### Shock!!

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### Objectives

Physiology
Approach to shock
ED evaluation
Management

•Cases/practice!

# Shock is no bueno. Septic shock 30-35% mortality Cariogenic shock 70-90% mortality



# **Definition of Shock**

- Acute circulatory failure
- Leading to decreased organ perfusion
- With inadequate delivery of oxygenated
- blood to tissues
- Resultant end-organ dysfunction.



# Pathophysiology

- $MAP = CO \times SVR$
- $MAP = (SV * HR) \times SVR$
- MAP = (f(preload, afterload, contractility) \*HR) x SVR
- MAP
  - Preload
  - Afterload
  - Contractility
  - SVR

(hypovolemic)
(obstructive)
(cardiogenic)
(distributive)

# Pathophysiology

- Aerobic → Anaerobic metabolism
  - Generates LACTATE



Shock is initially reversible, but eventually becomes irreversible
 cell death → end organ damage →
 multi-system organ failure → death



# How should I think?

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

- System/Ultrasound
  - Tank
  - Pipes
  - Pump



Table	1.	Categories	Of	Shock <sup>2</sup>
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Category	Hemodynamics	Causes	
Hypovolemic	↓ preload † SVR ↓ CO	Hemorrhage, GI losses, third spacing, burns	
Distributive	↓ preload ↓ SVR 1/↓ CO	Sepsis, anaphylaxis, neurogenic shock, pancreatitis	
Cardiogenic	† preload † SVR ↓ CO	Myocardial infarction, symptomatic bradycar- dia, valvular disease, heart blocks, end-stage heart failure	
Obstructive	↓ preload † SVR ↓ CO	Pulmonary embolism, tension pneumothorax, pericardial tamponade	

# By system/ultrasound

- Tank
  - Fluid status (IVC), Preload!!
  - Fluid in lungs/abd?
- Pipes
  - AAA? DVT?
- Pump
  - Hypercontractile? Hypocontractile?
  - RV strain, pericardial effusion?

### **ED** Department Evaluation

#### Doctor, doctor, what do we do?!?



### **ED** Department Evaluation

- ABCDE with simultaneous resuscitation
- IV- 2 large bore
- **02** supplemental, early intubation?
- Monitor
  - Vital Signs are IMPORTANT but not everything (can lag)
  - EKG





### Secondary Survey: H & P

#### HISTORY

- Comorbidities
- AMS or intubated? Friends/EMS useful
  - Trauma? (cause or result?)
- Helper: Review previous hospital records
- Medications? (Steroid dependence?)

### Secondary Survey: H & P

### PHYSICAL

• Perfusion

### Secondary Survey: H & P

#### PHYSICAL

- Perfusion
  - Skin temp
  - Mental status
  - Urine output

(protecting airway?)

- Mucous membranes
- Infx source?
- Congested?

(skin, lungs, urine) (JVD? Crackles?)



# Labs and Imaging

- Intravascular volume status Dry MM? JVD? IVC? UOP? Passive leg raise
- Ultrasound



- CBC, CMP, VBG (lactate), T&S
- ?ABG, ?Blood Cx, ?UA/Ucx, ?LP, Paracentesis?
- CXR, CT abd?



### RUSH Exam Sequencing

- 1. Parasternal Long Cardiac View
- 2. Apical Four-Chamber Cardiac View
- 3. Inferior Vena Cava View
- 4. Morison's with Hemothorax View
- 5. Splenorenal with Hemothorax View
- 6. Bladder View
- 7. Aortic Slide Views
- 8. Pneumothorax View
- 9. Pneumothorax View

Use Curvilinear Array for 1-7 Use High-Frequency Array for 8 & 9

#### Table 1

Rapid Ultrasound in SHock (RUSH) protocol: ultrasonographic findings seen with classic shock states

RUSH Evaluation	Hypovolemic Shock	Cardiogenic Shock	Obstructive Shock	Distributive Shock
Pump	Hypercontractile heart Small chamber size	Hypocontractile heart Dilated heart	Hypercontractile heart Pericardial effusion Cardiac tamponade RV Strain	Hypercontractile heart (early sepsis) Hypocontractile heart (late sepsis)
Tank	Flat IVC Flat jugular veins Peritoneal fluid (fluid loss) Pleural fluid (fluid loss)	Distended IVC Distended jugular veins Lung rockets (pulmonary edema) Pleural fluid (effusions) Peritoneal fluid	Distended IVC Distended jugular veins Absent lung sliding (pneumothorax)	Normal or small IVC (early sepsis) Peritoneal fluid (peritonitis) Pleural fluid (empyema)
Pipes	Abdominal aneurysm Aortic dissection	Normal	DVT	Normal

Abbreviations: DVT, deep venous thrombosis; IVC, inferior vena cava; RV, right ventricle.

### Management

- Goals:
  - Restore tissue perfusion
  - Treat underlying pathology





# **Restore Perfusion**

- Oxygen
- Fluids
  - Fill the tank/Preload!
- Pressors
  - Once euvolemic OR
  - S/p multiple boluses
- Blood?
  - 1<sup>st</sup> line if bleeding
  - Incr O2 delivery if Hgb low



### **Treat Pathology**

- Hypovolemic
  - Hemostasis
  - Replacement
- Distributive
  - Source control/abx
  - Epi
  - Supportive

- Cardiogenic
  - Reperfusion
  - Rhythm control
  - Optimize function
  - Obstructive
    - Relieve obstruction
    - Lysis/drainage



End-diastolic volume



End-diastolic volume





End-diastolic volume

### Management

Choice of vasopressor

- Etiology dependent!
- Cardiogenic  $\rightarrow$  Dobutamine, Milronone
- Hemorrhagic/Distributive/???
  - $\rightarrow$  FLUIDS!
  - → Norepinepherine (levophed)

#### **Clinical Application**

	Ist Line Agent	2nd Line Agent
Septic Shock	Norepinephrine (Levophed)	Vasopressin Epinephrine
Heart Failure	Dobutamine	(Adrenalin) Milrinone Dopamine
Cardiogenic Shock	Norepinephrine (Levophed) Dobutamine	
Anaphylactic Shock	Epinephrine (Adrenalin)	Vasopressin
Neurogenic Shock	Phenylephrine (Neosynephrine)	

### Disposition

- Appropriate consults
- ICU vs Stepdown vs Floor
- Medicine vs Cardiology vs Surgery
- Proper service is very important!! (can delay definitive management)

# EMS brings in patient



55yo M with hx HTN, constipation presents with bright red blood per rectum.

VS HR 102, BP 122/90 RR 18, Sat 100% afebrile



- History
  - Two episodes of BRBPR, filled toilet
  - No abd pain, no dizziness
- Exam
  - No distress, talking, comfortable
  - Cold extremities
  - Bright red blood on rectal exam

- Initial steps?
- Important features of presentation?
- Tests/labs?
- Category of shock?
- Management?
- Disposition?

#### Hemorragic shock

#### Criteria's of severities of hemorrhagic shock

Parameter	I	Ш	111	IV
Blood loss (ml)	<750	750–1500 1500–2000		>2000
Blood loss (%)	<15%	15–30%	30–40%	>40%
Pulse rate (beats/min)	<100	>100	>120	>140
Blood pressure	Normal	Decreased	Decreased	Decreased
Respiratory rate (bpm)	14–20	20–30	30–40	>35
Urine output (ml/hour)	>30	20–30	5–15	Negligible
CNS symptoms	Normal	Anxious	Confused	Lethargic

Crit Care. 2004; 8(5): 373-381.

Dept. Anesthesiology and Intensive Care Medicine, DSMA 2008

### Hemorrhagic Shock

- Definitive hemostasis!!!
  - Surgery, GI, IR
- Hgb can lag, bleeding is real
- If losing blood, give them BLOOD
  - Balanced transfusion
  - MTP

57yo M s/p low speed MVC, restrained driver



VS

HR 47, BP 80/50 RR 16, Sat 95% T 97.9 Exam Confused Diaphoretic Cold extremities No bruising or tenderness

- Initial steps?
- Important features of presentation?
- Tests/labs?



- Initial steps?
- Important features of presentation?
- Tests/labs?
- Category of shock?
- Management?
- Disposition?

Table 2. Etiologies Of Ca	ardiogenic Shock <sup>1</sup>	<sup>1</sup> • Hypertrophic Cardiomyopathy	
<ul> <li>Decreased Stroke Volume</li> <li>Acute Myocardial Infarction         <ul> <li>Right-sided infarct</li> <li>Large left-sided infarct</li> <li>Infarct in setting of existing dises</li> <li>Mechanical complications of infa</li> <li>Mechanical Complications Of Infa</li> <li>Acute mitral regurgitation due to</li> <li>Ventricular septal defect</li> </ul> </li> </ul>	ase arction farction papillary muscle rupture	<ul> <li>Restrictive Cardiomyopathy</li> <li>Myocarditis</li> <li>Takotsubo Cardiomyopathy</li> <li>Atrial Myxoma</li> <li>Orthotopic Transplant Rejection</li> <li>Cardiac Trauma         <ul> <li>Blunt</li> <li>Atrial Myxoma</li> <li>Orthotopic Transplant Rejection</li> </ul> </li> </ul>	Cardiac Shock 'Zebras' • Penetrating
<ul> <li>Free wall rupture</li> <li>Valvular Heart Disease</li> <li>Mitral stenosis or regurgitation</li> <li>Aortic stenosis or regurgitation</li> <li>Dilated Cardiomyopathy</li> <li>Ischemic</li> <li>Viral/bacterial</li> <li>Toxin-induced</li> <li>Rheumatologic</li> </ul>	<ul> <li>Thyroid disease</li> <li>Pheochromocytoma</li> <li>Congenital</li> <li>Peripartum</li> <li>Sarcoidosis</li> </ul>	Abnormal Heart Rates <ul> <li>Bradyarrhythmias</li> <li>Sick sinus syndrome</li> <li>Junctional bradycardia</li> <li>Complete heart block</li> </ul> Tachyarrhythmias <ul> <li>Atrial fibrillation/flutter</li> <li>Reentrant atrial tachycardia</li> </ul>	Ventricular tachycardia Ventricular fibrillation

### **Decompensated Heart Failure**



### **Cardiogenic Shock**

- MI vs CHF vs Dysrhythmia
- Pump problem!
  - Treatment of cause especially KEY
- +/- fluids based on etiology
- Low threshold for vasoactive medications

40 YOM with no PMH presents s/p syncope.

VS: HR 120, BP 70/50, RR 35, T 98.6

Alert Complaining of light-headedness Short of breath Recently came from Haiti



- Initial steps?
- Important features of presentation?
- Tests/labs?
- Category of shock?
- Management?
- Disposition?





#### **Parasternal Short**

#### Apical 4-Chamber



#### **Parasternal Short**

D sign

#### Apical 4-Chamber

RV Dilatation Septal Deviation

- Initial steps?
- Important features of presentation?
- Tests/labs?
- Category of shock?
- Management?
- Disposition?

### **Obstructive Shock**

- Identify obstruction
  - PE, tamponade, pneumo
  - IVC compression (abd compartment, mass)
- RELIEVE obstruction
  - Poke it, lyse it
- Ultrasound is KEY

# 79yo F, hx Dementia, old CVA, sent from nursing home for lethargy

VS HR 110, BP 82/59 RR 22, 02 95% Temp 99.9F oral



- Initial steps?
- Important features of presentation?
- Tests/labs?
- Category of shock?
- Management?
- Disposition?



SEPS	IS ST	<b>EPS</b> 20% Mortality	45% Mortality	
	15% Mortality <hr/> SEPSIS	SEVERE SEPSIS	SHOCK Severe Sepsis with <u>persistent</u> :	
SIRS T: >100.4 F < 96.8 F	2 SIRS	Sepsis + Signs of End Organ Damage	Hypotension Signs of End Organ Damage	
RR: >20 HR: >90 WBC: >12,000 <4,000	+	Hypotension (SBP <90)	Lactate >4 mmol	
>10% bands PCO2 < 32 mmHg	Contirmed or suspected infection	Lactate >4 mmol		

- Initial steps?
- Important features of presentation?
- Tests/labs?
- Category of shock?
- Management?
- Disposition?

### **Distributive Shock**

- Warm, vasodilated (usually)
- Recognize sepsis
  - <u>Source control</u> → EARLY antibiotics
- Don't be shy about fluids
  - Can intubate, but can't replace dead organs
- Vasopressors after bolus ~x2
- Anaphylaxis/neurogenic: early vasoactive meds

# Neurogenic Shock

- Injury T5 or above
  - w/in 30min,
- Loss of sympathetic tone (vasomotor and cardiac)
  - Hypotension
  - Bradycardia
  - Poikilothermia (unable to regulate)
- Phenylepherine!



# Anaphylactic Shock

- Exposure to allergen
- Multi-organ response



- Skin, GI, respiratory, vascular/cardiac
- Massive vasodilatation
   → low BP, low preload
- Epi, epi, epi, and more epi
- Steroids, antihistamines, H2 blockers, fluids

### Summary

- Recognize shock early
  - Not always hypotensive
- Differentiate based on physical, adjuvants
  - Ultrasound
- Correct hypoperfusion
  - Fluids, vasopressors
- Treat underlying cause
- Disposition appropriately

### References

Richards, J; Wilcox, S. "Diagnosis and Management of Shock in the Emergency Room" <u>EB Medicine</u>, March 2014, Vol 16 No 3

Tintinalli JE, C. Keith Stone, Roger L. Humphries, editors. <u>Tintinalli's Emergency Medicine</u>. 7th ed. New York: McGraw-Hill; 2011.





### Management

#### Hemodynamics of Shock

LearnTheHeart.com

Red arrow indicates primary abnormality	PCVVP (preload)	Cardiac Output	SVR (afterload)	Treatment
Hypovolemic shock	$\downarrow$	$\uparrow$	$\uparrow$	IV fluids
Cardiogenic shock	$\uparrow$	↓	$\uparrow$	Inotropes Revascularization
Distributive shock (septic, neurogenic)	$\downarrow$	$\uparrow$	$\downarrow$	Pressors IV fluids

PCWP = pulmonary capillary wedge pressure SVR = systemic vascular resistance