Bradford Teaching Hospitals NHS
NHS Foundation Trust

Cardiovascular support of neonates

Authors: Sam Wallis, Chakra Vasudevan

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Cardiovascular support

Assessment of the cardiovascular system (CVS)

No single measure gives an accurate indicator of CVS status.

Identifying compromise is difficult, especially in the early stages. Look for evidence of conditions that may cause compromise (see below). If you are worried, monitor multiple parameters closely and look for changes over time. Review regularly

Monitor

1. Heart rate
2. Respiratory Rate
3. Blood Pressure
4. Cap refill / Colour
5. Urine output
6. Acidosis, Lactate
7. Echocardiography (for assessment of filling / function)

Management

It is important to make a distinction between

1. **Cardiovascular support for the sick, compromised infant**

2. **Managing the circulatory transition in extreme preterm babies in the first few days of life (e.g. may be "hypotensive" but are otherwise well).**

Direct links to management flow charts

1. **Sick, compromised infant**

2. **Circulatory transition preterm infant**

1. Cardiovascular support for the sick term / sick preterm infant

In cases where you suspect acute cardiovascular deterioration with signs of systemic compromise

e.g. **- Sepsis**
- NEC
- PPHN / Meconium aspiration syndrome
- Ischaemic injury / HIE / Multi-organ failure
- Pneumothorax
- Pericardial effusion

See disease specific guidelines (e.g. PPHN) for further details

Management

The aim is maintain cerebral and other vital organ perfusion. Management will need to be individualised - discuss with neonatal consultant on-call.

1. *Treat cause promptly*
    a. Look for signs of infection / air leak / effusion
    b. Consider reducing drugs such as morphine
    c. Make sure any respiratory support is not causing cardiac compromise esp HFOV

2. *Aggressive fluid resuscitation especially where hypovolaemia likely* (e.g NEC, blood loss)
    a. 0.9% saline fluid bolus 10-20ml/kg
    b. Give blood / clotting products where indicated
    c. Reassess and repeat

3. *Respiratory support*
    a. Abdominal distension / oedema may increase respiratory compromise
    b. Respiratory support reduces metabolic demand
    c. Be aware that induction drugs for intubation can cause significant hypotension – consider treating with fluid / inotropes prior.

4. *Inotropes as required*

A specific target BP is difficult to define but in general a sick baby should have a mean BP >/= to their corrected gestational age. In some cases (e.g. PPHN) it may be important to achieve a higher BP.

Use an appropriate combination of pressor (eg Dopamine, Adrenaline, Noradrenaline) and inotropic (eg Dobutamine, Adrenaline, Milrinone) support.

a. **Dopamine** IV **5-20 micrograms/kg/min** (can give peripherally but risk of extravasation)
    i. Increases RV ejection fraction / Increases SVR

b. **Dobutamine** IV **5-20 micrograms/kg/min**
    i. Increases contractility, mild vasodilation but less good at improving BP

c. **Hydrocortisone** IV **2.5 milligramsg/kg** 6 hourly

Although there is no evidence either way, some units are now using Adrenaline and Milrinone as alternative first line agents to Dopamine and Dobutamine. NOTE DIFFERENCES IN UNITS.

d. **Adrenaline** IV **100 nanograms / kg/ minute** initially
    i. Can increase to 1000 nanograms / kg/ minute
    ii. Increases contractility, vasoconstricts at higher doses

e. **Milrinone** (Phosphodiesterase inhibitor – inotrope and vasodilator)

- Load with **50,000 nanograms** / kg IV (50 micrograms/kg) over **60mins**
  Reduce or omit loading dose if at risk of hypotension

- Maintenance infusion of IV **500 – 750 nanograms / kg / minute**

  Embrace dose is 750 nanograms / kg/ min. Half dose with renal impairment
  N.b BNFc dose of 30-45 micrograms/kg/hour = 500-750ng/kg/min
  (see BNFc and [3,4])

f. If response poor + needing Adrenaline doses > 0.2microg/kg/min then can consider adding
    i. **Noradrenaline** IV **100 nanograms /kg/minute** initially, slowly increased up to 1500 nanograms /kg/minute but use cautiously and watch peripheral perfusion
    ii. **Vasopressin 0.02units/kg/hour** increasing stepwise to 0.1units/kg/hr
    Vasopressin potentiates Adrenaline / spares pulmonary vasculature

5. *Central access*
    a. Monitoring
    b. Inotrope administration

6. *Assess response and re-evaluate plan*
    a. Monitor closely including - UO, CRT, Lactate

See flow chart on next page for more information

Acute cardiovascular deterioration / Signs of systemic compromise

Identify & Treat underlying cause promptly

Consider e.g. Infection, NEC, airleak, pericardial tamponade

Consider reducing morphine / check inotropes running correctly

Optimize respiratory support (i.e Mean airway pressure / PEEP)

Aggressive fluid resuscitation

0.9% saline 10 – 20 ml/kg and reassess

Blood and blood products if indicated

Inotropes

- **Dopamine 5 – 20 micrograms/kg/minute IV**
- **Dobutamine 5 – 20 micrograms/kg/minute IV**
- **Hydrocortisone 2.5 milligrams/kg IV 6 hourly**

Alternative Inotropic / pressor agents

- **Adrenaline 100-1000 nanograms/kg/minute IV**
- **Milrinone 500-750 nanograms /kg/ minute IV**

If needing Adrenaline > 0.2mcg/kg/min – Consider

- **Noradrenaline 100-1000 nanograms/kg/minute IV**
- **Vasopression 0.02 – 0.1 u/kg/hr IV**

2. Managing preterm circulatory transition

Managing the circulatory transition from in-utero to the ex-utero environment is an important part of early neonatal care. Blood pressure is often used as a way of monitoring this. However, a normal BP range for preterm infants is unknown. The commonly cited value of mean BP = gestational age is based on extremely limited evidence[1,2].

In addition the use of BP as a marker of cardiovascular health is misleading. The purpose of the cardiovascular system is to deliver oxygen to tissues and remove waste products. BP is a product both of cardiac output *and* systemic resistance and so can be normal / high when blood flow to tissues is poor – e.g. due to high peripheral resistance.

We would recommend an assessment of any baby should take into consideration all the markers outlined above. However it is important to appreciate this can be very difficult in extreme preterm infants where urine output and capillary refill is unreliable, and HR and RR may be affected by multiple other factors.

It may be reasonable to accept stable "low" BPs in preterm babies with no signs of compromise (normal lactate, pH, other vital signs), although this should be discussed with the consultant on duty. Most neonatologists would be uncomfortable with mean BPs several mmHgs below gestational age although individual practice varies.

Despite the limitations of BP measurement, hypotension *is* associated with IVH / Brain injury[3]. The ability to autoregulate cerebral blood flow is impaired in some extreme preterm infants and there is concern that low blood pressure, or rapid swings in blood pressure *may* predispose to bleeding. However it must be realised that treatment for preterm hypotension has **not** been associated with any improvement in outcomes[4,5,6].

Administration of saline boluses for hypotension is commonly used but there is no evidence of benefit[6] and it may cause higher levels of bronchopulmonary dysplasia[7,8,9,10]. As such we dot recommend saline boluses as routine treatment for hypotension. They may be indicated if there is evidence of reduced circulating volume but it may be more appropriate to give blood products as volume replacement, particularly in the presence of anaemia, or with a history of APH, blood loss or immediate cord clamping.

Management of preterm infants with -

1. Unacceptably low BP and evidence of poor end organ perfusion / compromise – manage as per pathway for sick infant
2. Unacceptable low BP but otherwise well and no evidence of poor end organ perfusion – **consider Dopamine as first line treatment**
3. Acceptable BP but signs of poor end organ perfusion (high lactate, low UO). In the absence of any reversible cause it may be appropriate to **give blood products / 1 x bolus 0.9% saline then commence Dobutamine as the initial inotrope.**

See flow chart on next page for more information

Circulatory Support Preterm infant

Low BP

Evidence of end organ hypoperfusion

Manage as Acute Deterioration

Low BP

No evidence of end organ hypoperfusion

Obtain invasive BP

Re zero / check if the reading is correct

?Anaemia or History of APH / blood loss/ immediate cord clamping

Consider

1. **Dopamine** (5 – 20 mcg/kg/min)

   If Dopamine > 10 – Consider

2. **Echo assessment of filling +/- Blood products or 10ml/kg of 0.9% saline**
3. **Add Dobutamine** (5-20mcg/kg/min)

Alternatives or if no response consider

Hydrocortisone (2.5mg/kg IV 6 hourly)

Adrenaline (100-1000 nanograms/kg/minute IV)

Milrinone (500-750 nanograms/kg/ minute IV)

Normal BP

Evidence of poor perfusion

Ix for non cardiac causes

Obtain invasive BP / Re- zero and ensure correct reading

?Anaemia or History of APH / blood loss / immediate cord clamping

1 x Fluid Bolus (0.9% saline) 10ml/kg or blood products if indicated and assess response

Transfuse blood products over 1 hour

Consider

Echo assessment of filling +/- Further 10ml/kg saline

If no response consider

1. **Dobutamine** 5- 20 mcg/kg/min
2. Further fluids and inotropic support depending on underlying cause and response to earlier interventions

References

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