An Introduction to Shock

SAEM Undergraduate Medical Education Committee
Emergency Medicine Clerkship Lecture Series
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Learning Objectives

- Review the approach to different types of shock states
- Review the principles of different shock states
  - Septic
  - Cardiogenic
  - Anaphylactic

Case #1

- 83 year old man presents with an altered mental status from a local nursing home
- PMH: HTN, prostate CA, chronic UTI's, CAD
- Medications: ASA daily, NTG prn, norvasc, HCTZ, colace
- NKDA

Case #1

Physical exam:

- VS: BP 86/40mmHg HR 115 RR 24 T 98.0°F SaO_2 97% RA
- HEENT: Edentulous
- Heart: Regular rhythm, tachycardic, 2/6 systolic murmur
- Lungs: Clear, tachypneic
- Abdomen: Soft, non-distended, + bowel sounds

Case #1

Physical exam:

- Extremities: diminished pulses, no edema
- Skin: warm
- Neurologic: oriented to name, moves all extremities, GCS 14

Case #1

- Describe your initial management?
  - What needs to be done with this patient in the first 5 minutes?

IV, O2, Monitor, ABC's

2 large bore IV lines (14 or 16 ga)

Aggressive fluid resuscitation with NS

Supplemental O_2

Cardiac monitoring

Case #1

- Based on your clinical suspicion, what laboratory studies are indicated?
- What imaging studies?

Sepsis - Definition

- Heterogeneous clinical syndrome caused by infection with any class of microorganism
  - Gram-negative: 55-60%
  - Gram-positive: 35-40%

Sepsis - Clinical Features

- Hypo-/hyperthermia
- Tachycardia-/Tachypnea
- Altered mental status
- Decreased capillary refill/mottling >2 seconds

Sepsis - Diagnostic Features

- Hyperglycemia
- Leukocytosis-/leukopenia
- Hyperlactemia

Severe Sepsis

- Sepsis with either hypotension or systemic manifestations of hypoperfusion
  - Lactic acidosis
  - Oliguria
  - Altered mental status

Septic Shock

- Sepsis associated with hypotension and or findings of end organ hypoperfusion

Characteristics of Septic Shock

- Systemic vasodilation and hypotension
- Tachycardia; depressed contractility
- Vascular leakage and edema leading to relative hypovolemia
- Compromised blood flow to vital organs
- Disseminated intravascular coagulation
- Metabolic acidosis
- Respiratory insufficiency and multiple organ failure

Systemic Inflammatory Response Syndrome (SIRS)

- Two or more of the following conditions
  - Temperature >38°C or <36°C
  - Heart rate > 90 beats/min
  - Respiratory rate >20 breaths/min
  - PaCO2, <32 mmHg
  - WBC >12,000 mm^3 or <4000, or >10% immature (band) cells

Multiple Organ Dysfunction Syndrome (MODS)

- Progressive organ failure following severe infectious or noninfectious insults (severe burns, multiple trauma)

Sepsis - Treatment

- Insure Adequate oxygenation and ventilation to limit work of breathing
- Aggressive IV fluid resuscitation (crystalloid)
- Antibiotic therapy
  - Empiric (after cultures)
  - Based on source/patient status (community,healthcare associated, immunocompromised)

Sepsis - Treatment

- ***Early goal directed therapy
- Vasopressor support - if hypotensive despite IVF
  - Based on initial response to fluid resuscitation
- Blood product transfusion
- Tight glucose control (controversial)
- Steroids (controversial)
  - If hypotensive despite IVF/pressors

Case #2

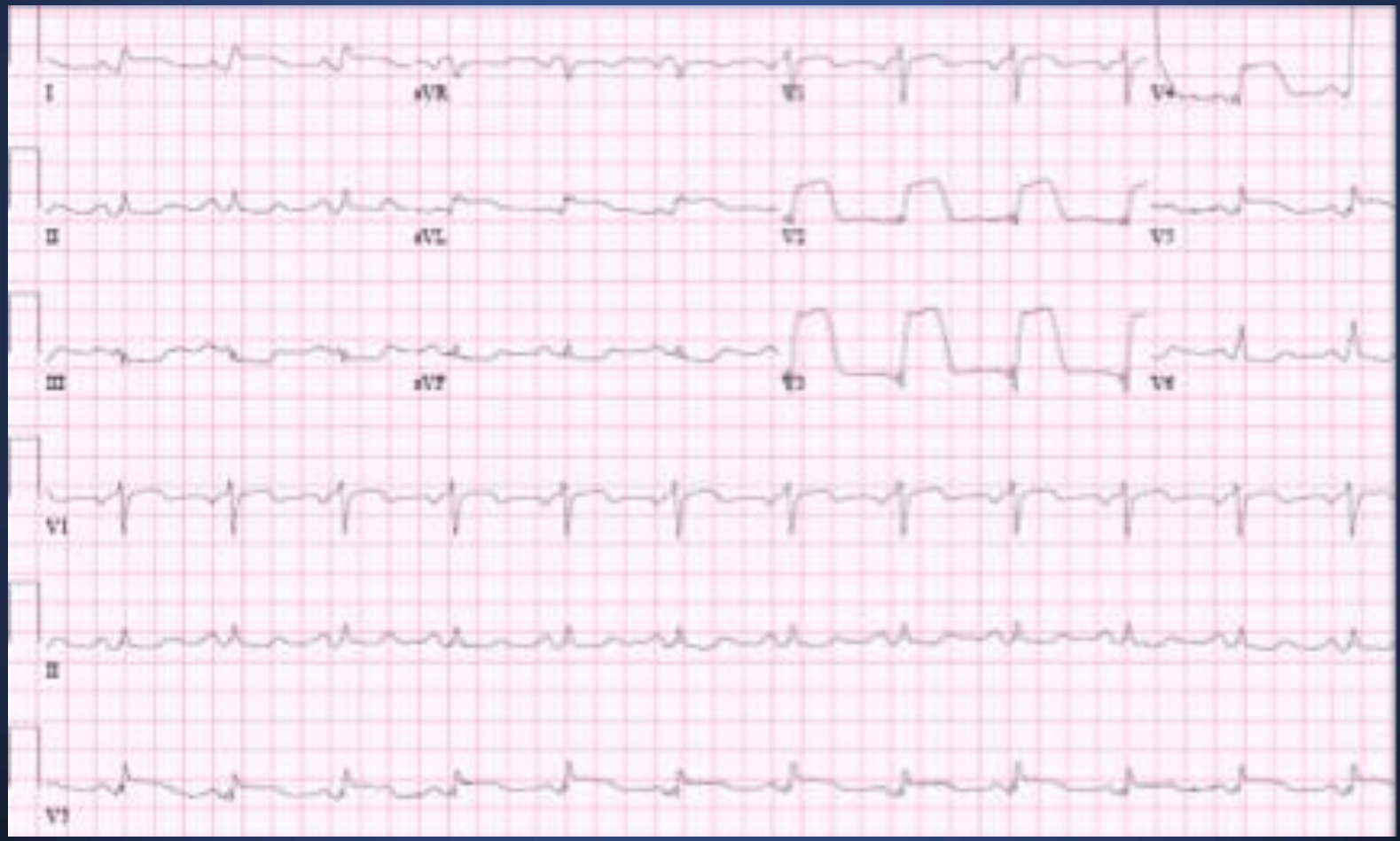
- A 62 year old female presents with progressive substernal chest pain, now with worsening shortness of breath
- PMH: Hypertension, CAD
- Meds: Clonidine, Lopressor, ASA
- Social: Smoker
- NKDA

Case #2

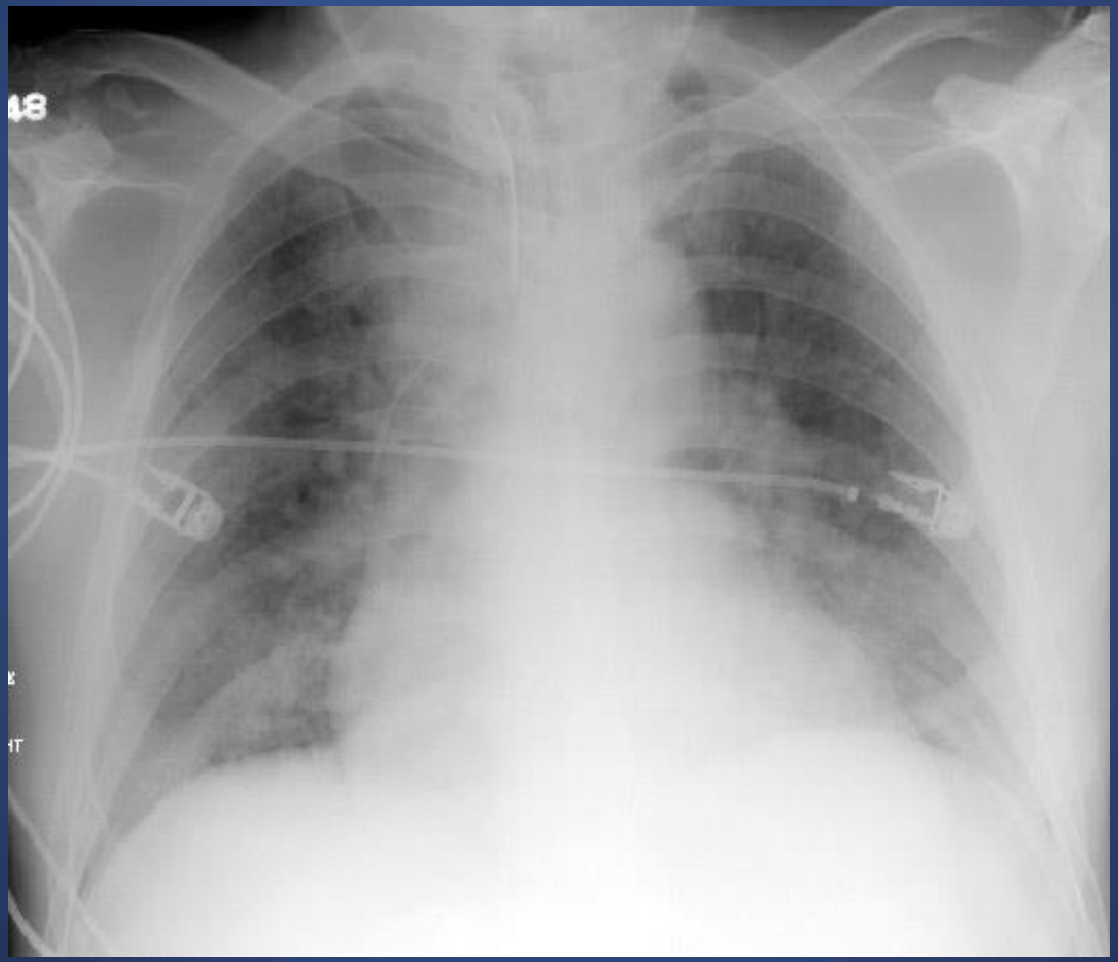
Physical exam

- VS: BP 86/50 HR 86 RR 24 T 37.0°F SaO_2 96%
- General: restless
- Heart: regular rate, harsh SEM, tachycardic
- Lungs: rales, tachypneic
- Abdomen: obese, NT/ND
- Extremities: LE edema

ECG



Chest Radiograph



Cardiogenic Shock - Definition

- Insufficient cardiac output to meet metabolic demands of tissues
- Usually from acute myocardial infarction (AMI) >40% of LV myocardium
- Sustained hypotension with inadequate tissue perfusion in spite of adequate left ventricular filling pressure

Cardiogenic Shock

- Manifested by organ dysfunction such as oliguria, confusion, cool extremities and lactic acidosis
- Strict definitions:
  - Systolic BP of <90 mmHg for greater than 30 minutes
  - Cardiac index of <2.2L/min/m^2 in the presence of a pulmonary capillary wedge pressure of >15 mmHg

Cardiogenic Shock - Clinical Features

- Hypoperfusion
- Hypotension
  - SBP <90 mmHg, or
  - MAP decrease by 30 mmHg
  - Pulse pressure <20 mmHg
- Organ dysfunction including:
  - Oliguria, confusion, cool extremities and lactic acidosis

Cardiogenic Shock - Causes

Pump failure

- Acute myocardial infarction (including RV)

Mechanical complications

- Acute valvular insufficiency
  - Acute mitral regurgitation
- Rupture of the interventricular septum
- Free wall rupture
- Tamponade

Other

- End stage cardiomyopathy
- Myocarditis
- Prolonged cardiopulmonary bypass
- LV outflow obstruction
- Aortic stenosis
- Obstruction to LV filling
- Mitral stenosis
- Acute aortic insufficiency

Initial Evaluation

- ABC's (primary survey)
- Careful history/physical exam
- Safety net
  - IV access, oxygen, cardiac monitoring
- 12-lead ECG
- CXR
- Labs:
  - CBC, CMP, coags, cardiac markers, BNP, etc.

Cardiogenic Shock - Management

- Will depend on suspected etiology
- Early cardiology involvement
- Bedside echocardiogram
- Invasive monitoring
- Diagnostic/therapeutic cardiac catheterization
- IABP
- Emergent CABG

Echocardiogram

- Can guide treatment by identifying any wall motion abnormalities
- Rapid diagnosis of mechanical causes of cardiogenic shock
  - Papillary muscle rupture
  - Acute mitral regurgitation
  - Acute VSD
  - Free wall rupture
  - Tamponade

Case #3

- 24 year old male, unrestrained driver, high speed MVA
- Complains of severe abdominal pain at the scene
- SBP 90 mmHg HR 118 RR 26
- GCS 14, responds to verbal stimuli
- Abdominal tenderness with guarding

CT Scan Abdomen

Hemorrhagic Shock

Class	I	II	III	IV
Blood Loss (ml)	<750	750-1,500	1,500-2,000	>2,000
Blood Loss (%)	<15%	15-30%	30-40%	>40%
HR	<100/min	>100	>120	>140
BP	Normal	□ Pulse Pressure	□ SBP	□□ SBP
Need for Transfusion	No	No	Most	All

Hypovolemic Shock

- Ensure adequate ventilation/oxygenation
- Control hemorrhage
- Aggressive IV fluids
- Consider pRBC transfusion
- Treat severe acidosis
- Correct underlying cause early
  - Surgical hemorrhage control

Hypovolemic Shock

- FAST scan
  - To OR directly versus CT scan/other imaging

Case #4

- 32 year old male presenting with acute onset shortness of breath/wheezing, pruritic rash, vomiting after eating shellfish

Anaphylactic Shock

- Widespread hypersensitivity
- Vasodilatation leads to:
  - Hypovolemia, altered cellular metabolism
- Histamine release leads to:
  - Increased permeability and massive vasodilatation
- Respiratory distress with bronchospasm and laryngospasm

Anaphylactic Shock

- Up to 2/3 of cases offending agent not identified
- Food most common identified cause
- Venom, medications, exercise, and latex are other causes

Anaphylaxis/Allergic Reactions

- Sensitization to:
  - Drugs (penicillin, sulfa)
  - Foods (shellfish, nuts, eggs, preservatives, tetrazine dyes)
  - Stings (hymenoptera)
- No sensitizing exposure:
  - Dextran, codeine, radiocontrast material

Anaphylactic Shock - Treatment

- Control airway and ventilation
- Crystalloid 10-20 mL/kg
- Epinephrine
- Diphenhydramine
- Steroids - 5-10 mg/kg hydrocortisone or 1-2 mg/kg methylprednisilone
- H_2 blockers

Approach to Patient in Shock

- General approach to a patient in the initial stages of shock follows similar principles regardless of the inciting factors or etiology

Shock - Description

- Inadequate blood/oxygen supply to tissues
- Build up of toxic metabolites
- Physiologic responses cannot meet tissue demands

Physical Exam

- Hypotension and tachycardia
- Peripheral hypoperfusion
- Peripheral vasoconstriction (common)
- Altered mental status
- Oliguria or anuria
- Metabolic acidosis (common)

Criteria for Diagnosis - Shock

- Ill appearance or altered mental status
- HR >100 bpm
- RR >22 bpm or $PaCO_2$ <32 mm Hg
- Arterial base deficit <-5 mEq/L or lactate > 4
- Urine output < 0.5mL/kg/hr
- Arterial hypotension > 20 minutes

** four criteria should be met, regardless of cause

Cardiovascular

- Systemic vasodilation and hypotension (SBP <90 mmHg)
- Tachycardia (100 bpm)
- Increased cardiac output (hyperdynamic - early, hypodynamic - late
- Ventricular dilation;decreased ejection fraction
- Loss of sympathetic responsiveness

Pulmonary and Renal

- Hyperventilation with respiratory alkalosis
- Pulmonary hypertension and edema
- Hypoxemia arterial $Pa0_2$<50 mmHg
- Reduced pulmonary compliance; increased work of breathing
- Respiratory muscle failure
- Renal hypoperfusion; oliguria
- Acute tubular necrosis and renal failure

Autonomic Response

- Arteriolar vasoconstriction - redistribute blood from skin, skeletal muscle, kidneys, splanchnic viscera
- Increase heart rate and contractility
- Release of vasoactive hormones
  - epinephrine, norepinephrine, dopamine, cortisol
- Release of ADH and activation of renin-angiotension-aldosterone system

Shock - Labs

- DIC
- Leukopenia, thrombocytopenia, polycythemia
- Metabolic acidosis
- Increased lactate

Stages of Shock

- Early reversible/compensatory shock
  - Mean arterial pressure drops 10 -15 mm Hg
  - Decrease in circulating blood volume (25-35%) 1000ml
  - Sympathetic nervous system stimulated; release of catecholamines

Intermediate

- Further drop in MAP (20%)
- Increase in fluid loss (1,500-2,500 ml)
- Peripheral vasoconstriction
- Body switches to anaerobic metabolism forming lactic acid as a waste product

Intermediate

- Body increases heart rate and vasoconstriction
- Heart and brain become hypoxic
- More severe effects on other tissues which become: ischemic and anoxic
- State of acidosis/hyperkalemia develops
- Needs rapid treatment

Refractory

- Refractory or irreversible shock
- Tissues are anoxic, cellular death widespread
- Restoration of blood pressure and fluid volume may not restore homeostasis of tissues
- Cellular death leads to tissue death; vital organs fail and death occurs

Shock

Components of Blood Flow

- Cardiac Output (CO)
- Blood volume/central venous pressure (CVP)
- Systemic vascular resistance (SVR)

Shock

	Pulmonary-Capillary Wedge Pressure	Cardiac Output	SVR
Hypovolemic	↓	↓	↑
Obstructive	↑ or ↓	↓	↑
Cardiogenic	↑	↓	↑
Distributive	↓	↑	↓

Hypovolemic shock

- Cool, clammy, mottled extremities
- Tachycardia, tachypnea
- Poor capillary refill
- Decreased pulses
- Flat neck veins
- Anxiety/obtundation
- Hypotension
- Oliguria

Obstructive shock

- Narrowed pulse pressure
- Diaphoresis
- Jugular vein distention
- Cool, clammy extremities
- Rales

Vasogenic

- Flushing
- Wide pulse pressure
- Sepsis
- Anaphylactic shock
- Neurogenic

Treatment

- Initial
  - Goal of treatment is to optimize perfusion and oxygenation of vital organs
- ABC's
  - Intubate if indicated
  - Large bore IV lines
  - Consider invasive monitoring in select circumstances to guide fluid resuscitation

Treatment

- Hypovolemic Shock
  - Identify source of blood / fluid loss
  - Aggressive fluid resuscitation (SBP>100)
  - Use crystalloid first
  - Transfuse as needed
  - Operative management for hemorrhagic shock

Treatment

- Cardiogenic Shock
  - Caution with fluid
  - Treat underlying cause- MI, tamponade, dysrhythmias
  - Inotropic support – dopamine, dobutamine, phenylephrine

Treatment

- Vasogenic Shock/Sepsis
  - Aggressive crystalloids
  - Ideal urine output >30cc/hr
  - Early antibiotics
  - Identify infectious etiology
  - Inotropes as needed

Treatment

- Anaphylactic Shock
  - Intubate for airway support
  - Histamine blockers
  - Corticosteroids
  - Nebulized albuterol
  - Epi 1:1000 SQ/IM
  - Epi 1:10000 IV if severe or refractory

Key Points

- Patients can be in shock with a normal blood pressure
  - Shock reflects a degree of tissue hypoperfusion
- Pay close attention to and understand the relationship:
  - MAP = CO x SVR
  - CO = HR x SV
- Sinus tachycardia is almost always a compensatory response
- Identify and treat the underlying cause not the HR

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