

Title	NWNODN Post-Haemorrhagic Hydrocephalus Guideline		
Reference	GL-ODN-08		
Author	Dr Manigandan Chandrasekaran, Consultant Neonatologist, LWH (Lead Author) Dr Gareth Penman, Consultant Neonatologist, MFT Dr Ruth Gottstein, Consultant Neonatologist, MFT Dr Jasim Shihab, Consultant Neonatologist, ELHT Mr William Dawes – Consultant Neurosurgeon , AHCH Miss Deborah Ferguson – Consultant Neurosurgeon, MFT Mr Roberto Ramirez - Consultant Neurosurgeon, MFT Mr John Kitchen - Consultant Neurosurgeon, MFT		
Target Audience	NWNODN clinicians		
Ratified by	SMT		
Date ratified	January 2023		
Date for review	January 2026 – Extended until 31 st May (under review to ensure latest best practice is adhered to)		
Version	FINAL		
Document status	This is a controlled document. Whilst this document may be printed, the electronic version posted on the intranet is the controlled copy. Any printed copies of this document are not controlled. As a controlled document, this document should not be saved onto local or network drives but should always be accessed from the intranet.		
Document history			
Date	Version	Co-Ordinator	Notes
	1.0	C.Nash / M. Chandrasekaran	Original document from 2019 up-dated & changed to ODN format as no neuroscience network. Specialist group document.

Contents

Executive Summary	3
Scope and Purpose	3
Roles and Responsibilities.....	3
Related Documents	3
Communication Plan	3
Process for Monitoring Compliance/Effectiveness.....	3
Arrangements for Review of the Policy.....	4
Background.....	5
The Role Of Transfontanelle Uss	5
Measuring Ventricular Size Using Transfontanelle Ultrasound	5
When To Intervene.....	5
How To Intervene	6
The Role Of Temporising Interventions In The Management Of Phh	6
Management Post Temporising Intervention / Decision For Permanent Vp Shunt.....	6
Summary.....	6
Appendix A	7
Appendix B.....	9
Appendix C.....	10
References	13
Appendix D	14

NWNODN Post-Haemorrhagic Hydrocephalus Guideline

Executive Summary

The purpose of this document is to provide regional guidelines for doctors, nurses and allied professionals in the clinical management of Neonates with post haemorrhagic hydrocephalus (PHH) from the point of diagnosis on the neonatal unit through to referral and management at the local networked regional paediatric neuroscience unit.

Based on best available evidence, the guidelines aim to standardise management on the neonatal unit with this condition, to provide guidance and common criteria for referral to the local neurosurgical unit including agreeing temporising manoeuvres to control raised ICP, indications for referral and neurosurgical management including indications and guidance for ventricular tap, ventricular subgaleal shunting (VSS) and ventricular peritoneal shunting (VPS). Peri-operative and post-operative management guidance is also provided.

Scope and Purpose

This guideline applies to all Neonates who are being cared for on a Tier 1/2 Neonatal Unit. This guideline applies to all health providers in the regional and District General Hospitals (DGH) in the Cheshire and Merseyside, Greater Manchester and Lancashire & South Cumbria localities. The purpose is to provide standardised care throughout the region and improve patient safety and clinical outcomes.

Roles and Responsibilities

This guideline applies to all clinical staff employed or contracted to work within the Paediatric Neurosciences Network (Alder Hey and Royal Manchester Children's Hospital) and the North West Neonatal Network hospitals, who care for Neonates. Staff have a responsibility to ensure that they are aware of this guideline and its contents. They should clearly document their rationale if they have not complied with the recommendations detailed in this guideline. It is the responsibility of department managers, consultants, team leaders and education leaders to ensure staff are aware of this guideline.

Related Documents

Neonatal Transfer/transport guidelines should be followed at all times.

All referrals, whether antenatal or postnatal, emergency or planned, should be made using the North West Perinatal ODN Cot Bureau telephone number: 0300 330 9299

Communication Plan

The clinical guidelines will be tabled at the Neonatal Steering group and Neurosciences Board for ratification. Following this the guidelines will be circulated to all the units and shared on the Neonatal and Neurosciences Websites.

Process for Monitoring Compliance/Effectiveness

The purpose of monitoring is to provide assurance that the agreed approach in the guidance is being followed to ensure we get things right for patients, use resources well and protect our reputation. Our monitoring will therefore be proportionate, achievable and deal with specifics that can be assessed or measured.

Audit results will be circulated and presented at the multidisciplinary audit meetings, identified in the monitoring table. Any areas of non-compliance or gaps in assurance that arise from the monitoring of this guideline will result in an action plan detailing recommendations and proposals to address areas of non-compliance and/or embed learning. Monitoring of these plans will be coordinated by the group/committee identified in the monitoring table.

Those responsible for instigating the resulting actions will be identified in the audit meeting minutes and the action plans and results will also be reviewed. The resulting actions will be reviewed or followed up at the subsequent multidisciplinary audit meeting(s).

Key aspects of the procedural document that will be monitored:

What aspects of compliance with the document will be monitored	What will be reviewed to evidence this	How and how often will this be done	Detail sample size (if applicable)	Who will co-ordinate and report findings (1)	Which group or report will receive findings
Audit of referrals/pathways	Outcome data	Retrospectively Annually	TBA	Neonatal/Surgical Trainee	Neonatal Steering Group/ Neurosciences Board

- *State post not person.*

Where monitoring identifies deficiencies, actions plan will be developed to address them.

Arrangements for Review of the Policy

The clinical guidelines will be reviewed every 3 years.

Background

In the UK there are around 700-750 cases of neonatal intraventricular haemorrhage every year and this number has remained essentially static for the last decade (1). Outcome studies (2) have implicated NIVH as a significant independent variable in predicting long term neurodevelopmental outcome, in particular when associated with progression to post haemorrhagic hydrocephalus (PHH) (3).

Both the severity of intraventricular haemorrhage (IVH) and the risk of developing post haemorrhagic hydrocephalus (PHH) have been shown to correlate with the degree of prematurity (4). PHH remains the commonest cause of hydrocephalus in children (5) but precisely how many neonates with IVH progress to develop post haemorrhagic hydrocephalus remains unclear. Similarly, the pathogenesis of PHH following IVH is not fully understood and as such there is no reliable indicator which neonates with IVH will go on to develop PHH.

The Role Of Transfontanelle Uss

Due to the risk of haemorrhage in neonates born prematurely, transfontanelle ultrasound is advocated within 72 hours of birth with on-going surveillance of those found to have IVH. The aim of monitoring is to define the subgroup who go on to develop progressive ventriculomegaly.

Measuring Ventricular Size Using Transfontanelle Ultrasound

Ventricular size can be estimated using the ventricular index (VI). This measurement, taken from a coronal image at the level of the foramen of Monroe, is the maximum distance from the midline to the outer border of the anterior horn of the lateral ventricle (as shown in appendix).

In addition to the ventricular index, other measurements are increasingly being used Anterior Horn Width (AHW) and the Thalamo-Occipital Distance (TOD), and have been shown to be sensitive correlates of the risk of developing ongoing PHH (6).

When To Intervene

It is generally accepted that progression of the ventricular index beyond the 97th + 4mm line should trigger intervention (see below). This arbitrary threshold is used on the premise that progression past this line will compromise the neonate, impact on white matter development, and more pertinently that the risk of intervention is outweighed by the potential for harm due to raised intraventricular pressure.

Differences in opinion persist regarding the role of symptoms in defining when and if to intervene but the consensus is that the development of symptoms related to raised intraventricular haemorrhage is a late sign and CSF diversion / intervention should be instigated based on radiological findings (i.e., progression past the 97th + 4mm) even in the absence of clinical symptoms(7).

How To Intervene

In cases of progressive ventriculomegaly i.e., when the VI crosses the $97^{\text{th}} + 4\text{mm}$, two therapeutic lumbar punctures, or a ventricular tap, withdrawing 10ml/kg, are recommended. If the VI continues to increase despite 2xLP / VT then the neonate should be transferred to the neurosurgery tertiary centre at the earliest *safe* opportunity for surgical CSF drainage.

The Role Of Temporising Interventions In The Management Of Phh

Transfer for surgical CSF diversion usually occurs within the first 20-30 days of life. The insertion of a permanent ventricular shunt is generally agreed to be contraindicated at this early stage due to the perceived high risk of shunt failure; thin friable skin, increasing the risk of wound problems / skin erosion, impaired immunity secondary to premature birth, potentially hostile abdomen / risk of NEC with poor CSF absorption, and the risk of shunt blockage secondary to blood-stained CSF with high protein count. The insertion of a temporising intervention also defines the group of neonates (approx. 15-20%) who do not need permanent shunt insertion.

The two main temporising interventions include ventricular access device and ventricular subgaleal shunt (8) with choice really dependent on institutional experience (9) with no clear benefit of either method found.

Management Post Temporising Intervention / Decision For Permanent VP Shunt

Following temporising intervention, neonates are managed locally at their referring centres in close collaboration with the neurosurgery team, with ongoing assessment of the ventricular system (using transfontanelle USS) and intermittent CSF aspiration, to maintain the VI below the $97^{\text{th}} + 4\text{mm}$ threshold, as required.

As the neonate reaches term equivalent or $>2\text{kg}$ in weight, an MRI should be performed and at this point a decision regarding the need for permanent shunt insertion is made in collaboration with the neurosurgical team.

Summary

The aim of surgical CSF diversion is to reduce intraventricular pressure in neonates with progressive ventriculomegaly secondary to intraventricular haemorrhage ($>97^{\text{th}} + 4\text{mm}$). This is under the premise that progressive ventriculomegaly is indicative of raised intraventricular pressure and further to this, that reducing ventricular pressure will preserve the developing periventricular white matter leading to improvements in neurodevelopmental outcome.

Appendix A

Neonatal Pathway for intervention and referral in preterm babies with post-haemorrhagic hydrocephalus

Post-haemorrhagic hydrocephalus found on cranial USS with either:

- Ventricular indices > 97th centile for gestation
or
- Clinical signs of hydrocephalus such as Head circumference increasing by >2cm/week, tense fontanelle and splayed sutures



Monitor progress twice weekly¹ until stable or meets trigger for intervention

- Plot head circumference on growth chart
- Cranial USS measurement of ventricular indices, anterior horn width and trans-occipital diameter (as available)



Triggers for intervention (either 1 or 2 present)

1. Bilateral or Single VI size more than 4mm above the 97th centile
OR
2. Bilateral or Single VI size above the 97th centile with any one of the following
AHW > 6mm
OR
TOD > 25mm
OR
Neurological symptoms²



Intervention to remove 10 ml/kg CSF and send for cell count, culture, glucose and protein (Inform Neurosurgery team at this point , not for referral)

- Lumbar puncture or ventricular tap³
- If neither possible refer to NICU / neurosurgery for transfer

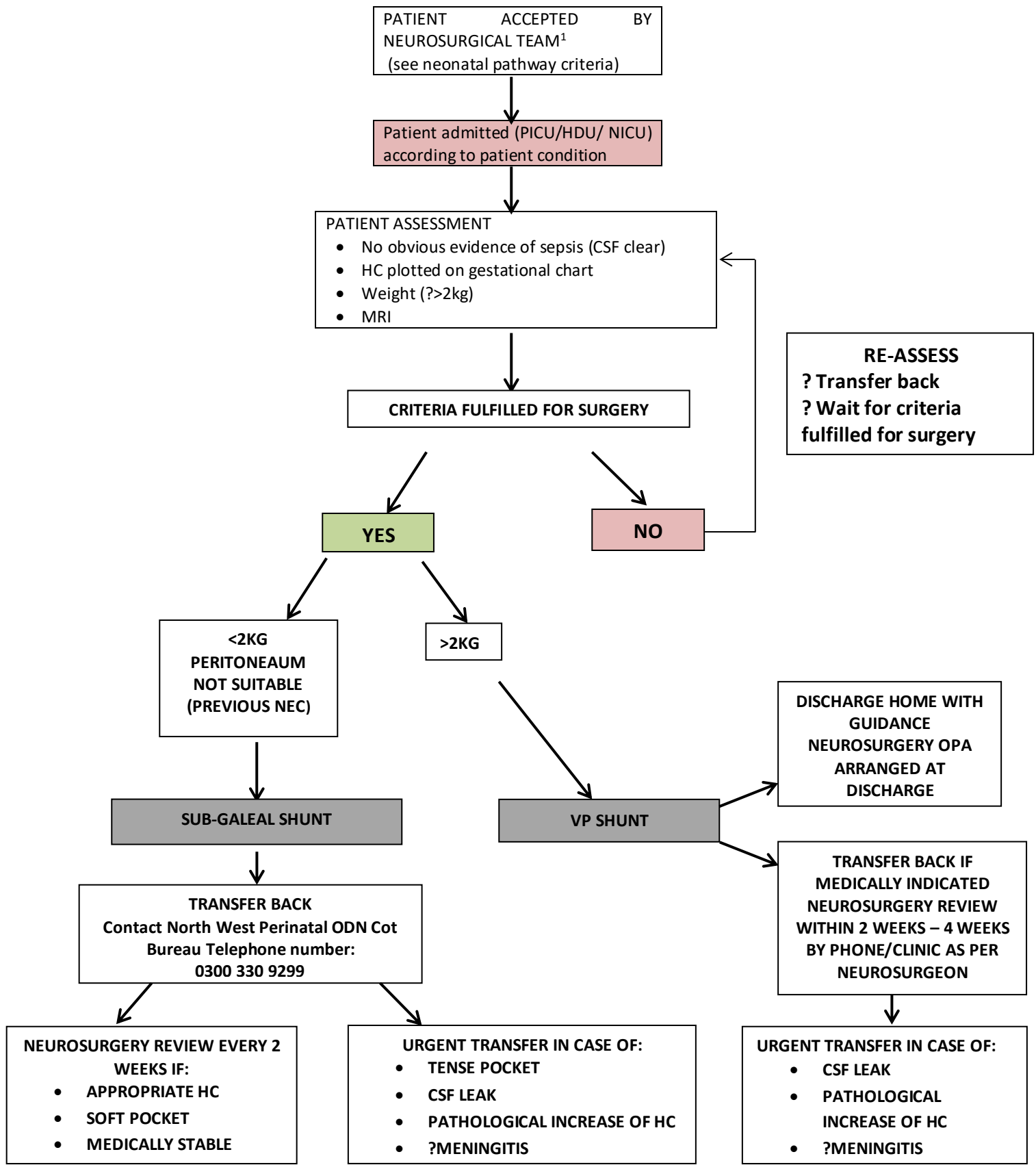


If triggers for intervention present despite 2 attempts at CSF drainage, refer to neurosurgical team at Alder Hey or St. Mary's via North West perinatal ODN⁴

- Complete neurosurgical referral pathway form
- An MRI is NOT required at this stage
- Conference call with neurosurgeon and neonatal consultant

1. It is not mandatory to perform Cranial US twice a week, can be done as advised by local Neurosurgeon's advice
2. Neurological features include apnoea, bradycardia, seizures and poor feeding or feeding intolerance without alternative explanation.
3. It is not necessary to measure CSF pressure. LP is preferred over ventricular tap.
4. Referral to neurosurgery should follow the NW ODN Surgical Referral Pathway process:
 - All acute neurosurgical referrals and neurosurgical advice calls should be routed via the NW Perinatal Cot Bureau [Tel: 0300 330 9299] at the outset. This will ensure all referrals, whether they are for a transfer request or advice, are logged, a conference call set up and a cot location process initiated in the early phase of referral. Connect North West (CNW), the NWNODN Neonatal transport team, will be made aware of the patient).
 - Conference calling is an integral part of the referral/advice process. The call should include the neurosurgical team (including consultant neurosurgeon), medical staff at the referring and receiving units, bed manager (if applicable), CNW transport team and other specialist staff as required. If a member of the senior team is not available, a deputy from the speciality/service should participate in the call and the consultant subsequently informed of the plan of care.

Appendix B
Surgical Management of a Neonate



Footnotes

When a baby is accepted by neurosurgical team, preparation for transfer to include:

- Local review with anaesthetic team to consider fitness for surgery and the need for preop investigations (e.g., ECHO)
- Up to date bloods including FBC and CRP with transfusion arranged in advance if necessary

Appendix C

NWNODN Combined Neurosurgical & Neonatal Pathway Post-Haemorrhagic Ventricular Dilatation Data Collection/Referral Form

- This form is for the referral of preterm neonates with post-haemorrhagic ventricular dilatation.
- The neonatal pathway for management of these infants should be referred to and appropriate steps followed PRIOR to referral.
- Please ensure that a cot bureau conference telephone call referral is made to accompany this document (Cot Bureau 0300 330 9299).
- Patient identifiable information should only be sent between two NHS.Net email accounts. **This form contains patient identifiable information so can only be sent from an nhs.net email account.**
- Please send a copy of this form with the patient

Patient Demographics			
Name			
Sex		D.O.B	
Gestation at birth		Post-menstrual Age	
Birth Weight		Current Weight	
Address:		NHS No./ Local URN/Badger ID	

Referring Unit		
Hospital		
Referring Consultant	Name:	Contact Details:

Clinical Details:			
Resp:	(Ventilator dependence, oxygen requirement...)		
Cardiac:	(Known congenital heart defects, PDA...)		
Abdominal:	(*Concerns with NEC, previous surgery, short-gut ...)		
Sepsis:	(*Current sepsis, significant previous sepsis/colonisation...)		
Other:			
Birth OFC:		Centile	
Current OFC:		Centile:	

****Please send HC chart**

**NWNODN Combined Neurosurgical & Neonatal Pathway
Post-Haemorrhagic Ventricular Dilatation
Data Collection/Referral Form**

Criteria for Referral (please tick as appropriate)	
	Infant with non-physiological enlargement of head circumference:
	+ Persistent ventricular index >4mm above 97 th centile for gestation (see chart)
	+ Rapidly increasing ventricular index likely to cross threshold line >4mm above 97 th centile for gestation
	+ Ventricular index >97 th centile for gestational age with significant neurological features (please detail below)

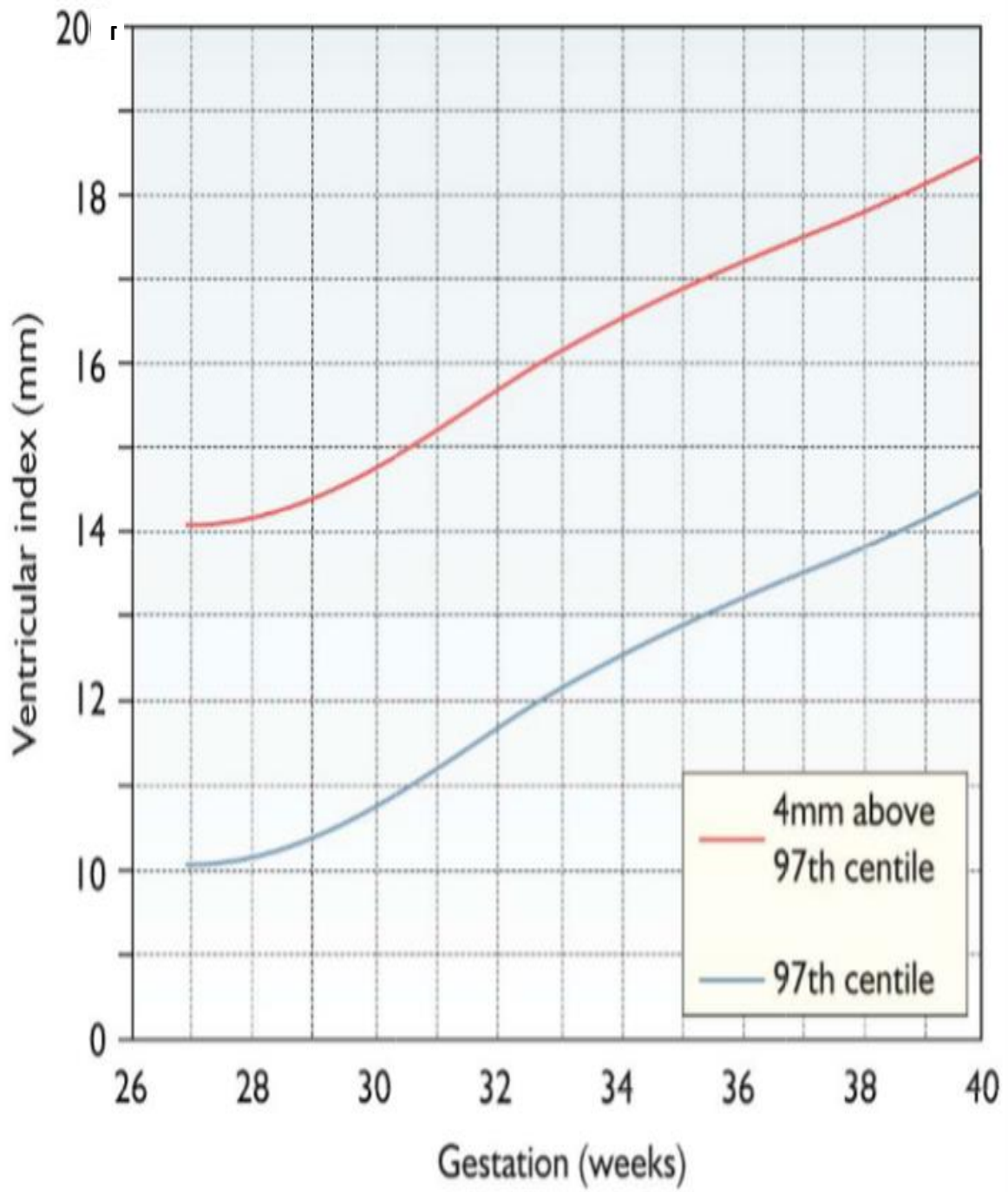
Neurological Features (please tick as appropriate):			
	Bradycardia (+/- apnoea)		Eye deviation/sun-setting
	Widening sutures/anterior fontanelle		Sleepiness/irritability
	Vomiting/poor feeding (unexplained)		Seizures

Interventions		
Date	1 st :	2 nd : (if performed)
Latest CSF tap	<input type="radio"/> LP <input type="radio"/> Ventricular Tap (preferred)	Volume removed:
Microscopy/ Biochemistry	(if available)	

*Please plot ventricular index on chart attached

*Please attach copy of head circumference chart prior to sending

NWNODN Combined Neurosurgical & Neonatal Pathway
Post-Haemorrhagic Ventricular Dilatation Data Collection/Referral Form

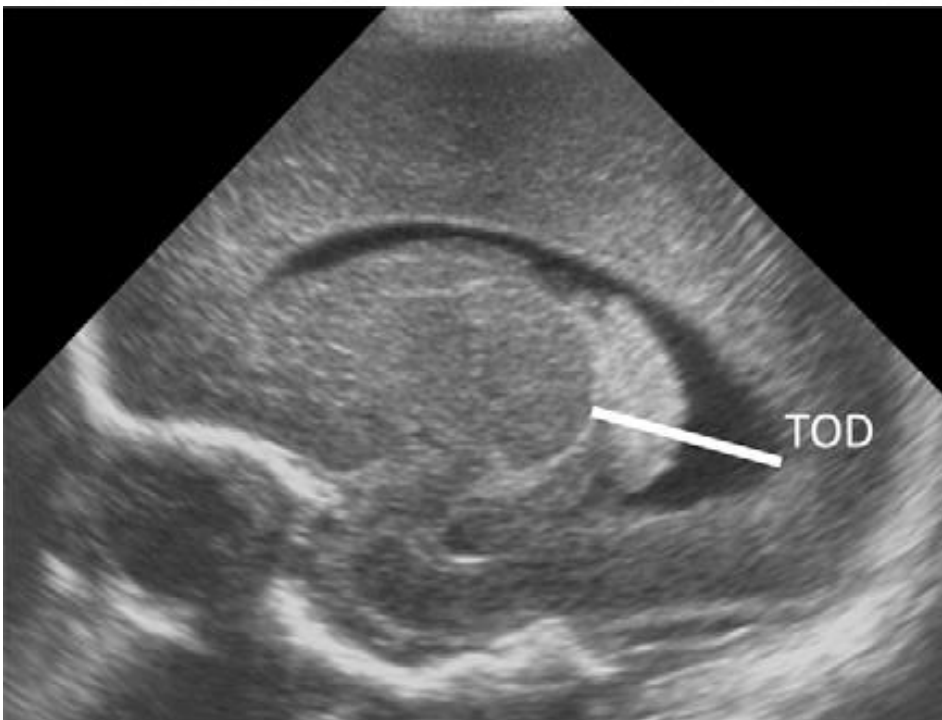
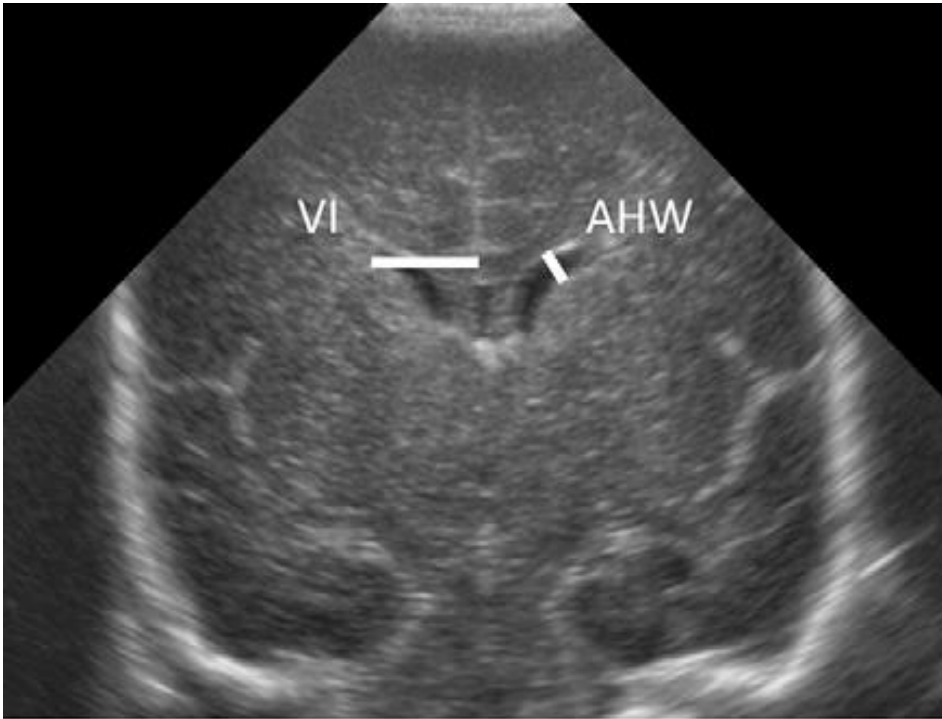


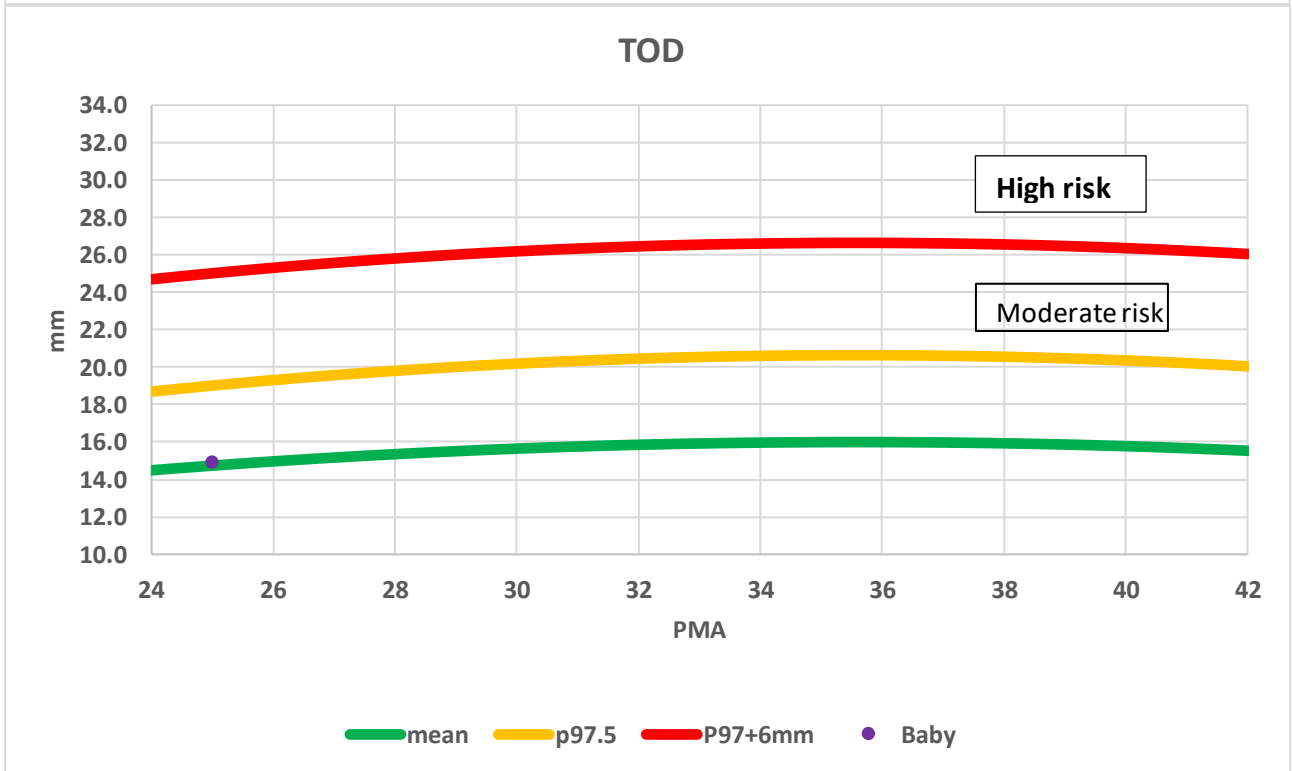
References

1. Gale C, Statnikov Y, Jawad S, Uthaya SN, Modi N. Neonatal brain injuries in England: population-based incidence derived from routinely recorded clinical data held in the National Neonatal Research Database. *Arch Dis Child-Fetal Neonatal Ed.* 2018;103(4):F301-F6.
2. Wood N, Costeloe K, Gibson A, Hennessy E, Marlow N, Wilkinson A. The EPICure study: associations and antecedents of neurological and developmental disability at 30 months of age following extremely preterm birth. *Arch Dis Child-Fetal Neonatal Ed.* 2005;90(2):F134-F40.
3. Bassan H, Limperopoulos C, Visconti K, Mayer DL, Feldman HA, Avery L, et al. Neurodevelopmental outcome in survivors of periventricular hemorrhagic infarction. *Pediatrics.* 2007;120(4):785-92.
4. Ballabh P. Intraventricular hemorrhage in premature infants: mechanism of disease. *Pediatric research.* 2010;67(1):1-8.
5. Kahle KT, Kulkarni AV, Limbrick DD, Warf BC. Hydrocephalus in children. *The Lancet.* 2015.
6. Brouwer MJ, de Vries LS, Groenendaal F, Koopman C, Pistorius LR, Mulder EJ, et al. New reference values for the neonatal cerebral ventricles. *Radiology.* 2012;262(1):224-33.
7. Leijser LM, Miller SP, van Wezel-Meijler G, Brouwer AJ, Traubici J, van Haastert IC, et al. Posthemorrhagic ventricular dilatation in preterm infants: When best to intervene? *Neurology.* 2018;90(8):e698-e706.
8. Chari A, Mallucci C, Whitelaw A, Aquilina K. Intraventricular haemorrhage and posthaemorrhagic ventricular dilatation: moving beyond CSF diversion. *Child's Nervous System.* 2021;37(11):3375-83.
9. Wellons III JC, Shannon CN, Holubkov R, Riva-Cambrin J, Kulkarni AV, Limbrick Jr DD, et al. Shunting outcomes in posthemorrhagic hydrocephalus: results of a Hydrocephalus Clinical Research Network prospective cohort study. *Journal of Neurosurgery: Pediatrics.* 2017;20(1):19-29.

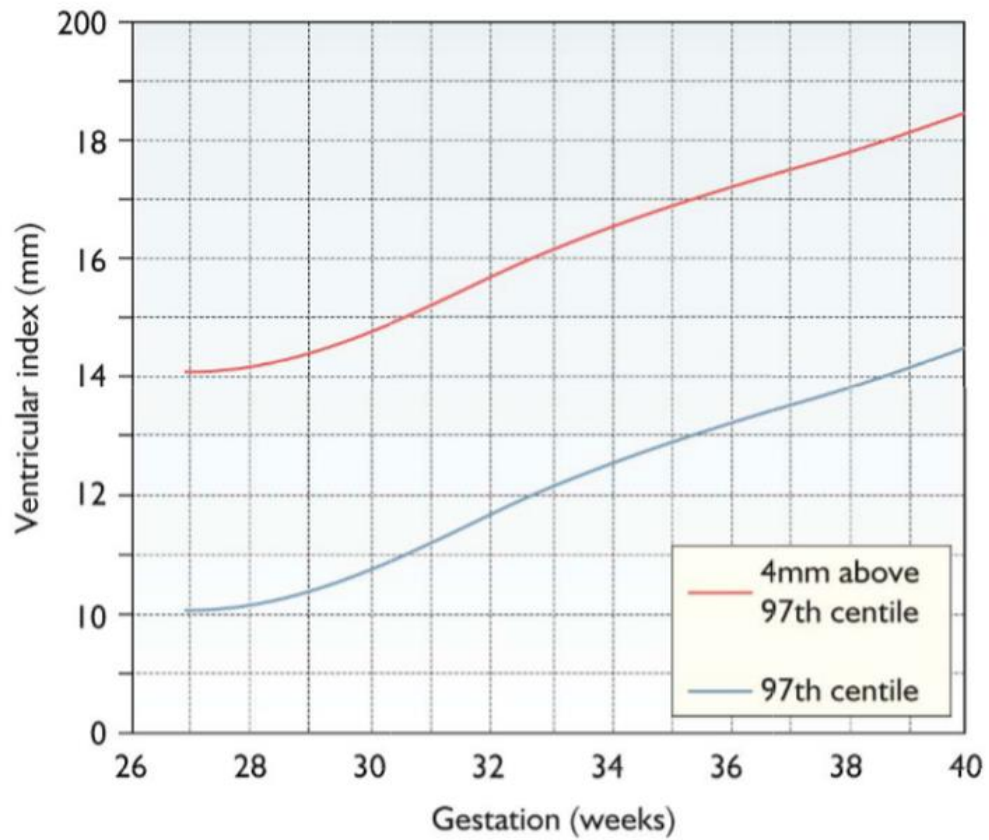
Appendix D

Measurement and normogram of Ventricular index(VI), Anter horn width (AHW) and Thalamooccipital (TO) distance)





El-Dib M, Limbrick DD Jr, Inder T, Whitelaw A, Kulkarni AV, Warf B, Volpe JJ, de Vries LS. Management of Post-hemorrhagic Ventricular Dilatation in the Infant Born Preterm. *J Pediatr.* 2020 Nov;226:16-27.e3. doi: 10.1016/j.jpeds.2020.07.079. Epub 2020 Jul 30. PMID: 32739263; PMCID: PMC8297821.



Levene M.I., Starte D.R.: A longitudinal study of post haemorrhagic ventricular dilatation in the newborn. Arch Dis Child. 1981. 56:905-910.

Note: This ventricular index chart aligns closely with data from a more recent reference range in infants 24-42 weeks' gestation [Brouwer MJ et al. New Reference Values for the Neonatal Cerebral Ventricles, Radiology 2012; 262:224-233]