East Midlands Congenital Heart Network

East Midlands Neonatal Operational Delivery Network

NETWORK GUIDELINE

Title:	**Management of Patent Ductus Arteriosus (PDA) in preterm infants and Referral Criteria for PDA Closure**
Version:	**2**
Date:	**July 2026**
Review Date:	**July 2029**
Approval:	**EMNODN Clinical Governance Group**
Authors:	**Dr Joanna Preece in conjunction with East Midlands Congenital Heart Network (EMCHN) and East Midlands Congenital Heart Centre (EMCHC)**
Consultation:	**EMNODN Clinical Governance Group and EMCHC**
Distribution:	**Neonatal units within EMNODN and EMCHC**
Risk Managed:	**Appropriate management of PDA in preterm infants and referral pathways for surgical management.**

This document is a guideline and standard operating procedure. Its interpretation and application remains the responsibility of the individual clinician, particularly in view of its applicability across the different Trusts in the East Midlands Neonatal Operational Delivery Network. Please also consult any local policy/guideline document where appropriate and if in doubt contact a senior colleague.

Caution is advised when using guidelines after a review date.

In the exceptional circumstances that a Trust in the EMNODN opts not to follow an EMNODN approved guideline they should complete an EMNODN Derogation Form.

REVIEW AND AMENDMENT LOG

Version	Type of Change	Date	Description of Change
1	-	Jul 20	-
2	Update of clinical advice and referral pathways	Mar 26	Revision based on the changed service arrangements for Paediatric Cardiology from Glenfield to Leicester Royal Infirmary sites.

Contents

This document is a clinical care pathway in the main. More detailed guidance on the management of PDA in preterm babies is available via the UHL website or can be requested from EMCHC or Neonatology at UHL.

1. Definitions and Abbreviations

CLD	Chronic Lung Disease
PDA	Patent Ductus Arteriosus
EMNODN	East Midland Neonatal Operational Delivery Network
EMCHC	East Midland Congenital Heart Centre
GFR	Glomerular Filtration Rate
IV	Intravenous
IVH	Intraventricular Haemorrhage
NEC	Necrotising Enterocolitis
NIC	Nurse in Charge
UHL	University Hospitals of Leicester

2. Contact Numbers

UHL Main Switchboard	0300 303 1573
NNU LRI	0116 2586462 or 0116 2585437
Cardiology Registrar on call - Bleep	Bleep 4347 / Mobile 07950 873074
CenTre Transport	0300 300 0038

3. Introduction and Scope

PDA is a significant cause of morbidity amongst preterm babies and leads to Left to right shunting resulting in increased blood flow to the lungs, increased pulmonary arterial pressure and/or “steal” of blood from the systemic circulation. This can be associated with other complications such as pulmonary haemorrhage, extubation failure, IVH and NEC and can contribute to the development of CLD.

This guideline is aimed at all healthcare professionals in the EMNODN involved in the care of preterm infants born before 30 weeks gestation within their neonatal services. The principle patient group relevant to this guidance are preterm babies born before 30 weeks gestation but may apply to other babies born after this time.

This guideline does not include the management of babies with PDA associated with other structural congenital heart disease or patients outside of neonatal services. For these babies, clinical advice from the cardiology team should be sought when considering management strategies.

4. Key Points

	Key Points	**Evidence**
1	Routine prophylaxis or targeted treatment with non-steroidal anti-inflammatory drugs based on echo findings in the first 72 hours is no longer recommended. (Gupta S et al 2024; Hundscheid T et al 2023)	Grade A
2	Babies that have a symptomatic PDA should have an echo performed to assist with determining clinical significance	
3	Babies with a symptomatic PDA and signs of significant shunt on echo should be treated with a 3 day course of ibuprofen with repeat echo after treatment to assess the need for a further course 48-72 hours after the first.	Grade C
4	Where ibuprofen is contraindicated, paracetamol can be considered as an alternative.	
5	Both ibuprofen and paracetamol are more likely to be effective if given before 21 days but may be considered up to 28 days.	

6	There is no evidence to support the routine use of diuretics – their use should be restricted to babies where there is thought to be heart failure and fluid overload (Green T et al 1983)	Grade B
7	Aggressive fluid restriction is not recommended, calorific intake should be maintained and milk intake should be not be restricted (Reller et al 1985)	
8	PDA ligation or device closure may be considered where a symptomatic PDA has failed to respond to medical treatment. The decision to refer for ligation or duct closure should be made by the attending service consultant after discussion with a second consultant colleague.	Grade B
9	Following transfer to UHL NNU for PDA closure, a baby will require a detailed assessment by cardiology for suitability for and feasibility of device closure or surgical ligation. Parents should be informed of this essential step in the assessment of their baby before final plans for surgery can be agreed.	
10	Any changes in the decision to offer the procedure should be discussed and agreed in a joint MDT between the referring unit, cardiology and the Leicester team.	

5. Clinically / Haemodynamically Significant PDA

PDA often present with recognised clinical symptoms but absence of these symptoms does not rule out a significant PDA. The clinically important effects of a PDA are also dependent on the baby's ability to compensate. Clinical signs are also a poor predictor of duct size and correlate poorly with the degree of ductal blood flow (Davis P et al 1995). However, these clinical signs and symptoms are useful to highlight the presence of a PDA and significance can then be assessed.

- Symptoms
  - Difficulty weaning from the ventilator or failure to extubate
  - Increasing ventilator or oxygen requirements without another obvious cause (for example airway problems, infection or pneumothorax)
  - Significant pulmonary haemorrhage (blood from ETT with deterioration in respiratory status)
  - Evidence of other organ dysfunction e.g. deranged kidney or liver function, abdominal distension or suspected NEC
  - Baby remaining ventilator dependent where post-natal steroids are being considered to try to achieve extubation.

- Signs
  - Heart murmur,
  - active precordium and bounding peripheral pulses,
  - wide pulse pressure, low diastolic blood pressure +/- resulting low mean arterial pressure
  - Signs of heart failure – Hepatomegaly, pulmonary oedema, cardiomegaly on CXR

5.1 Echocardiographically Significant PDA

It is good practice to assess significance of PDA by personnel trained or experienced in neonatal Echocardiography and early measurement of duct size can be used to predict the likelihood of spontaneous closure (Moss S et al 2003; Evans N 2005).

The presence of 2 or more of the following is a reasonable guide to identifying an 'echocardiographically significant' PDA but the presence of these in isolation does not determine *clinical* significance.

- Diameter of >2.0 mm at the narrowest point
- Pulsatile ductal flow pattern
- Left heart dilatation (LA/Ao >1.5:1)
- Signs of ductal steal - retrograde post-ductal aortic, mesenteric or cranial arterial diastolic flow

See Appendix 2 - Echo parameters and Assessment of Ductal Shunt for more detail of parameters to guide assessment of severity of ductal shunt.

5.2 Management

This guidance is based on recommended treatments for a symptomatic PDA.

5.2.1 Fluid Management

Careful fluid management in the first few days of life may decrease the incidence of PDA. Studies looking at fluid restriction as part of treatment show variable results (Bell E et al 1980; Reller M et al 1985).

Aggressive fluid restriction is not recommended due to the impact on calorific intake. Babies with a PDA have increased metabolic demands and nutrition should be maximised as far as possible but it is sensible to avoid excessive parenteral fluid input. Calorific intake should be maintained and milk intake not restricted.

During treatment with non-steroidal drugs, consideration should be given to the possible reduction in GFR with relative fluid restriction during therapy and close monitoring of fluid balance including a daily weight, regular assessment of urine output and at least daily measurement of serum electrolytes, urea and creatinine.

There is no evidence to support the routine use of diuretics and their use should be restricted to babies where there are signs of heart failure with fluid overload (Green T et al 1983).

5.2.2 Echocardiographic Assessment

Echocardiography should be carried out to assess the presence and size of a PDA. When using scans to make decisions around management and referral for surgical therapies, this should be completed by an appropriately trained or experienced consultant within neonatology or paediatrics or within cardiology, by a senior cardiology trainee or consultant.
Where structural congenital heart disease is suspected or doubt exists in ruling it out, a formal cardiology opinion should be sought that may include a request for a cardiologist performed echo.

5.2.3 Drug Treatment of PDA

A Cochrane review concluded that ibuprofen is at least as effective as indomethacin for the treatment of PDA in preterm babies (Ohlsson A et al 2010; Lago P et al 2002; Gupta s et al 2024). A later review (Ohlsson A et al 2020) supported the use of oral ibuprofen and whilst the intravenous (IV) route remains the mainstay, use of the oral route may be used as per consultant discretion e.g. in fully fed babies with no IV access. There is no benefit to prophylactic or targeted treatment within 72 hours of birth (Gupta S et al 2024).

Babies with a symptomatic PDA and signs of a significant shunt on echo should receive a 3 day course of ibuprofen. Suggested dose regimes in this guideline are based on those used in studies showing benefit. It is recommended that individual neonatal services have an agreed

regime approved though local Trust systems. There is little evidence comparing different dose regimes though some studies have used higher doses.

5.2.4 Suggested Dosaging Regime for Ibuprofen

- 10mg/kg IV Ibuprofen as a single dose
- 2 further doses at 24 hour intervals of 5mg/kg IV
- Oral doses are as per the IV regime

Repeat echo after treatment and if the duct remains significant, consider a further course 48 to 72 hours later (Van Overmeire B et al 2001). The earlier a course is given, the higher the chance of successful closure.

Feeds do not need to be stopped during ibuprofen use and may provide some gastro protection. The decision to continue enteral feeds should be based on a full assessment of abdominal signs and review of the baby's condition as a whole.

Repeat courses after some time
Where a duct has closed following an early course of ibuprofen but later reopens and is symptomatic, consider a further course of treatment (Van Overmeire B et al 2001).

Contraindications to use of Ibuprofen

- Platelets < 50 x 10^9/L
- Radiological signs of or high clinical suspicion of NEC
- Emerging IVH or significant IVH
- Evidence of renal failure e.g. rising creatinine or low urine output
- Concurrent treatment with hydrocortisone as this may increase the risk of gastric erosion or perforation

5.2.5 Paracetamol

Use of paracetamol for duct closure is currently unlicensed but there are a number of studies including a Cochrane review in 2022 that show it to be as effective as ibuprofen in closing a PDA (Jansani N et al 2022).

There is ongoing work around the longer term effects of paracetamol but the studies are of low quality. Paracetamol is not recommended for routine use for the closure of PDA but may be considered where Ibuprofen is contraindicated (Rosé J et al 2026). This is a consultant level decision. In all drug choices and decisions to use medical treatment for a PDA, discussions with the family should be documented in the notes.

Suggested dosage regime for paracetamol (Rosé J et al 2026).

- 20mg/kg loading dose
- 7.5mg/kg 6 hourly for total of 5 days

6. Surgical or Device Closure of PDA

There is a relative lack of evidence to support surgical ligation of PDA and the rate of ligation in preterm infants has been reducing in favour of conservative and medical treatments or device closure (Brooks J et al 2005; Hasan F et al 2020; Al-Turkait et al 2022).

Surgical ligation carries a significant risk of morbidity including pneumothoraces, chylothoraces, pulmonary oedema and recurrent laryngeal nerve damage.

Transcatheter device closure for PDA is becoming the intervention of choice where there has not been adequate response to medical treatment or where this is contraindicated. (Baruteau A et al 2014; Mitra S et al 2024). Studies show good outcomes and safety profiles in infants >700grams in weight and some indicate lower mortality and reduced hospital stay when compared to surgical ligation (Sathanandam S et al 2021; Baruteau A et al 2023).

Whilst most babies born before 28 weeks who have a PDA undergo spontaneous closure before discharge (95%), observational studies have shown significant morbidity in those babies with symptomatic ducts (Baruteau A et al 2014; Chan B et al 2021).

Early referral is likely to originate from tertiary services, either inborn babies or babies transferred into these services due to the need for a high level of neonatal intensive care. Referrals made for older babies may originate from a wider group of level 2 and 3 neonatal services as may include babies who remain CPAP dependent despite prolonged medical and supportive management.

6.1. Referral Criteria

Referral for surgical or device closure of PDA should only be considered in babies with

- A clinically significant PDA (as defined above) AND
- Echocardiographic signs of a significant duct (as defined above) OR
- Hemodynamically significant PDA which has failed to close despite supportive and medical management ***AND*** baby is beyond 4 weeks of age when NSAID may be less effective

If referral is felt to be clinically appropriate by the neonatal team responsible for the inpatient neonatal care, the criteria for Referral to East Midland Congenital Heart Centre at LRI is:

- Babies born < 30 weeks gestation at high risk of death or developing severe BPD

AND

- More than 10 days old or requiring more than 10 days of mechanical ventilation

AND

- Have a haemodynamically significant PDA on echo assessment (Appendix 2)

OR

- Symptomatic preterm infants where the PDA has failed to respond to medical treatment or in cases where medical treatment is contraindicated including babies still dependent on non-invasive support at a corrected gestational age of term.

7. Pathway for Referral

Referral procedures should follow the pathway as laid out in Appendix 1. All patients referred will be discussed by the cardiac MDT to assess suitability for device closure or surgical ligation.

In the past, babies would be transferred on the day of surgery to Glenfield hospital for an elective surgical list. Referral from centres outside Leicester therefore did not require a cot in the Leicester NICU. Following relocation of the East Midlands Congenital Cardiology service to LRI, babies being transferred for PDA closure will transfer to Leicester NICU in advance of the planned procedure.
As for all tertiary neonatal services, availability of a bed on a specified day may not always be possible due to other capacity pressures and therefore transfer in advance increases the

likelihood of a planned procedure day being possible. The UHL Neonatal Service will follow appropriate escalation policies if there are capacity issues around the day of transfer.

Neonatal teams working together can alert the Leicester NNU team of the potential forthcoming need for a bed and to share clinical information regarding handover, parental communications and predicted availability of neonatal cots. To facilitate this, it is recommended that the Nurse in Charge (NIC) on LRI NICU **(telephone 07950 882788)** is informed of when a baby has been discussed at the Joint cardiology MDT and is potentially suitable for duct closure so that their name can be added to the list of impending admissions.

Where the clinical status of a baby changes (either before or after transfer to LRI) collaborative working between the referring and receiving neonatal consultants will ensure good continuity of care and effective joint working. Where a decision to not proceed to ductal closure is thought to be appropriate, this should only be made in conjunction with the referring consultant and only following a joint MDT where an alternative plan can be made.

Steps For referral

1. Baby identified as potentially needing PDA closure
2. Echocardiographic assessment with recorded images completed by an appropriately trained neonatologist or paediatrician with expertise in cardiology
3. Agreement by 2 Consultant Neonatologists following review of the clinical details and echo findings (if done), that referral for closure is appropriate. This step is to ensure ensure consistency within each service. Where necessary, the baby should also be discussed with a Neonatal consultant in the allied Neonatal tertiary service (see flow chart).
4. Telephone referral to cardiology tier 2 or consultant at EMCHC (contact via UHL switchboard 0300 303 1573) for consideration and review of echo findings at a Joint cardiology MDT meeting (routinely occurs weekly on Wednesdays but adhoc meetings can also be arranged). It is the cardiology team's responsibility to prioritise the case for discussion at the MDT and to present the case on behalf of the referring centre where necessary.
5. Inform the Nurse in charge (NIC) at LRI NICU that the baby is being discssed at the MDT – NIC to add baby's name to the list of impending admissions and inform Neonatal Consultant responsible for LRI NICU admissions.
6. Outcome of the MDT to be documented by cardiology and uploaded to the Heartsuite database and to include priority categorisation for intervention if agreed.
7. On the day of the MDT, Cardiology tier 2 or consultant to communicate the outcome of the MDT by telephone to the ***referring*** neonatologist/paediatrician. The referring paediatrician/neonataologist will communicate this information to parents including that the plan for duct closure is ***provisional*** and may change based on the final cardiology assessment on arrival in Leicester.
8. Where a suitable echo cannot be arranged at the referring hospital, the baby will need to be referred initially to a tertiary neonatal service for assessment prior to referral to cardiology and the MDT.
9. Once the theatre or catheter operative lists are planned, Cardiology administrative team must communicate this information to the referring centre so transfer can be arranged.
10. Following the MDT and once a ***provisional*** operative date is agreed, a formal request needs to be made by the referring neonatal service through CenTre transport service for a cot on LRI NNU at least 2-3 days prior to planned surgery date with the aim of moving the baby the day before surgery. Where there are known capacity issues in the NNU in Leicester, the local escalation policy will be followed to try and facilitate availability of a cot.
11. It is the referring hospital's responsibility to ensure the baby is fit for surgery e.g. free of infection, anaemia corrected as this may delay surgery once the baby is transferred.

12. Complete a medical handover of baby between referring hospital and LRI NNU ***consultants***. It is important that a consultant to consultant referral is made at this stage to ensure an accurate clinical history of progress is shared and to aid continuity with discussions with parents.Baby will be asessed by LRI Cardiology team on the day of transfer / day before planned treatment (including UHL babies) to confirm baby still meets the criteria for the procedure. Parents to be updated following this and arrangements for formal consent to be made.
13. Where intervention plans may change following cardiology review, the UHL Neonatal consultant will arrange a conference call with the referring team to communicate this information. Ideally this will also involve the Cardiologist.
14. Baby to return back to the referring neonatal service once clinically stable after at least 24 hours of the post operative period is complete.
15. The discharge letters back to the referring servce must include copies of the operative notes and scanned to Badger EPR. The opererative notes should be available the day after surgery from the EMCHC surgical secretaries (tel 01162 502796).

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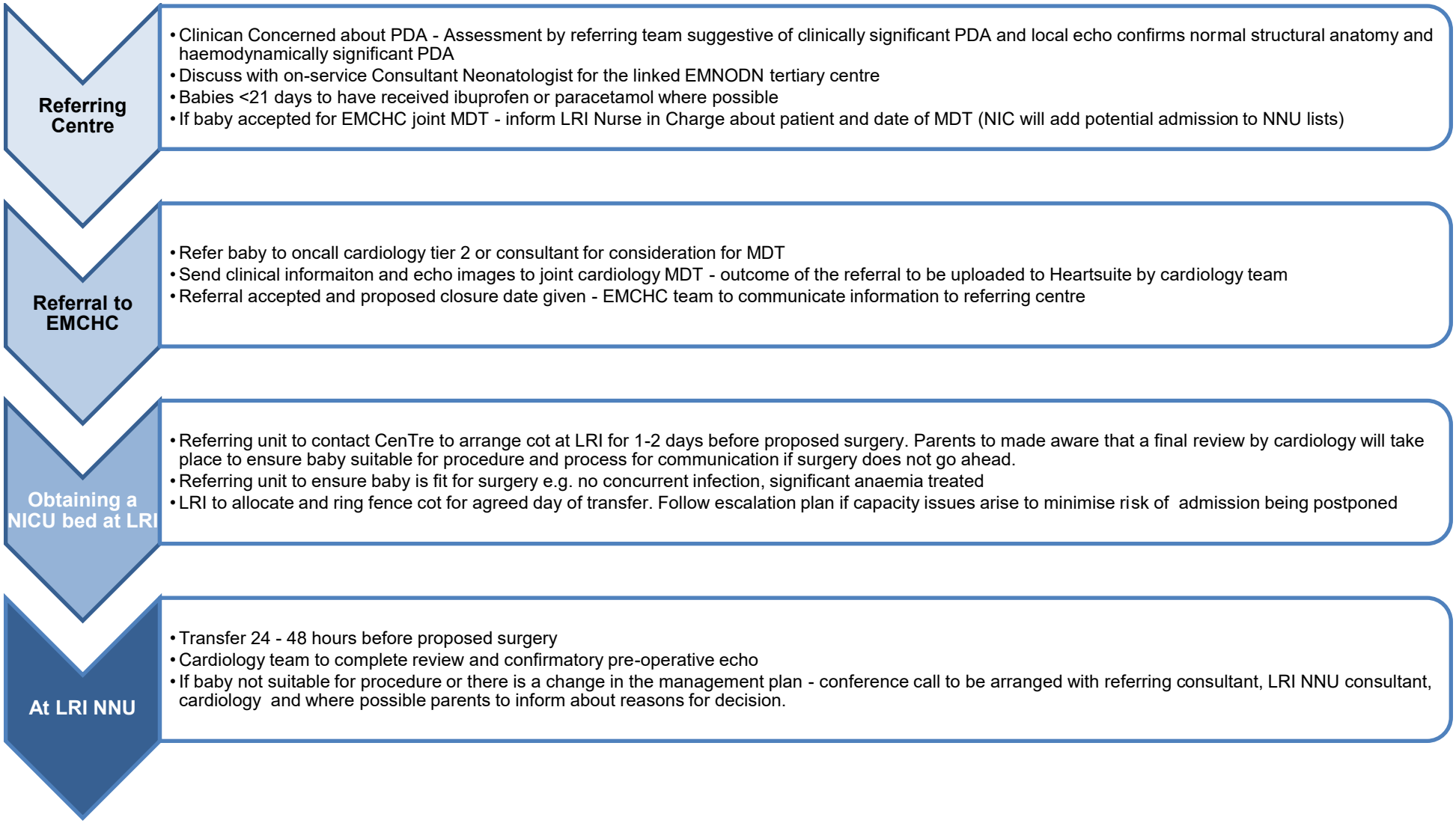
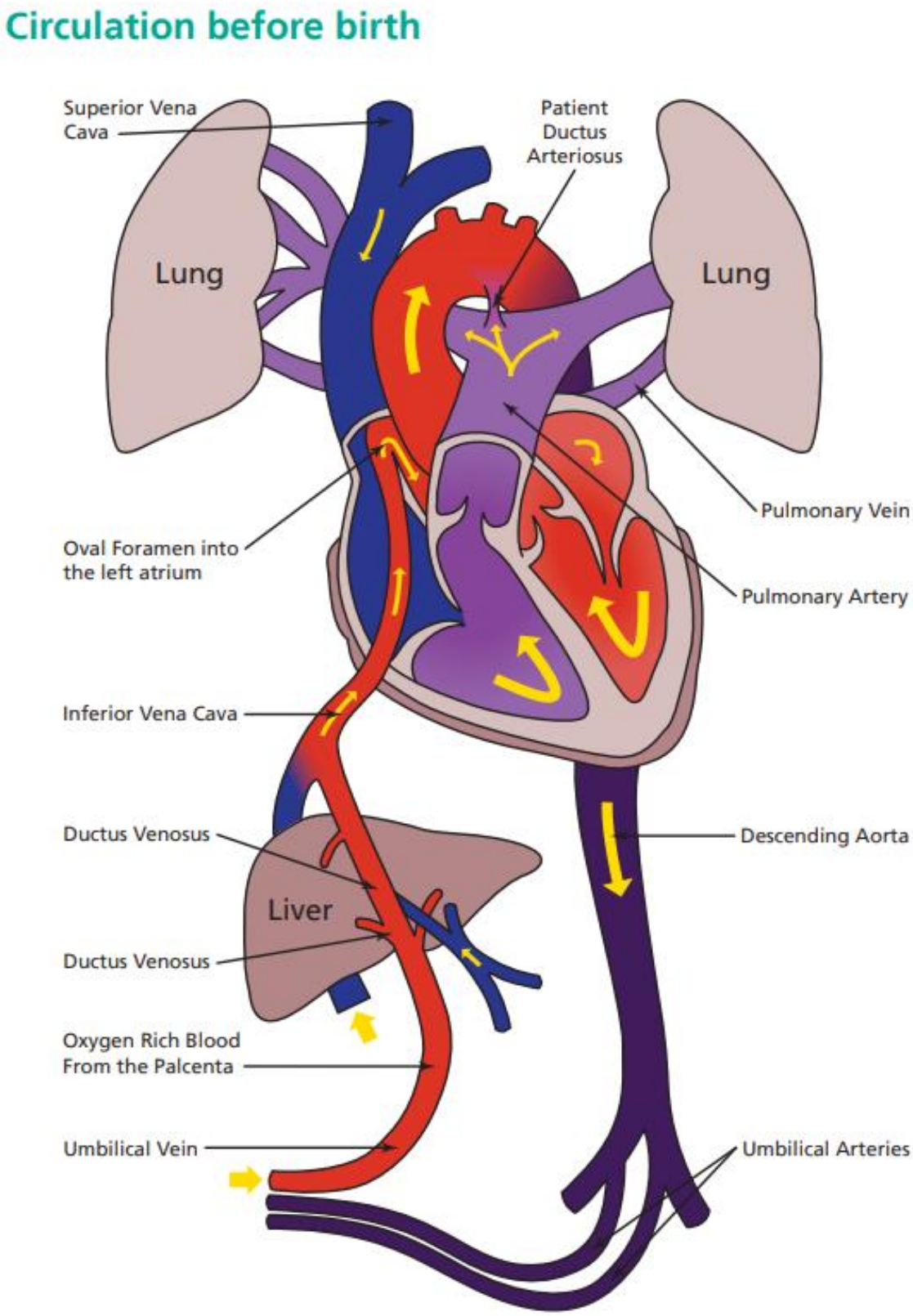
Appendix 1: EMNODN / EMCHC Pathway for PDA Ligation



Appendix 2: Echo Parameters and Assessment of Ductal Shunt

Feature	Small Shunt	Moderate Shunt	Large Shunt
Size of PDA - diameter - PDA to LPA ratio	 < 1.5mm <0.5	 1.5mm – 2,0mm 0.5 - 1	 >2mm >2
Flow through the PDA - V max	 >2m/s	 1.5 – 2m/sec	 <1.5m/s
Pulmonary over circulation Left sided overload - LA/Ao ratio Pressure increase in LA - Mitral valve E:A Pulmonary Overflow -LVO	 <1.5 <1 <200ml/kg/min	 1.5-2.0 1 200-300ml/kg/min	 >2 >1 >300ml/kg/min
Systemic blood flow/End organ perfusion - Descending aortic flow - SMA/ celiac artery diastolic flow - MCA diastolic flow	 Forward Forward Forward	 Absent Forward Absent	 Reversed Absent/reversed Reversed

Appendix 3: Useful resources for Parent Information - PDA, Ligation/Device closure



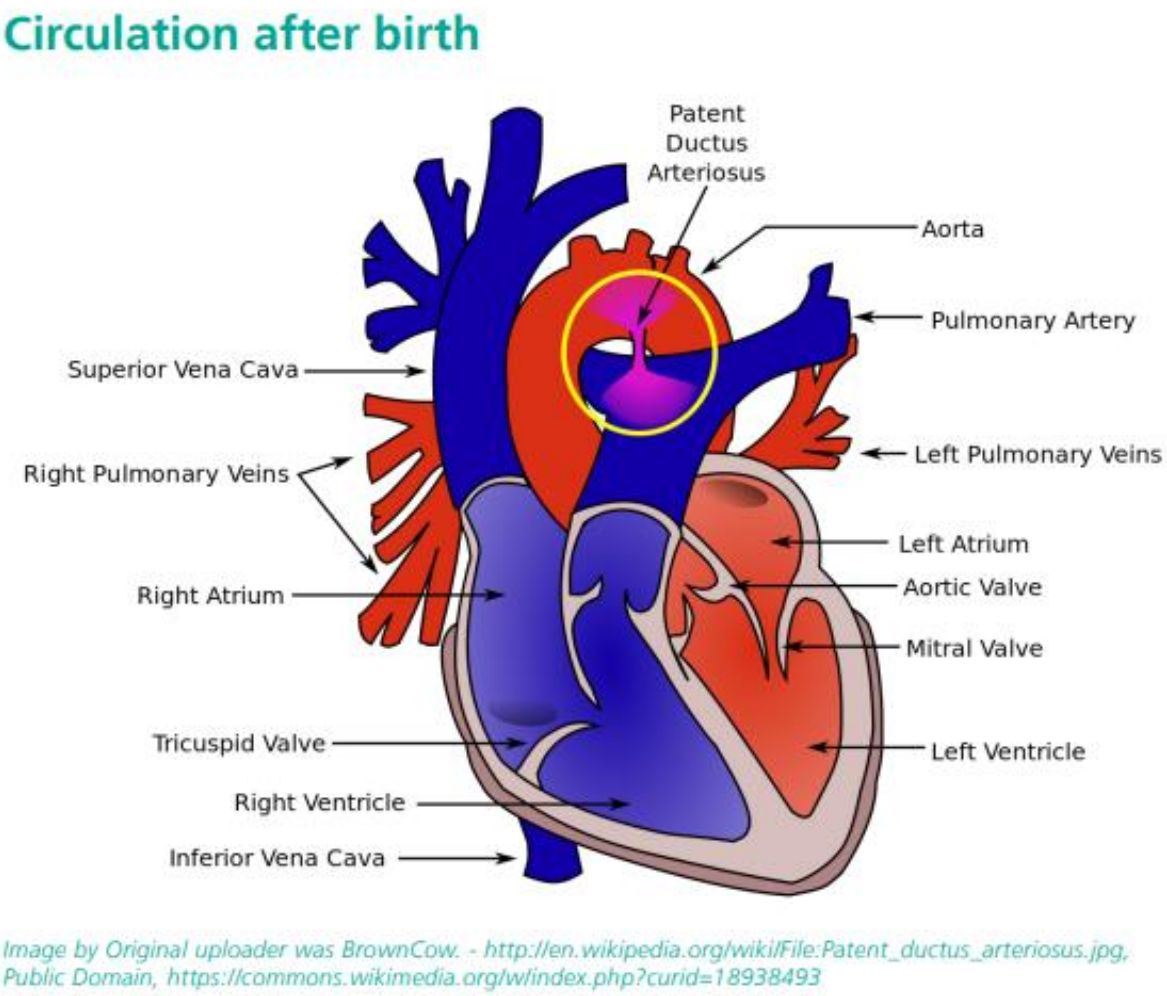


Image by Original uploader was BrownCow. - http://en.wikipedia.org/wiki/File:Patent_ductus_arteriosus.jpg, Public Domain, https://commons.wikimedia.org/w/index.php?curid=18938493

Information Leaflets

The East Midlands Congenital Heart Network do not currently have their own patient information leaflet but often refer parents to other suitable resources currently available. Clinicians using these information leaflets should review applicability to an individual patient's condition. Examples of commonly used leaflets can be found via the following links:

1. Great Ormond Street Hospital – PDA and Duct Ligation
https://www.gosh.nhs.uk/conditions-and-treatments/conditions-we-treat/patent-ductus-arteriosus-pda/

2. British Heart Foundation – Information and support - Patent Ductus Arteriosus
https://www.bhf.org.uk/informationsupport/conditions/patent-ductus-arteriosus-pda