Arterial Line Associated Reduced Limb Perfusion
UHL Paediatric Intensive Care Guideline

1. Introduction & Scope

Arterial occlusion in children is uncommon. It is usually associated with arterial vascular access. In an American study of 10,394 children who received an arterial line on PICU, 0.75% had a thrombotic complication. Arterial lines may cause arterial compromise in 4 ways:

1. Physical obstruction to the artery due to the size of the cannula
2. a thrombus (clot) forming around the cannula
3. vessel wall damage (flap of intima)
4. arterial spasm.

The consequences of reduced arterial flow may be serious with limb loss or long term reduction in limb growth.
There have been no randomised control trials to determine the optimal management of iatrogenic arterial occlusions. The available evidence on management consists of case series.

The aims of this guideline is to provide guidance for the management of reduced limb perfusion associated with arterial lines

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Version: 3 Approved by PICU/CICU Clinical Practice Group June 2018
Trust Ref: C115/2016
Next Review: June 2021
NB: Paper copies of this document may not be the most recent version. The definitive version is in the UHL Policies and Guidelines Library.
Treatment Algorithm for Arterial Line Associated Reduced Limb Perfusion

Clinical examination
Assessment of line patency
- Pale distal limb, cool distal limb
- Saturation trace not picking up on limb
- Arterial trace dampened or non-existent
- Weak or absent pulses
- Absent handheld Doppler pulses

Continue hourly observations of limb and pulse check

Reduced limb perfusion
Or line malfunction

Warm well perfused
limb, pulses present

Urgent discussion with Consultant
Immediate removal of any indwelling arterial access in the affected limb and review in 15 minutes

Warm well perfused
Limb, pulses present

Re-examine limb 15 minutes after removal of arterial line

Reduced limb perfusion

Start Heparin Infusion
Initial bolus of 75 units/kg then 25 units/kg/hour
- Keep child centrally and peripherally normothermic
- Check clotting profile & increase as per Heparin protocol
- Consider formal Doppler ultrasound

Normal Limb Perfusion

Abnormal Limb Perfusion 2 hours post Heparin or severe compromise

Thrombolysis
All patients need discussion with PICU Consultant and Paediatric Cardiologist.
- If post op Paediatric Congenital Heart Surgeon
  1) Consider 10 mls/kg FFP or Octaplas
  2) Start tPA 50 mcg/kg/hr

Reassess limb & complications hourly
If no pulses & no major complications increase tPA by 50 mcg/kg/hr (max normally 300 mcg/kg/hr however some units allow 600 mcg/kg/hr)
All dose changes need to be discussed with the PICU & Cardiology Consultant.
If limb at severe risk dose may be increased more quickly
NB. BNFC recommends max of 6 hours and in children max per day of 100mg of Alteplase

REPERFUSION OBTAINED
Observe for features of compartment syndrome following reperfusion
Consider plastic surgical referral
Features of compartment syndrome:
- Pain in limb
- Tender muscles on palpation
- Pain on passive limb movement
- Sensory deficit distally
- Peripheral pulses may still be present
- Fascia over muscle tense to palpation – compare to normal limbs
- Consider pressure measurements

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2. Principles of arterial line care

Full clinical evaluation and recording of arterial status of limb prior to arterial catheterisation
Meticulous clinical observation of arterial line sites
Early recognition of arterial line malfunction
Early recognition of reduced limb perfusion associated with arterial line Multi-disciplinary approach
Re-establishment of limb perfusion
Clear communication to the child’s parents

2.2 Risk factors for arterial thrombosis

Small size vessels (neonates)
Large size arterial lines (greater than 22G)
Multiple arterial stabs/cannulation
Risk factors for arterial thrombosis
Sepsis Hypotension
Inotrope requirement
Hyperviscosity

2.3 Features of disordered arterial limb perfusion

Pale distal limb
Cold distal limb
Weak or absent pulses
Evidence of neurosensory deficit (conscious, older children)
Saturation trace not picking up on limb
Arterial trace dampened or non-existent
Absent hand held Doppler pulses
Mottling of skin
Necrotic areas on skin
Pain on moving limb
Tense muscle compartments on palpation.
When undertaking intramuscular pressure measurement by needle manometry, readings > 20mmHg are abnormally high and > 40 mmHg mandate immediate fasciotomy.

2.4 Management algorithm
(See algorithm page 2)
Heparinisation

It is recommended that children with arterial thrombosis start a heparin infusion to achieve twice normal APTT levels (Monagle 2008). Heparin inhibits further clot generation, therefore optimising the body's own fibrinolytic system to break down any existing clot.

Heparin is commenced by giving a loading dose of 75units/kg and then immediately starting an infusion of 25units/kg/hour. An APTT level should be checked at 4 hours after starting the infusion and dose adjustments made aiming for an APTT of 55-65 seconds. An ACT can also be checked earlier with an aim of 180 to 200 seconds. The infusion will continue for 24 hours in the first instance and further duration will be guided by the clinical improvement. If target APTT levels are not reached with a Heparin infusion rate of 30units/kg/hour, check anti-thrombin III level (needs booking in lab day before) and administration of FFP or Octaplas to replenish anti-thrombin III. Conversion to LMWH to complete 5 to 7 days of treatment may be considered.

Thrombolytic therapy (consultant team decision only)
Administration of thrombolytic therapy is advised for pediatric patients with limb threatening (absent pulses) or organ-threatening arterial thrombosis who fail to respond to initial unfractionated heparin therapy, and who have no known contraindications (Monagle 2008). The absence of pulses even in a limb that appears well perfused in associated with poor growth resulting in different limb length in later life.

Fibrinolytic drugs break down thrombus by augmenting the body's own fibrinolytic system.
Tissue plasminogen activator (tPA) is the most appropriate drug due to its high fibrin affinity, preferential activation of plasminogen bound to fibrin, lack of antigenicity and short half-life (4 minutes in plasma and 45 minute thrombolytic effect). Administration of fresh frozen plasma (FFP) or Octaplas prior to using tPA may increase success rates by providing sufficient plasminogen levels, particularly in neonates. NB if Heparin > 30 units/kg/hr then give FFP or Octaplas.

Contra-indications to thrombolytic therapy (Raffini 2009)
Conditions that increase the risk of major bleeding during thrombolytic therapy are considered contraindications and are listed below. These contraindications are not absolute or evidence-based, and in every individual clinical situation, the relative risks of thrombolytic therapy must be weighed against potential benefits.

1. Major surgery within 7 – 10 days;
2. Active major bleeding;
3. Central nervous system surgery/ischemia/ trauma/haemorrhage within 30 days;
4. Seizures within 48 hours;
5. Inability to maintain platelet count greater than 75 x 109/L;
6. Inability to maintain fibrinogen greater than 1 g/L;
7. Uncontrolled hypertension.

Route of administration for thrombolysis
Thrombolysis may be given systemically or through a catheter in close proximity to the arterial thrombus. Catheter directed thrombolysis can be extremely effective and allows low dose tPA to reach the site of action immediately. The requirement for a further arterial cannula may prevent its use in neonates and infants due to the small size of their arteries and the risk of reducing arterial flow still further. (Khan 2008, Ruud 2003).

Dose of thrombolysis
Low dose systemic tPA infusion (10 to 50 mcg/kg/hour) appears to have low incidence of serious bleeding (Wang 2003, Cannizzaro 2005) in comparison to high dose tPA (0.5mg/kg/hour) which is associated with serious complications (10-40% major bleeding; Gupta 2001, Newall 2007).

Start at 50 mcg/Kg/hr and increase hourly by 50 mcg/kg/hr if no improvement. If severe concerns around limb viability starting dose may be increased. This should be documented by the Consultant Paediatric Intensivist and Consultant Paediatric Cardiologist. If post cardiac surgery the Paediatric Cardiac Surgeon must be involved from the beginning

Surgery
As the site of arterial damage is known (the site of the arterial access), exposure of the vessel in ischaemic limbs will reveal the damaged artery and any intra-arterial thrombosis. This thrombus can be removed by arteriotomy. The early involvement of the cardiothoracic surgical team allows treatment decisions to be made.
3. Education and Training

No new training is required to implement this guideline.

4. Monitoring Compliance

<table>
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<th>What will be measured to monitor compliance</th>
<th>How will compliance be monitored</th>
<th>Monitoring Lead</th>
<th>Frequency</th>
<th>Reporting arrangements</th>
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<td>Incident reports</td>
<td></td>
<td>Yearly</td>
<td>Quality assurance lead</td>
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5. Supporting References


6 Key Words

Reduced limb perfusion, Arterial lines, Heparinisation, Thrombolysis

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<tr>
<th>CONTACT AND REVIEW DETAILS</th>
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<tbody>
<tr>
<td>Guideline Lead (Name and Title)</td>
</tr>
<tr>
<td>Claire Westrope- Consultant PICU/ECMO</td>
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<tr>
<td>James Whitelaw – Consultant Paed Intensivist</td>
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<th>REVIEW RECORD</th>
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<tr>
<td>Description Of Changes (If Any)</td>
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<td>Adjustment to the length of tPA administration to keep in line with maximum limits</td>
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