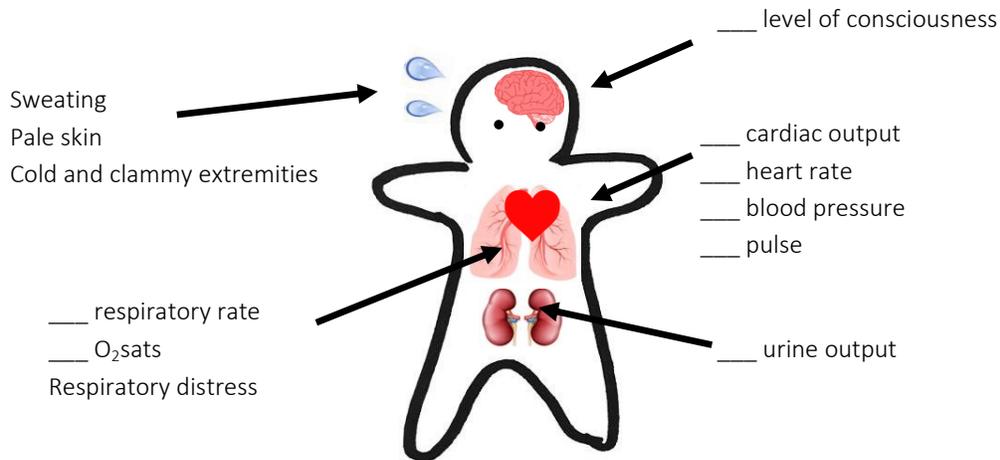


## Vasopressors and Inotropes in Cardiogenic Shock

### Cardiogenic Shock:

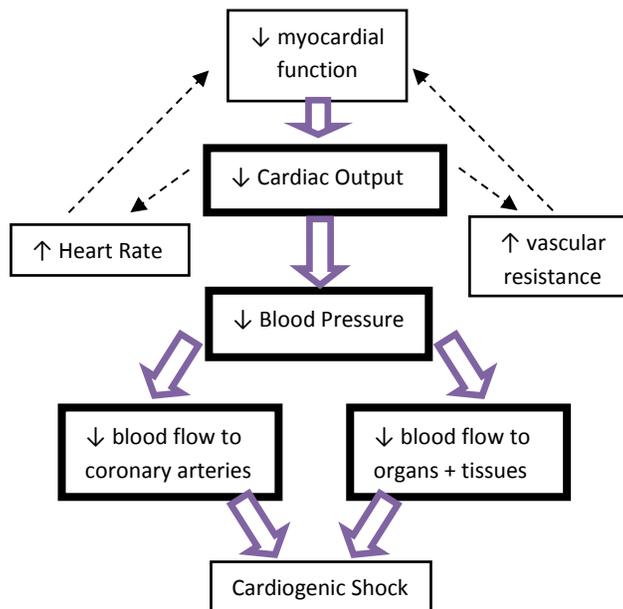
- Medical emergency where a weakened ♥ is not able to sufficiently perfuse blood and oxygen to the body's organs and tissues



### 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:  $\beta$ -blockers (BB), Calcium channel blockers (CCB)
- Reperfusion:
  - Emergency revascularization with CABG or PCI
  - Intra-aortic balloon pump  $\uparrow$  coronary perfusion & oxygen to myocardium  $\rightarrow$   $\downarrow$  work of heart } Requires time

**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:

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

One drug, many receptors!

Medications	α1	β1	β2	D	Compatibility	Comments
<b>Vasopressors (Adrenergic Agents)</b>						
Norepinephrine (Levophed®)	+++	++	+	0	Compatible with D5W (dextrose protects norepinephrine) ◆ Less stable with NS ◆ Compatible via Y-site: furosemide  For continuous IV infusion > 2-6 hours: preferably via central line	1 <sup>st</sup> choice for cardiogenic shock ◆ associated with ↓ death at 28 days and ↓ failed therapy vs. dopamine
Epinephrine (Adrenaline®)	+++	+++	++	0	May be mixed with dextrose and saline solutions  For continuous IV infusion > 2-6 hours: preferably via central line	1 <sup>st</sup> choice for anaphylactic shock ◆ Low doses = β1 agonist ◆ ↑ dose = ↑ α1 stimulation
DOPamine (Inotropin®) Low Mod High	0 + ++	+ ++ ++	0	++	Compatible with D5W, NS, lactated Ringer's mannitol ◆ Avoid flushing the tubing as a bolus of the drug can be fatal  For continuous IV infusion: preferably via central line (peripheral line may be used for up to 24 hours and at < 5mcg/kg/min) ◆ Must use infusion control device	Option for cardiogenic shock, and symptomatic bradycardia ◆ As ↑ dose = ↑ α1 stimulation: ↑↑ vasoconstriction ↑ HR and contractility

β 1 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 ∴ 1<sup>st</sup> choice for cardiogenic shock

β2 receptor stimulation

– inhibits insulin secretion ∴ monitor for hyperglycemia with \_\_\_\_\_ and \_\_\_\_\_

Medications	$\alpha_1$	$\beta_1$	$\beta_2$	D	Compatibility	Comments
<b>Inotrope (Adrenergic Agents)</b>						
DOBUTamine (Dobutrex®)	0/+	+++	++	0	Compatible with D5W, NS, lactated Ringer's ◆ Not compatible with furosemide	◆ used for severe refractory heart failure and cardiogenic shock (e.g. low cardiac output despite fluid resuscitation and use of inotrope/vasopressor)
Isoproterenol (Isuprel®)	0	+++	+++	0	Compatible with dextrose and saline solutions ◆ Do not administer concomitantly with epinephrine; may alternate at 4 hours intervals	Inovasodilator ◆ use in hypovolemic or septic shock with low cardiac output state, bradyarrhythmias
<b>Inotrope (Phosphodiesterase Enzyme 3 inhibitor)</b>						
Milrinone (Primacor®)	N/A Inhibits phosphodiesterase in cardiac and vascular tissue which $\uparrow$ cAMP and $\uparrow$ cardiac contraction and vasodilation				Compatible with D5W, saline solutions ◆ Not compatible with furosemide ◆ Requires dosage adjustment in renal failure	Inovasodilator: used for treating medically refractory heart failure ◆ use may be limited by hypotension – may require an adrenergic agonist (e.g. norepinephrine)

+++ : 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) sfaster acting
  - Dobutamine may be added on for  $\uparrow$  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

- 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 phentolamine SC liberally to  $\downarrow$  vasoconstriction **within 12 hours**
- A central venous catheter would eliminate the risk of peripheral extravasations and facilitate  $\uparrow$  rapid distribution

### References:

- De Backer D, Biston P, Devriendt J, Madi C, Chochrad D, Aldecoa C, Brasseur A, Defrance P, Gottignies P, Vincent JL. Comparison of dopamine and norepinephrine in the treatment of shock. *New England Journal of Medicine*. 2010 Mar 4;362(9):779-89.
- Ellender TJ, Skinner JC. The use of vasopressors and inotropes in the emergency medical treatment of shock. *Emergency medicine clinics of North America*. 2008 Aug 31;26(3):759-86.
- Djogovic D, MacDonald S, Wensel A, Green R, Loubani O, Archambault P, Bordeleau S, Messenger D, Szulewski A, Davidow J, Kircher J. Vasopressor and inotrope use in Canadian emergency departments: evidence based consensus guidelines. *CJEM*. 2015 Feb 1;17(S1):1-6.
- Fraser Health. *Parenteral Drug Therapy Manual: Dobutamine*. Available from: remote.fraserhealth.ca [Accessed 29<sup>th</sup> Nov 2016].
- Fraser Health. *Parenteral Drug Therapy Manual: Dopamine*. Available from: remote.fraserhealth.ca [Accessed 29<sup>th</sup> Nov 2016].
- Fraser Health. *Parenteral Drug Therapy Manual: Epinephrine*. Available from: remote.fraserhealth.ca [Accessed 29<sup>th</sup> Nov 2016].
- Fraser Health. *Parenteral Drug Therapy Manual: Isoproterenol*. Available from: remote.fraserhealth.ca [Accessed 29<sup>th</sup> Nov 2016].
- Fraser Health. *Parenteral Drug Therapy Manual: Milrinone*. Available from: remote.fraserhealth.ca [Accessed 29<sup>th</sup> Nov 2016].
- Fraser Health. *Parenteral Drug Therapy Manual: Norepinephrine*. Available from: remote.fraserhealth.ca [Accessed 29<sup>th</sup> Nov 2016].
- Josephson L. Cardiogenic Shock. *Dimens Crit Care Nurs*. 2008;27(4):160-170.
- Manaker S. Use of vasopressors and inotropes. Available from: uptodate.com [Updated 13<sup>th</sup> Sept 2016, Accessed 29<sup>th</sup> Nov 2016].
- National Heart Lung and Blood Institutes. What are the signs and symptoms of cardiogenic shock? Available from: <https://www.nhlbi.nih.gov/health/health-topics/topics/shock/signs>
- National Heart Lung and Blood Institutes. *What causes cardiogenic shock?* Available from: <https://www.nhlbi.nih.gov/health/health-topics/topics/shock> [Accessed 29<sup>th</sup> Nov 2016]/
- Overgaard CB, Džavik V. Inotropes and vasopressors review of physiology and clinical use in cardiovascular disease. *Circulation*. 2008 Sep 2;118(10):1047-56.
- Rae AP, Hutton I. Cardiogenic Shock and the Haemodynamic Effects of Arrhythmias. *Br. J. Anaesth*. 1986, 58, 151-168.
- Reynolds HR, Hochman JS. Cardiogenic Shock. *Circulation*. 2008 Feb 4; 117:686-697.