

Shock

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Objectives

- To develop an understanding of the definition and pathophysiology of shock
- To develop an understanding and overview of the different types of shock
- To develop a systematic approach to the detection and management of shock

Definition of Shock

- Although early definitions of shock lack scientific terminology and reveal the inadequate understanding of pathophysiology prevalent at the time, they compensate for it in simplicity and accuracy
- John Collins Warren described shock as “a momentary pause in the act of death”
- Samuel Gross defined it as “a rude unhinging of the machinery of life”
- With improved understanding of cellular physiology and function, we now recognize Gross' "machinery of life" to be the delivery and utilization of oxygen at the cellular level
- As a result, shock is currently best defined as a multifactorial syndrome resulting in inadequate tissue perfusion and cellular oxygenation affecting multiple organ systems

Definition of Shock

- **Inadequate perfusion and oxygenation of cells and tissues leads to:**
 - Cellular dysfunction and damage
 - Organ dysfunction and damage

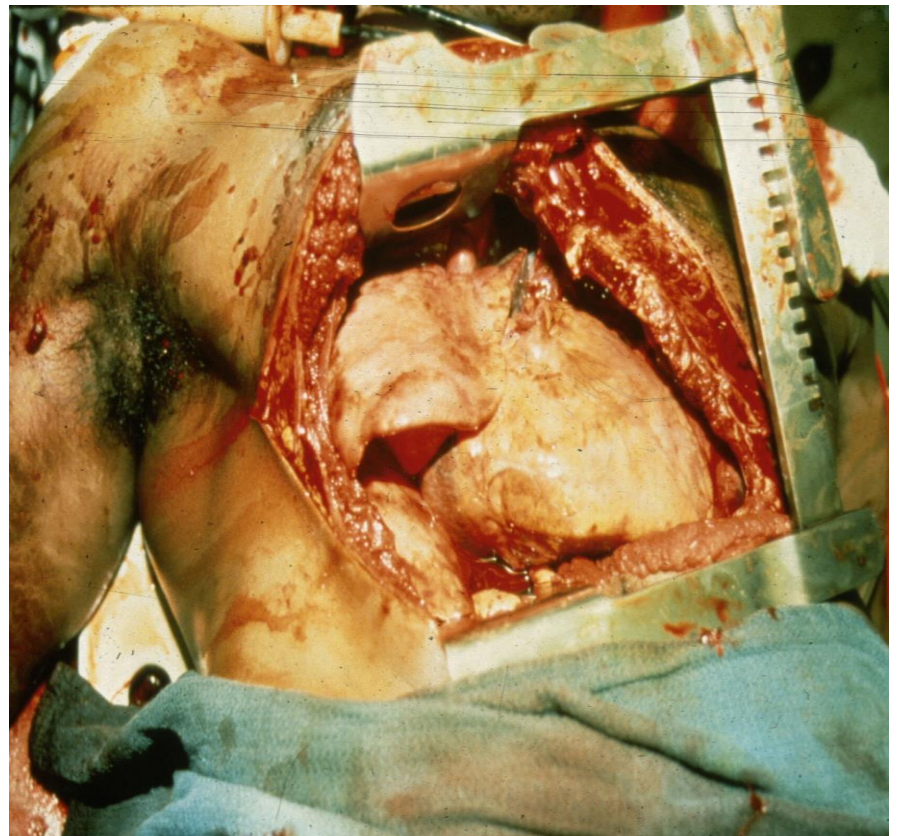
Why should you care?

- High mortality - 20-90%
- Early on the effects of O_2 deprivation on the cell are REVERSIBLE
- Early intervention reduces mortality



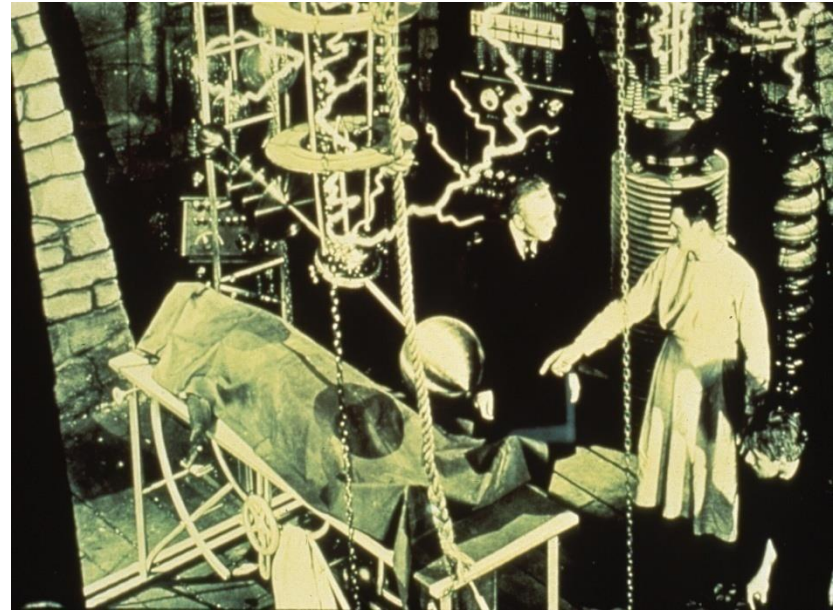
The Circulatory System

- Components:
 - Heart (pump)
 - Blood Vessels
 - Blood



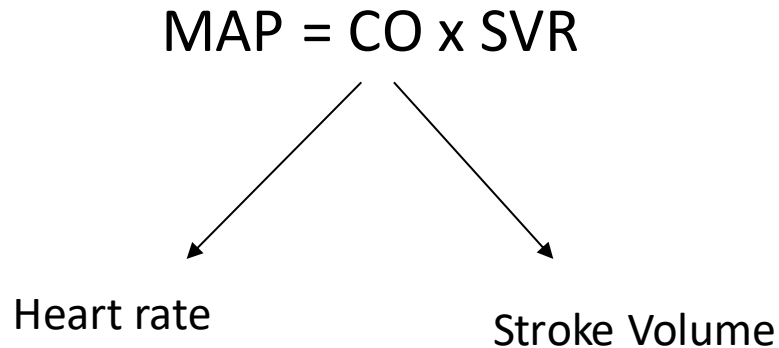
Circulation and Electricity

- Circulation
 - The flow of blood
- Electricity
 - The flow of electrons
- Ohms law: $V = IR$
(Voltage = Current x Resistance)
- $BP = CO \times SVR$
(Cardiac Output x System Vascular Resistance)



Pathophysiology: Overview

- Tissue perfusion is determined by Mean Arterial Pressure (MAP)



Classification

- 4 types of shock
 - Cardiogenic
 - Obstructive
 - Hypovolemic
 - Distributive

Table 270–1. Classification of Shock

Hypovolemic	Septic
Traumatic	Hyperdynamic (early)
Cardiogenic	Hypodynamic (late)
Intrinsic	Neurogenic
Compressive	Hypoadrenal

Cardiogenic Shock: Pathophysiology

- Heart fails to pump blood out

$$\text{MAP} = \text{CO} \times \text{SVR}$$



HR Stroke Volume

Cardiogenic Shock: Pathophysiology

Normal

$$\text{MAP} = \text{CO} \times \text{SVR}$$

Cardiogenic

$$\text{MAP} = \downarrow \text{CO} \times \text{SVR}$$

$$\text{MAP} = \downarrow \text{CO} \times \uparrow \text{SVR}$$

$$\downarrow \text{MAP} = \downarrow \downarrow \text{CO} \times \uparrow \text{SVR}$$

Cardiogenic Shock: Causes

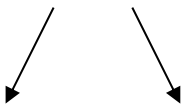
$$\downarrow \text{MAP} = \downarrow \text{CO (HR x Stroke Volume)} \times \uparrow \text{SVR}$$

- Decreased Contractility (Myocardial Infarction, myocarditis, cardiomyopathy, Post resuscitation syndrome following cardiac arrest)
- Mechanical Dysfunction – (Papillary muscle rupture post-MI, Severe Aortic Stenosis, rupture of ventricular aneurysms etc)
- Arrhythmia – (Heart block, ventricular tachycardia, SVT, atrial fibrillation etc.)
- Cardiotoxicity (B blocker and Calcium Channel Blocker Overdose)

Obstructive Shock: Pathophysiology

- Heart pumps well, but the output is decreased due to an obstruction (in or out of the heart)

$$\text{MAP} = \text{CO} \times \text{SVR}$$



HR x Stroke volume

The diagram shows two arrows originating from the 'CO' in the equation above. One arrow points down to 'HR' and the other points down to 'Stroke volume'.

Obstructive Shock: Pathophysiology

Normal

$$\text{MAP} = \text{CO} \times \text{SVR}$$

Obstructive

$$\text{MAP} = \downarrow \text{CO} \times \text{SVR}$$

$$\text{MAP} = \downarrow \text{CO} \times \uparrow \text{SVR}$$

$$\downarrow \text{MAP} = \downarrow \downarrow \text{CO} \times \uparrow \text{SVR}$$

Obstructive Shock: Causes

$$\downarrow \text{MAP} = \downarrow \text{CO (HR x Stroke Volume)} \times \uparrow \text{SVR}$$

- Heart is working but there is a block to the outflow
 - Massive pulmonary embolism
 - Aortic dissection
 - Cardiac tamponade
 - Tension pneumothorax
- Obstruction of venous return to heart
 - Vena cava syndrome - eg. neoplasms, granulomatous disease
 - Sickle cell splenic sequestration

Hypovolemic Shock: Pathophysiology

- Heart pumps well, but not enough blood volume to pump

$$\text{MAP} = \text{CO} \times \text{SVR}$$

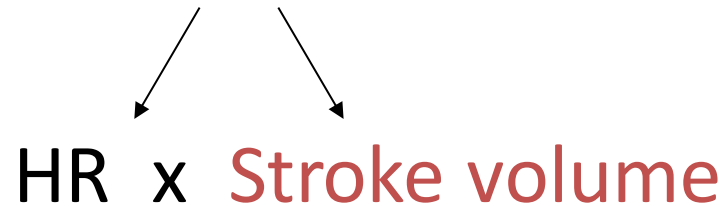


Diagram illustrating the components of Cardiac Output (CO):

CO is composed of HR (Heart Rate) and Stroke volume.

$$\text{HR} \times \text{Stroke volume}$$

Hypovolemic Shock: Pathophysiology

Normal

$$\text{MAP} = \text{CO} \times \text{SVR}$$

Hypovolemic

$$\text{MAP} = \downarrow \text{CO} \times \text{SVR}$$

$$\text{MAP} = \downarrow \text{CO} \times \uparrow \text{SVR}$$

$$\downarrow \text{MAP} = \downarrow \downarrow \text{CO} \times \uparrow \text{SVR}$$

Hypovolemic Shock: Causes

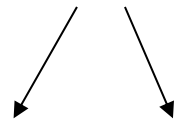
$$\downarrow \text{MAP} = \downarrow \text{CO (HR x Stroke Volume)} \times \uparrow \text{SVR}$$

- Decreased Intravascular volume (Preload) leads to Decreased Stroke Volume
 - Hemorrhagic - trauma, GI bleed, AAA rupture, ectopic pregnancy
 - Hypovolemic - burns, GI losses, dehydration, third spacing (e.g. pancreatitis, bowel obstruction), Addisonian crisis, Diabetic Ketoacidosis

Distributive Shock: Pathophysiology

- Heart pumps well, but there is peripheral vasodilation due to loss of vessel tone

$$\text{MAP} = \text{CO} \times \text{SVR}$$



HR x Stroke volume

Distributive Shock: Pathophysiology

Normal

$$\text{MAP} = \text{CO} \times \text{SVR}$$

Distributive

$$\text{MAP} = \text{CO} \times \downarrow \text{SVR}$$

$$\text{MAP} = \uparrow \text{CO} \times \downarrow \text{SVR}$$

$$\downarrow \text{MAP} = \uparrow \text{CO} \times \downarrow \downarrow \text{SVR}$$

Distributive Shock: Causes

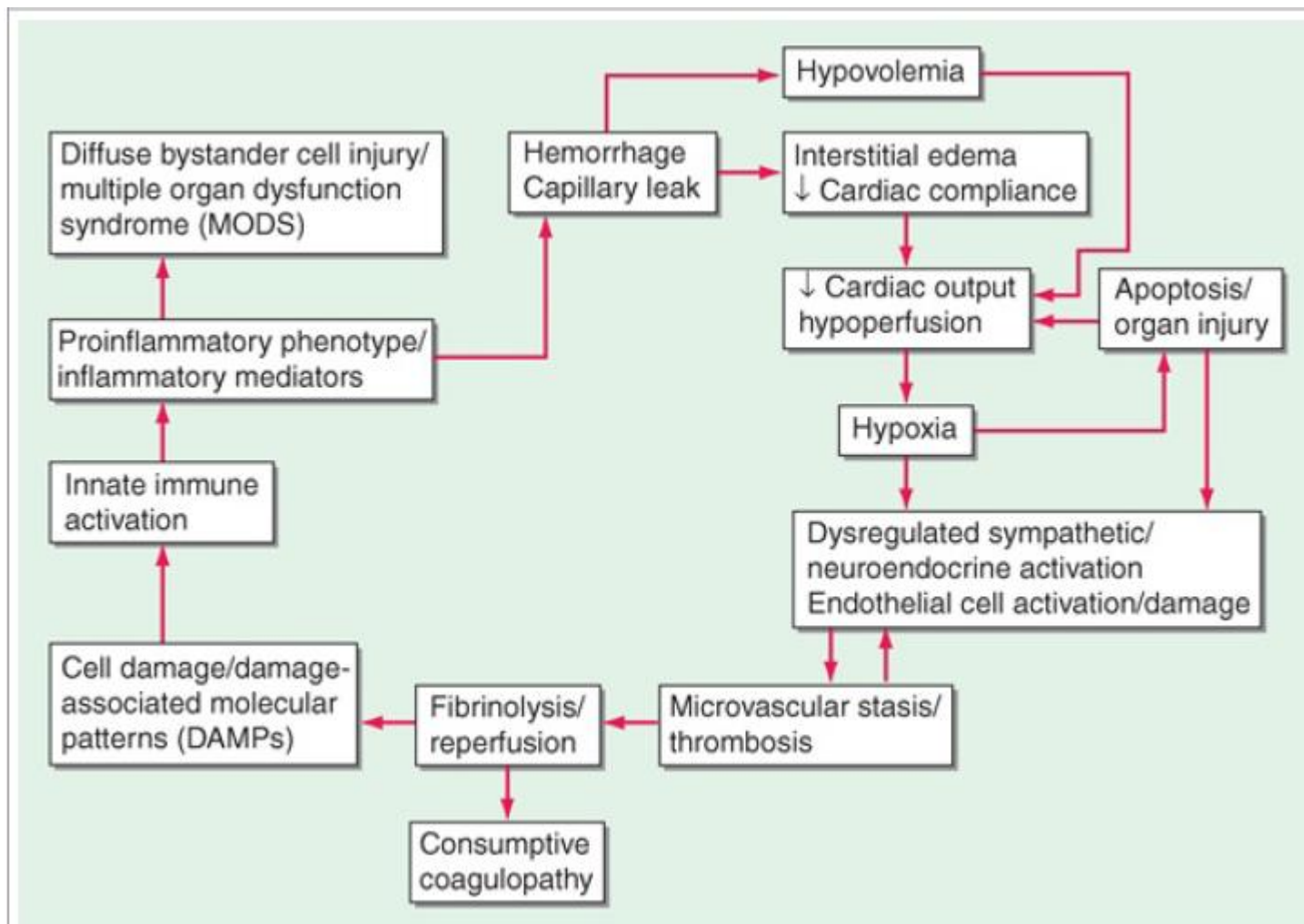
$$\downarrow \text{MAP} = \uparrow \text{CO (HR x SV)} \times \downarrow \text{SVR}$$

- Loss of Vessel tone
 - Inflammatory cascade
 - Sepsis and Toxic Shock Syndrome
 - Anaphylaxis
 - Post resuscitation syndrome following cardiac arrest
 - Decreased sympathetic nervous system function
 - Neurogenic - C spine or upper thoracic cord injuries
 - Toxins
 - Due to cellular poisons - Carbon monoxide, methemoglobinemia, cyanide
 - Drug overdose (α_1 antagonists)

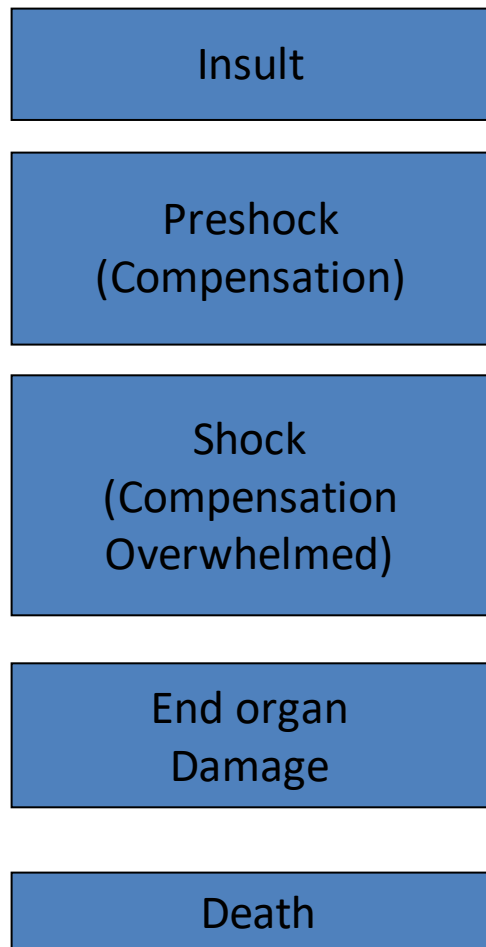
Additional Compensatory Mechanisms

- Renin-Angiotensin-Aldosterone Mechanism
 - All components lead to vasoconstriction
 - Aldosterone leads to water conservation
- ADH leads to water retention and thirst
- Inflammatory cascade

Shock induced vicious cycle



Stages of Shock



Timeline and progression will depend on:

- Cause
- Patient Characteristics
- Intervention

Symptoms and Signs of Shock

- Level of consciousness

Initially may show few symptoms

- Continuum starts with
 - Anxiety
 - Agitation
 - Confusion and Delirium
 - Obtundation and Coma
- Pulse
 - Tachycardia HR > 100 - What are a few exceptions?
 - Rapid, weak, thready distal pulses
- Respirations
 - Tachypnea
 - Shallow, irregular, labored

Symptoms and Signs of Shock

- Blood Pressure
 - May be normal!
 - Definition of hypotension
 - Systolic < 90 mmHg
 - MAP < 65 mmHg
 - 40 mmHg drop systolic BP from baseline
- Skin
 - Cold, clammy (Cardiogenic, Obstructive, Hemorrhagic)
 - Warm (Distributive shock)
 - Mottled appearance in children
 - Look for petechia
- Dry Mucous membranes
- Low urine output <0.5 ml/kg/hr

	Hypovolemic Shock	Distributive Shock	Cardiogenic Shock	Obstructive Shock
HR	Increased	Increased (Normal in Neurogenic shock)	May be increased or decreased	Increased
JVP	Low	Low	High	High
BP	Low	Low	Low	Low
SKIN	Cold	Warm (Cold in severe shock)	Cold	Cold
CAP REFILL	Slow	Slow	Slow	Slow

Global Tissue Hypoxia

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

Multorgan Dysfunction Syndrome (MODS)

- Progression of physiologic effects as shock ensues
 - Cardiac depression
 - Respiratory distress
 - Renal failure
 - DIC
- Result is end organ failure



Approach to the Patient in Shock

- ABCs
 - Cardiorespiratory monitor
 - Pulse oximetry
 - Supplemental oxygen
 - IV access
 - ABG, labs
 - Foley catheter
 - Vital signs including rectal temperature



Diagnosis

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



Further Evaluation

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

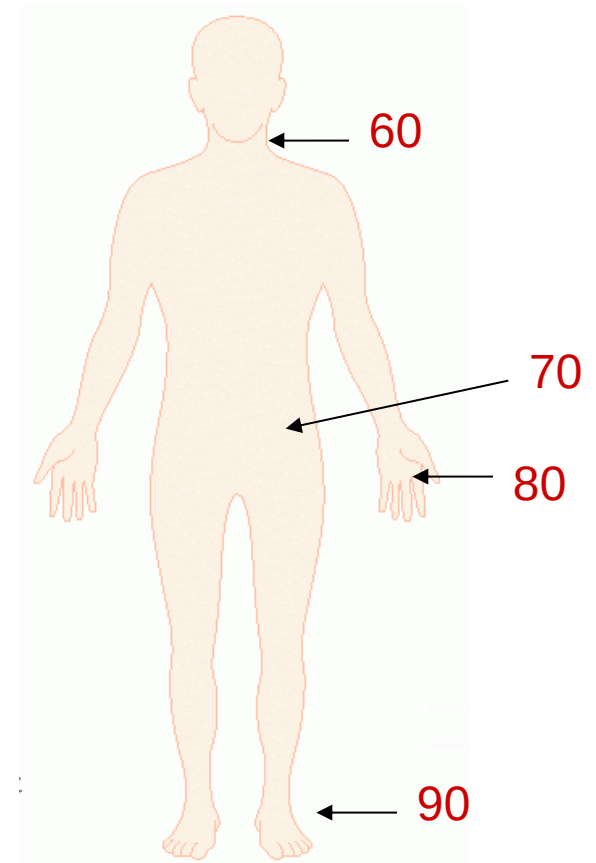
Approach to the Patient in Shock

- 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

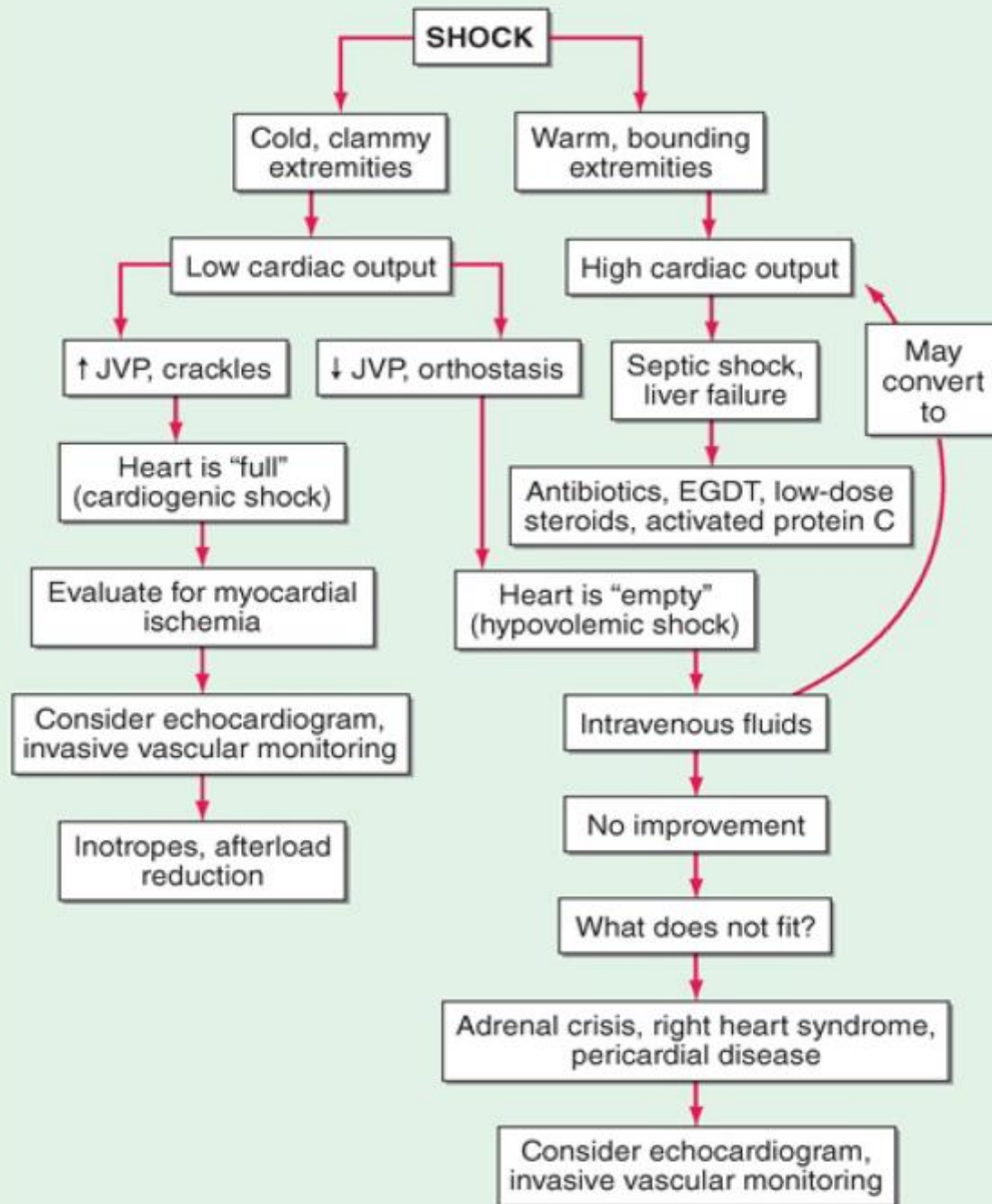
Shock



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



APPROACH TO PATIENT IN SHOCK

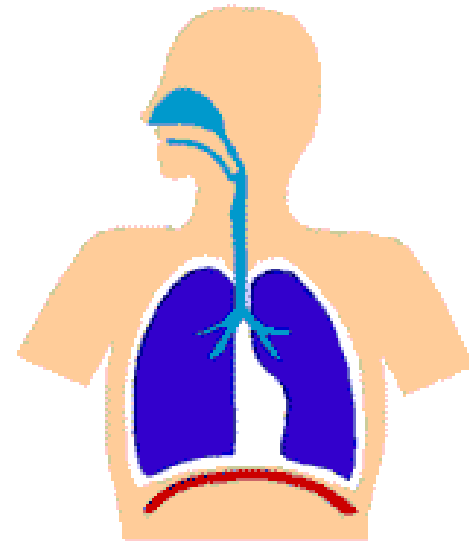


Goals of Treatment

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

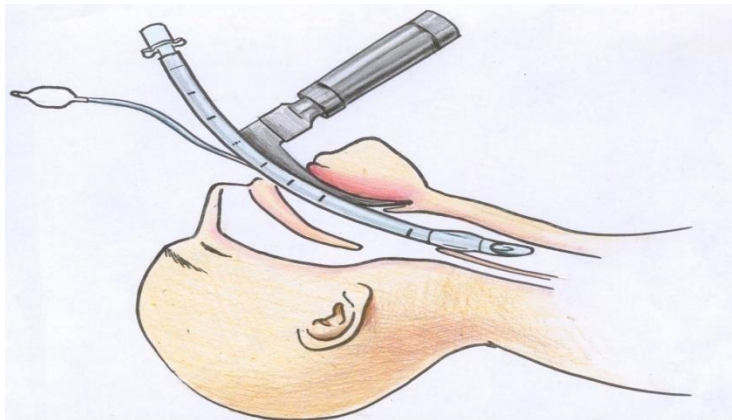
Airway

- Determine need for intubation but remember: intubation can worsen hypotension
 - Sedatives can lower blood pressure
 - Positive pressure ventilation decreases preload
- May need volume resuscitation prior to intubation to avoid hemodynamic collapse

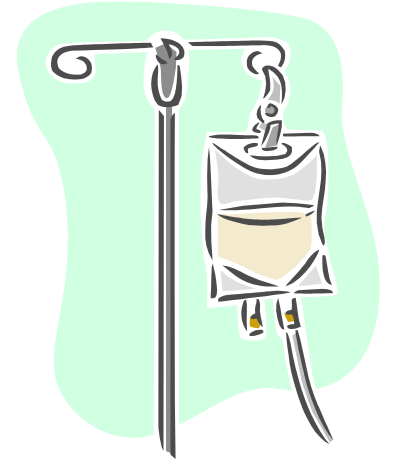


Control Work of Breathing

- 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 mmHg
 - MAP 65 to 90 mmHg
 - Central venous oxygen concentration $> 70\%$

Vasopressors & Inotropic Agents

- Dopamine
- Dobutamine
- Norepinephrine
- Epinephrine
- Amrinone



Dopamine

- Low dose (0.5 - 2 $\mu\text{g/kg/min}$) = dopaminergic
- Moderate dose (3-10 $\mu\text{g/kg/min}$) = β -effects
- High dose ($> 10 \mu\text{g/kg/min}$) = α -effects
- SIDE EFFECTS
 - tachycardia
 - $> 20 \mu\text{g/kg/min}$ Δ to norepinephrine

Dobutamine

- β -agonist
- 5 - 20 $\mu\text{g/kg/min}$
- potent inotrope, variable chronotrope
- caution in hypotension (inadequate volume)
may precipitate tachycardia or worsen
hypotension

Norepinephrine

- Potent α -adrenergic vasopressor
- Some β -adrenergic, inotropic, chronotropic
- Dose 1 - 100 $\mu\text{g}/\text{min}$
- Unproven effect with low-dose dopamine to protect renal and mesenteric flow.

Epinephrine

- α - and β -adrenergic effects
- potent inotrope and chronotrope
- dose 1 - 10 $\mu\text{g}/\text{min}$
- increases myocardial oxygen consumption particularly in coronary heart disease

Amrinone

- Phosphodiesterase inhibitor, positive inotropic and vasodilatory effects
- increased cardiac stroke output without an increase in cardiac stroke work
- most often added with dobutamine as a second agent
- load dose = 0.75 -1.5 mg/kg → 5 - 10 µg/kg/min drip
- main side-effect - thrombocytopenia

Vasopressors

- Assure adequate fluid volume
- Administer via CVL
- Do not use dopamine for renal protection
- Requires arterial line placement
- Vasopressin:
 - Refractory shock
 - Infusion rate 0.01 – 0.04 Units/min



“Shock is a symptom of its cause.”

In general, treat the cause...

Start treatment immediately

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

Hypovolemic Shock



Classes of Hypovolemic Shock

	<u>Class I</u>	<u>Class II</u>	<u>Class III</u>	<u>Class IV</u>
Blood Loss	< 750	750-1500	1500-2000	> 2000
% Blood Vol.	< 15%	15 – 30%	30 – 40%	> 40%
Pulse	< 100	> 100	> 120	> 140
Blood Pressure	Normal	Normal	Decreased	Decreased
Pulse Pressure	Normal	Decreased	Decreased	Decreased
Resp. Rate	14 – 20	20 – 30	30 – 40	> 40
UOP	> 30	20 – 30	5 – 15	negligible
Mental Status	sl. Anxious	mildly anx	confused	lethargic
Fluid	crystalloid	crystalloid	blood	blood

Hypovolemic Shock

- Non-hemorrhagic
 - Vomiting
 - Diarrhea
 - Bowel obstruction, pancreatitis
 - Burns
 - Neglect, environmental (dehydration)
- Hemorrhagic
 - GI bleed
 - Trauma
 - Massive hemoptysis
 - AAA rupture
 - Ectopic pregnancy, post-partum bleeding

Evaluation of Hypovolemic Shock

- CBC
- ABG/lactate
- Electrolytes
- BUN, Creatinine
- Coagulation studies
- Type and cross-match
- As indicated
 - CXR
 - Pelvic x-ray
 - Abd/pelvis CT
 - Chest CT
 - GI endoscopy
 - Bronchoscopy
 - Vascular radiology

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

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



Etiologies

What are some causes of cardiogenic shock?

- AMI
- Sepsis
- Myocarditis
- Myocardial contusion
- Aortic or mitral stenosis, HCM
- Acute aortic insufficiency

Ancillary Tests

- EKG
- CXR
- CBC, Chem 10, cardiac enzymes, coagulation studies
- Echocardiogram

Treatment of Cardiogenic Shock

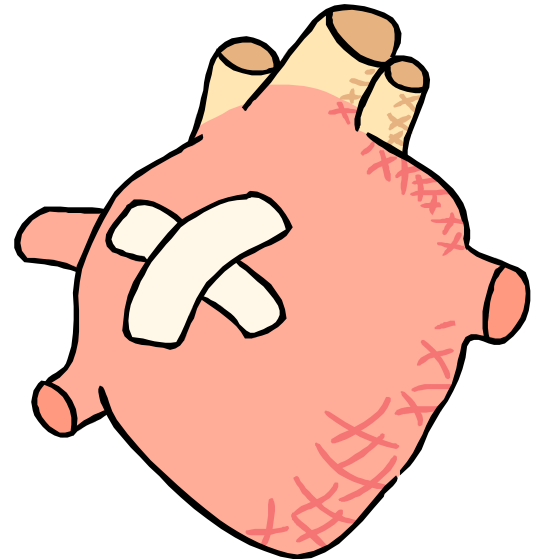
- Goals- Airway stability and improving myocardial pump function
- Cardiac monitor, pulse oximetry
- Supplemental oxygen, IV access
- Intubation will decrease preload and result in hypotension
 - Be prepared to give fluid bolus

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)

Cardiogenic Shock

- **Preload augmentation** - Consider Fluids
- **Contractility**
 - dopamine
 - dobutamine
 - phosphodiesterase inhibitor
- **Afterload reduction**
 - nitroglycerin
 - dobutamine



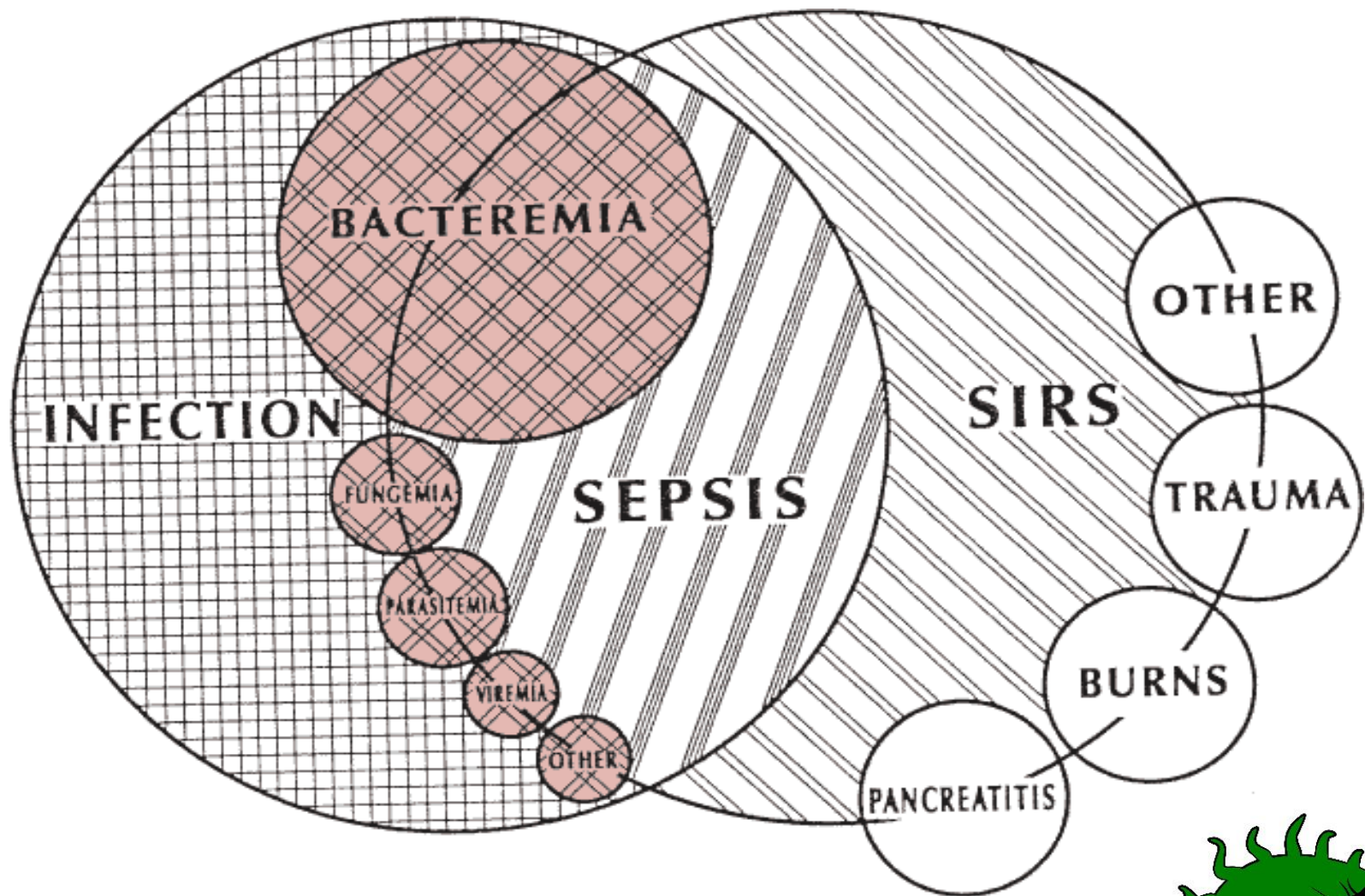
What Type of Shock is This?

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

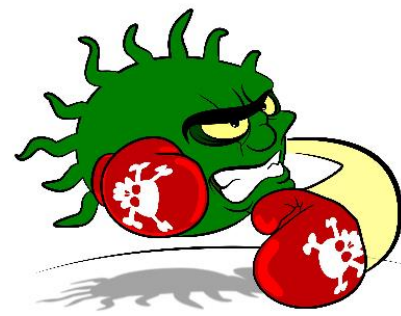
Septic

Types of Shock

- Hypovolemic
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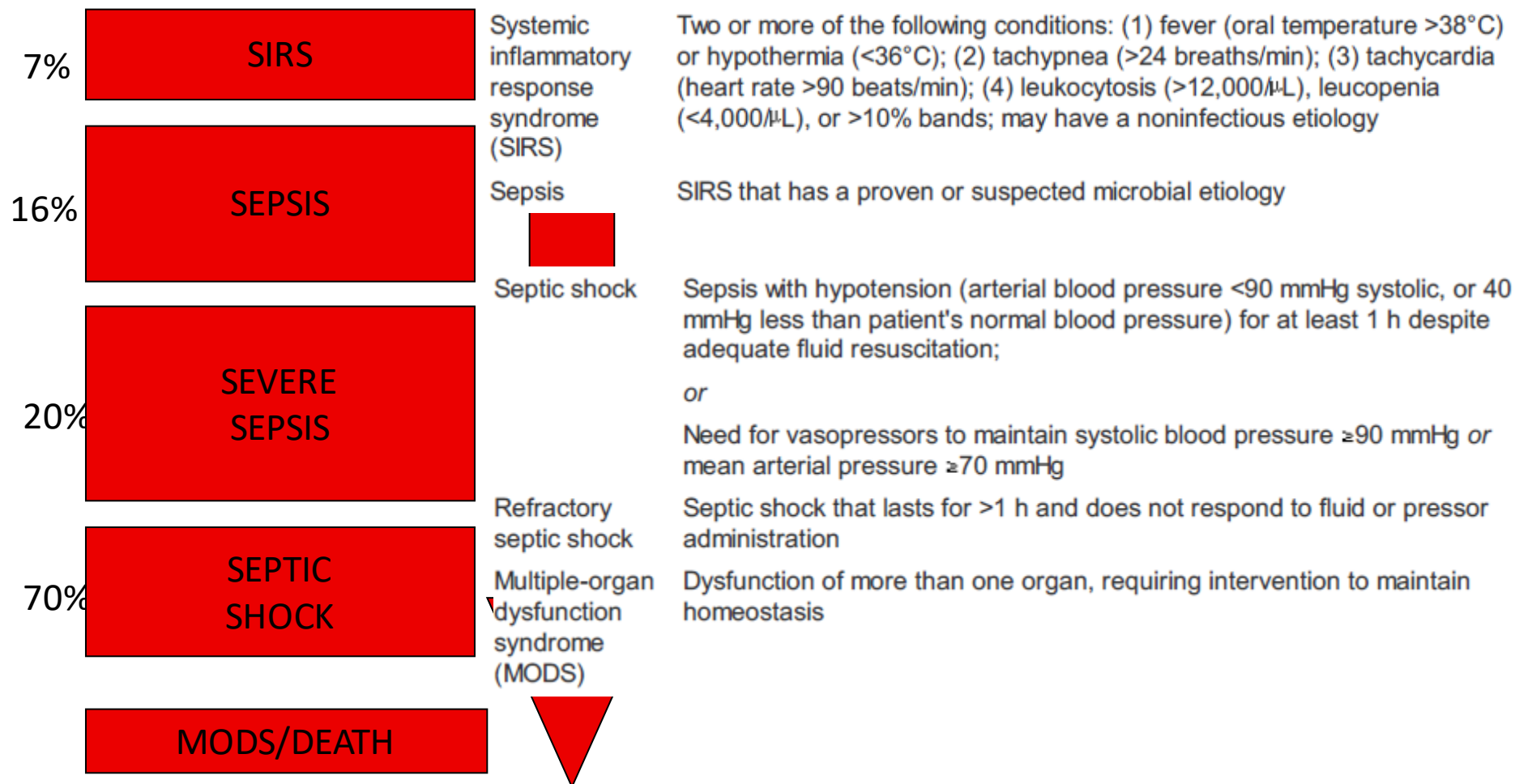
BLOOD BORNE INFECTION





Stages of Sepsis

Mortality



Bacteremia

Presence of bacteria in blood, as evidenced by positive blood cultures

Septicemia

Presence of microbes or their toxins in blood

Systemic inflammatory response syndrome (SIRS)

Two or more of the following conditions: (1) fever (oral temperature $>38^{\circ}\text{C}$) or hypothermia ($<36^{\circ}\text{C}$); (2) tachypnea (>24 breaths/min); (3) tachycardia (heart rate >90 beats/min); (4) leukocytosis ($>12,000/\mu\text{L}$), leucopenia ($<4,000/\mu\text{L}$), or $>10\%$ bands; may have a noninfectious etiology

Sepsis

SIRS that has a proven or suspected microbial etiology

Septic shock

Sepsis with hypotension (arterial blood pressure <90 mmHg systolic, or 40 mmHg less than patient's normal blood pressure) for at least 1 h despite adequate fluid resuscitation;

or

Need for vasopressors to maintain systolic blood pressure ≥ 90 mmHg or mean arterial pressure ≥ 70 mmHg

Refractory septic shock

Septic shock that lasts for >1 h and does not respond to fluid or pressor administration

Multiple-organ dysfunction syndrome (MODS)

Dysfunction of more than one organ, requiring intervention to maintain homeostasis

Ancillary Studies

- Cardiac monitor
- Pulse oximetry
- CBC, Chem 7, coags, LFTs, lipase, UA
- ABG with lactate
- Blood culture x 2, urine culture
- CXR
- Foley catheter (why do you need this?)

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

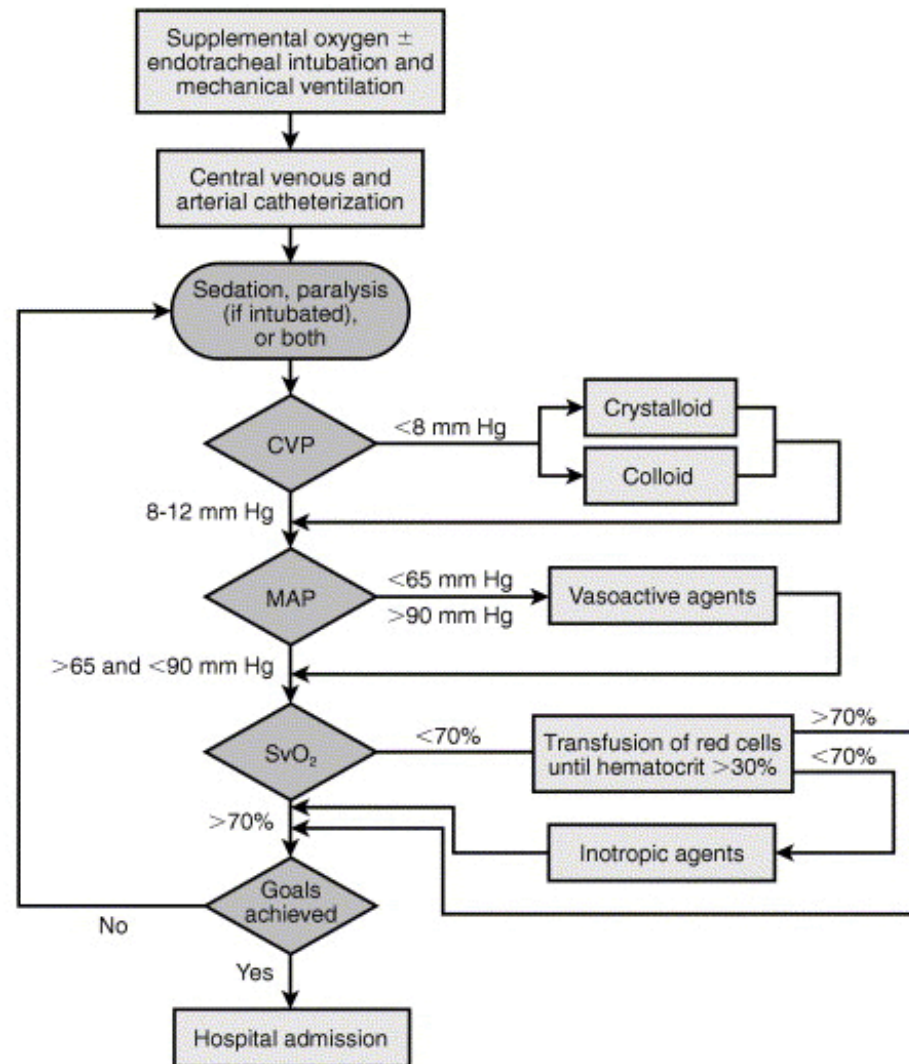
Treatment of Sepsis

- **Antibiotics-** Survival correlates with how quickly the correct drug was given
- Cover gram positive and gram negative bacteria
 - Beta-Lactams/ Quinolones / Aminoglycosides/ Carbapenems
 - Vancymycin/ Linezolid
- 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. influenzae*
 - Neutropenic – Cefepime or Imipenem
 - Immunosuppressed- Anti-fungals

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

Treatment Algorithm



Initial Resuscitation

- **CVP: 8- 12 mm Hg**
- **MAP $\geq$ 65 mm Hg**
- **UOP $\geq$ 0.5 cc/kg/hr**
- **Mixed venous Oxygen Sat $\geq$ 70%**
- **Lactate <4**
- **Consider:**
 - **Transfusion to Hgb $\geq$ 9**
 - **Vasopressors**
 - **Hydrocortisone**

What Type of Shock is This?

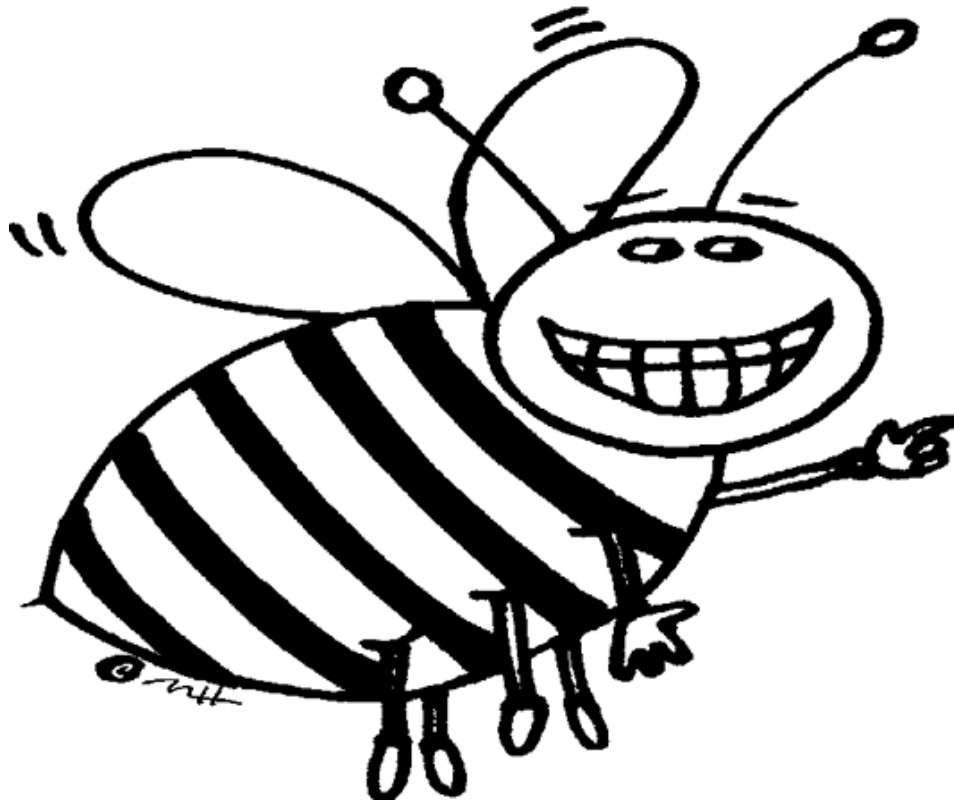
- A 34 yo F presents to the ER after dining at a restaurant where shortly after eating the first few bites of her meal, became anxious, diaphoretic, began wheezing, noted diffuse pruritic rash, nausea, and a sensation of her “throat closing off”. She is currently hypotensive, tachycardic and ill appearing.

Types of Shock

- Hypovolemic
- Septic
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Anaphylactic

Anaphylactic 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
- 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
 - Corticosteroids
 - Anti-histaminics
 - Bronchodilators



Epinephrine

0.3 mg IM of 1:1000 (epi-pen)

Repeat every 5-10 min as needed

For CV collapse, 1 mg IV of 1:10,000

If refractory, start IV drip

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
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Obstructive Shock



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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: Pericardiocentesis



Obstructive Shock

- Pulmonary embolism
 - Virchow's triad: hypercoagulable state, endothelial injury, hemostasis
 - Signs: Tachypnea, tachycardia, hypoxia
 - Low risk: D-dimer
 - Higher risk: CT chest or VQ scan
 - Rx: Heparin, consider thrombolytics

What Type of Shock is This?

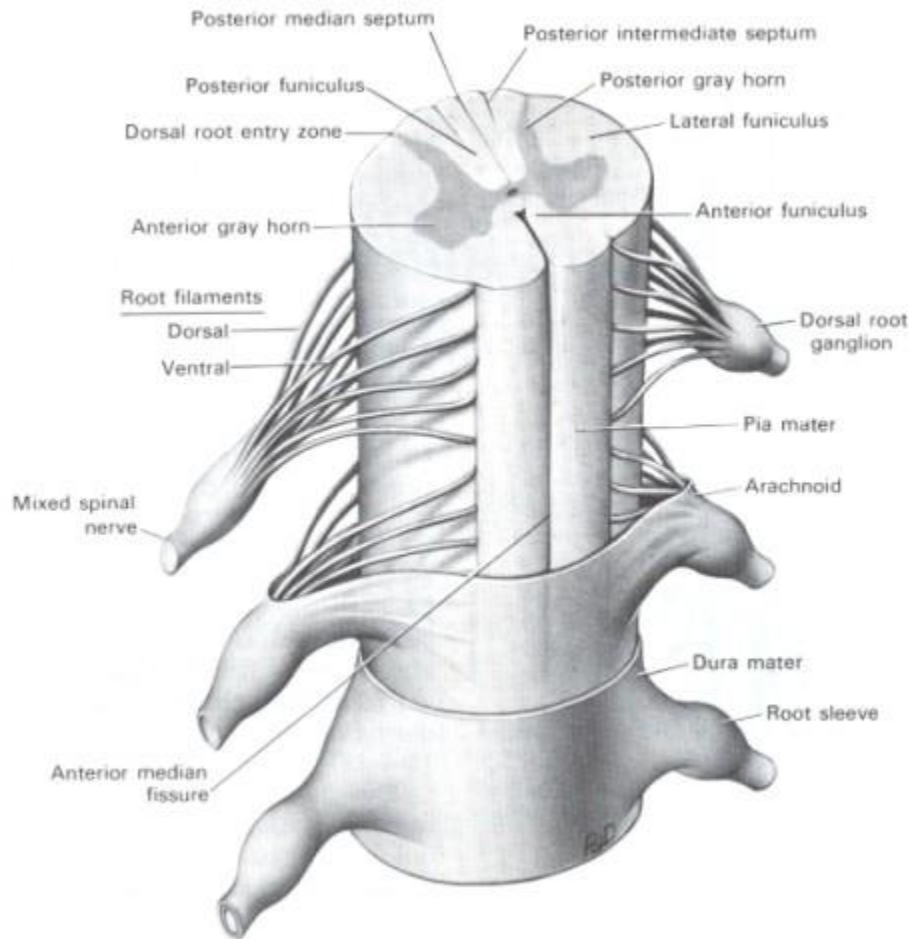
- A 41 yo M presents to the ER after an MVC complaining of decreased sensation below his waist and is now hypotensive, bradycardic, with warm extremities

Neurogenic

Types of Shock

- 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
- Role of Methylprednisolone

Concluding Remarks

- ABCDE
 - **A**irway
 - control work of **B**reathing
 - optimize **C**irculation
 - assure adequate oxygen **D**elivery
 - achieve **E**nd points of resuscitation
- Monitor the patient
 - Do not need central venous pressure and ScvO₂
 - Use the HR, MAP, mental status, urine output
 - Lactate clearance
- Always consider fluids!!!
- Start antibiotics within an hour!
 - Do not wait for cultures or blood work

Summary

- Look for **early** signs of shock
- SHOCK $\neq$ hypotension
- Know how to distinguish different types of shock and treat accordingly
- Inadequate tissue perfusion that is unresponsive to initial treatment should lead to aggressive, goal-directed therapy
- Correction of the precipitating, underlying condition is essential for patient survival
- Early treatment to predefined physiologic endpoints reduces the potentially devastating complication of end-organ dysfunction and failure

Thank You!