



Crumlin | Temple Street | Tallaght | Connolly

**CHI NURSING PRACTICE GUIDELINE ON THE CARE OF THE CHILD WITH A
TRANSTHORACIC INTRACARDIAC LINE(S)
AND / OR EXTRACARDIAC GLENN LINE, POST CARDIAC SURGERY**

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1.0 Introduction

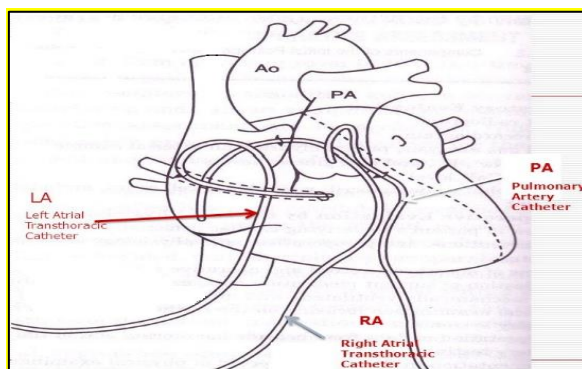
Intracardiac lines are central lines, which are placed in the heart following cardiac surgery in infants and children. There is a small potential risk with their use (Beham *et al.* 2017, Stein *et al.* 2019, Lisanti *et al.* 2020). They are attached to a standardised hemodynamic flush system and display digital readings of pressures in the patient’s heart, dependent on line location.

They include:

- Left Atrial (LA) line
- Right Atrial (RA) line
- Pulmonary Arterial (PA) line

Intracardiac lines are usually inserted using double purse string technique, prior to discontinuation of cardio-pulmonary bypass

Position of Transthoracic Intracardiac Lines



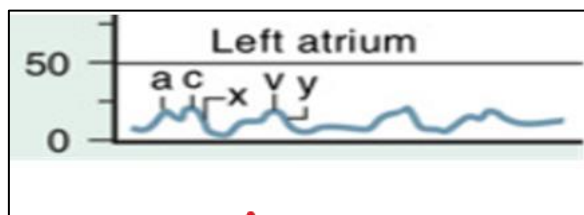
Adapted from Doig, S. (2019) cites Roth, S. J. (1998)

Left Atrial (LA) Line

The catheter is placed via a transthoracic approach directly into the left atrium (junction of LA and upper pulmonary vein) and anchored to the heart by suture (Beke and Lincoln 2008). It displays left ventricular end diastolic pressure (preload) of the left atrium. This is an indirect assessment of left ventricular compliance. The surgeon may place this if left ventricular function or the mitral valve is compromised. Normal LA pressure is 6-10 mmHg in children and usually slightly higher than CVP (Horrax 2002). A high LA pressure may indicate cardiac failure, tamponade or fluid overload and a low LA pressure may indicate reduced pulmonary venous return to the heart (Horrax 2002).

Figure 1: Normal LA pressure waveform

NB low-pressure wave and no diacritic notch



(Bansal *et al.* 2021)

'A' wave = Atrial systole (*elevated mitral stenosis / decrease left ventricular compliance*)

'C' wave = Movement of the A.V. valve towards atrium, during A.V. valve closure

'V' wave = Atrial filling with A.V. valve closed (Isovolumetric time period) (*elevated mitral insufficiency or large L=>R shunt i.e. VSD*)

Pulmonary Artery (PA) Line

In CHI, a Pulmonary Artery Line is threaded through the surface of the heart, through the right ventricular outflow tract and into the pulmonary artery.

A PA line measures right atrial pressure and pulmonary artery systolic, diastolic and mean pressures (Curley and Malone-Harmon, 2001). The catheter can also provide a true mixed venous oxygen saturation (SvO₂) allowing for analysis of any change in the balance of oxygen supply and demand (Hazinski, 2013). The mean pulmonary artery pressure is recorded and compared to mean systemic blood pressure.

Figure 2: Normal Pulmonary Artery Wave Form



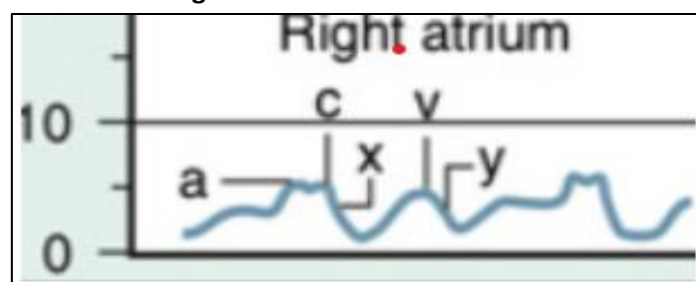
(Bansal *et al.* 2021)

Right Atrial Line

A right atrial line is sited via the right atrial appendage. It may be preferable over a neck central line in a future Glenn pathway for single ventricle physiology (Flori *et al.* 2000, Abdullah 2014). RA may stay in place longer, it can be used for central vascular access as it is tunnelled through the chest wall and can be kept for up-to 4 weeks (CHI Cardiothoracic Surgeons, 2022).

A RA line can potentially decrease or prevent the incidence of venous thromboembolism, limb ischemia, vessel occlusion preserve, chylothorax and infection (Kumar *et al.* 2017).

Figure 3: Normal RA waveform



(Bansal *et al.* 2021)

Glenn Line

The Glenn line is placed via right internal jugular and advanced to the superior vena cava (SVC). This is essentially a central venous access line but is inserted for the purpose of measuring the Glenn pressure following the Bidirectional Glenn procedure.

In a child with a complicated Glenn e.g. a previous Norwood Procedure, this would not usually be the primary central access and an additional CVC would be placed for drug and fluid administration. If the child is a straightforward Glenn patient, a Glenn line without additional central access will suffice. (CHI Crumlin Cardiothoracic Surgeons, 2022). In this case anti coagulation, such as a LMWH, may be considered due to the risk of clots.

Table 1: Intracardiac Catheter(s), Normal Pressure Range and Potential Causes for Elevated or Reduced Pressure

Intracardiac Catheter	Normal Pressure Range	Elevated Pressure	Reduced Pressure
Right Atrial (RA) / Central Venous (CVP)	5-8 mm Hg <i>(NB: add peep to ventilated patients)</i>	<ul style="list-style-type: none"> • Volume overload • Decreased right ventricular function • Cardiac Tamponade; • Artefact; • Catheter malfunction 	<ul style="list-style-type: none"> • Hypovolemia • Artefact
Left Atrial (LA)	<ul style="list-style-type: none"> • Normal LA pressure is 6-10 mm Hg in children • Usually slightly higher than CVP 	<ul style="list-style-type: none"> • Increased Preload /Volume overload • Decreased left ventricular function / insufficiency or stenosis of left AV valve • Cardiac Tamponade; • Arrhythmia • Artefact 	<ul style="list-style-type: none"> • Decreased Preload/ Hypovolemia; • Artefact; • Decreased left atrial pressure in conjunction with elevated RA and/or CVP can develop with Pulmonary Hypertension
Pulmonary Artery (PA)	<ul style="list-style-type: none"> • Normal PA pressure is 20-30/6-10 mmHg • NB: Mean PA is documented and should be less than • 12 mm Hg. 	<ul style="list-style-type: none"> • Vascular disease • Pulmonary parenchymal disease • Mitral stenosis • LA Failure • Pulmonary vascular changes due to increased pulmonary blood flow (<i>Pulmonary Hypertension</i>) 	

(Horrax 2002, Slota 2019, Krishnamoorthy *et al.* 2020)

2.0 Nursing Care Considerations of Transthoracic Intracardiac Lines (LA, RA and PA lines) and / or Extracardiac Glenn Line

NURSING CONSIDERATIONS	RATIONAL AND REFERENCE
<p>NB: LA line is situated in systemic circulation</p> <p>Standardised hemodynamic flush solution (500mls/500 i.e. heparin) and monitoring circuit is attached to the LA/ PA/ RA/ Glenn line. Care of circuit as per arterial and CVC lines.</p> <p>Intracardiac line transducer should set to the phlebostatic reference point (level of the right atrium) and zeroed and calibrated at the beginning of the shift or on receiving the patient and as clinically indicated</p> <p>Intracardiac line placement is confirmed by CXR</p> <p>Nurses should not access or flush LA lines unless instructed by the cardiothoracic consultant or intensivist and have completed advanced competency training (ECLS specialist).</p> <p>Do not administer medication or blood products through the LA line.</p> <p>Meticulous attention to not flush LA line, avoiding air / fluid into the line. Label line and transducer with 'DO NOT FLUSH' label. <i>(NB: Use Red on White Label)</i></p> <p>LA and PA lines are used for pressure reading only and not for volume or drug administration. (This includes Glenn lines when there is other central access)</p> <p>NB: Patients with systemic venous to arterial shunts in mixing physiology have an increased risk for embolic events from all invasive lines</p> <p>Ensure Intracardiac lines are labelled at transducer and at distal end. Use:</p> <ul style="list-style-type: none"> • Left Atrial (LA) -Black on Red Label <ul style="list-style-type: none"> ○ NB: Include; DO NOT FLUSH' label at transducer and line for LA Line. • Pulmonary Artery (PA) – Black on Yellow Label • Right Atrial (RA) – Black on White Label 	<p>Same as arterial and CVP monitoring (Horrax 2002).</p> <p>To ensure accurate measurement of the child's pressure reading. (Hazinski 2013)</p> <p>LA line enters the systemic circulation and there is a risk of emboli. An air embolus can travel to the cerebral vessels or coronaries. (Beke and Lincoln 2008, NMBI 2015)</p> <p>LA line is in the systemic circulation and may predispose to air emboli or end organ dysfunction (Beke and Lincoln 2008).</p> <p>Air/fluid can cause critical coronary/ cerebral arterial emboli (Wey 2000, Backer <i>et al.</i> 2013).</p> <p>Risk of vessel wall trauma, perforation and air emboli and thrombosis (Hazinski, 2013)</p> <p>LA line accesses systemic circulation and risk of air emboli.</p> <p>Maintain patient safety (Appendix II)</p>

<ul style="list-style-type: none"> • Glenn – Black on White Label <p>Observe for air bubbles, thrombus or particulate matter, or dampened waveform (<i>Contact cardiothoracic surgeon, as clinically indicated</i>).</p>	
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3.0 Assisting with Removal of Intrathoracic Line (LA/RA/PA) or Extracardiac Glenn Line

Assisting with Removal of Intrathoracic	
NURSING CONSIDERATIONS	RATIONALE AND REFERENCE
<p>LA/PA and Glenn line should ideally be removed on day 2 or 3 post operatively once hemodynamically stable. It may be delayed if the patient is coagulopathic.</p> <p>LA/ RA / PA lines are removed before mediastinal chest drain.</p> <p><i>NB: Minimum of 4 hours</i></p> <p><i>The intracardiac line can only be removed while the mediastinal drain is still in situ. Ensure patent.</i></p> <p><i>NB: If the mediastinal drain has been removed, the intracardiac line has to remain in place for a minimum of 5 days.</i></p> <p>NB: LA line removal is always performed by the cardiac surgeon/CT ANP.</p> <p>Pre Procedure</p> <p>Fast patient prior to the procedure:</p> <ul style="list-style-type: none"> • Clear Fluid: 1 hour • Breast Milk: 4 hour • Solid food, including milk: 6 hours 	<p>RA may stay in place longer as it can be used for central vascular access as it is tunnelled through the chest wall and can be kept for up-to 4 weeks (CHI Cardiothoracic Surgeons, 2022).</p> <p>There is a risk of bleeding and tamponade (Stein <i>et al.</i> 2019,)</p> <p>Any bleed will drain into chest drain if it occurs. (Backer <i>et al.</i> 2013).</p> <p>This is to allow adhesions to develop.</p> <p>PICU nurse should always practice within their scope of practice (NMBI 2015)</p> <p>In the event patient requires return to OT for bleeding. Liaise with cardiothoracic team (As per local guidelines).</p>

<p>Ensure FBC, coagulation screen have been performed prior to removal unless otherwise directed by consultant cardio-thoracic surgeon/ intensivist.</p> <ul style="list-style-type: none"> • Platelet count should be >80,000 G/L, • Fibrinogen >1.0g/L, • APTT not > 5 above normal range • PT not > 3 above normal range, • INR must be less than <1.5 <p>Unit of red cells should be readily available in satellite fridge when removing RA, LA or PA line.</p> <p>Obtain baseline vital signs and chest drain losses / ensure patency</p> <p>Prophylactic heparin infusion discontinued 4 hours pre procedure as per Antithrombotic guideline</p> <p>Therapeutic heparin discontinued 6 hours prior to procedure</p> <p>Liaise with medical/surgical team regarding holding other anticoagulation therapy i.e. aspirin, Tinzaparin</p> <p>Prepare Child</p> <p>Administer analgesia and sedation as prescribed by doctor prior to procedure</p> <p>Please refer to the ‘<i>Procedural Analgesia and Sedation in PICU/HDU</i>’ on the PICU i-drive.</p> <p>Patient should be positioned in a flat / supine position</p> <p>Explain procedure to patient/parents as appropriate</p>	<p>Abnormal clotting factors will increase the risk of bleeding during line removal (Stein et al. 2019). A low platelet count may delay removal of catheter(s) (Beham <i>et al.</i> 2017). There is a risk of haemorrhage and cardiac tamponade (Flori <i>et al.</i> 2000, Horrax 2002). Emergency chest exploration may be required (Gottlieb and Stayer 2016). Values reviewed by CHI Cardiothoracic Surgeons</p> <p>Risk of haemorrhage has been reported and incidence of transfusion required in up to 20% of patients (Stein <i>et al.</i> 2019).</p> <p>There may be some haemorrhage following removal and child is at risk of cardiac tamponade (Horrax 2002).</p> <p>Anti-thrombotic guideline (OLCHC 2016)</p> <p>To promote comfort and adequate pain relief for the patient (CHI at Crumlin 2022)</p> <p>To uphold the protocol for good practice and to ensure correct medication is administered. (NMBI 2020).</p> <p>Risk of air embolism</p> <p>To inform child/ parents and gain co-operation</p> <p>To ensure consent for procedure</p> <p>Promotes patients/ parent’s understanding and trust (Ball <i>et al.</i> 2017).</p>
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<p>Provide privacy for the child during the procedure</p> <p>Procedure</p> <p>(Assisting Cardiac Surgeon/ANP CT)</p> <p>Equipment</p> <ul style="list-style-type: none"> • Dressing trolley • Dressing pack • Stitch cutter • 2%Chlorhexidine / 70% Alcohol solution • Occlusive dressing i.e. Op-Site™ Post Op <ul style="list-style-type: none"> ○ (6.5 cms x 5 cms) • Additional gauze prn • Personal Protective Equipment (PPE) <ul style="list-style-type: none"> ○ (Visor/ goggles, plastic apron) <p><i>NB: Clinell® wipes can be used for skin asepsis</i></p> <p>NB: Procedure carried out by cardiac surgeon/ CT ANP.</p> <p>Prepare trolley for procedure and open and lay sterile field and equipment</p> <p>Wash hands using aseptic non-touch technique (ANTT) (Surgical).</p> <p>The cardiac surgeon/ CT ANP will clean the skin around the insertion site with cleansing agent as per local policy.</p> <p>Cardiac surgeon / CT ANP remove intracardiac line.</p> <p>Post Procedure</p> <p>Continuous vital signs and observations.</p> <p>15-minute recording of vital signs initially, reduce as condition indicates.</p> <p>Monitor and record for excessive chest drain bleeding following the procedure.</p> <p>CXR and ECHO preformed 1-hour post line removal</p> <hr/>	<p>To maintain the child’s privacy and dignity (Ball <i>et al.</i> 2017, Hockenberry Wilson and Rodgers 2018).</p> <p>The preterm infant / neonate is particularly at risk of burns due to pooling of liquids. Their skin, especially preterm < 34 weeks’ gestation, may take 2-3 weeks for stratum corneum to mature and are at particular risk ie. Erythema, chemical burn, excoriation and skin breakdown. (NPPG 2021, Pharmacy, CHI Crumlin 2021).</p> <p>To aid the procedure (Lister 2021).</p> <p>To minimize the risk of infection and to have the equipment ready (RCPI/HSE 2015)</p> <p>To prevent cross infection, universal precautions (As per local guidelines).</p> <p>Reduces transfer of microorganisms (CHI, 2022)</p> <p>Early detection of patient deterioration ie. Cardiac tamponade (Horrox 2002). Emergency blood transfusion and mediastinal exploration may be required (Backer <i>et al.</i> 2013).</p> <p>Risk of cardiac tamponade. Screen for mediastinal bleeding (Pratap <i>et al.</i> 2015).</p> <p>To adhere to hospital waste policy and reduce transmission of organisms.</p> <p>Standard precautions (As per local guidelines).</p> <p>To maintain an accurate record of the procedure, nursing care and to facilitate communication and continuity of care. To ensure safe practice and maintain accountability (HSE 2011, RCPI/HSE 2014, NMBI 2016).</p>
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<p>Signs and Symptoms of Cardiac Tamponade</p> <p>Pericardial Tamponade is a rare but serious complication.</p> <p><i>(Signs & symptoms include: pallor, collapsed child; tachycardia; increased CVP/LAP, tachypnoea; dyspnoea, reduced capillary refill, cool extremities, decreased SaO2; perspiring; decreased conscious level; hypotension).</i></p> <p>Report immediately to cardio-thoracic surgical team.</p> <p><i>It is a medical emergency.</i></p>	
<p>Disposal</p> <p>Dispose of equipment as per waste policy.</p>	
<p>Documentation</p> <p>The doctor and nurse will record the procedure in medical / nursing notes / clinical information management system (CIMS) including date, time, who removed intrathoracic cardiac line(s). Also the infant/child’s’ condition and response to the procedure.</p>	

4.0 Complications of Transthoracic Cardiac Lines (LA/RA/PA)

- Migration and / or premature removal (earlier than planned). Unrecognised migration of a RA line out of atrium and into pericardial space, may cause insidious progressive cardiac tamponade i.e. IV fluids / TPN (*Backer et al. 2013*).
- No function / line occlusion (no blood aspirate or dampened / loss of line waveform)
- Higher risk in infants < 3 months and patients. Lower risk in LA lines
- Thrombus formation (diagnosed on cardiac echo)
- Infection (CABSI) Positive catheter blood culture. Increased risk reported in open sternum patients and PA lines. Decreased risk with LA lines
- Air Emboli – LA line is in systemic circulation and risk of air emboli to cerebral blood vessels
- Leaking / extravasation

NB: it has been reported that RA lines have higher incidence of complications and this has been attributed to the higher fragility of the right atrium and thinner wall.

Post Removal

- Bleeding (*unexpected drainage, pericardial collection resulting in cardiac tamponade*)
- Failed catheter removal / retention
- Need for intervention
- Cardiovascular instability

(Flori *et al.* 2000, Pratap *et al.* 2015, Lisanti *et al.* 2019, Stein *et al.* 2019)

Removal of Glenn Line

As per CVC guidelines (OLCHC 2017)

5.0 Stakeholder involvement

Name	Grade	Location
Vigi Nair	CNEF, PICU	CHI Crumlin
Tara Connaughton,	CNEF,	PICUs CHI Crumlin
Eileen Tiernan	CNEF	PICU, CHI Crumlin
Fionnuala Gardiner	RANP Cardiothoracics	CHI Crumlin
Katie Morris	CNEF	PICU CHI Crumlin

6.0 Implementation plan

This guideline will be used as part of the education and training of new staff during induction to the PICUs and other areas caring for infants and children with Intracardiac lines.

7.0 Monitoring and Evaluation

Use of this guideline will be monitored by the nursing education team in the PICUs.

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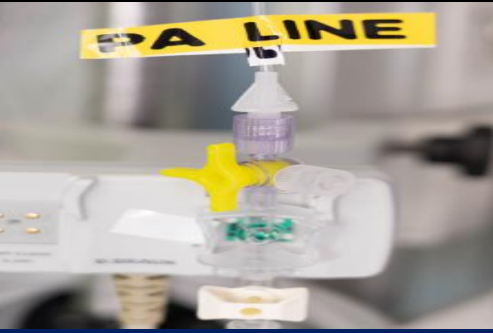


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Appendix I: Labelling of Intracardiac Lines

	LINE SITE	TRANSDUCER
<p>Left Atrial (LA) Line Black on Red Label</p> <p><i>NB: Include ;DO NOT FLUSH’ label at transducer and line for LA Line</i></p>		
<p>Right Atrial (RA) Line Right Atrial (RA) – Black on White Label</p>		
<p>Pulmonary Artery (PA) Line Pulmonary Artery (PA) – Black on Yellow Label</p>		
<p>GLENN Line Glenn – Black on White Label</p>		

CHI@Crumlin (Audiovisual Dept) 2022

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