Title:	NWNODN Extra Corporeal Membrane Oxygenation (ECMO) Neonatal Referral Pathway
Reference number	PW-ODN-04
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Target Audience	NWNODN clinicians SMT and Board members
Ratified by:	SMT
Date Ratified:	8.9.21
Review Date:	8.9.24
Version:	Final
Document status:	Ratified & shared at NSGs

Introduction

ECMO is routinely used to support children and adults with respiratory and/or cardiovascular dysfunction with increasing numbers of children supported over the last three decades [1] ECMO is an effective life-saving treatment for neonates with severe but potentially reversible respiratory failure [2]

The purpose of this ECMO pathway is to ensure all infants born within the NWNODN receive equitable, high quality care, and that specialist ECMO resources and services are utilised efficiently and appropriately.

Consideration for ECMO

ECMO is most often used to treat neonates with severe respiratory and or cardiac failure, which is often associated with persistent pulmonary hypertension of the newborn (PPHN). This should be unresponsive to optimal ventilatory and pharmacological treatment, associated with a high risk of mortality and considered to be potentially reversible.

Indications for Respiratory ECMO referral [3-4]

Early referral and discussion of potential ECMO patients with the ECMO Centre is encouraged for the following reasons:

1. To establish candidacy for ECMO.
2. To enable further optimisation at the referring centre and potentially avoid ECMO.
3. To ensure adequate stabilisation prior to transfer for ECMO.

The following situations should prompt an early discussion with the ECMO Centre:

The baby should have a gestational age ≥ 35 weeks and weight of ≥ 2 kg and at least one of the following:

- Inability to maintain the pre-ductal SpO2 > 85% or post-ductal SpO2 > 70%
- Ongoing need for high pressure ventilation (PIP > 28 cmH20 on conventional ventilation or MAP > 17 cmH2O on HFOV) for 24-48 hours
- Hypoxic respiratory failure with OI > 40 sustained for at least 4 hours despite optimising conventional ventilation and trial of inhaled nitric oxide[1]
- Hypercapnic respiratory failure with PaCO2 > 10 kPa/pH < 7.15 despite optimal ventilation
- Inadequate tissue oxygen delivery (indicated by pH < 7.15 or lactate > 5 mmol/L)
- Refractory systemic hypotension, resistant to fluid and inotropic therapy.
- Echocardiographic evidence of severe pulmonary hypertension resistant to pulmonary vasodilator therapy

Exclusion Criteria

- Significant coagulopathy or uncontrollable bleeding
- Major intracranial haemorrhage (e.g. > grade 2 IVH) or evidence of severe brain injury[2]

[1] Or OI>30 if on HFOV plus inhaled nitric oxide.

[2] A cranial ultrasound scan should ideally be performed prior to referral

- **Irreversible lung injury**
- **Major life-limiting congenital/chromosomal anomalies (including cardiac malformation)[3] such as Trisomy 13 and 18 but not Trisomy 21.**
- **Cardiac arrest other than immediately at birth**

Indications for ECMO in babies with congenital diaphragmatic hernia (CDH)

Please refer to NWNODN CDH guideline.

The benefit of ECMO in the treatment of infants with CDH remains unclear but should be considered on an individual basis. Early discussion and referral of patients with CDH for potential ECMO support is strongly encouraged to allow sufficient time for a MDT meeting (including Neonatal, PICU, General Surgical and Cardiac Surgical teams) to consider all the relevant perinatal determinants of outcome before the patient is *in extremis*.

Referral

If an infant meets the criteria for ECMO and/or the attending clinicians feel that it may benefit, please contact the neonatal transport team, Connect North West (0300 330 9299) in the first instance, who will be able to set up a conference call with the ECMO team to develop a management plan. Please see the referral flow chart and complete the checklist in appendices 1 and 2, respectively. Please have all relevant antenatal information available.

A conference call will be organised by the Connect NW cot bureau and the following individuals will be invited to join the call:

- **Referring consultant**
- **Local NICU consultant (if referral from linked LNU)**
- **ECMO Consultant**
- **Connect NW transport team (or NWTS consultant if CNW unavailable)**
- **Alder Hey PICU Consultant**

Please download and complete the Alder Hey ECMO referral form (https://alderhey.nhs.uk/services/ecmo) and then email a copy to alderhey.ecmo2@nhs.net

References

1. Thiagarajan RR, Barbaro RP, Rycus PT, et al. Extracorporeal life support organization registry international report 2016. ASAIO J. 2017; 63:60–7.
2. Elbourne D, Field D, Mugford M. Extracorporeal membrane oxygenation for severe respiratory failure in newborn infants. The Cochrane Database of Systematic Reviews 2002, Issue 1.
3. Snoek KG, Reiss IK, Greenough A, et al. CDH EURO Consortium. Standardized Postnatal Management of Infants with Congenital Diaphragmatic Hernia in Europe: The CDH EURO Consortium Consensus - 2015 Update. Neonatology. 2016;110(1):66-74.
4. Wild KT, Rintoul N, Kattan J, Gray B. Extracorporeal Life Support Organization (ELSO): Guidelines for Neonatal Respiratory Failure. ASAIO J. 2020 May;66(5):463-470.

[3] An echocardiogram +/- cardiology referral should ideally be performed prior to referral

Appendix 1

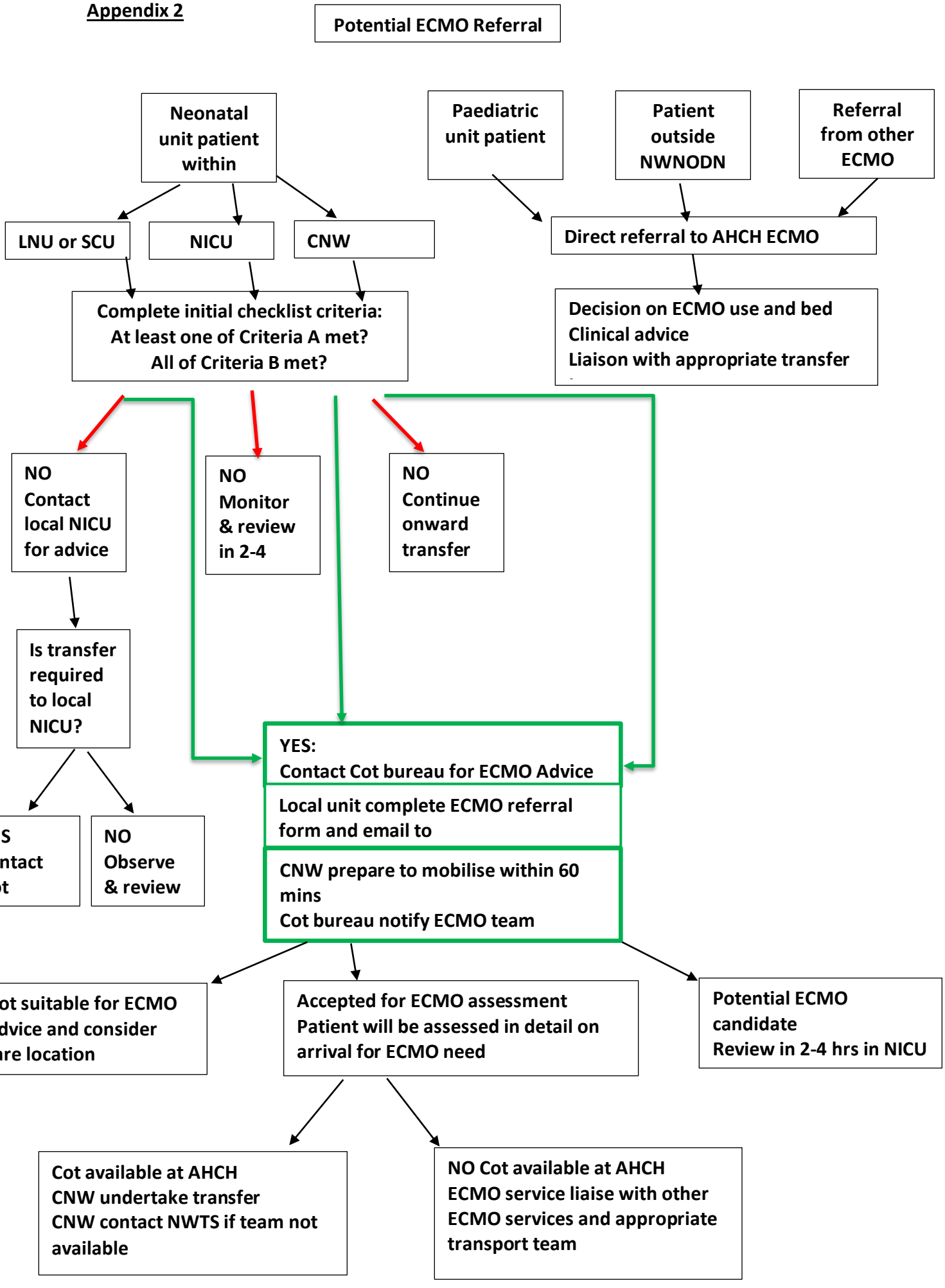
Checklist
Criteria A – At least one of these conditions should be met:

- ☐ **Inability to maintain the pre-ductal SpO2 > 85% or post-ductal SpO2 > 70%**
- ☐ **Ongoing need for high pressure ventilation (PIP > 28 cmH20 on conventional ventilation or MAP > 17 cmH2O on HFOV) for 24-48 hours**
- ☐ **Hypoxic respiratory failure with OI > 40 sustained for at least 4 hours despite optimising conventional ventilation and trial of inhaled nitric oxide**
- ☐ **Hypercapnic respiratory failure with PaCO2 > 10 kPa/pH < 7.15 despite optimal ventilation**
- ☐ **Inadequate tissue oxygen delivery (indicated by pH < 7.15 or lactate > 5 mmol/L)**
- ☐ **Refractory systemic hypotension, resistant to fluid and inotropic therapy.**
- ☐ **Echocardiographic evidence of severe pulmonary hypertension resistant to pulmonary vasodilator therapy**

Criteria B – ALL of these conditions should be met:

- ☐ **Gestational age ≥ 35 weeks**
- ☐ **Current weight ≥ 2 Kg**
- ☐ **No significant coagulopathy or uncontrollable bleeding**
- ☐ **Absence of major intracranial haemorrhage (e.g. > grade 2 IVH) or severe brain injury**
- ☐ **Potentially reversible lung injury**
- ☐ **No major life-limiting congenital/chromosomal anomalies (including cardiac malformation) such as Trisomy 13 and 18 but not Trisomy 21.**
- ☐ **No prior cardiac arrest other than immediately at birth**

Appendix 2


Potential ECMO Referral
Neonatal unit patient within
Paediatric unit patient
Patient outside NWNODN
Referral from other ECMO
LNU or SCU
NICU
CNW
Direct referral to AHCH ECMO
Complete initial checklist criteria:
At least one of Criteria A met?
All of Criteria B met?
Decision on ECMO use and bed
Clinical advice
Liaison with appropriate transfer
NO
Contact local NICU for advice
NO
Monitor & review in 2-4
NO
Continue onward transfer
Is transfer required to local NICU?
YES:
Contact Cot bureau for ECMO Advice
Local unit complete ECMO referral form and email to
CNW prepare to mobilise within 60 mins
Cot bureau notify ECMO team
YES
contact Cot
NO
Observe & review
Not suitable for ECMO
Advice and consider care location
Accepted for ECMO assessment
Patient will be assessed in detail on arrival for ECMO need
Potential ECMO candidate
Review in 2-4 hrs in NICU
Cot available at AHCH
CNW undertake transfer
CNW contact NWTS if team not available
NO Cot available at AHCH
ECMO service liaise with other ECMO services and appropriate transport team