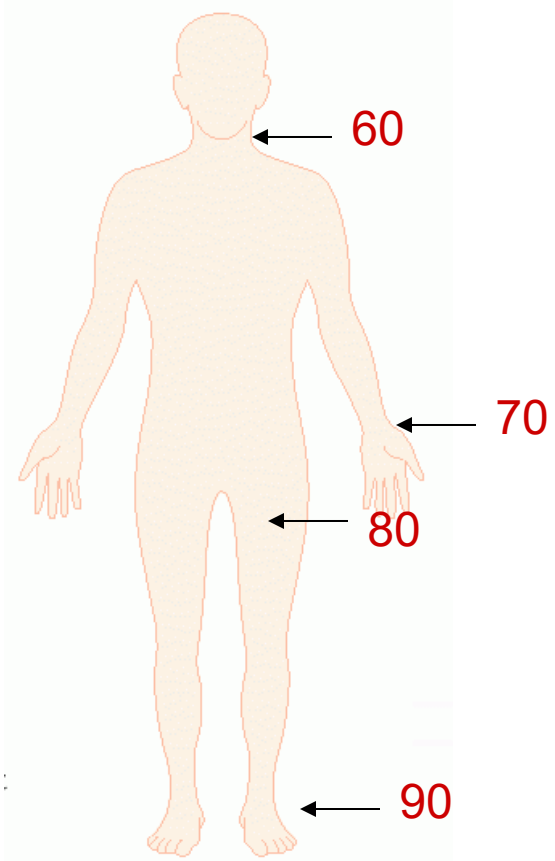
Is This Patient in Shock? Quiz 1

- Patient looks ill
- Altered mental status
- Skin cool and mottled or hot and flushed
- Weak or absent peripheral pulses
- SBP <110
- Tachycardia

Yes!
These are all signs and symptoms of shock

Shock

- Do you remember how to quickly estimate blood pressure by pulse?
- If you palpate a pulse, you know SBP is at least this number



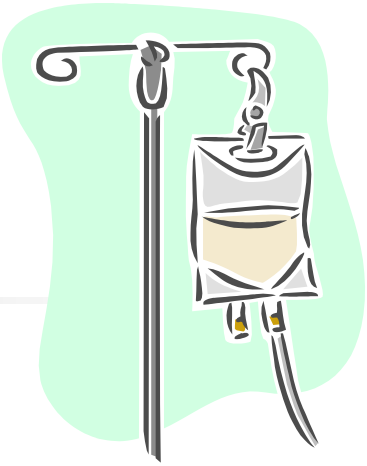
Goals of Treatment

- ABCDE
  - **A**irway
  - control work of **B**reathing
  - optimize **C**irculation
  - assure adequate oxygen **D**elivery
  - achieve **E**nd points of resuscitation

Control Work of Breathing

- Respiratory muscles consume a significant amount of oxygen
- Tachypnea can contribute to lactic acidosis
- Mechanical ventilation and sedation decrease WOB and improves survival

Optimizing Circulation



- Isotonic crystalloids
- Titrated to:
  - CVP 8-12 mm Hg
  - Urine output 0.5 ml/kg/hr (30 ml/hr)
  - Improving heart rate
- May require 4-6 L of fluids
- No outcome benefit from colloids

Maintaining Oxygen Delivery

- Decrease oxygen demands
  - Provide analgesia and anxiolytics to relax muscles and avoid shivering
- Maintain arterial oxygen saturation/content
  - Give supplemental oxygen
  - Maintain Hemoglobin > 10 g/dL
- Serial lactate levels or central venous oxygen saturations to assess tissue oxygen extraction

End Points of Resuscitation

- Goal of resuscitation is to maximize survival and minimize morbidity
- Use objective hemodynamic and physiologic values to guide therapy
- Goal directed approach
  - Urine output > 0.5 mL/kg/hr
  - CVP 8-12 cm.H2O
  - MAP 65 to 90 mmHg
  - Central venous oxygen concentration > 70%

Persistent Hypotension

- Inadequate volume resuscitation
- Pneumothorax
- Cardiac tamponade
- Hidden bleeding
- Adrenal insufficiency
- Medication allergy

What Type of Shock is This?

- 68 yo M with hx of HTN and DM presents to the ER with abrupt onset of diffuse abdominal pain with radiation to his low back. The pt is hypotensive, tachycardic, afebrile, with cool but dry skin

Hypovolemic Shock

Types of Shock

- Hypovolemic
- Septic
- Cardiogenic
- Anaphylactic
- Neurogenic
- Obstructive

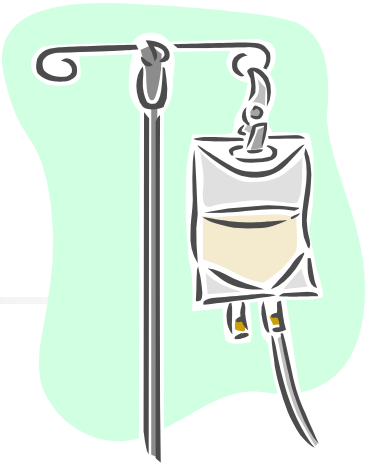
Hypovolumic Shock Classification

- Hemorrhagic
  - Trauma, GI
- Non hemorrhagic
  - Dehydration
    - vomiting, diarrhea,fistulas, burns, polyuric (eg, DKA, DI)
  - Third spacing
    - post-op, pancreatitis, ascites, nephrosis

Hypovolemic Shock

- ABCs
- Establish 2 large bore IVs or a central line
- Crystalloids
  - Normal Saline or Lactate Ringers
  - Up to 3 liters
- PRBCs
  - O negative or cross matched
- Control any bleeding
- Arrange definitive treatment

Optimizing Circulation



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  - CVP 8-12 mm Hg
  - Urine output 0.5 ml/kg/hr (30 ml/hr)
  - Improving heart rate
- May require 4-6 L of fluids
- No outcome benefit from colloids

Types of intravenous fluids

1- Crystalloids

- Hypotonics (Dextrose 5% , saline 0.45% , dexstrose 5% in saline 0.9% 4:1)
- Isotonic solutions :- (saline 0.9% , ringer ringer lactate . ringer acetate & normosol)
- Hypertonic solutions (Nacl 3% , 7.5% , mannitol 10% , 20% , sodium bicarbonate 0.5% , 7.5% , 8.4%)

Types of intravenous fluids

2- Colloids

A- Natural = blood derived

- Human albumin
- FFP

B- Synthetic

- Dextrane starch
- Gelatins
- HES (Hydroxyn Ethyl Starch)

Types of intravenous fluids

3- Blood transfusion

- Whole blood
- Packed RBCs
- FFP
- Cryo precipitate
- Human albumin
- Coagulation factors
- Immune factors
- platelets

End Points of Resuscitation

- Goal of resuscitation is to maximize survival and minimize morbidity
- Use objective hemodynamic and physiologic values to guide therapy
- Goal directed approach
  - Urine output > 0.5 mL/kg/hr
  - CVP 8-12 cm.H2O
  - MAP 65 to 90 mmHg
  - Central venous oxygen concentration > 70%

What Type of Shock is This?

- A 55 yo M with hx of HTN, DM presents with "crushing" substernal CP, diaphoresis, hypotension, tachycardia and cool, clammy extremities

Cardiogenic

Types of Shock

- Hypovolemic
- Septic
- Cardiogenic
- Anaphylactic
- Neurogenic
- Obstructive

Cardiogenic Shock

- Defined as:
  - SBP < 90 mmHg
  - CI < 2.2 L/m/m^2
  - PCWP > 18 mmHg

  Or Pop > 18 mmHg

- Signs:
  - Cool, mottled skin
  - Tachypnea
  - Hypotension
  - Altered mental status
  - Narrowed pulse pressure
  - Rales, murmur

Cardiogenic Shock Classification

- Myocardial
  - Infarction, contusion, myocarditis, cardiomyopathy, pharmacologic tach.&brad., depressant factors
- Mechanical
  - Valvular stenosis, regrurgitation
  - Septal Defects
- Arrhythmia

Etiologies

- What are some causes of cardiogenic shock?
  - AMI
  - Sepsis
  - Myocarditis
  - Myocardial contusion
  - Aortic or mitral stenosis, HOCM
  - Acute aortic insufficiency

Treatment of Cardiogenic Shock

- Goals- Airway stability and improving myocardial pump function
- Cardiac monitor, pulse oximetry
- Supplemental oxygen, IV access
- Intubation will decrease preload and result in hypotension
  - Be prepared to give fluid bolus

Treatment of Cardiogenic Shock

- AMI
  - Aspirin, beta blocker, morphine, heparin
  - If no pulmonary edema, IV fluid challenge
  - If pulmonary edema
    - Dopamine – will ↑ HR and thus cardiac work
    - Dobutamine – May drop blood pressure
    - Combination therapy may be more effective
  - PCI or thrombolytics
- RV infarct
  - Fluids and Dobutamine (no NTG)
- Acute mitral regurgitation or VSD
  - Pressors (Dobutamine and Nitroprusside)

What Type of Shock is This?

- An 81 yo F resident of a nursing home presents to the ED with altered mental status. She is febrile to 39.4, hypotensive with a widened pulse pressure, tachycardic, with warm extremities

Septic

Types of Shock

- Hypovolemic
- Septic
- Cardiogenic
- Anaphylactic
- Neurogenic
- Obstructive

Distributive Shock Classification

- SIRS-related (any shock can end up w/SIRS)
  - Sepsis (infectious); pancreatitis; trauma; burns.
- Anaphylactic/anaphylactoid
- Spinal Trauma (low pulse, SVR low)
- Toxic, pharmacologic
- Endocrine (throid, adrenal crisis)

Sepsis

- Two or more of SIRS criteria
  - Temp > 38 or < 36 C
  - HR > 90
  - RR > 20
  - WBC > 12,000 or < 4,000
- Plus the presumed existence of infection
- Blood pressure can be normal!

Septic Shock

- Sepsis (remember definition?)
- Plus refractory hypotension
  - After bolus of 20-40 mL/Kg patient still has one of the following:
    - SBP < 90 mm Hg
    - MAP < 65 mm Hg
    - Decrease of 40 mm Hg from baseline

Septic Shock

- Clinical signs:
  - Hyperthermia or hypothermia
  - Tachycardia
  - Wide pulse pressure
  - Low blood pressure (SBP<90)
  - Mental status changes
- Beware of compensated shock!
  - Blood pressure may be “normal”

Treatment of Septic Shock

- 2 large bore IVs
  - NS IVF bolus- 1-2 L wide open (if no contraindications)
- Supplemental oxygen
- Empiric antibiotics, based on suspected source, as soon as possible

Treatment of Sepsis

- Antibiotics- Survival correlates with how quickly the correct drug was given
- Cover gram positive and gram negative bacteria
  - Zosyn 3.375 grams IV and ceftriaxone 1 gram IV ***or***
  - Imipenem 1 gram IV
- Add additional coverage as indicated
  - Pseudomonas- Gentamicin or Cefepime
  - MRSA- Vancomycin
  - Intra-abdominal or head/neck anaerobic infections- Clindamycin or Metronidazole
  - Asplenic- Ceftriaxone for *N. meningitidis, H. infuenzae*
  - Neutropenic – Cefepime or Imipenem

Persistent Hypotension

- If no response after 2-3 L IVF, start a vasopressor (norepinephrine, dopamine, etc) and titrate to effect
- Goal: MAP > 60
- Consider adrenal insufficiency: hydrocortisone 100 mg IV

What Type of Shock is This?

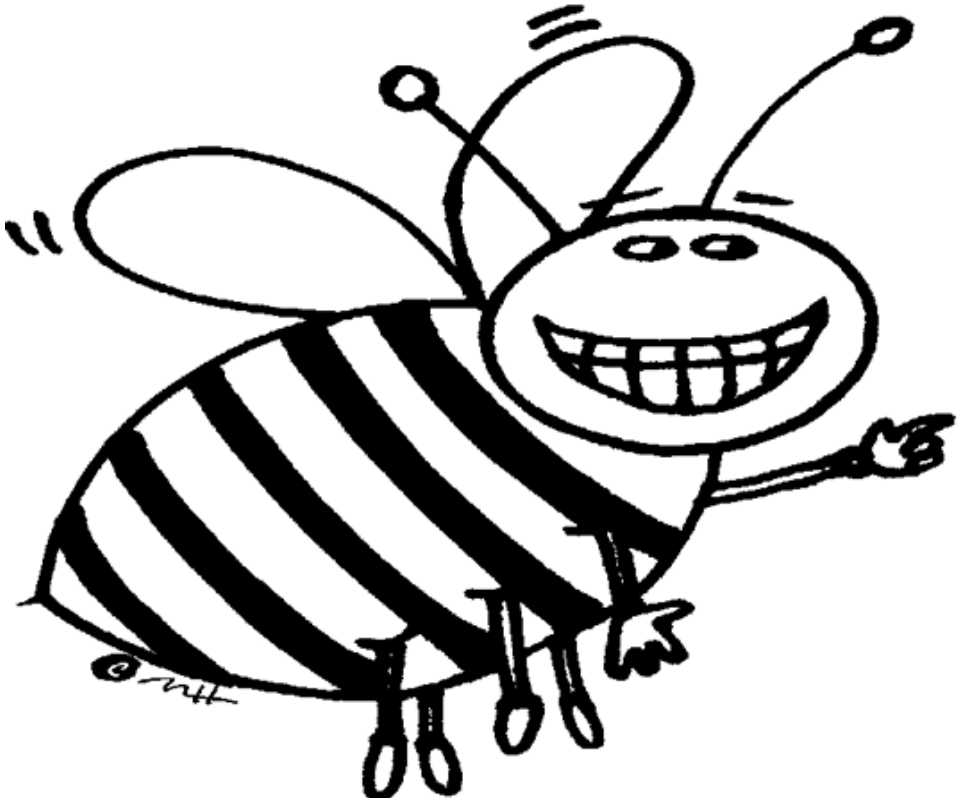
- A 34 yo F presents to the ER after dining at a restaurant where shortly after eating the first few bites of her meal, became anxious, diaphoretic, began wheezing, noted diffuse pruritic rash, nausea, and a sensation of her "throat closing off". She is currently hypotensive, tachycardic and ill appearing.

Anaphalactic

Types of Shock

- Hypovolemic
- Septic
- Cardiogenic
- Anaphylactic
- Neurogenic
- Obstructive

Anaphalactic Shock



Anaphylactic Shock

- Anaphylaxis – a severe systemic hypersensitivity reaction characterized by multisystem involvement
  - IgE mediated
- Anaphylactoid reaction – clinically indistinguishable from anaphylaxis, do not require a sensitizing exposure
  - Not IgE mediated

Anaphylactic Shock

- What are some symptoms of anaphylaxis?
  - First- Pruritus, flushing, urticaria appear
  - Next- Throat fullness, anxiety, chest tightness, shortness of breath and lightheadedness
  - Finally- Altered mental status, respiratory distress and circulatory collapse

Anaphylactic Shock

- Risk factors for fatal anaphylaxis
  - Poorly controlled asthma
  - Previous anaphylaxis
- Reoccurrence rates
  - 40-60% for insect stings
  - 20-40% for radiocontrast agents
  - 10-20% for penicillin
- Most common causes
  - Antibiotics
  - Insects
  - Food

Anaphylactic Shock

- Mild, localized urticaria can progress to full anaphylaxis
- Symptoms usually begin within 60 minutes of exposure
- Faster the onset of symptoms = more severe reaction
- Biphasic phenomenon occurs in up to 20% of patients
  - Symptoms return 3-4 hours after initial reaction has cleared
- A “lump in my throat” and “hoarseness” heralds life-threatening laryngeal edema

Anaphylactic Shock- Diagnosis

- Clinical diagnosis
  - Defined by airway compromise, hypotension, or involvement of cutaneous, respiratory, or GI systems
- Look for exposure to drug, food, or insect
- Labs have no role

Anaphylactic Shock- Treatment

- ABC's
  - Angioedema and respiratory compromise require immediate intubation
- IV, cardiac monitor, pulse oximetry
- IVFs, oxygen
- Epinephrine
- Second line
  - Corticosteriods
  - H1 and H2 blockers

Anaphylactic Shock- Treatment

- Epinephrine
  - 0.3 mg IM of 1:1000 (epi-pen)
  - Repeat every 5-10 min as needed
  - Caution with patients taking beta blockers- can cause severe hypertension due to unopposed alpha stimulation
  - For CV collapse, 1 mg IV of 1:10,000
  - If refractory, start IV drip

Anaphylactic Shock - Treatment

- Corticosteroids
  - Methylprednisolone 125 mg IV
  - Prednisone 60 mg PO
- Antihistamines
  - H1 blocker- Diphenhydramine 25-50 mg IV
  - H2 blocker- Ranitidine 50 mg IV
- Bronchodilators
  - Albuterol nebulizer
  - Atrovent nebulizer
  - Magnesium sulfate 2 g IV over 20 minutes
- Glucagon
  - For patients taking beta blockers and with refractory hypotension
  - 1 mg IV q5 minutes until hypotension resolves

Anaphylactic Shock - Disposition

- All patients who receive epinephrine should be observed for 4-6 hours
- If symptom free, discharge home
- If on beta blockers or h/o severe reaction in past, consider admission

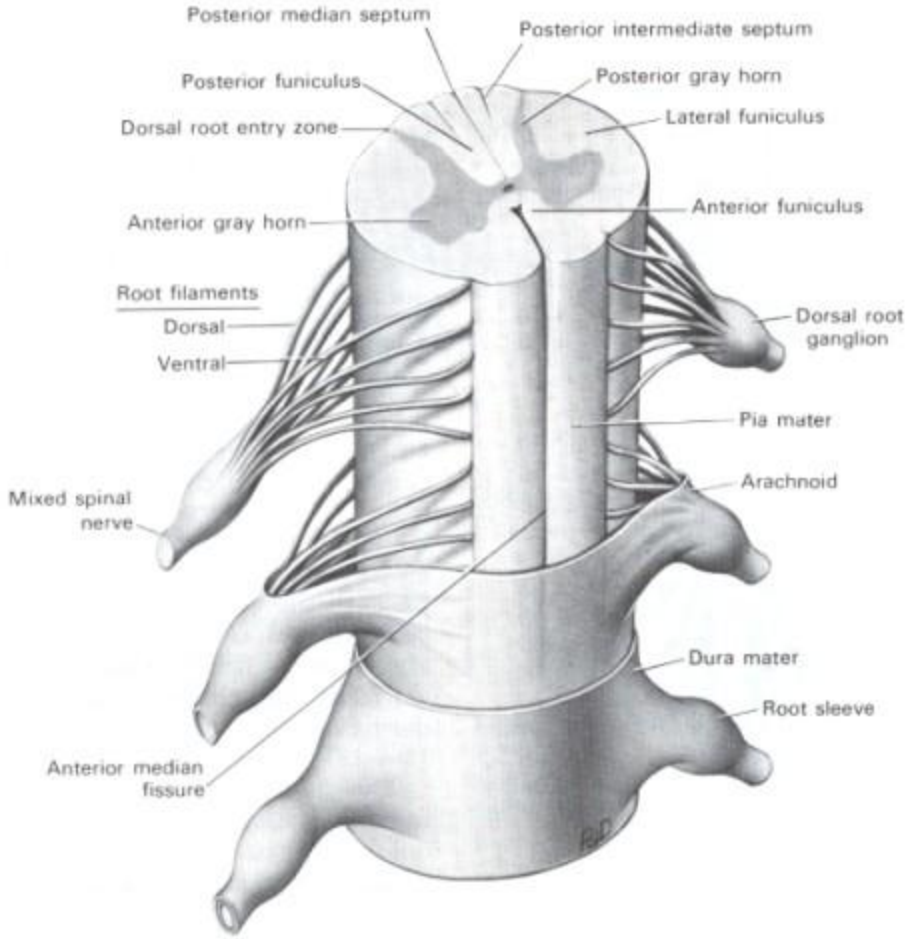
What Type of Shock is This?

- A 41 yo M presents to the ER after an MVC complaining of decreased sensation below his waist and is now hypotensive, bradycardic, with warm extremities

<u>Types of Shock</u>

- Hypovolemic
- Septic
- Cardiogenic
- Anaphylactic
- Neurogenic
- Obstructive

Neurogenic Shock



Neurogenic Shock

- Occurs after acute spinal cord injury
- Sympathetic outflow is disrupted leaving unopposed vagal tone
- Results in hypotension and bradycardia
- Spinal shock- temporary loss of spinal reflex activity below a total or near total spinal cord injury (not the same as neurogenic shock, the terms are not interchangeable)

Neurogenic Shock

- Loss of sympathetic tone results in warm and dry skin
- Shock usually lasts from 1 to 3 weeks
- Any injury above T1 can disrupt the entire sympathetic system
  - Higher injuries = worse paralysis

Neurogenic Shock- Treatment

- A,B,Cs
  - Remember c-spine precautions
- Fluid resuscitation
  - Keep MAP at 85-90 mm Hg for first 7 days
  - Thought to minimize secondary cord injury
  - If crystalloid is insufficient use vasopressors
- Search for other causes of hypotension
- For bradycardia
  - Atropine
  - Pacemaker

Neurogenic Shock- Treatment

- Methylprednisolone
  - Used only for blunt spinal cord injury
  - High dose therapy for 23 hours
  - Must be started within 8 hours
  - Controversial- Risk for infection, GI bleed

What Type of Shock is This?

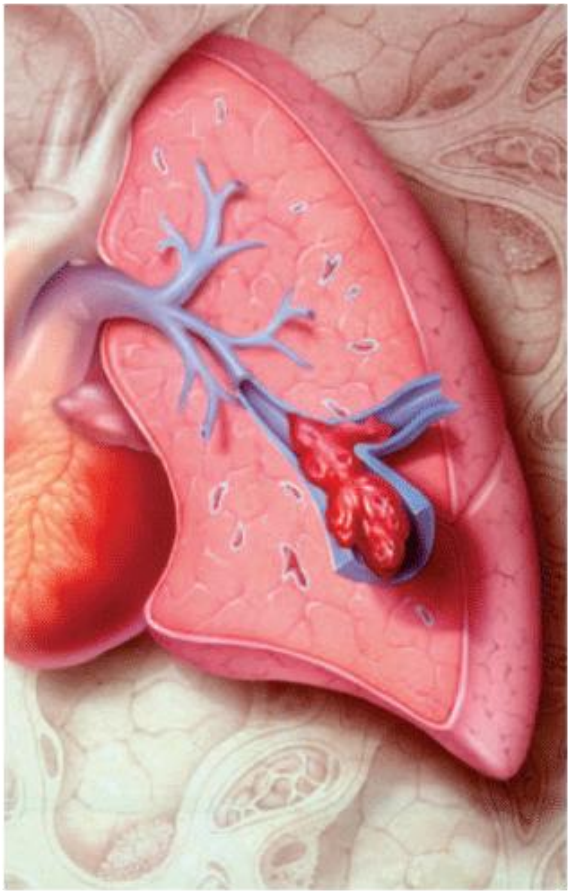
- A 24 yo M presents to the ED after an MVC c/o chest pain and difficulty breathing. On PE, you note the pt to be tachycardic, hypotensive, hypoxic, and with decreased breath sounds on left

Obstructive

Types of Shock

- Hypovolemic
- Septic
- Cardiogenic
- Anaphylactic
- Neurogenic
- Obstructive

Obstructive Shock



Obstructive Shock Classification

- Extrinsic Vascular Compression
  - tumors, fibrosis
- Increased Intrathoracic Pressure
  - Tension pneumo; high auto peep in PPV
- Flow obstruction
  - PE, Air embolism, tumors, Ao dissection, Ao coarctation, acute pulmonary HTN, tamponade.

Obstructive Shock

- Tension pneumothorax
  - Air trapped in pleural space with 1 way valve, air/pressure builds up
  - Mediastinum shifted impeding venous return
  - Chest pain, SOB, decreased breath sounds
  - No tests needed!
  - Rx: Needle decompression, chest tube

Obstructive Shock

- Cardiac tamponade
  - Blood in pericardial sac prevents venous return to and contraction of heart
  - Related to trauma, pericarditis, MI
  - Beck's triad: hypotension, muffled heart sounds, JVD
  - Diagnosis: large heart CXR, echo
  - Rx: Pericardiocentisis

Obstructive Shock

- Pulmonary embolism
  - Virscow triad: hypercoaguable, venous injury, venostasis
  - Signs: Tachypnea, tachycardia, hypoxia
  - Low risk: D-dimer
  - Higher risk: CT chest or VQ scan
  - Rx: Heparin, consider thrombolytics

Obstructive Shock

- Aortic stenosis
  - Resistance to systolic ejection causes decreased cardiac function
  - Chest pain with syncope
  - Systolic ejection murmur
  - Diagnosed with echo
  - Vasodilators (NTG) will drop pressure!
  - Rx: Valve surgery