

Patent Ductus Arteriosus (PDA). Referral for Surgical or Catheter closure – Preterm infants

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Aims

To standardise and optimise referrals for surgical or catheter closure of a PDA in premature infants and ex-premature graduates of the Neonatal unit.

Background and indications for standard operating procedure/protocol

For guidance on neonatal management of the PDA please see the Neonatal ODN PDA guideline <https://www.networks.nhs.uk/nhs-networks/yorkshire-humber-neonatal-odn/guidelines-1/guidelines-new/cardiovascular>

As with most aspects of PDA management, opinion is divided on “if”, “when” and “how” to intervene surgically.

- If managed conservatively the PDA will close spontaneously in most preterm babies over time
 - 85% of VLBW infants (<1500g) before discharge¹
 - Those which do persist may not be of any haemodynamic significance and frequently close during the first year of life¹.
- There is no definitive evidence that treating PDAs leads to better outcomes.
 - Reported figures vary but complications can occur secondary to surgical ligation. These include Pneumothorax, Recurrent laryngeal nerve palsy and Chylothorax. Referring clinicians and families should be aware of these risks^{2,3}. The NICOR 2016-2019 report a 30 day national survival following ligation of 98.2%. Therefore mortality should also be highlighted by the referring team to families as a small but distinct possibility.
 - Observational studies have shown higher incidences of long term morbidity (BPD, ROP, Developmental impairment) in babies who have had a PDA ligation. However this cannot be considered as causal and may be due to selection bias in those referred⁴.
- There are clearly some babies who have problematic PDAs and other studies have suggested that patients with prolonged exposure to a large PDA have an increased risk of BPD^{5,6}
- The development of percutaneous techniques for PDA closure in preterm babies means it is now possible to consider this as an alternative to surgical ligation in selected cases where the anatomy is favourable
 - 83% Catheter occlusion success rate in babies <3.5kg, 100% >3.5kg (Leeds Hospital data)
 - At present this can be considered once a baby is 2kg+ but there are cases where it has been possible in smaller babies⁷.

The following provides guidance on when to discuss a baby with the tertiary neonatal team and paediatric cardiology.

- Diagnosis and assessment of PDA should be in the remit of the referring hospital.
- The [appendix](#) includes some information on Echo assessment of PDAs in preterm babies which may be useful.
- As always there may be babies who do not fit the following criteria but are nonetheless a cause for concern and should be discussed.

Procedure method (step by step)

Inpatient

Indications

Babies who meet the following clinical criteria (and >2kg if considering catheter occlusion)

Persistent respiratory signs and symptoms consistent with pulmonary overload including

- Ventilator dependency after 28 days of life
- Unable to wean off CPAP / High flow oxygen with a persistent or rising oxygen requirement at 36 weeks corrected gestation
- Tachypnoeic / signs of pulmonary oedema (e.g. cardiomegaly / pulmonary plethora on CXR) which are compromising feeding / growth



Moderate or Large size PDA on Echo

- As defined in [Appendix 1](#)



Not responded to conservative management

- At least 1 course of medical treatment (unless contraindications)
- Consider 2nd course before referral including Paracetamol or higher dose Ibuprofen (see ODN PDA guideline)
- No response to or unable to wean off diuretics (usually Chlorothiazide and Spironolactone)



Appropriate assessment and management of other co-morbidities. Discuss with local NICU consultant team prior to Cardiology referral

- Chronic lung disease - consider low dose steroid course
- Gastro-oesophageal reflux - optimise if any evidence of GORD
- Nutrition - optimise in consultation with dietician, especially if fluid restricted

Contraindications

1. Suspicion of duct dependent lesion (although still need discussion with Cardiology)
2. Baby unfit for transfer
3. Other life limiting conditions and agreement that PDA intervention is not in baby's best interests
4. Recent or on-going evidence of infection

Referral process

1. Contact Paediatric Cardiology team (Consultant of week) direct to discuss case.
2. Share images as available via IEP (Image Exchange Portal) in advance of Tuesday JCC meeting.
 - Include PDA view to show length and morphology, Doppler profile and other relevant images including 4 chamber loop.
3. If referral accepted then contact Embrace and Leeds Neonatal Consultant to arrange transfer.
4. Ensure repeat Echo done pre-transfer to Leeds as PDAs do sometimes close spontaneously (ideally within 48 hours prior to transfer).
5. Babies transferred to Leeds Paediatric Cardiology ward or NNU require pre-surgical MRSA decolonisation
 - A recent MRSA screen result is important but as PDA ligation / occlusion involves insertion of a foreign body, decolonisation is required **regardless** of MRSA status.
 - Typically 5 days of Nasal Mupiricin + Octenisan washes but see LTH guidance below.
 - This should happen in the referring hospital *prior to* transfer, with a plan to complete decolonisation on the day of surgery. Please include documentation of this in any discharge / transfer letter.

For specific details about screening and decolonisation see

<http://www.lhp.leedsth.nhs.uk/common/guidelines/detail.aspx?ID=684>

Outpatient

PDA follow-up of Preterm infants after discharge

- If clinical signs of PDA have resolved at discharge then no routine follow-up is required
- Clinical signs of PDA (murmur) but asymptomatic
 - If not yet confirmed on scan then consider whether Echo needed before discharge (exclude CHD)
 - Review in clinic with Local PEC / Neonatologist with expertise in Cardiology
 - For small PDAs (<1.5mm) in preterm infants, it may be appropriate just to see in a standard neonatal clinic and repeat an Echo only if a murmur persists or if there are significant respiratory co-morbidities (e.g. unable to wean home oxygen, recurrent chest infections).
 - Discuss with / Refer to Cardiology if asymptomatic PDA persists
 - Many PDAs will close spontaneously^{1,8,9} (median 9 months in some series) but this becomes less likely over time. Consider referral by 12 months of age for consideration for closure
 - Discuss and refer earlier if any signs of volume loading or elevated pulmonary pressures on Echo.
- Symptomatic PDA or requiring diuretic treatment
 - Confirmatory Echo with pre-discharge
 - PEC / Cardiology follow-up.
 - If symptomatic or sizeable PDA persists as outpatient then refer for closure.

Consider Echo in any baby still requiring oxygen beyond 44 weeks corrected gestation (including home oxygen) in case of

- Significant PDA or congenital heart lesion not detected clinically
- Co-existent Pulmonary hypertension

Patient Information

Parent information leaflets- see <http://flipbooks.leedsth.nhs.uk/LN004435.pdf>

or translatable version in any language at <https://www.leedsth.nhs.uk/patients-visitors/our-hospitals/leeds-childrens-hospital/a-z-of-children-hospital-leaflets/congenital-heart-disease>

Conflicts of Interests

Nil

Algorithms

Provenance:

Evidence Base: References

References

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11. David van Laere et al on behalf of the European Special Interest Group 'Neonatologist Performed Echocardiography' (NPE). Application of Neonatologist Performed Echocardiography in the assessment of a patent ductus arteriosus *Pediatric Research* 2018; 84: 46–56.

Appendix 1

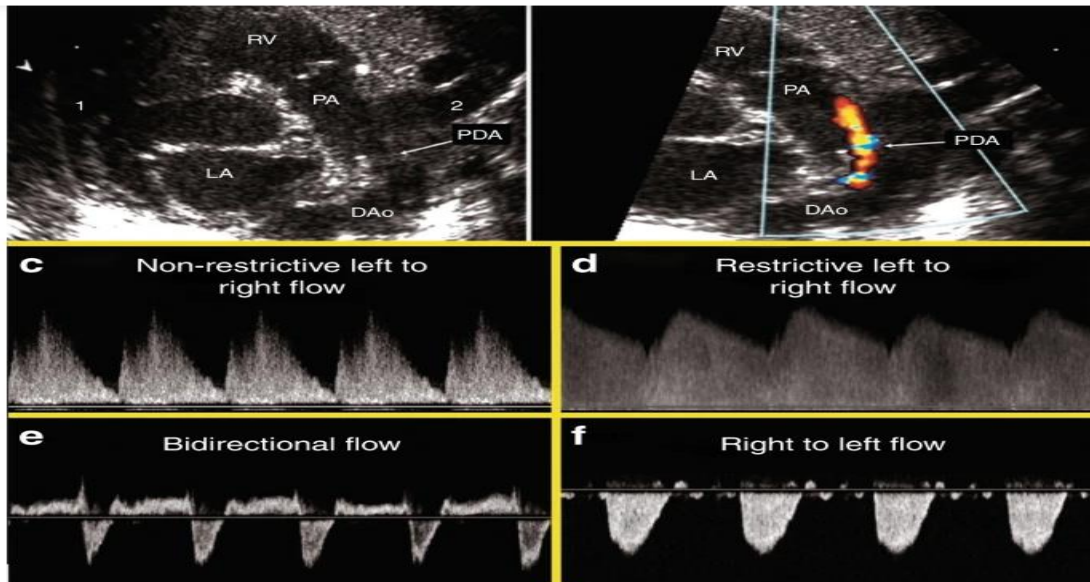
Echocardiographic assessment of the PDA¹⁰ derived from

McNamara PJ, Sehgal A. Towards rational management of the patent ductus arteriosus: the need for disease staging. Arch Dis Child Fetal Neonatal Ed. 2007 Nov; 92(6): F424–F427.

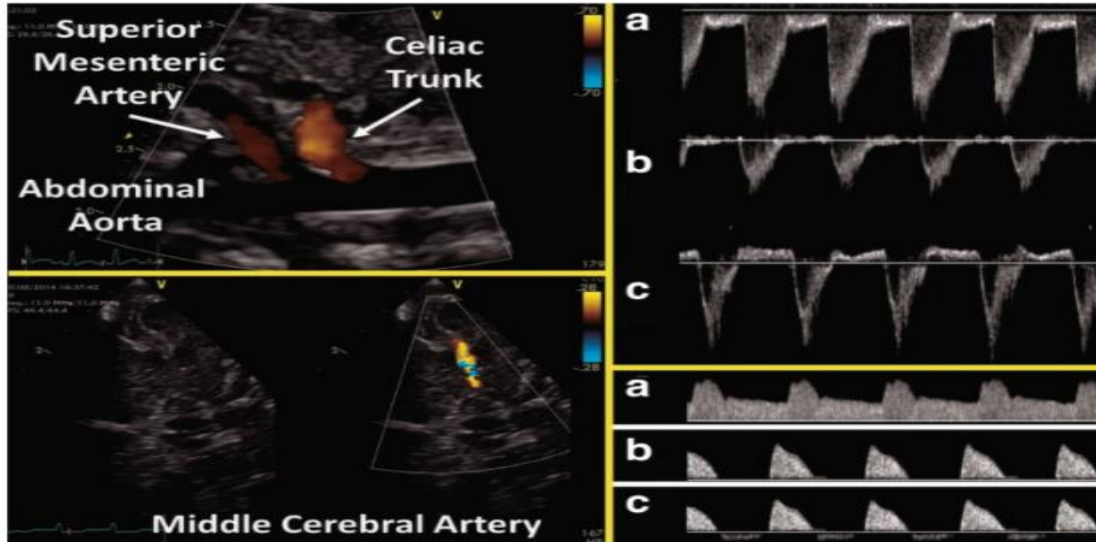
E1: No Duct	No evidence of duct on Echo
E2: Small	Small non significant duct on Echo Ductal diameter <1.5mm Restrictive continuous transductal flow No signs of left heart volume loading (LA:Ao ratio <1.5:1) Normal end organ diastolic flow (SMA, MCA, renal arteries)
E3: Moderate	Ductal diameter 1.5-3.0mm Unrestrictive pulsatile transductal flow Mild-moderate left heart volume loading (LA:Ao ratio >1.5-2:1) Decreased or absent end diastolic flow in SMA, MCA or renal artery
E4: Large	Ductal diameter >3.0mm Unrestrictive pulsatile transductal flow (Vmax <2m/s) Severe left heart volume loading (LA:Ao ratio >2:1) Reversal of end diastolic flow in SMA, MCA or renal artery

Echocardiographic assessment of the PDA¹¹ from

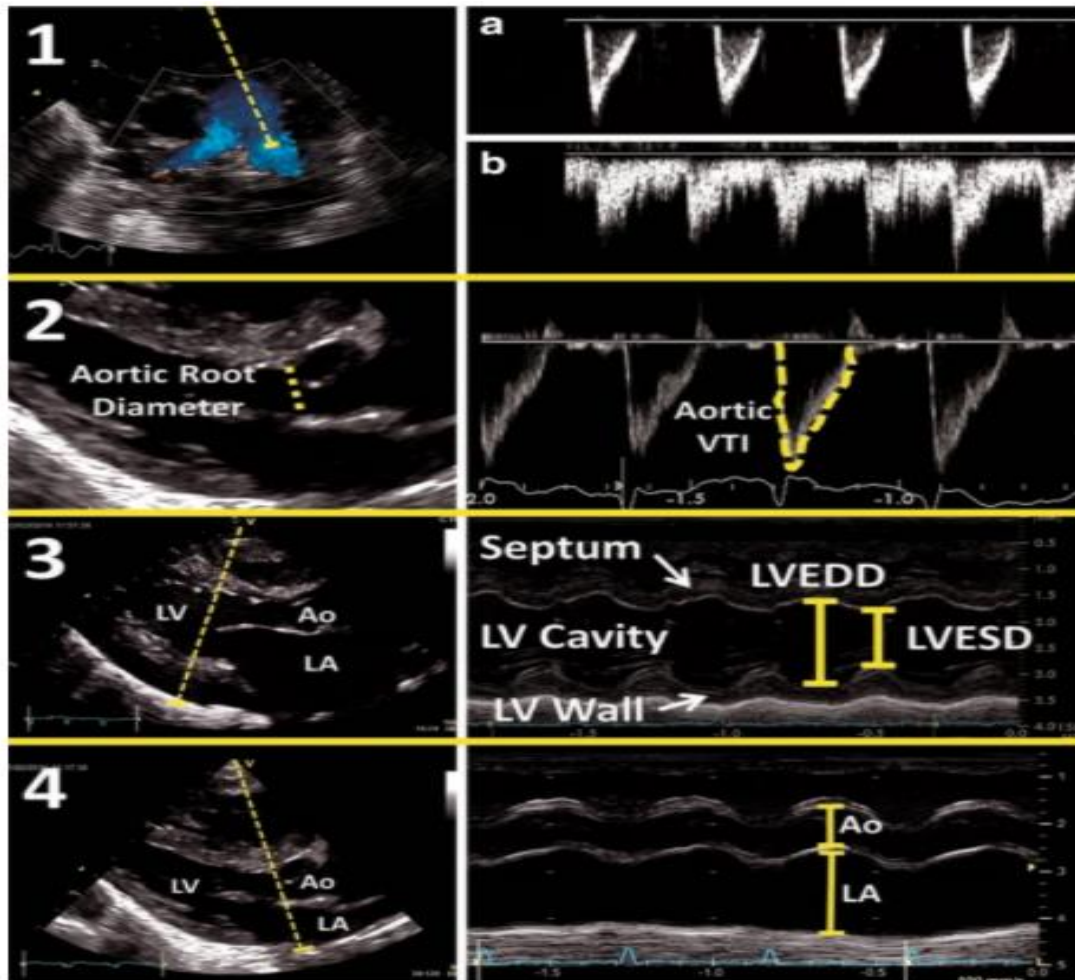
David van Laere et al on behalf of the European Special Interest Group 'Neonatologist Performed Echocardiography' (NPE). Application of Neonatologist Performed Echocardiography in the assessment of a patent ductus arteriosus *Pediatric Research* 2018; 84: 46–56.



PDA 2D, color Doppler image and Doppler flow patterns. The top panels demonstrate the PDA in 2D (a) and color Doppler (b). **c** Pulsatile or non-restrictive pattern: characterized by a left to right (LtR) shunt with an arterial waveform and high peak systolic velocity: end-diastolic velocity ratio. **d** Restrictive pattern: characterized by high systolic and diastolic velocity, and low peak systolic velocity: end-diastolic velocity ratio. **e** Bidirectional pattern: elevated pulmonary pressures equal to or near systemic. **f** Right to left (RtL) flow: supra-systemic pulmonary pressures



Assessment of diastolic flow in a post-ductal artery. Measurement of pulsed wave Doppler pattern in the celiac trunk, the abdominal aorta, and the middle cerebral can highlight the effect of left-to-right shunting across the PDA. In the top Doppler panel, three abdominal aortic Doppler wave forms are illustrated demonstrating normal forward diastolic flow (**a**), absent diastolic flow (**b**), and reversed diastolic flow (**c**). A similar pattern can be seen in the lower Doppler panel which is representative of celiac and middle cerebral arteries



Assessment of left heart volume loading. (1) Measurement of diastolic flow in the left pulmonary artery. **a** Normal situation without ductal left-to-right shunting. **b** Illustrates forward diastolic flow in the presence of significant left-to-right ductal flow. (2) Measurement of LVO: increased LVO in the setting of a PDA indicated increased pulmonary venous return. (3) Measurement of LV diameter in diastole: increased LV diameter is another surrogate marker for increased LV end-diastolic volume. (4) LA:Ao ratio: atrial enlargement can be indexed to a relatively fixed aortic root diameter to further estimate in degree of increased LA volume