Paediatric Intensive Care Unit

Thromboprophylaxis post paediatric cardiac surgery (Anticoagulation and Antiplatelet Management)

Staff relevant to:	Medical and nursing staff on PICU/CICU involved in the management of patients following congenital heart surgery and cardiac catheterisation
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1. Introduction and Who Guideline applies to

Optimal thromboprophylaxis after cardiac surgery is uncertain. Much of what is known regarding cardiac thrombotic phenomenon is derived from adult studies. These guidelines have been written following review of the medical literature using current gold standards for anticoagulation practice. Additionally, these guidelines have been written in consultation with intensive care, cardiology, cardiac surgery, haematology and pharmacy taking into consideration local practice. This document provides a guide to the indication and management of anticoagulation and/or antiplatelet therapy in the immediate post op period on PICU/CICU for children following congenital heart surgery.

Applies to: All patients admitted to PICU/CICU following a cardiac surgical procedure as well as interventional cardiology procedures.

Related Guidelines

- Blalock-Taussig (BT) Shunt or Central Shunt UHL Paediatric Intensive Care Guideline C49/2020
- Post Cardiac Surgery UHL Childrens Intensive Care Guideline C150/2016
- Thrombolysis UHL Paediatric Intensive Care Guideline C31/2021
- Paediatric Warfarin dosing UHL Childrens Intensive Care Guideline C197/2016
- VTE prophylaxis in children UHL CICG C121/2016,
- Stroke UHL Childrens Guideline D9/2020
- Chest drain insertion, care and removal C41/2016
- Pacing wires removal C 147/2016
- Heparin adjustment chart : heparin adjustment chart.FINAL.pdf

2. Guideline Standards and Procedures

2.1 Background

- Bleeding is a well-known complication in patients following surgical procedures.
- Congenital cardiac surgery in children often requires the use of prosthetic material, e.g. PTFE, Dacron, Bovine pericardium, Porcine pericardium, CorMatrix, for repair by means of patches, conduits, and valves. All foreign material has a degree of thrombogenicity
- In the immediate post-operative period following congenital heart surgery, an optimal balance is needed between the risk of bleeding from the surgical site, and the risk of unwanted thrombosis.
- These are general guidelines and surgeons should be consulted regularly about unusual/individual cases. Certain patients may be at higher risk of developing thrombi e.g. low cardiac output, poor ventricular function, chyle losses, septic, known pro-thrombotic condition, some specific procedures which decrease systemic venous blood flow due to systemic veins replumbing procedures (e.g. BDG, TCPC) or narrowing (e.g. Senning procedure), in combination with fluid shifts and hypovolemia (as a result of for example severe Chylothorax) can predispose to thrombogenic risk. Under such circumstances the use of prophylactic

heparin may be inappropriate. These patients should be considered on an individual basis for targeted anticoagulation.

Abbreviations:

ASD Atrial Septal Defect
AVSD Atrioventricular Septal Defect
BTS Blalock-Taussig Shunt
VSD Ventricular Septal Defect
PDA Patent ductus arteriosus
TAPVC Total Anomalous Pulmonary Venous Connection
TGA Transposition of the Great Arteries
TOF Tetralogy of Fallot
SVC Superior vena cava
PA Pulmonary artery

Table 1: Anticoagulation after Cardiac operation

Cardiac operation	Immediate postop (<48 hrs)	Until PICU discharge
ASD, VSD, AVSD PDA ligation TGA, TOF, TAPVC	No anticoagulation	No anticoagulation
BT shunt / Central shunt	Therapeutic heparin	Aspirin & Clopidogrel
Norwood Sano	Therapeutic heparin	Aspirin & Clopidogrel
Unilateral Glenn /BCPC	Prophylactic heparin	Aspirin
Bilateral Glenn	Therapeutic heparin	Aspirin
Stent in SVC / PA	Therapeutic heparin	Aspirin
Fontan	Therapeutic heparin	Warfarin, Target INR 2.5
Hybrid procedure (PDA stent)	Therapeutic heparin	Aspirin & Clopidogrel

Table 2: Anticoagulation after valve surgery

Cardiac operation	Immediate postop (<48 hrs)	Until PICU discharge
Valve repairs	No anticoagulation	Aspirin
Pulmonary Valve replacement with bio prosthetic valve (e.g. Trifecta)	No anticoagulation	Aspirin (to consider Warfarin for 3 months, target INR 2.5)
Pulmonary valve replacement with a RV-PA conduit -Contegra (bovine jugular vein) -Hancock (Dacron graft with a porcine valve)	Therapeutic heparin	Aspirin (to consider Warfarin for 3 months, ,target INR 2.5))
Tricuspid valve replacement with a bio prosthetic valve	Prophylactic heparin	Warfarin
Aortic / Mitral valve replacement with bio prosthetic valve	No anticoagulation	Aspirin (*warfarin if thrombogenic risk) (to consider warfarin for 3 months, target INR 2.5)
Aortic valve repair with patch material or Ozaki	No anticoaguolation	Aspirin (6 months)
Mechanical Prosthetic valve (St Judes, Medtronic, On-X)	Therapeutic heparin	Warfarin Aortic Valve INR 2.5 (range 2 - 3) On-X mechanical valve (Warfarin target INR 2 + Aspirin) Mitral valve INR 3
Homograft valves Aortic/Pulm Ross	No anticoagulation	Aspirin

*Risk factors include previous thromboembolism, systemic ventricular dysfunction, and hypercoagulable condition

Table 3: Diagnostic and interventional Cardiac catheterisation

	Immediate post –op(<48 hrs)	Until PICU discharge
Endovascular stents for non-coronary lesions		Aspirin & Clopidogrel
Stent in SVC or PA	Therapeutic heparin	Aspirin & Clopidogrel
Transcatheter ASD device closure	No anticoagulation	Aspirin
Transcatheter Coil or device closure of PDA or collaterals		No anticoagulation/ Antiplatelet therapy
Percutaneous Valve		Aspirin
PDA stent	Therapeutic heparin	Aspirin & Clopidogrel
Stented shunts	Therapeutic heparin	Aspirin & Clopidogrel
RVOT stent	Therapeutic heparin	Aspirin
Lower extremity pulse loss and evidence of limb ischaemia after cardiac catheterisation	Therapeutic heparinization for 12 - 48 hours; transition to fibrinolytic therapy if limb ischaemia persists (see Thrombolysis guideline)	

2.2 Shunted dependent circulation and single ventricle palliation

Due to short length and very high flow rate acute thrombosis is less common with mBTS compared to classical BT shunt nevertheless thrombotic occlusion of BT shunt remains a problem. Smaller shunt size (<4mm), smaller infant size, increased perioperative hemoglobin, intravascular volume depletion persistently draining effusions or infection are risk factors for shunt thrombosis

Following Norwood-Sano procedure there are no specific studies examining the role of anticoagulant prophylaxis, although common practice is to use heparin immediately post operatively followed by aspirin as per BT shunts.

Thrombotic complications after Glenn are infrequently reported but the potential for thrombosis to increase pulmonary pressures and so restrict the potential for subsequent Fontan surgery is important. Thromboembolism remains a major cause of early and late morbidity and mortality following the Fontan procedure.

In patients with palliated single ventricles, risk factors for thrombus should be minimized (i.e. arrhythmias, ventricular dysfunction, prolonged immobilization, blind end pulmonary artery stump) when possible.

In infants and children with Central Venous line (CVL) who ultimately requires a Palliative either BDG or Fontan procedure, low dose IV Heparin may be reasonable until the CVL is removed.

2.3 Anticoagulation for prosthetic valves:

Replacement valves used in children may be both mechanical and tissue valves. It is common for tissue valves to be used on the right side (pulmonary/tricuspid) and in select cases mechanical valves to be used on the left side in children.

There are few prospective studies and no RCTs in children. Recommendations are based on the strong evidence supporting thromboprophylaxis in adults and the available evidence in children.

There is growing evidence (level IIA) that anticoagulation therapy (Warfarin) for 3 months following a tissue valve implantation improve valve durability.

2.4 Cardiac catheterisation:

Incidence of thrombo-embolic complications associated with Cardiac catheterisation in children reported in the literature range from 0.8 to 40% for arterial thrombosis and 0 to 20% for venous thrombosis.

Since the femoral artery is the major entry vessel of choice, one of the significant complications is femoral arterial occlusion. Clinical manifestations of Femoral artery thrombosis vary from silent vessel occlusion to severe limb ischemia. Routine systemic heparinization during the catheterization has significantly reduced the incidence of this problem. Please refer to table 3 for management of limb ischemia post cardiac catheterization.

2.5 Notes on starting heparin infusion

Heparin is the anticoagulant most commonly used in children. Unfractionated heparin (UFH) produces its major anticoagulant effect by inactivating thrombin and activated factor Xa through an antithrombin dependent mechanism. Heparin clearance is significantly faster in infants and children than in adults, hence **children require higher doses to achieve adult therapeutic ranges**. Monitoring of therapeutic efficacy of heparin has centered on the use of the activated partial thromboplastin time (APTT), and is currently the method used in our trust to monitor anticoagulation efficacy although this method is difficult to standardize.

When very high levels of heparin fail to increase APTT to the therapeutic range dose escalation may

be dangerous and can be avoided by monitoring UFH therapy and adjusting the dose according to results of anti-Xa levels and occasionally supplementing antithrombin (AT III concentrate or FFP). These include achieving anti-factor Xa levels of **0.35 to 0.70 units/ml**. In such circumstances, please consult Haematology for advice.

There are few or no data to define optimal prophylactic /low doses of UFH. Clinicians commonly use a dose of 10 units/kg/hour as a continuous infusion, although the efficacy of this has not been proven.

Start heparin infusion postoperatively when:

- Bleeding is not a concern (chest drain loss is less than < 3ml/kg/h).
- Based on thrombotic / bleeding risk, commence Heparin 2 – 4 hours post-op (or APTT < 60s)
- In shunts anticoagulation therapy should be instituted as soon as safely possible

Therapeutic Heparin:

- Follow Heparin protocol
- Review post-op APTT and bleeding is not a concern
- Restart Heparin 1 hour post procedure (e.g. chest closure, chest drain insertion, pacing wires removal, or other procedures) if no bleeding concerns

<u>In coarctation of the aorta repair (from left thoracotomy) and BT shunts we DO NOT reverse the Heparin in theatre!!!!</u>

Prophylactic Heparin:

- Heparin 10 units/kg/h should be started ~ 4 hours post cardiac surgery (if bleeding is not an issue – chest drains <3ml/kg/h).
- There is no loading dose given
- There is no target APTT
- Prophylactic heparin doesn't need to be stopped for sternal closure.

2.6 When starting a patient on Aspirin:

- the patient's chest MUST be closed
- Intracardiac lines (LA line or PA line) MUST be removed
- Pacing wires should be out
- Feed absorption MUST be established.

2.7 Notes on starting Warfarin

Warfarin therapy in neonates and infants is challenging because of physiologically decreased plasma levels of Vitamin K dependant factors in newborns, increased variability in nutritional intake, higher

weight based dose requirements and less time in therapeutic range. In general warfarin is not recommended in infants <1 years unless the infant requires anticoagulation of a mechanical valve.

Start Warfarin only when no other surgical procedures are planned for that patient (usually after pacing wire removal) and oral intake is adequate.

A single INR target is preferable for each patient to reduce fluctuations in INR as well as to avoid patients having INR consistently near the upper or lower boundary of the range. Acceptable range includes 0.5 INR units on each side of this target.

2.8 Thromboprophylaxis management prior to procedures:

Heparin

The decision to stop heparin prior to procedures is based on risk stratification of bleeding versus thrombosis for each individual patient. As a rough guide:

When to hold heparin	
Hold 4 hours prior to procedure	Major surgery
	Chest tube insertion
	PD catheter insertion
	Lumbar puncture
Hold 2 hours prior to procedure	Pacing wires
	Intracardiac lines
	Chest closure
No need to hold drug	Chest tube removal
	PD catheter removal

Review the clotting profile and platelet count (should be >50 x 10^9/L for chest drain insertion and major surgery; >100x10^9/L for brain and eye surgery, NICE 2015) prior to the procedure. If any doubt about the results, repeat the test.
Patients on Therapeutic heparin (titrated to APTT 60-80 sec) may require waiting until closer to the time of procedure before stopping heparin. This decision should be discussed with a consultant.

3. Education and Training

None

4. Monitoring Compliance

What will be measured to monitor compliance	How will compliance be monitored	Monitoring Lead	Frequency	Reporting arrangements
Auditing thromboprophylaxis practice in the unit	Audit	PICU Consultants	TBC	Departmental audit group

5. Supporting References

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6. Key Words

Aspirin, BT Shunt, Cardiac Catheterisation, Congenital Heart Surgery, Fontan, Heparin, Thrombosis, Valve Surgery, Warfarin

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The Trust recognises the diversity of the local community it serves. Our aim therefore is to provide a safe environment free from discrimination and treat all individuals fairly with dignity and appropriately according to their needs.
As part of its development, this policy and its impact on equality have been reviewed and no detriment was identified.

Contact and review details	
Guideline Lead (Name and Title) Pompa Kukreja - Consultant	**Executive Lead** **Chief Medical Officer**
Details of Changes made during review: **June 2024:** None.	