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Figure 1: Stepwise management of hemodynamic support in infants and children

0 min
- Recognize decreased mental status and perfusion.
- Begin high flow O₂, establish IV/IO access.
- Initial resuscitation: Push boluses of 20 cc/kg isotonic saline or colloid up to & over 60 cc/kg until perfusion improves or unless rales or hepatomegaly develop.
- Correct hypoglycemia & hypocalcemia. Begin antibiotics.
- Shock not reversed?

5 min
- Fluid refractory shock: Begin inotrope IV/IO, use atropine/ketamine IV/IO/IM to obtain central access & airway if needed.
- Reverse cold shock by titrating central dopamine or, if resistant, titrate central epinephrine.
- Reverse warm shock by titrating central norepinephrine.
- Shock not reversed?

15 min
- Catecholamine resistant shock: Begin hydrocortisone if at risk for absolute adrenal insufficiency.
- Monitor CVP in PICU, attain normal MAP, CVP & ScvO₂ > 70%.

60 min
- Cold shock with normal blood pressure:
  1º goals: Titrate epinephrine, ScvO₂ > 70%, Hgb > 10 g/dL
  2º goals: add vasodilator* (nitrovasodilators, nitrinimone, imrinnone, & others) with volume loading, consider levosimendan
- Cold shock with low blood pressure:
  1º goals: Titrate epinephrine, ScvO₂ > 70%, Hgb > 10 g/dL
  2º goals: Add norepinephrine, Add dobutamine if ScvO₂ < 70%
  Consider nitrinone, enoximone or levosimendan
- Warm shock with low blood pressure:
  1º goals: titrate norepinephrine, ScvO₂ > 70%
  2º goals: consider vasopressin, terlipressin or angiotensin
  Add dobutamine or low dose epinephrine if ScvO₂ < 70%
- Shock not reversed?

Persistent catecholamine resistant shock: Rule out and correct pericardial effusion, pneumothorax, & intra-abdominal pressure > 12 mm/Hg. Use pulmonary artery catheter, PICCO monitor, PAH &/or doppler ultrasound to guide fluid, inotrope, vasopressor, vasodilator and hormonal therapies.
- Goal C.I. > 3.3L & < 6.0 L/min/m²
- Shock not reversed?

Refractory shock: ECMO (110 mL/Kg/min) &/or CRRT (> 35 mL/Kg/hr)
Stepwise management of hemodynamic support in infants and children

**Recognize decreased mental status and perfusion.** Begin high flow O_2. Establish IV/IO access.

**Initial resuscitation:** Push boluses of 20 cc/kg isotonic saline or colloid up to & over 60 cc/kg until perfusion improves or unless rales or hepatomegaly develop.
Correct hypoglycemia & hypocalcemia. Begin antibiotics.

**Shock not reversed?**

**Fluid refractory shock:** Begin inotrope IV/IO, use atropine/ketamine IV/IO/IM to obtain central access & airway if needed. Reverse cold shock by titrating central dopamine or, if resistant, titrate central epinephrine. Reverse warm shock by titrating central norepinephrine.

**Dose range:** dopamine up to 10 mcg/kg/min, epinephrine 0.05 to 0.3 mcg/kg/min

**Shock not reversed?**

**Catecholamine resistant shock:** Begin hydrocortisone if at risk for absolute adrenal insufficiency.

**Monitor CVP in ICU, attain normal MAP, CVP & ScvO_2 > 70%**

**Cold shock with normal blood pressure:**
1° goals: Titrated epinephrine, ScvO_2 > 70%, Hgb > 10 g/dL
2° goals: add vasodilator* (nitrovasodilators, milrinone, inamrinone, & others) with volume loading. Consider levosimendan.

**Cold shock with low blood pressure:**
1° goals: Titrated epinephrine, ScvO_2 > 70%, Hgb > 10 g/dL
2° goals: Add norepinephrine Add dobutamine if ScvO_2 < 70%
Consider milrinone, enoximone or levosimendan

**Warm shock with low blood pressure:**
1° goals: titrate norepinephrine, ScvO_2 > 70%,
2° goals: consider vasopressin, terlipressin or angiotensin Add dobutamine or low dose epinephrine if ScvO_2 < 70%

**Shock not reversed?**

**Persistent catecholamine resistant shock:** Rule out and correct pericardial effusion, pneumothorax, & intra-abdominal pressure >12 mm/Hg. Use pulmonary artery catheter, PICCO monitor, PARD &/or doppler, PICCO monitor, PATD &/or doppler ultrasound to guide fluid, inotrope, vasopressor, vasodilator and hormonal therapies.
Goal C.I. > 3.3 L/minute/m²

**Shock not reversed?**

**Refractory shock:** ECMO (110 mL/kg/min) &/or CRRT (>35 mL/kg/hr)
Figure 1: Stepwise management of hemodynamic support in infants and children

- **0 min**
  - Recognize decreased mental status and perfusion.
  - Begin high flow O₂. Establish IV/IO access.

**Recognize decreased mental status and perfusion.** Begin high flow O₂. Establish IV/IO access.

**Reverse cold shock** by titrating central dopamine or, if resistant, titrate central epinephrine.

**Reverse warm shock** by titrating central norepinephrine.

**Shock not reversed?**

**Catecholamine resistant shock:** Begin hydrocortisone if at risk for absolute adrenal insufficiency.

**Monitor CVP in ICU, attain normal MAP, CVP & ScvO₂ > 70%**

- **Cold shock with normal blood pressure:**
  1° goals: Titrate epinephrine, ScvO₂ > 70%, Hgb > 10 g/dL
  2° goals: Add vasodilator* (nitrovasodilators, milrinone, inrionone, & others) with volume loading, consider levosimendan

- **Cold shock with low blood pressure:**
  1° goals: Titrate epinephrine, ScvO₂ > 70%, Hgb > 10 g/dL
  2° goals: Add norepinephrine Add dobutamine if ScvO₂ < 70%
  Consider milrinone, enoximone or levosimendan

- **Warm shock with low blood pressure:**
  1° goals: titrate norepinephrine, ScvO₂ > 70%,
  2° goals: consider vasopressin, terlipressin or angiotensin
  Add dobutamine or low dose epinephrine if ScvO₂ < 70%

**Shock not reversed?**

**Persistent catecholamine resistant shock:** Rule out and correct pericardial effusion, pneumothorax, & intra-abdominal pressure >12 mmHg.

Use pulmonary artery catheter, PICCO monitor, PAID &/or doppler ultrasound to guide fluid, inotrope, vasopressor, vasodilator and hormonal therapies.

Goal C.I. > 3.3 & < 6.0 L/min/m²

**Shock not reversed?**

**Refractory shock:** ECMO (110 mL/Kg/min) &/or CRRT (> 35 mL/Kg/h)
**Initial resuscitation:** Push boluses of 20 cc/kg isotonic saline or colloid up to & over 60 cc/kg until perfusion improves or unless rales or hepatomegaly develop. Correct hypoglycemia & hypocalcemia. **Begin antibiotics.**

**Figure 1: Stepwise management of hemodynamic support in infants and children**

0 min
- Recognize decreased mental status and perfusion.
- Partial high flow O₂/Fo2 > 60%

**5-15 min**
- or, if resistant, titrate central epinephrine
- Reverse warm shock by titrating central norepinephrine.
- **Shock not reversed?**

**Catecholamine resistant shock:** Begin hydrocortisone if at risk for absolute adrenal insufficiency

Monitor CVP in PICU, attain normal MAP/CVP & ScvO₂ > 70%

**Cold shock with normal blood pressure:**
1° goals: Titrate epinephrine, ScvO₂ > 70%, Hgb > 10 g/dL
2° goals: add vasodilator* (nitrovasodilators, milrinonine, inrinrinone, & others) with volume loading, consider levosimendan

0.05 to 0.3 mcg/kg/min

**Cold shock with low blood pressure:**
1° goals: Titrate epinephrine, ScvO₂ > 70%, Hgb > 10 g/dL
2° goals: Add norepinephrine
Add dobutamine if ScvO₂ < 70%
Consider milrinone, enoximone or levosimendan

**Warm shock with low blood pressure:**
1° goals: Titrate norepinephrine, ScvO₂ > 70%,
2° goals: consider vasopressin, terlipressin or angiotensin
Add dobutamine or low dose epinephrine if ScvO₂ < 70%

**Persistent catecholamine resistant shock:** Rule out and correct pericardial effusion, pneumothorax, & intra-abdominal pressure >12 mm/Hg.
Use pulmonary artery catheter, PICCO monitor, PAWD &/or doppler ultrasound to guide fluid, inotrope, vasopressor, vasodilator and hormonal therapies.
Goal C.I. > 3.3& < 6.0 L/min/m²

**Shock not reversed?**

**Refractory shock:** ECMO (110 mL/Kg/min) &/or CRRT (> 35 mL/Kg/hr)

With 2nd PIV start inotrope.
Figure 1: Stepwise management of hemodynamic support in infants and children

**Fluid refractory shock:** Begin inotrope IV/IO, use atropine/ketamine IV/IO/IM to obtain central access & airway if needed.

**Reverse cold shock** by titrating central dopamine or, if resistant, titrate central epinephrine

**Reverse warm shock** by titrating central norepinephrine.

**Catecholamine resistant shock:** Begin hydrocortisone if at risk for absolute adrenal insufficiency

Monitor CVP in PICU, attain normal MAP, CVP & ScvO₂ > 70%

**Cold shock with normal blood pressure:**
1st goals: Titrate epinephrine, ScvO₂ > 70%, Hgb > 10 g/dL
2nd goals: add vasodilator* (nitrovasodilators, milrinone, inrinoone, & others) with volume loading, consider levosimendan

**Cold shock with low blood pressure:**
1st goals: Titrate epinephrine, ScvO₂ > 70%, Hgb > 10 g/dL
2nd goals: Add norepinephrine, Add dobutamine if ScvO₂ < 70%
Consider milrinone, enoximone or levosimendan

**Warm shock with low blood pressure:**
1st goals: titrate norepinephrine, ScvO₂ > 70%,
2nd goals: consider vasopressin, terlipressin or angiotensin
Add dobutamine or low dose epinephrine if ScvO₂ < 70%

**Shock not reversed?**

**Persistent catecholamine resistant shock:** Rule out and correct pericardial effusion, pneumothorax, & intra-abdominal pressure >12 mm/Hg.
Use pulmonary artery catheter, PICCO monitor, PAOD &/or Doppler ultrasound to guide fluid, inotrope, vasopressor, vasodilator and hormonal therapies.
Goal CI > 3.3 & < 6.0 L/min/m²

**Refractory shock:** ECMO (110 mL/Kg/min) &/or CRRT (> 35 mL/Kg/hr)
Catecholamine resistant shock: Begin hydrocortisone if at risk for absolute adrenal insufficiency

Monitor CVP in PICU, attain normal MAP-CVP & ScvO₂ > 70%

Cold shock with normal blood pressure:
1° goals: Titrate epinephrine, ScvO₂ > 70%, Hgb > 10 g/dL

2° goals: add vasodilator* (nitrovasodilators, milrinonine, imrindone, & others) with volume loading, consider levosimendan

Cold shock with low blood pressure:
1° goals: Titrate epinephrine, ScvO₂ > 70%, Hgb > 10 g/dL

2° goals: Add norepinephrine
Add dobutamine if ScvO₂ < 70%
Consider milrinone, enoximone or levosimendan

Warm shock with low blood pressure:
1° goals: titrate norepinephrine, ScvO₂ > 70%,

2° goals: consider vasopressin, terlipressin or angiotensin
Add dobutamine or low dose epinephrine if ScvO₂ < 70%

Refractory shock: ECMO (110 mL/Kg/min) &/or CRRT (> 35 mL/Kg/hr)
Cold shock with normal blood pressure:
1° goals: Titrate epinephrine, ScvO₂ > 70%, Hgb > 10 g/dL
2° goals: add vasodilator* (nitrosovasodilators, milrininone, imrinone, & others) with volume loading, consider levosimendan
Figure 1: Stepwise management of hemodynamic support in infants and children

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<td>Recognize decreased mental status and perfusion.</td>
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<td>Begin high flow O&lt;sub&gt;2&lt;/sub&gt;. Establish IV/IO access.</td>
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Cold shock with low blood pressure:

1º goals: Titrate epinephrine, ScvO<sub>2</sub> > 70%, Hgb > 10 g/dL

2º goals: Add norepinephrine
Add dobutamine if ScvO<sub>2</sub> < 70%
Consider milrinone, enoximone or levosimendan
Warm shock with low blood pressure:
1° goals: titrate norepinephrine, \( \text{ScvO}_2 > 70\% \),
2° goals: consider vasopressin, terlipressin or angiotensin
Add dobutamine or low dose epinephrine if \( \text{ScvO}_2 < 70\% \)

Refactory shock: ECMO (110 mL/Kg/min) &/or CRRT (> 35 mL/Kg/hr)
Persistent catecholamine resistant shock: Rule out and correct pericardial effusion, pneumothorax, & intra-abdominal pressure > 12 mmHg.

Use pulmonary artery catheter, PICCO monitor, FATD & or doppler ultrasound to guide fluid, inotrope, vasopressor, vasodilator and hormonal therapies.

Goal C.I. > 3.3 & < 6.0 L/min/m²

ECMO or CRRT (> 35 mL/Kg/hr) shock not reversed?

ECMO: Central Access

Initial resuscitation: Push bolus of 20 cc/kg isotonic saline or colloid up to & over 60 cc/kg until perfusion improves or unless rules or hypoperfusion develop

Correct intravascular & hypocalcemia. Begin antibiotics.


**Figure 2: Stepwise management of hemodynamic support in neonates**

<table>
<thead>
<tr>
<th>Time</th>
<th>Action</th>
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<tbody>
<tr>
<td>0 min</td>
<td>Recognize decreased perfusion, cyanosis, and RDS. Maintain airway and establish access according to NRP guidelines.</td>
</tr>
<tr>
<td>5 min</td>
<td><strong>Initial resuscitation:</strong> Push boluses of 10 cc/kg isotonic saline or colloid up to 60 cc/kg until perfusion improves, unless hepatomegaly develops. Correct hypoglycemia &amp; hypocalcemia. Begin antibiotics. Begin prostaglandin until ductal-dependent lesion is ruled out.</td>
</tr>
<tr>
<td>15 min</td>
<td><strong>Fluid refractory shock:</strong> Titrate dopamine up to 10 mcg/kg/min. Consider dobutamine.</td>
</tr>
<tr>
<td>60 min</td>
<td><strong>Fluid refractory dopamine-resistant shock:</strong> Titrate epinephrine 0.05 to 0.3 mcg/kg/min.</td>
</tr>
<tr>
<td></td>
<td><strong>Catecholamine resistant shock:</strong> Monitor CVP in NICU, attain normal MAP-CVP &amp; ScvO₂ &gt; 70%. SVC flow &gt; 40 mL/Kg/min or CI 3.3 L/m²/min.</td>
</tr>
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</table>

**Cold shock with normal blood pressure & evidence of poor LV function (ScvO₂ < 70% despite Hgb > 12 g/dL, SVC flow < 40 mL/Kg/min or CI < 3.3 L/m²/min) add vasodilator (nitrovasodilators, mivirinone) with volume loading.**

**Cold shock with low blood pressure & evidence of RV dysfunction (PPHN with ScvO₂ < 70% SVC flow < 40 mL/Kg/min or CI < 3.3 L/m²/min) Add inhaled nitric oxide, consider milrinone or amrinone, consider inhaled heprost or IV adenosine.**

**Warm shock with low blood pressure: add volume & norepinephrine. Consider vasopressin, terlipressin, or angiotensin. Use isotropes to keep ScvO₂ > 70%. SVC flow > 40 mL/Kg/min or CI 3.3 L/m²/min.**

**Refractory shock:** Rule out & correct pericardial effusion, pneumothorax, Use hydrocortisone for absolute adrenal insufficiency, and T₃ for hypothyroidism. Begin pentoxifylline if VLBW newborn. Consider closing PDA if hemodynamically significant. **shock not reversed?**

**ECMO**

(110 mL/Kg/min)
Figure 2: Stepwise management of hemodynamic support in neonates

0 min

- Recognize decreased perfusion, cyanosis, and RDS.
- Maintain airway and establish access according to NRP guidelines

5 min

- **Initial resuscitation:** Push boluses of 10 cc/kg isotonic saline or colloid up to 60 cc/kg until perfusion improves, unless hepatomegaly develops.
- Correct hypoglycemia & hypocalcemia. Begin antibiotics.
- Begin prostaglandin until ductal-dependent lesion is ruled out.

- **shock not reversed?**

15 min

- **Fluid refractory shock:** Titrate dopamine up to 10 mcg/kg/min. consider dobutamine

- **shock not reversed?**

60 min

- **Fluid refractory dopamine-resistant shock:** Titrate epinephrine 0.05 to 0.3 mcg/kg/min

- **shock not reversed?**

- **Catecholamine resistant shock:** Monitor CVP in NICU. attain normal MAP-CVP & ScvO₂ > 70%.
- SVC flow > 40 mL/Kg/min or CI 3.3 L/m²/min

- **Cold shock with normal blood pressure & evidence of poor LV function** (ScvO₂< 70% despite
- Hgb > 12 g/dL,
- SVC flow < 40 mL/Kg/min or CI < 3.3 L/m²/min)
- Add vasodilator* (nitrovasodilators, mironidine) with volume loading.

- **Cold shock with low blood pressure & evidence of RV dysfunction** (PPHN with ScvO₂< 70%)
- SVC flow < 40 mL/Kg/min or CI < 3.3 L/m²/min)
- Add inhaled nitric oxide, consider mironidine or amrinone, consider inhaled Ilampot or IV adenosine.

- **Warm shock with low blood pressure:** add volume & norepinephrine. Consider vasopressin, terlipressin, or angiotensin.
- Use isotopes to keep ScvO₂ > 70%.
- SVC flow > 40 mL/Kg/min & CI 3.3 L/m²/min

- **shock not reversed?**

- **Refractory shock:** Rule out & correct pericardial effusion, pneumothorax.
- Use hydrocortisone for absolute adrenal insufficiency, and T₃ for hypothyroidism.
- Begin pentoxifylline if VLBW newborn. Consider closing PDA if hemodynamically significant.

- **shock not reversed?**

- **ECMO** (110 mL/Kg/min)
Recognize decreased perfusion, cyanosis, and RDS. Maintain airway and establish access according to NRP guidelines.

**Figure 2: Stepwise management of hemodynamic support in neonates**

- **0-5 min**
  - **shock not reversed?**
    - **Fluid refractory shock:** Titrate dopamine up to 10 mcg/kg/min. consider dobutamine
    - **shock not reversed?**
      - **Fluid refractory dopamine-resistant shock:** Titrate epinephrine 0.05 to 0.3 mcg/kg/min
      - **shock not reversed?**
        - **Catecholamine resistant shock:** Monitor CVP in NICU, attain normal MAP-CVP & ScvO₂ > 70%.
          - SVC flow > 40 mL/Kg/min or CI > 3.3 L/min²

- **15 min**
  - **shock not reversed?**
    - **Cold shock with normal blood pressure & evidence of poor LV function** (ScvO₂ < 70% despite Hgb > 12 g/dL, SVC flow < 40 mL/Kg/min or CI < 3.3 L/min²)
      - add vasodilator*(nitrovasodilators, minoxidil)
        - with volume loading.
    - **Cold shock with low blood pressure & evidence of RV dysfunction** (PPHN with ScvO₂ < 70%)
      - SVC flow < 40 mL/Kg/min or CI < 3.3 L/min²
      - Add inhaled nitric oxide, consider nitrinone or amrinone, consider inhaled heparin or IV adenosine.
    - **Warm shock with low blood pressure:**
      - *add volume & norepinephrine.
        - Consider vasopressin, terlipressin, or angiotensin. use isotropes to keep ScvO₂ > 70%.
      - SVC flow > 40 mL/Kg/min & CI > 3.3 L/min²

- **60 min**
  - **shock not reversed?**
    - **Refractory shock:** Rule out & correct pericardial effusion, pneumothorax, Use hydrocortisone for absolute adrenal insufficiency, and T₃ for hypothyroidism.
      - Begin pentoxifylline if VLBW newborn. Consider closing PDA if hemodynamically significant.
    - **shock not reversed?**
      - ECMO (110 mL/Kg/min)
**Initial resuscitation:** Push boluses of 10 cc/kg isotonic saline or colloid up to 60 cc/kg until perfusion improves, unless hepatomegaly develops.
Correct hypoglycemia & hypocalcemia. **Begin antibiotics.** Begin prostaglandin until ductal-dependent lesion is ruled out.

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**Catecholamine resistant shock:** Monitor CVP in NICU, attain normal MAP-CVP & ScvO₂ > 70%.
SVC flow > 40 mL/Kg/min or CI > 3.3 L/m²/min

**Cold shock with normal blood pressure & evidence of poor LV function:**
(ScvO₂ < 70% despite Hgb > 12 g/dL, SVC flow < 40 mL/Kg/min or CI < 3.3 L/m²/min)
add vasodilator *(nitrovasodilators, milrinone)* with volume loading.

**Cold shock with low blood pressure & evidence of RV dysfunction:**
(PPHN with ScvO₂ < 70% SVC flow < 40 mL/Kg/min or CI < 3.3 L/m²/min)
Add inhaled nitric oxide, consider milrinone or anitagonone, consider inhaled threoprost or IV adenosine.

**Warm shock with low blood pressure:**
Add volume & norepinephrine.
Consider vasopressin, terlipressin, or angiotensin.
**Use isotropes to keep ScvO₂ > 70%**.
SVC flow > 40 mL/Kg/min & CI > 3.3 L/m²/min

**Shock not reversed?**

**Refractory shock:** Rule out & correct pericardial effusion, pneumothorax, Use hydrocortisone for absolute adrenal insufficiency, and T₃ for hypothyroidism.
Begin pentoxifylline if VLBW newborn. Consider closing PDA if hemodynamically significant.

**Shock not reversed?**

**ECMO**
(110 mL/Kg/min)**
Figure 2: Stepwise management of hemodynamic support in neonates

0 min
- Recognize decreased perfusion, cyanosis, and RDS.
- Maintain airway and establish access according to NRP guidelines

5 min
- Initial resuscitation: Push boluses of 10 cc/kg isotonic saline or colloid up to 60 cc/kg until perfusion improves, unless hepatomegaly develops.
- Correct hypoglycemia & hypocalcemia. Begin antibiotics.
- Begin prostaglandin until ductal-dependent lesion is ruled out.

 Fluid refractory shock: Titrate dopamine up to 10 mcg/kg/min. consider dobutamine

Fluid refractory dopamine-resistant shock: Titrate epinephrine 0.05 to 0.3 mcg/kg/min

| Normal blood pressure & evidence of poor LV function (ScvO2 < 70% despite Hgb > 12 g/dL, SVC flow < 40 mL/Kg/min or CI < 3.3 L/m²/min) add vasodilator* (nitrovasodilators, minirinone) with volume loading. |
| Low blood pressure & evidence of RV dysfunction (PPHN with ScvO2 < 70% SVC flow < 40 mL/Kg/min or CI < 3.3 L/m²/min) Add inhaled nitric oxide, consider minirinone or amrinone, consider inhaled iloprost or IV adeven. |
| Low blood pressure: add volume & norepinephrine. Consider vasopressin, terlipressin, or angiotensin. Use inotropes to keep ScvO2 > 70%. SVC flow > 40 mL/Kg/min & CI 3.3 L/m²/min |


shock not reversed?

ECMO
(110 mL/Kg/min)
Figure 2: Stepwise management of hemodynamic support in neonates

- **0 min**: Recognize decreased perfusion, cyanosis, and RDS. Maintain airway and establish access according to NRP guidelines.
- **5 min**: Initial resuscitation: Push boluses of 10 cc/kg isotonic saline or colloid up to 60 cc/kg until perfusion improves, unless hepatomegaly develops. Correct hypoglycemia & hypocalcemia. Begin antibiotics. Begin prostaglandin until ductal-dependent lesion is ruled out.
- **15 min**: Shock not reversed? Fluid refractory shock: Titrate dopamine up to 10 mcg/kg/min.

**Catecholamine resistant shock**: Monitor CVP in NICU, attain normal MAP-CVP & ScvO2 > 70%, SVC flow > 40 mL/Kg/min or CI 3.3 L/m²/min

**Cold shock with normal blood pressure & evidence of poor LV function** (ScvO2 < 70% despite Hgb > 12 g/dL).
- SVC flow < 40 mL/Kg/min
- or CI < 3.3 L/m²/min
- add vasodilator* (nitrosovasodilators, milrinone with volume loading).

**Cold shock with low blood pressure & evidence of RV dysfunction** (PPHN with ScvO2 < 70%)
- SVC flow < 40 mL/Kg/min
- or CI < 3.3 L/m²/min
- Add inhaled nitric oxide, consider milrinone or amrinone, consider inhaled iloprost or IV adenosine.

**Warm shock with low blood pressure**: add volume & norepinephrine. Consider vasopressin, terlipressin, or angiotensin.
- use inotropes to keep ScvO2 > 70%, SVC flow > 40 mL/Kg/min & CI 3.3 L/m²/min
Cold shock with normal blood pressure & evidence of poor LV function (ScvO₂ < 70% despite Hgb > 12 g/dL, SVC flow < 40 mL/Kg/min or CI < 3.3 L/m²/min) add vasodilator* (nitrosovasodilators, milrininone) with volume loading.

Warm shock with low blood pressure: add volume & norepinephrine. Consider vasopressin, terlipressin, or angiotensin. Use inotropes to keep ScvO₂ > 70%. SVC flow > 40 mL/Kg/min & CI 3.3 L/m²/min
60 min

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**Cold shock with low blood pressure & evidence of RV dysfunction (PPHN with ScvO₂ < 70%)**

**SVC flow < 40 mL/Kg/min or CI < 3.3 L/m²/min**

*Add inhaled nitric oxide, consider milrinone or amrinone, consider inhaled Ileprost or IV adeosine.*
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<td><strong>Fluid resuscitation:</strong> Add 20 cc/kg/hr of crystalloid.</td>
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<td>60 min</td>
<td><strong>Fluid refractance:</strong> Consider vasopressin, terlipressin, or angiotensin. Use inotropes to keep $ScvO_2 &gt; 70%$, $SVC$ flow $&gt; 40$ mL/Kg/min &amp; CI $&gt; 3.3$ L/m$^2$/min.</td>
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Warm shock with low blood pressure: **add volume & norepinephrine.** Consider vasopressin, terlipressin, or angiotensin. **Use inotropes to keep $ScvO_2 > 70\%$, $SVC$ flow $> 40$ mL/Kg/min & CI $> 3.3$ L/m$^2$/min.**
Figure 2: Stepwise management of hemodynamic support in neonates

- **0 min**: Recognize decreased perfusion, cyanosis, and RDS. Maintain airway and establish access according to NRP guidelines.

  - **Initial resuscitation**: Push boluses of 10 cc/kg isotonic saline or colloid up to 60 cc/kg until perfusion improves, unless hepatomegaly develops. Correct hypoglycemia & hypocalcemia. Begin antibiotics. Begin prostaglandin until ductal-dependent lesion is ruled out.

    - **shock not reversed?**

  - **Fluid refractory shock**: Titrate dopamine up to 10 mcg/kg/min. consider dobutamine

    - **shock not reversed?**

  - **Fluid refractory dopamine-resistant shock**: Titrate epinephrine 0.05 to 0.3 mcg/kg/min

    - **shock not reversed?**

- **5 min**: Catecholamine resistant shock: Monitor CVP in NICU, attain normal MAP-CVP & ScvO₂ > 70%.

- **15 min**: SVC flow > 40 mL/kg/min or CI 3.3 L/m²/min

- **60 min**: Cold shock with normal blood pressure & evidence of poor LV function (ScvO₂< 70% despite dopamine) Cold shock with low blood pressure & evidence of RV dysfunction (PPHN with ScvO₂< 70% despite dopamine & dobutamine) Warm shock with low blood pressure: add volume & norepinephrine. Consider vasopressin, indomethacin, or steroids

**Refractory shock**: Rule out & correct pericardial effusion, pneumothorax, Use hydrocortisonfor absolute adrenal insufficiency, and T3 for hypothyroidism. Begin pentoxifylline if VLBW newborn. Consider closing PDA if hemodynamically significant.

**shock not reversed?**

- **ECMO (110 mL/Kg/min)**
CONTINUED EMPHASIS is directed to

1) First hour resuscitation and inotrope therapy directed to goals of threshold heart rates, normal blood pressure, and capillary refill $\leq$ 2 seconds

2) Subsequent ICU hemodynamic support directed to goals of $\text{ScvO}_2 > 70\%$ and Cardiac Index $3.3-6.0 \text{ L/min/m}^2$
2014 ACCM/PALS Guidelines
New Major Recommendations / Developments

1) If peripheral inotrope required support when central access is not available, start with epinephrine

2) Institution specific QIM bundles (3-4 elements in each)
   - Recognition
   - Resuscitation
   - Stabilization
   - Performance