Vasopressors and Inotropes in Cardiogenic Shock

**Cardiogenic Shock**:  
- Medical emergency where a weakened ♥ is not able to sufficiently perfuse blood and oxygen to the body's organs and tissues

**Possible Causes**:  
- Pump (Left ventricle) Failure  
  - From myocardial infarction  
- Other causes:  
  - Valvular heart disease (e.g. aortic or mitral regurgitation, aortic stenosis)  
  - Ventricular septal rupture  
  - Cardiac tamponade  
  - Arrhythmias (e.g. ventricular)  
  - Obstructive disorders (e.g. pulmonary embolism, constrictive pericarditis)

Note: Important to manage both the underlying condition and cardiogenic shock!

**Treatments**:  
- Avoid negative inotropes and vasodilators initially  
  - For example: β-blockers (BB), Calcium channel blockers (CCB)  
- Reperfusion:  
  - Emergency revascularization with CABG or PCI  
  - Intra-aortic balloon pump ↑ coronary perfusion & oxygen to myocardium → ↓ work of heart  

**Goals of Medications**: prompt treatment of hypotension and hypoperfusion (mortality rate ~ 50% with cardiogenic shock)
VASOPRESSORS: ↑ vasoconstriction ➔ ↑ perfusion to body and coronary arteries
INOTROPES: ↑ cardiac contractility ➔ ↑ cardiac output

Cardiac Actions of Receptors:

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Location</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>α1 adrenergic</td>
<td>Vascular smooth muscle</td>
<td>↑ contraction (+ inotrope) No effect on heart rate</td>
</tr>
<tr>
<td>β1 adrenergic</td>
<td>Heart</td>
<td>↑ contraction (+ inotrope) ↑ heart rate (+ chronotrope) ↑ cardiac output</td>
</tr>
<tr>
<td>β2 adrenergic</td>
<td>Vascular smooth muscle</td>
<td>Vasodilation</td>
</tr>
<tr>
<td>Dopamine (D)</td>
<td>Renal Splanchnic (mesenteric) Coronary Cerebral</td>
<td>Vasodilation</td>
</tr>
<tr>
<td>2nd Subtype</td>
<td>Vasoconstriction (↑ norepinephrine release)</td>
<td></td>
</tr>
</tbody>
</table>

One drug, many receptors!

<table>
<thead>
<tr>
<th>Medications</th>
<th>α1</th>
<th>β1</th>
<th>β2</th>
<th>D</th>
<th>Compatibility</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vasopressors (Adrenergic Agents)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norepinephrine (Levophed®)</td>
<td>+++</td>
<td>++</td>
<td>+</td>
<td>0</td>
<td>Compatible with D5W (dextrose protects norepinephrine) ♦ Less stable with NS ♦ Compatible via Y-site: furosemide</td>
<td>1st choice for cardiogenic shock ♦ associated with ↓ death at 28 days and ↓ failed therapy vs. dopamine</td>
</tr>
<tr>
<td>Epinephrine (Adrenaline®)</td>
<td>+++</td>
<td>+++</td>
<td>++</td>
<td>0</td>
<td>May be mixed with dextrose and saline solutions</td>
<td>1st choice for anaphylactic shock ♦ Low doses = β1 agonist ♦ ↑ dose = ↑ α1 stimulation</td>
</tr>
<tr>
<td>DOPamine (Inotropin®) Low Mod High</td>
<td>0</td>
<td>+</td>
<td>++</td>
<td>++</td>
<td>0</td>
<td>Compatible with DSW, NS, lactated Ringer’s mannitol ♦ Avoid flushing the tubing as a bolus of the drug can be fatal</td>
</tr>
</tbody>
</table>

β1 receptor stimulation
− ↑ risk of dysrhythmias (e.g. sinus tachycardia, atrial fibrillation with RVR, ventricular tachycardias)
− ↑ myocardial oxygen consumption = ↑ risk of cardiac ischemia
  • ↓ risk with norepinephrine: 1st choice for cardiogenic shock

β2 receptor stimulation
− inhibits insulin secretion: monitor for hyperglycemia with ___________ and ___________
<table>
<thead>
<tr>
<th>Medications</th>
<th>a1</th>
<th>b1</th>
<th>b2</th>
<th>D</th>
<th>Compatibility</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dobutamine (Dobutrex®)</td>
<td>0/+</td>
<td>+++</td>
<td>++</td>
<td>0</td>
<td>Compatible with D5W, NS, lactated Ringer’s</td>
<td>♦ used for severe refractory heart failure and cardiogenic shock (e.g. low cardiac output despite fluid resuscitation and use of inotrope/vasopressor)</td>
</tr>
<tr>
<td>Isoproterenol (Isuprel®)</td>
<td>0</td>
<td>+++</td>
<td>+++</td>
<td>0</td>
<td>Compatible with dextrose and saline solutions</td>
<td>Inovasodilator</td>
</tr>
<tr>
<td>Milrinone (Primacor®)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Inhibits phosphodiesterase in cardiac and vascular tissue which ↑ cAMP and ↑ cardiac contraction and vasodilation</td>
<td>Inovasodilator: used for treating medically refractory heart failure (e.g. norepinephrine)</td>
</tr>
</tbody>
</table>

+++: Very strong effect; ++: Moderate effect; +: Weak effect; 0: No effect

Summary:
- In cardiogenic shock, inotropes and vasopressors are used for short-term support of circulatory system until device therapy or surgical intervention can be initiated and heart function has improved.
- Vasopressors: Dopamine and Norepinephrine's vasoconstriction > inotrope effects
  - Start with norepinephrine as (1) associated with less death at 28 days than dopamine in patients with cardiogenic shock, (2) associated with less dysrhythmias than dopamine, (3) faster acting
  - Dobutamine may be added on for ↑ inotropic effects
- Compatibility: all are compatible with D5W

Peripheral Extravasations: inadvertent leakage of IV fluid or drug from intravascular to interstitial space

**Signs and Symptoms**: An affected area: redness, swelling and pain
- With vasopressors (e.g. dopamine, epinephrine, norepinephrine): Excessive local vasoconstriction ⇒ pale, cold, hard and painful
  Can lead to sloughing and necrosis of skin
- Dobutamine: If infiltrated SC, may cause local pain without local ischemia

**Management**: Notify physician if suspected ASAP
- Stop infusion immediately and mark area with sharpie
- For vasopressors (e.g. dopamine, epinephrine, norepinephrine):
  - 10-15ml of NS containing 5-10mg phenolamine SC liberally to ↓ vasoconstriction **within 12 hours**
- A central venous catheter would eliminate the risk of peripheral extravasations and facilitate ↑ rapid distribution

References: