Clinical Guideline

VASOACTIVE DRUGS - MANAGEMENT PRINCIPLES IN PAEDIATRICS

SETTING

FOR STAFF
All registered practitioners (nursing and medical)

PATIENTS
All paediatric patients receiving continuous infusions of vasoactive drugs

Introduction

Critically ill children may receive vasoactive drug infusions as part their clinical management in a number of clinical areas within BRHC. This guidance has been developed to provide standard practice management principles throughout BRHC and minimise the potential risks associated with the delivery of vasoactive medications.

Nursing responsibilities when caring for a child receiving an infusion of a vasoactive drug are;

- To ensure that the child receives the appropriate dose of the prescribed vasoactive drug, according to BRHC guidelines and Trust policy.
- To monitor the patient for response to the infusion, potential side effects and changes in their clinical condition.
- To ensure that infusions are changed in accordance with BRHC guidelines / Trust ANTT policy with minimal consequences to the cardiovascular stability of the patient.
- To ensure, following successful weaning of a vasoactive drug infusion that the intravenous line through which the infusion was administered is managed appropriately according to BRHC guidelines and Trust policy.
- To ensure that any deterioration or clinical concerns about the patient are escalated promptly via the Outreach Team, responsible medical team, HDU Consultant and PIC.

Medical responsibilities when caring for a child receiving an infusion of a vasoactive drug are;

- Ensure that prescriptions for vasoactive medications are written legibly and according to Trust policy. Expected clinical parameters are also clearly documented.
- Undertake regular clinical review of the child requiring vasoactive support – this will be determined by the underlying clinical condition of the child e.g. dilated cardiomyopathy on
long term support needs daily clinical review while post-surgical patients requiring a vasopressor infusion need immediate and frequent review until clinical stability is achieved.

Cardiac HDU –

- Infusion rates and drug prescriptions should be reviewed daily as a minimum – adjustments to infusion rates, increasing or decreasing the level of support must be undertaken in discussion with the Consultant on service.
- Review of the prescribed dose in relation to the child’s weight should be undertaken as a minimum twice weekly.
- Routine echocardiogram to assess cardiac function should be considered at least weekly.
1. Definition

A vasoactive drug is a broad term used to describe a group of chemicals which exert one or more of the following effects on the cardiovascular system through activation of specific receptors.

- **Inotropes**: drugs which exert an effect on the myocardium and may be thought of in two broad groups;
  - Positive inotropes are drugs which enhance the contractility of the myocardium leading to an increase in cardiac output.
  - Negative inotropes are drugs that decrease the force of myocardial contractility, decreasing the heart rate, myocardial contractility and AV node conduction.

- **Chronotropes**: drugs which influence the rate of the heartbeat

- **Vasodilators**: drugs which act directly on the muscles in blood vessel walls to cause a widening of the vessel diameter

- **Vasoconstrictors / Vasopressors**: drugs which act directly on the muscles in the blood vessel walls to cause a narrowing of the vessel diameter.

Often these drugs may exert a combined action or different effects may be seen depending on the dose being delivered to the patient. Examples of this are detailed in the table below.

<table>
<thead>
<tr>
<th></th>
<th>Inotrope</th>
<th>Chronotrope</th>
<th>Vasoconstriction</th>
<th>Vasodilation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adrenaline</td>
<td>+++</td>
<td>++</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>(Epinephrine)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noradrenaline</td>
<td>+</td>
<td>0</td>
<td>+++</td>
<td>0</td>
</tr>
<tr>
<td>(Norepinephrine)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isoprenaline</td>
<td>+</td>
<td>+++</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>Dopamine</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>0</td>
</tr>
<tr>
<td>Dobutamine</td>
<td>+++</td>
<td>++</td>
<td>0</td>
<td>++</td>
</tr>
</tbody>
</table>
2. Inotropic Effects

Inotropes are commonly used in the care of the critically ill child. These drugs work on specific receptors which are identified in Table 2 below, along with a brief summary of the effects the receptors exert within the body.

<table>
<thead>
<tr>
<th>Receptors</th>
<th>Effects</th>
<th>Agonists (drugs which enhance the effects)</th>
<th>Notes</th>
</tr>
</thead>
</table>
| Alpha 1 α₁ | - Vasoconstriction of veins and arteries  
- Increased myocardial contractility | Adrenaline  
Noradrenaline  
Dopamine | Increases blood pressure  
Decreases urine output  
Decreases skin and splanchnic perfusion |
| Alpha 2 α₂ | - Vasodilation  
- Negative chronotropic effect | Adrenaline  
Noradrenaline | |
| Beta 1 β₁ | - Increased heart rate  
- Increased cardiac contractility  
- Increased conduction velocity | Isoprenaline  
Adrenaline  
Dopamine  
Noradrenaline  
Dobutamine | Increases heart rate  
Increases systemic perfusion |
| Beta 2 β₂ | - Vasodilatation  
- Bronchodilation | Isoprenaline  
Adrenaline  
Dopamine  
Noradrenaline  
Dobutamine | Increases blood flow to skin  
Decreases wheeze |
| Dopaminergic | - Dilation of renal mesenteric coronary and cerebral vascular beds | Dopamine | Increases urine output |

A list of the most frequently used vasoactive medications their effects and side effects is detailed in section 3.
## 3. Vasoactive Drugs – effects and side effects

<table>
<thead>
<tr>
<th>Vasoactive Drug</th>
<th>Effect</th>
<th>Side Effects</th>
</tr>
</thead>
</table>
| **Adrenaline**  | - α and β agonist, β₁ effects  
- Increased α effects at high doses | - Tachycardias  
- Increased myocardial work  
- Increased O₂ consumption  
- Splanchnic constriction |
| **Dobutamine** | - Predominantly β₁ effect with some β₂ and α effects  
- Can give peripherally | - Tachyarrhythmias  
- Hypotension  
- Pulmonary constriction |
| **Dopamine**    | **Low Dose**  
- dilation of vascular bed  
- increased heart rate | - Tachyarrhythmias  
- Increased PAP  
- Inhibits production of  
  - Thyroid Stimulation Hormone (TSH)  
  - Aldosterone |
| **Epoprostenol**| - Relaxation of vascular smooth muscle  
- Decrease in systemic vascular resistance  
- Increased HR  
- Decreased diastolic blood pressure  
- Inhibits platelet aggregation  
- Vasodilation | - Cerebral vasodilation  
- Increased cerebral blood flow  
- Hypotension  
- Bradycardia |
| **Esmolol**     | - Negative inotrope and chronotrope  
- Blocks beta-adrenoreceptors receptors  
- Decreased blood pressure  
- Slows atrio-ventricular conduction – lowers HR | - Severe bradycardia  
- Hypotension  
- Asystole  
- Very short acting / half life |
| **Glyceryl Trinitrate (GTN)** | - Low dose venodilation  
- High dose venous and arterial vasodilation  
- Blockade of alpha receptors in pulmonary circulation  
- Increased heart rate | - Hypotension  
- Tachycardia / Bradycardia  
- Headache |
| **Hydralazine** | - Peripheral vasodilator  
- Predominantly an arteriolar vasodilator which leads to decreased systemic vascular resistance (SVR)  
- Increased Heart Rate  
- Increased cardiac output | - Tachycardia  
- Palpitations  
- Hypotension  
- Headaches |
| **Isoprenalin** | - Positive inotrope and chronotrope  
- Potent bronchodilator  
- Decrease in peripheral vascular resistance (β2)  
- Increased automaticity and enhances atrioventricular nodal conduction | - Palpitations  
- Headaches  
Cardiac arrhythmias if other drugs e.g. digoxin or beta-adrenoreceptors are being given |
| **Labetalol**   | Anti-hypertensive  
- Decreases systolic and diastolic blood pressure  
- Decreases heart rate and cardiac output | - Liver damage  
- Hypotension |
### Vasoactive Drugs – effects and side effects (cont.)

<table>
<thead>
<tr>
<th>Vasoactive Drug</th>
<th>Effect</th>
<th>Side Effects</th>
</tr>
</thead>
</table>
| **Lignocaine**  | - Anti-arrhythmic  
|                  | - Local anaesthetic | - Seizures  
|                  |  | - Heart block  
|                  |  | - Hypotension |
| **Metaraminol** | - α and β agonist - major effect vasoconstriction  
|                  | - increases heart rate and blood pressure  
|                  | - Effects longer lasting than Noradrenaline | - Tachyarrhythmias  
|                  |  | - Increased myocardial work  
|                  |  | - Increased O₂ consumption  
|                  |  | - Hepatic and mesenteric ischaemia |
| **Milrinone**   | - Phosphodiesterase inhibitor  
|                  | - Increases intracellular cyclic AMP (cAMP)  
|                  | - Increases cardiac contractility  
|                  | - Vasodilatation | - Arrhythmias, hypotension,  
|                  |  | - Liver and GI dysfunction,  
|                  |  | - Thrombocytopenia |
| **Noradrenaline** | - α and β agonist - major effect vasoconstriction  
|                  | - increases heart rate and blood pressure  
|                  | - High doses may increase afterload and therefore worsen end organ ischaemia | - Tachyarrhythmias  
|                  |  | - Increased myocardial work  
|                  |  | - Increased O₂ consumption  
|                  |  | - Hepatic and mesenteric ischaemia |
| **Sodium Nitroprusside (SNP)** | - Vasodilation and hypotension  
|                  | - Decreased blood pressure  
|                  | - Increased heart rate | - SNP breaks down to cyanide  
|                  |  | Ensure levels of cyanide are measured if infusion continues for > 72 hours |
| **Calcium Gluconate** | - Increased myocardial contractility  
|                  | - Enhances ventricular automaticity | - Bradycardias  
|                  |  | - Hypotension  
|                  |  | - Tissues necrosis / extravasation  
|                  |  | Digoxin and high calcium doses can cause arrhythmias |

### 4. Routes of Administration for Vasoactive Medications

All of the drugs can, in an emergency, be given via an intra-osseous needle. However, we would only advocate the need for Adrenaline (Epinephrine), Noradrenaline (Norepinephrine), Dopamine and Dobutamine to be used in this way. If you have any concerns about this or any other questions about the route of administration always seek advice / support from one of the Senior Nurses.
### Commencing Vasoactive Medications via a short term central line

Vasoactive medications should be commenced on the Distal lumen, Seahorse PIC do not use needle-free bungs on vasoactive drug lumens, a three way tap should be attached and there should always be an available port to connect additional infusions.

<table>
<thead>
<tr>
<th>Inotrope</th>
<th>Short long line or central line</th>
<th>Peripheral Line</th>
<th>ETT</th>
<th>Oral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adrenaline (Epinephrine)</td>
<td>✓</td>
<td>X</td>
<td>✓</td>
<td>X</td>
</tr>
<tr>
<td>Dopamine</td>
<td>✓</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Dobutamine</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Epoprostenol</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Esmolol</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Glyceryl Trinitrate (GTN)</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
<td>✓</td>
</tr>
<tr>
<td>Hydralazine</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Isoprenaline</td>
<td>✓</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Labetalol</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
<td>✓</td>
</tr>
<tr>
<td>Metaraminol</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Milrinone</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Noradrenaline (Norepinephrine)</td>
<td>✓</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Sodium Nitroprusside (SNP)</td>
<td>✓</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
5. Preparation of Infusions Prior to Changing Syringes

The key consideration when preparing to change a child’s vasoactive drug infusions is to ensure that you have prepared the new infusion(s) well in advance of the anticipated time of change. As the majority of vasoactive medications have a very short half-life of 2-3 minutes (Arino et al 2004), any disruption to the continuity of the infusion may have significant deleterious effects on the child’s cardiovascular stability. **NB:** Current policy is for Microclave connections **NOT TO BE USED** on lines through which vasoactive medications are being infused.

<table>
<thead>
<tr>
<th>Action</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. If the child is receiving more than one inotrope or vasoactive medication they must be changed one at a time leaving an adequate period of time between changes (minimum 10 minutes)</td>
<td>• Accurately assess stability of the child throughout the procedure and minimise where possible adverse changes in the child’s clinical stability</td>
</tr>
<tr>
<td>2. Commence the process of changing the infusion(s) at least one hour before the old one runs out or expires. Remember to allow more than one hour if there are more than one inotrope to change.</td>
<td>• Allow sufficient time for the safe change of each infusion</td>
</tr>
<tr>
<td>3. Where possible / appropriate explain the procedure to the child’s parents / family and where appropriate to the child.</td>
<td>• Keep parents informed of changes in their child’s condition and reduce anxieties</td>
</tr>
<tr>
<td>4. Check prescription as in accordance with unit and Trust Drug Policy.</td>
<td>• Minimise error and act in accordance with Trust Policy (2004) and NMC (2008).</td>
</tr>
<tr>
<td>5. Make up infusion(s) as prescribed using ANTT as per Trust policy</td>
<td>• To minimise the potential of error and contamination</td>
</tr>
<tr>
<td>6. Ensure the syringe is correctly labelled and clearly identifiable (if changing the strength of the drug in the syringe - see pages 22-23 for correct labelling)</td>
<td>• To ensure child receives the correct drug running at the prescribed (correct) rate / dose</td>
</tr>
</tbody>
</table>
7. Attach syringe to manometer line and prime the line. Leave the free end of the line in a clean plastic tray

8. With the manometer line **NOT** connected to the child, start the infusion running at the prescribed rate of administration. If the drug to be infused has a rate of 5mls/hr or less it should run for 15 minutes prior to being connected to the child.

- To allow the infusion to be fully primed and running at the correct rate prior to attaching to the child while maintaining the principles of ANTT as per Trust policy
- The ‘mechanical slack’ associated with the manometer tubing and the pressure required to drive the plunger of the syringe is taken up almost instantaneously by the Injectomat MC Agilia pumps in use on the unit however it is appropriate to allow a short period of time to ensure that the syringe barrel has completed engaged with the drive mechanisms of the pump to ensure immediate delivery of the infusion
6. Procedure for Changing Syringes

Additional Information
Current practice is the use of ‘direct switching technique’ rather than the ‘double pumping technique’ – there is a paucity of evidence available to advocate strongly for either method as being superior however there is limited evidence (in 3 small clinical trials) to support the use of the ‘direct switching technique’ as it is a quicker and more efficient method and there is less risk of the child experiencing major changes in their mean arterial blood pressure than when they are receiving the titrated infusions associated with ‘double pumping’.

IMPORTANT - If you are caring for a child who is cardiovascually unstable please seek advice from one of the senior nurses before attempting to change infusions as there may be a need to use the double pumping technique instead (PIC only). This is when the old infusion and new infusion run concurrently on the same line. As soon as a spike in blood pressure is seen the old infusion is switched off using the three way tap and disconnected. It is essential that senior help is sought if you are unsure of how to carry out this technique.

The direct switching technique for changing syringes

<table>
<thead>
<tr>
<th>Action</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. When you are ready to change the infusion ensure stability of the child's cardiovascular status and note the mean blood pressure and heart rate.</td>
<td>• Wherever possible maintain the clinical stability of the child during the change process</td>
</tr>
<tr>
<td>NOTE: If you have ANY concerns regarding the cardiovascular status of the child, DO NOT change the drug infusion - seek help from senior nursing / medical staff</td>
<td></td>
</tr>
<tr>
<td>2. Identify the port on the 3-way tap where the existing drug infusion, (the one to be changed) is running. The new infusion will be attached on the same port, exactly where the old infusion has been running. Take the clean plastic tray containing the free end of the new manometer tubing and place immediately adjacent to the identified 3-way tap port.</td>
<td>• To allow for the smooth transfer from old to new infusion with minimal disruption to the child's condition</td>
</tr>
</tbody>
</table>
3. When you are ready, turn the 3-way tap so that the identified port where the vasoactive drug is running is closed. Immediately, remove the old infusion and connect the new infusion. As soon as the new infusion has been connected, turn the 3-way tap back to open this port to the new infusion.

- This maintains the flow of all other infusions during the changeover and minimises the length of time the infusion is interrupted for

**IF YOU ARE UNSURE OF ANY OF THE ABOVE STEPS YOU MUST SEEK ASSISTANCE FROM ONE OF THE SENIOR NURSES**

4. Closely observe child’s heart rate and blood pressure. Do not leave the child unsupervised during this period of change over. Report to nurse in charge/medical team any significant changes in the child’s cardiovascular status. You may note a transient alteration in the child’s cardiovascular status.

- To monitor the effect of change over and act accordingly if there is a compromise in the child’s clinical condition

**IF YOU ARE AT ALL CONCERNED YOU MUST SEEK HELP IMMEDIATELY.**

5. Reset the total volume infused on the new infusion pump to zero

- Discard any volume totaled during the pre-connection period

6. Discard the old infusion in accordance with Trust Policy.

- Safe disposal of waste and effective use of waste disposal resources according to UHB Trust policy

7. Document the change on child’s observation chart and sign the prescription / infusion chart

- Ensure accurate and timely documentation of procedure in accordance with UHB Trust policy
7. **Care Of Central Venous Lines After Completion Of Vasoactive Drug Administration**
   (For Hickman Lines - see below)

**Definition / Rationale**
The use of short term Central Venous Lines (CVL's) for accessing large veins and administering continuous intravenous drug therapies is commonplace. Once the intravenous drug therapy has been completed, the lumens of the CVL may not be required for further use, but must be available should the need arise, while the CVL remains in situ.

The aim of the nurse caring for a child whose continuous intravenous drug therapy has ceased is two-fold:-

- To ensure the child does not suffer an accidental bolus dose of an intravenous medication they no longer require
- To ensure patency of the unused lumen to facilitate blood sampling and availability of access should the need arise

**Points for Practice**

1. When a continuous intravenous infusion has been completed ensure that the child is isolated from the infusion line by turning three-way-tap to the off position / clamping the line.
2. Once the infusion has been discontinued for 4 hours and the child is clinically stable, follow the guidelines below.

**Equipment Required**

- Gloves
- Clean plastic tray / alcohol soaked medical wipes x 2
- 10ml syringe x 1
- 10ml luer-lock syringe containing 0.9% Sodium Chloride 4mls attached to a 100cm extension line
- Injectomat MC Agilia infusion pump

**Preparation**

- Where appropriate explain procedure to child and their parents / family to reduce anxiety levels
- Wash hands
- Prepare equipment as above
### Procedure

<table>
<thead>
<tr>
<th>Action</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check the three-way tap is closed to the patient or the line is clamped</td>
<td>To avoid accidental entrainment of air into the line.</td>
</tr>
<tr>
<td>Remove the infusion tubing from the access port on the line and using a clean end of access port.</td>
<td>To remove any remaining volume of the completed infusion being delivered unnecessarily to the child</td>
</tr>
<tr>
<td>Attach a 10ml syringe to access port, open clamp or three-way tap to patient and slowly aspirate 3mls of blood from the line.</td>
<td></td>
</tr>
<tr>
<td>Isolate the patient from the line by closing three-way tap to patient / using clamp on the line</td>
<td></td>
</tr>
<tr>
<td>Remove the syringe containing the aspirated blood and place on a plastic tray to be discarded in the sharps bin.</td>
<td></td>
</tr>
<tr>
<td>Attach the luer-lock syringe containing the 0.9% Sodium Chloride flush to the access port, ensuring that the access port is fully primed with fluid and contains no air.</td>
<td>This will ensure that the access port contains no air that may be inadvertently delivered to the child with the flush</td>
</tr>
<tr>
<td>Infuse the 0.9% Sodium Chloride flush at the same rate as the continuous infusion - if less than 1ml per hour it is acceptable to run the flush at 1ml per hour.</td>
<td>To ensure that the child does not receive a bolus of the medication at a rate higher than the previous infusion rate</td>
</tr>
<tr>
<td>Once the flush has completed turn the three-way- tap / clamp off to the patient</td>
<td></td>
</tr>
<tr>
<td>Remove the flush system and clean access port using a alcohol medical wipe</td>
<td></td>
</tr>
</tbody>
</table>
Additional Considerations

For small infant / neonatal CVL’s there may be a concern of the line blocking if the pump is infusing the 0.9% Sodium Chloride at a very slow rate. If this is the case – withdraw the blood as above, and then very slowly flush the line manually.

Important – PIC ONLY

DO NOT DO THIS IF THE NEONATE / INFANT HAS BEEN RECEIVING SNP – SEEK ADVICE FROM SENIOR STAFF

If there is a three-way tap on the line follow these instructions

- Attach a 2ml syringe filled with 0.9% Sodium Chloride to the access port and flush saline through the three-way tap to the adjacent access port, (ensuring that the three-way tap remains off to the patient) to remove the last traces of infusion solution from the three-way tap.

Finally

- Attach either a white non-injectable bung, if the line is not required for use or a needless bung if the child requires intermittent bolus drug administration.

WHAT TO DO IF THE LINE DOES NOT ASPIRATE BLOOD -

- Seek advice from a senior member of staff

HICKMAN LINES

Follow the procedure as indicated above. Always use a 10 ml syringe when aspirating the line, and remove the volume of blood as indicated on the side of the appropriate lumen.

When flushing the line, again follow the above procedure using a 10 ml luer-lock syringe, using the volume as indicated on the side of the appropriate lumen.
8. **Concentrations of Vasoactive Drugs For Children Weighing Less Than 40kg**

Vasoactive drugs will be delivered as single strength infusions in all clinical areas with the exception of PIC where they may be in single, double or quadruple strength infusions.

<table>
<thead>
<tr>
<th>Vasoactive Drug</th>
<th>Single Strength in 50 ml</th>
<th>Double Strength in 50 ml</th>
<th>Quadruple Strength in 50 ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adrenaline</td>
<td>0.3 mg/kg</td>
<td>0.6 mg/kg</td>
<td>1.2 mg/kg</td>
</tr>
<tr>
<td>Dopamine</td>
<td>15 mg/kg</td>
<td>30 mg/kg</td>
<td>60 mg/kg</td>
</tr>
<tr>
<td>Dobutamine</td>
<td>15 mg/kg</td>
<td>30 mg/kg</td>
<td>60 mg/kg</td>
</tr>
<tr>
<td>Epoprostenol</td>
<td>30 microgram/kg</td>
<td>60 microgram/kg</td>
<td>120 microgram/kg</td>
</tr>
<tr>
<td>Esmolol</td>
<td>500mg in 50 ml</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Glyceryl Trinitrate (GTN)</td>
<td>3 mg/kg</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>&gt;16 kg - 1mg / ml = neat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isoprenaline</td>
<td>0.3 mg/kg</td>
<td>0.6 mg/kg</td>
<td>1.2 mg/kg</td>
</tr>
<tr>
<td>Milrinone</td>
<td>1.5 mg / kg</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>&gt;33kg use neat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noradrenaline</td>
<td>0.3 mg/kg</td>
<td>0.6 mg/kg</td>
<td>1.2 mg/kg</td>
</tr>
<tr>
<td>Sodium Nitroprusside (SNP)</td>
<td>3 mg/kg</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>&gt;16 kg - 1mg / ml = neat</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vasoactive Drug</th>
<th>Single Strength in 25 ml</th>
<th>Double Strength in 25 ml</th>
<th>Quadruple Strength in 25 ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amiodarone</td>
<td>&lt; 10kgs – 30mg/kg</td>
<td>&lt; 10kgs – 60mg/kg</td>
<td>&lt; 10kgs – 120mg/kg</td>
</tr>
<tr>
<td></td>
<td>&gt; 10kgs – 15mg/kg</td>
<td>&gt; 10kgs – 30mg/kg</td>
<td>&gt; 10kgs – 60mg/kg</td>
</tr>
</tbody>
</table>
### 9. Concentrations Of Vasoactive Drugs For Children Weighing More Than 40kg

<table>
<thead>
<tr>
<th>Vasoactive Drug</th>
<th>Single Strength in 50 ml</th>
<th>Double Strength in 50 ml</th>
<th>Quadruple strength in 50 ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adrenaline (Epinephrine)</td>
<td>0.06 mg/kg</td>
<td>0.12 mg/kg</td>
<td>0.24 mg/kg</td>
</tr>
<tr>
<td>Dopamine</td>
<td>3 mg/kg</td>
<td>6 mg/kg</td>
<td>12 mg/kg</td>
</tr>
<tr>
<td>Dobutamine</td>
<td>3 mg/kg</td>
<td>6 mg/kg</td>
<td>12 mg/kg</td>
</tr>
<tr>
<td>Epoprostenol</td>
<td>500 microgram /50ml = neat</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Esmolol</td>
<td>500mg in 50 ml</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Glyceryl Trinitrate (GTN)</td>
<td>&gt;16 kg 1mg / ml = neat</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Isoprenaline</td>
<td>0.3 mg/kg</td>
<td>0.6 mg/kg</td>
<td>1.2 mg/kg</td>
</tr>
<tr>
<td>Milrinone</td>
<td>50mg / 50ml = neat</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Noradrenaline (Norepinephrine)</td>
<td>0.06 mg/kg</td>
<td>0.12 mg/kg</td>
<td>0.24 mg/kg</td>
</tr>
<tr>
<td>Sodium Nitroprusside (SNP)</td>
<td>&gt;16 kg - 1mg / ml = neat</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
10. Labelling Of Vasoactive Drug Infusions

The indication of the strength of the infusion i.e. single / double or quadruple strength is demonstrated by the number of sticky labels on the manometer tubing, drug label attached to the syringe and noted in red print on the child’s observation chart.

SINGLE STRENGTH DRUG LABEL – HOSPITAL WIDE USE

DOUBLE STRENGTH DRUG LABEL – PIC ONLY

QUADRUPLE STRENGTH DRUG LABEL – PIC ONLY
IMPORTANT

When a child is receiving the following doses of vasoactive drugs they should be receiving **SINGLE STRENGTH** infusions only (mcg = microgram)

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adrenaline</td>
<td>0.1 mcg/kg/min (1ml/hr)</td>
</tr>
<tr>
<td>Amiodarone</td>
<td>10 mcg/kg/min (1ml/hr) or 5mcg/kg/min if over 25kg</td>
</tr>
<tr>
<td>Dobutamine</td>
<td>5 mcg/kg/min (1ml/hr)</td>
</tr>
<tr>
<td>Dopamine</td>
<td>5 mcg/kg/min (1ml/hr)</td>
</tr>
<tr>
<td>Epoprostenol</td>
<td>10 nanograms/kg/min</td>
</tr>
<tr>
<td>Esmolol</td>
<td>1ml/hr = 167mcg/body weight/min</td>
</tr>
<tr>
<td>Glyceryl Trinitrate</td>
<td>1mcg/kg/min (1ml/hr)</td>
</tr>
<tr>
<td>Isoprenaline</td>
<td>0.1mcg/kg/min (1ml/hr)</td>
</tr>
<tr>
<td>Milrinone</td>
<td>0.5mcg/kg/min (1ml/hr for children less than 33kg)</td>
</tr>
<tr>
<td>Noradrenaline</td>
<td>0.1 mcg/kg/min (1ml/hr)</td>
</tr>
<tr>
<td>Sodium Nitroprusside</td>
<td>1ml/hr = 1 mcg/kg/min (1ml/hr for children less than 16kg)</td>
</tr>
</tbody>
</table>
11. Concentrating Or Diluting Vasoactive Drug Infusions – PIC Only

If a child is receiving high infusions rates / multiple vasoactive infusions / is fluid restricted or is having difficulty in maintaining their blood glucose levels then the concentration of their vasoactive medications may be altered to provide more leeway in their fluid regimen.

Before changing the concentration of vasoactive infusions e.g.:

- Single strength to double or quadruple strength
- Double strength to quadruple strength
- Quadruple strength to double strength
- Double strength to single strength

- It is extremely important that you are very aware that the delivery of the volume of the drug will change due to the change in the concentration of the drug. The decision to alter the concentration of vasoactive infusion therefore must be discussed with one of the senior medical staff and the nurse in charge.

When increasing the strength of vasoactive drugs they can go from single strength to quadruple strength.  

However

- Be very aware and cautious of the reduction in the rate of this infusion as this has the potential to induce cardiovascular instability in the child.

When reducing the strength of vasoactive drugs, they should be reduced from:

- Quadruple strength to double strength to single strength

**NEVER**
- Quadruple strength to single strength
12.  Safety Issues Related to Vasoactive Drug Infusions

A.  Minimum monitoring for a non-ventilated child receiving single organ / cardiovascular support:
   - ECG
   - SpO₂
   - Non-invasive BP - Regularity of BP monitoring will be determined by the individual child’s condition

Minimum monitoring for a ventilated child receiving cardiovascular support:
   - ECG, SpO₂, I.A. line (or non-invasive BP – 1/4 hourly)

B.  If the child has an intra-arterial line in situ, they must have continuous ECG monitoring.

C.  Ensure you check the drug prescription chart to ascertain that it is in date, the correct dose is prescribed and that the infusion correlates with the prescription.

D.  Ensure you check your equipment i.e. the pumps that are delivering the infusions. Ensure they are plugged into the mains and zeroed each day at 2400 (PIC) OR 0700 (Hospital wide).

E.  Bolusing of vasoactive drugs - NEVER do this, unless instructed by a senior member of the medical staff.

F.  'Injectomat MC Agilia Pump Pressures':
   - Once the new infusion has been delivered by the Injectomat MC Agilia pump for several minutes, observe the pump pressure - as visible by the circular graphic representation the right of the Injectomat MC Agilia pump’s display. The three sections of the circle represent low, medium and high pressures and the arrow indicates the current level of pressure. The exact numerical pressure and the maximum set pressure can be found in the menu. Ensure that there is at least 100mmHg gap between the pumping and alarm pressure. You may need to increase the alarm pressure to achieve this. The Injectomat MC Agilia will deliver a pre alarm 50mmHg before the maximum pressure is reached.
   - If the pump pressure continues to increase, investigate the line / cannula for obstruction or occlusion.
13. Peripherally Administered Vasopressors for post-surgical patients (PIC and Daisy Burns / Neuro HDU only)

Hypotension following surgical procedures in the paediatric population is uncommon, but must be urgently managed to prevent avoidable harm from occurring (e.g. acute kidney injury, spinal cord ischaemia following scoliosis correction).

Typical indications for Metaraminol or Phenylephrine therapy include offsetting iatrogenic vasodilatation such as post-scoliosis correction or due to thoracic epidural sympathetic block. These drugs may also be required for maintenance of intracranial pressure in sedated patients following head injury.

Target Group:

Vaspressors may be commenced only following review by HDU/PICU registrar/consultant, consultant anaesthetist or consultant in charge of patients care. **The HDU consultant must be notified prior to consideration of vasopressor therapy.**

An arterial line must be in situ, calibrated and working correctly or a definite plan for insertion of arterial line in place.

Contraindications:
- all burns patients - risk of burn extension and ischaemia
- free flap patients - risk of flap ischaemia
- cardiac surgery - unless by direct consultant instruction

Cautions:
- surgery >36 hours previously - patient needs clinical review first
- hypovolaemia
  - in absence of bleeding or sepsis, a 10-20ml/kg isotonic fluid bolus will usually correct hypotension/hypoperfusion
- haemorrhage
  - may not be obvious and is easily missed in post-surgical and trauma patients
- sepsis
  - patient may require vasopressors but should be **urgently** reviewed and managed as per the Sepsis Guidelines.
Monitoring of Patients:
- All monitoring should be as per Management Principles for Vasoactive Drugs in BRCH document and Peripheral Cannula Care Guidelines.
- Mean arterial pressure (MAP) is the best indirect measure of tissue perfusion that is readily available for use in the high dependency setting.
- A minimum and maximum mean arterial pressure must be recorded in the patient notes.
- Target MAP must be handed over when transferring care between staff of ward areas.

**Metaraminol** is the drug of choice unless otherwise directed;

Preparing the infusion:
- Supplied in glass ampules as a colourless solution containing Metaraminol 10mg in 1ml
- Stored in drug cupboard at room temperature
- **Standard concentration for patients 10 – 66.5kg** = 0.15mg/kg diluted in 50ml 0.9% sodium chloride unless otherwise directed
- **Patients <10kg**: Initial concentration = 0.3mg/kg diluted in 50 ml 0.9% sodium chloride unless otherwise directed
- **Patients >66.6kg**: Initial concentration = 10mg diluted in 50ml 0.9% sodium chloride unless otherwise directed

Managing the infusion:
- **Standard Infusion rate for patients 10 – 66.5kg**: 1-10ml/hr = 0.05 - 0.5micrograms/kg/min
  - Commence at 5ml/hr = 0.25micrograms/kg/min
  - Adjust by 1ml/hour = 0.05micrograms/kg/min every 5 minutes
- Children <10kg: infusion rate: 0.5-5ml/hr = 0.05 - 0.5micrograms/kg/min
  - Start infusion at 2.5 ml/hr (0.25micrograms/kg/min)
  - Adjust by 0.5ml/hr
- Children >66.6kg: infusion rate: = 0.15ml/kg/hr = 0.05-0.5micrograms/kg/min
  - Start infusion at 0.075mls/kg/hr (0.25micrograms/kg/min)
  - Adjust by 0.015ml/kg/hr
- May be combined with other compatible infusions (Dobutamine, potassium chloride containing fluids, glucose 5 & 10% and sodium chloride 0.9%) if attached with an anti-siphon and anti-reflux valve system e.g. as found in a TIVA line (available from theatres). Ideally should have a dedicated line for its use.
Weaning the infusion:
- Weaning should be at clinicians instructions usually reducing the dose by 0.5-1ml/hour every 15-30 mins as long as BP and clinical parameters remain within the specified range

Caution:
If MAP rises to greater than 20mmHg above the upper limit of the target range, stop the infusion and call for immediate advice. Significant hypertension promotes bleeding in post-surgical patients

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**Emergency Management of Hypotension by Appropriately Experienced Staff**

Consultants and some anaesthetic/PICU registrars may wish to give intermittent boluses of vasopressors to restore MAP in an emergency. These drugs should not be bolused from an infusion pump and must be prescribed as a one off dose on the patients drug chart.

**Metaraminol:** standard bolus dose is 10 micrograms/kg
- Patients <50kg: Prepare 100micrograms/ml (1 ampule in 99ml 0.9% sodium chloride)
  - Administer 0.1ml/kg every 2 mins
- Patients >50kg: Prepare 500micrograms/ml (1 ampule in 19ml 0.9% sodium chloride)
  - Administer 1ml every 2 mins

**Phenylephrine:** Standard dose is 2-5micrograms/kg
- All patients: 1 ampule (10mg) should be diluted into 500ml 0.9% sodium chloride
  - = 20 micrograms/ml
  - Administer 0.1 - 0.5ml/kg every 3-5 mins

Caution: phenylephrine in more concentrated boluses may be associated with significant bradycardia
14. References


RELATED DOCUMENTS
- Y-Site Compatibility of Intravenous Infusions

AUTHORISING BODY
- PICU governance group

SAFETY
- There is the risk of cardiovascular instability if vasoactive drugs are incorrectly managed

QUERIES
- Contact the Senior Nurse on PICU (Ext 28018)
- Caroline Haines, Consultant Nurse PIC/HDU, ext. 28380
- Jenny Gray, PICU Pharmacist, bleep 2887 or ext. 27040
- Sandra Batcheler, Nurse Educator, ext. 28685