Hemodynamic Support

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Hemodynamic Support

Overview

- Differential Diagnosis of Shock
- Interpretation of Invasive Monitoring
- Use of Inotropes & Pressors
- Mechanical Support
- Evidence Based Guidelines for Resuscitation
Defining Shock

• **Physiologic state characterized by significant, systemic reduction in tissue perfusion causing end-organ dysfunction**

• **Hypotension with**
  – altered mental status
  – oliguria/anuria
  – dry mucous membranes, cool/clammy skin
  – delayed capillary refill
Differential Diagnosis of Shock

- **Hypovolemic**
- **Cardiogenic**
- **Distributive**
Hypovolemic Shock

- Decreased preload
  - Hemorrhage
    - Trauma
    - GI source
    - Ruptured aneurysm
  - Fluid Loss
    - Burn injury
    - Enteral (diarrhea/vomiting)
    - 3rd spacing
Cardiogenic Shock

- Pump failure
  - Cardiomyopathy
    - Infarction
    - Dilated cardiomyopathies
    - Stunned/depressed myocardium
  - Arrhythmias
    - Atrial or ventricular
    - Bradycardia
  - Mechanical
    - Valvular
    - Septal defects
    - Tumor/myxoma
  - Obstructive/ Extracardiac
    - Tension pneumothorax
    - Tamponade
    - Severe pulmonary hypertension
Distributive/ Vasodilatory Shock

- Septic
- Neurogenic
- Drug/Toxin
- Systemic Inflammatory Response
- Adrenal Insufficiency
Shock Hemodynamics

PCWP  CO  SVR

HYPOVOLEMIC  ↓  ↑

CARDIOGENIC  ↑  ↓  ↑

DISTRIBUTIVE  ↓  ↑  ↓
Pulmonary Artery Catheter

- Provides detailed information (measured and derived) regarding volume status, cardiac function, vascular tone
- *JAMA*, 1996-5 yr review of 5,735 pts
  - PACs in initial 24hrs assoc w/increased mortality
  - Not dangerous, not helpful either
Flow Directed Catheter
PAC Controversy

- *Chest*, 2002 - 417 physicians presented a vignette
  - PAC data improved tx plans
  - 10% persisted with harmful plans

- *Int Care Med*, 2003 - survey of 126 critical care physicians using 3 vignettes
  - #1 50%
  - #2 44%
  - #3 37%
• *J Trauma*, 1998-
  – Pts with EF <40% w/ ↑ splanchnic perfusion, improved pH with ↑ preload compared to inotropes
  – No adverse affect on pulmonary function

• *NEJM*, 2001- early goal directed therapy (CVP 8-12) improves mortality in septic shock

• *Circulation*, 2004 (ACC/AHA) -
  – 250ml bolus for cardiogenic shock, no evidence of pulm edema
  – Optimal PCWP ≈ 18-25

• Increased preload needed for right sided infarction
• Maximize Starling curve
Crystalloid vs Colloid

- *Cochrane Rev, 2004-*
  - meta analysis of 46 RCT’s comparing crystalloids to colloids
  - No survival benefit using colloid
  - Expense not justified outside of a randomized trial
Pressors and Inotropes

• Pharmacologic manipulation of alpha adrenergic, beta adrenergic, and/or dopamine receptors

• Rational use relies on understanding the following
  – One agent can affect multiple receptors
  – Dose-dependent nature of effects
  – Direct versus reflex actions

• Optimizing physiology
  – Stop bleeding, treat infection
  – Adequate volume
  – Physiologic milieu

• Frequent reevaluation
### Inotropes/ Pressors

<table>
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<tr>
<th>Drug</th>
<th>Receptor</th>
<th>HR</th>
<th>Inotropy</th>
<th>SVR</th>
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<tr>
<td>Dopamine</td>
<td>DA → β₁→α₁</td>
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<td>(1-20mcg/kg/min)</td>
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<tr>
<td>Dobutamine</td>
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<td>(2.5-20mcg/kg/min)</td>
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<tr>
<td>Norepinephrine</td>
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<td>(0.5-20 mcg/min)</td>
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<tr>
<td>Epinephrine</td>
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<td>↑↑↑</td>
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<tr>
<td>(2-10 mcg/min)</td>
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<tr>
<td>Phenylephrine</td>
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<td>Isoproterenol</td>
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<td>(1-10 mcg/min)</td>
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Pressors

• **Vasopressin** - direct effect on vascular smooth muscle causing vasoconstriction
  – *Circulation, 2003; Anesth, 2002*:
    - Addition of vasopressin to norepinephrine improves outcomes in distributive shock

• **Milrinone** - PD inhibitor
  – $\uparrow$ cAMP levels = $\uparrow$ Ca$^{++}$ = $\uparrow$ contractility
  – Peripheral actions limit use in hypotension, 1° use in heart failure
Mechanical Support
Intra-aortic balloon pump

- Inserted via femoral artery into descending aorta
- Inflation/deflation synchronized with cardiac cycle
- Augments coronary diastolic flow, decreases afterload
- Contraindications: Aortic insufficiency, ileofemoral disease
- VADs, CPB/ECMO
Goal-Directed Therapy

- *NEJM*, 2001 - application of GDT for septic shock in ED

- Randomized to 6hrs of GDT vs control prior to ICU admission

- Overall mortality reduced from 46.5% to 30.5%
Conclusions

• Shock can be multifactorial, PACs can be helpful adjuncts to therapy

• Early recognition and prompt initiation of treatment are key

• Goal-directed resuscitation improves outcomes