Management of Post-Haemorrhagic Ventricular Dilatation in the Neonatal Intensive Care Unit (NICU)

Guideline Responsibilities and Authorisation

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Target Audience	SMO, Registrars, Nurse Practitioners, Clinical Nurse Specialists, Registered Nurses, Enrolled Nurses
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Guideline Review History

Version	Updated by	Date Updated	Summary of Changes
01	Marisa Pacella	April 2022	First version
02	Vinayak Kodur	May 2024	Updated the management

1 Overview

1.1 Purpose

To diagnose and manage post-haemorrhagic ventricular dilatation arising as a complication of intraventricular haemorrhage.

1.2 Staff group

Health NZ Waikato medical and registered nursing staff in NICU.

1.3 Patient group

Very Low Birth Weight (<1500 g) neonates and/or gestational age < 32 weeks, until discharge.

1.4 Definitions

AHW	Anterior horn width
BW	Birth Weight
EVD	External ventricular drain
ELVIS	Early versus Late Ventricular Intervention Study
HUSS	Head ultrasound scan
IVH	Intraventricular haemorrhage
LP	Lumbar Puncture
MRI	Magnetic Resonance Imaging
NAT	Neonatal Advanced Trainee
PHH	Post-haemorrhagic hydrocephalus
PHVD	Post-haemorrhagic Ventricular Dilatation
PVL	Periventricular Leukomalacia
VI	Ventricular index
VLBW	Very Low Birth Weight
VP	Ventriculoperitoneal shunt
VR	Ventricular reservoir
VSG	Ventriculo-Subgaleal shunt

2 Clinical Management

2.1 Screening for IVH

Early HUSS – Optional.

- Consider if it is likely to impact clinical decision-making such as unexplained decrease in haemoglobin, hypotension, or concern for life-threatening deterioration. Do not routinely perform as minimal handling is recommended for VLBW patients who are <72 hours of age.

Day 5 – Routine HUSS.

- Performed for all neonates <32 weeks gestation or <1500 g BW.
- In the stable neonate, it is acceptable to wait up to 7 days of age.
- Consider HUSS for >1500 g or >32 weeks if clinically unstable (e.g. coagulopathic, unexplained anaemia, or neurologic symptoms).
- Consider HUSS if gestational age is unknown.

Week 6 – Routine HUSS.

- Performed for resolution of IVH and detection of PVL.

Term-corrected – A third HUSS (or MRI) is recommended at 36-40 weeks if:

- abnormal previous scan (grade 3+ IVH, PVL, ventriculomegaly)

2.2 Follow-up HUSS for Abnormal Findings

- IVH is classified into four grades by Papille (CT scan based system) and Volpe (ultrasound-based system. We commonly use Volpe's ultrasound based system to define severity of IVH.

IVH Grade	Definition	Recommended follow-up
I	Haemorrhage confined to cuadothalamic groove also referred as germinal matrix haemorrhage.	Repeat US within 1-2 weeks.
II	Extension of the haemorrhage beyond the caudo-thalamic groove into the lateral ventricle but occupying < 50% ventricular space	Repeat US within 1 week
III	Extensive haemorrhage occupying > 50% of the lateral ventricle with distension of lateral ventricles. *Continued over page* (Note this is different than PHVD which generally occurs later as a complication of IVH)	Repeat US within 3 to 7 days depending on the clinical condition of the baby.

IV	Periventricular haemorrhagic infarction. This is often seen with smaller bleeds (grade I or II) IVH but can be seen with grade III as well. Often described as a separate entity.	Repeat US within 3 to 7 days depending on the clinical condition of the baby.

- Plot VI, AHW and TOD on respective chart (Appendix B)
- If any scans show ventricular dilatation:
  - Perform interval scans until ventricle size stabilizes and decreases. Frequency of these interval scans can be every 3 to 7 days as per the clinical condition of the baby. This can be liberalised when there is no evidence of rapid ventricular dilation to once a fortnight.
  - Perform head circumferences on Thursday and Sunday (two times in a week). Increased head circumference is a LATE sign of hydrocephalus.

3 Post-haemorrhagic Ventricular Dilatation

3.1 Definition

IVH can lead to non-communicating or communicating PHVD. Definition of PHVD has changed recently since ELVIS (Early versus Late Ventricular Intervention Study) where low threshold for intervention was found to be beneficial than higher threshold. High threshold for intervention was defined as a ventricular index (VI) >97th percentile (or 2 S.D.+4mm) or anterior horn width (AHW) > 10 mm. A low threshold for intervention was defined as a VI > 97th percentile but before crossing the 97th percentile + 4 mm line, the AHW > 6 mm but before crossing the 10mm line. (see Section 6. Appendix A & B).

3.2 Refer

Discuss any patient that meets the definition of PHVD with Paediatric Neurosurgeons at Starship.

3.3 Treatment

There is no consensus regarding early vs conservative treatment for PHVD based on meta-analysis/systematic review. However, this Cochrane review (2017) included 4 trials that were conducted in 1980-1990 with significant variation in indication, timing and effectiveness of lumbar puncture (LP). LP was performed at very late stage in majority of these studies where ventricles were severely dilated and there was high variation in amount of CSF drained (1-40 ml/kg).

Temporising measures such as serial LPs occur while awaiting neurosurgical evaluation and treatment. Serial LPs may prevent the need for neurosurgical interventions as demonstrated in ELVIS. 2 year follow up of the ELVIS trial suggested that early intervention at VI of >97th percentile or AHW > 6mm was associated with lower odds of death or severe neurodevelopmental disability when compared to higher threshold group.

In more recent studies, when stabilisation or regression of ventricular size did not occur spontaneously or even after 2 or 3 LPs, the insertion of a VR or VSG is used as a temporising measure. (Appendix D).

Risk zone stratification:
Based on the measurement of VI, AHW and TOD, at risk infants to be stratified in to the 3 risk zones for risk of poor neurodevelopmental outcomes (green, yellow or red).

Management is based on the risk stratification (Appendix C).

Green zone

- In addition to clinical monitoring of fontanelles, sutures and head circumference, twice a week or once a week head US (based on the grade of IVH) to keep a close watch on the ventricular size.

Yellow zone

- Consider serial LPs in these infants
- A nurse practitioner or an experienced registrar or NAT to do the serial lumbar punctures under guidance of a SMO. Aim to remove 10-15 ml/kg of CSF depending on the ventricular size and haemodynamic status of the infant. Consult with SMO if unsure. Send CSF for cell count, biochemistry, pathology and culture. Consider repeating cranial US after each LP if possible to assess the effect of CSF drainage.
- The success of CSF drainage depends on the underlying primary pathology (communicating PHVD or non-communicating PHVD). In addition to operator characteristics, LPs are successful in draining the desired volume in infants with dilatation of all ventricles (lateral, third and fourth). Those with mixed or non-communicating PHVD (small or non-dilated fourth ventricle) may respond well on initial LP but may have poor success rate on subsequent LPs. In such scenarios, consider discussion with Paediatric Neurosurgeons at the earliest.
- If ventricles continue to increase despite LPs, consider temporising measures. (About 50% of the infants may need temporising measures.) Discuss with Starship Neurosurgical team if not discussed prior.

Red zone

- Consider serial LPs while awaiting neurosurgical evaluation.
- These infants are at greater risk of non-responding to LP alone. Consider involving Starship Neurosurgical team early.
  If ventricles continue to increase despite LPs, consider temporising measures. (About 50% of the infants may need temporising measures.)
- A nurse practitioner or an experienced registrar or NAT to do the serial lumbar punctures under guidance of a SMO. Aim to remove 10-15 ml/kg of CSF depending on the ventricular size and haemodynamic status of the infant. Send CSF for cell count,

biochemistry, pathology and culture. Consider repeating cranial US after each LP if possible to assess the effect of CSF drainage.

- Aim of the serial LPs is to reduce VI < 97th percentile and AHW < 6 mm hence it is important to do a follow up head US.

External Ventricular Drain (EVD) or Ventriculoperitoneal (VP) shunt

- Follow the criteria mentioned above to refer an infant to Starship Neurosurgery.
- The final surgical interventions are dependent on the Neurosurgeon and their experience in the management of PHVD.

4 Audit Indicators

- Quarterly comparisons of IVH rates - Australian and New Zealand Neonatal Network (ANZNN)
- Annual review of PHVD cases – both those that did and did not required VP shunt

5 Evidence base

5.1 References

- Cizmeci MN et al. (2020) Randomized controlled early versus late ventricular intervention study in posthemorrhagic ventricular dilatation: outcome at 2 years. J Pediatr, Vol 226, pp 28-35.
- de Vries LS et al. (2018) Treatment thresholds for intervention in posthaemorrhagic ventricular dilation: a randomised controlled trial. Arch Dis Child Fetal Neonatal Ed., Vol 104, pp F70-F75.
- 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.
  Guillot M et al. (2020) Routine imaging of the preterm neonatal brain. Paediatr Child Health, 25(4: 249-255.
- Hand IL et al. (2020) Routine neuroimaging of the preterm brain. Pediatrics, 146(5): e2020029082.
- Whitelaw A et al. (2017) Repeated lumbar or ventricular punctures in newborns with intraventricular haemorrhage. Cochrane Database of Systemic Reviews, https://doi.org/10.1002/14651858.CD000216.pub2.

5.2 Associated Health NZ Waikato Documents

- Extremely Low Birth Weight (ELBW) Bundle of Care for Prevention of Intra Ventricular Haemorrhage (IVH) Ref 6240

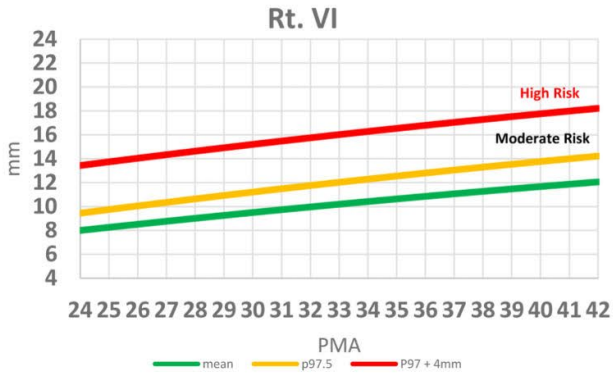
  Lippincott Procedures: Shunt or reservoir care, neonate

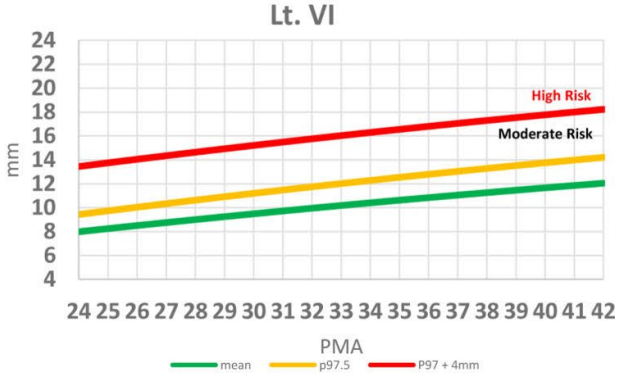
Appendix A – Ventricular Index (VI), Anterior Horn Width (AHW), and Thalamo-Occipital Distance (TOD)

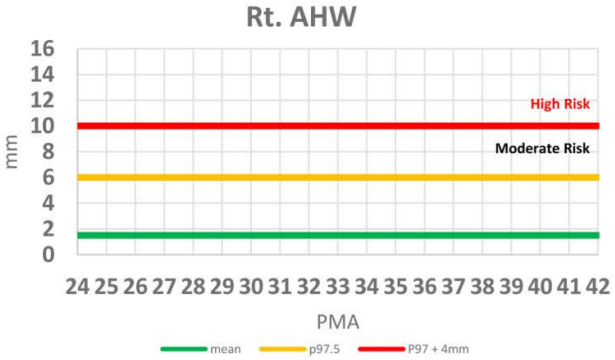
Appendix B – Monitoring chart for infants suspected with PHVD.

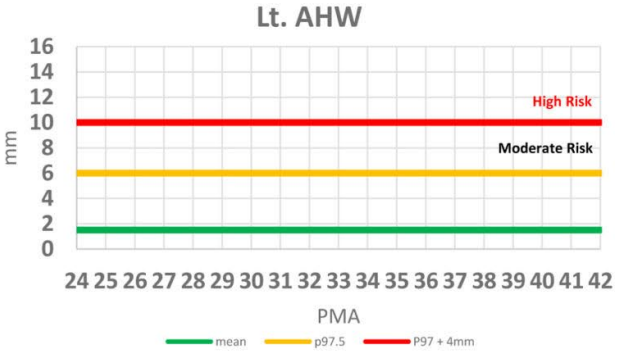
Name:
DOB:

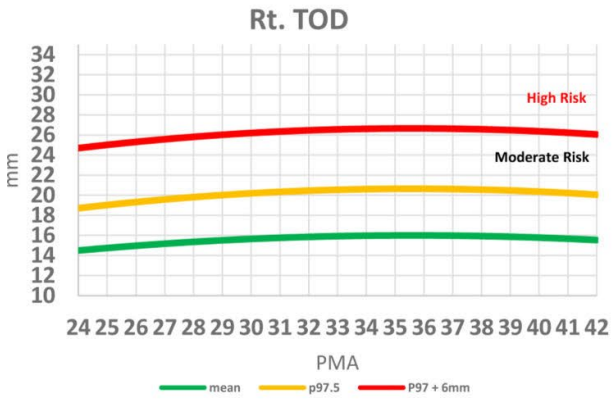
Ventricular Measurement Risk Zones

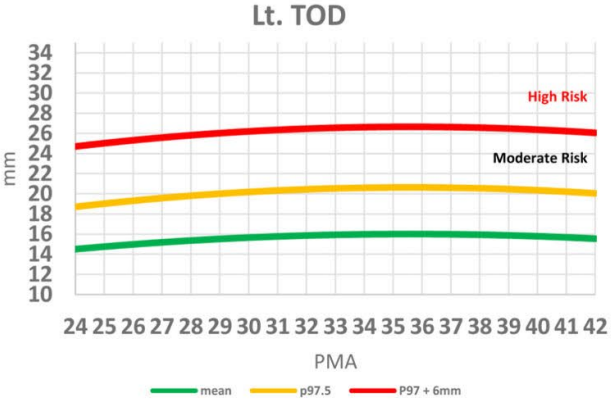












Date	PMA	Rt. VI	Rt. AHW	Rt. TOD	Lt. VI	Lt. AHW	Lt. TOD

Appendix C – Risk zone stratification

	Green Zone	Yellow Zone	Red Zone
Presence of key criteria • Ventricular Index • AHW • TOD	≤ 97th percentile & ≤ 6mm &/or ≤ 25mm	>97th percentile & > 6mm &/or >25mm	>97th percentile+ 4mm & > 10 mm &/or > 25mm
& presence of following criteria • HC growth • Sutures • Fontanelles	< 2cm / week Normal At level	< 2cm / week Normal At level	> 2cm / week Separated Bulging
Management • Lumbar puncture • Head scan frequency • Neurosurgery • MRI at term	No LP Weekly till stabilisation Not indicated Not indicated	LP 2 or 3 times 3 to 7 days till stabilisation After failed LPs Strongly consider	LP 2 or 3 times 3 to 7 days till stabilisation Early referral Strongly consider

Appendix D – Temporising measures: