

Clinical pathway for the early detection and management of post-hemorrhagic ventricular dilatation (PHVD) in preterm infants

Version: 2

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1.0 Introduction

Very preterm infants (gestational age <32 weeks) with high-grade intraventricular hemorrhage (grade III ± periventricular hemorrhagic infarction) are at high risk of developing post-hemorrhagic ventricular dilatation (PHVD). Early PHVD intervention in very preterm infants may improve neurodevelopmental outcome. The goal of this pathway is the early detection and neurosurgical assessment of PHVD and, if needed, early intervention.

Target Population: The flow diagram applies to very preterm infants at PHVD risk admitted to NICU's that refer to The Hospital for Sick Children ('SickKids') for tertiary care and management. Infants should be followed from birth to term equivalent age (TEA) or discharge from the NICU.

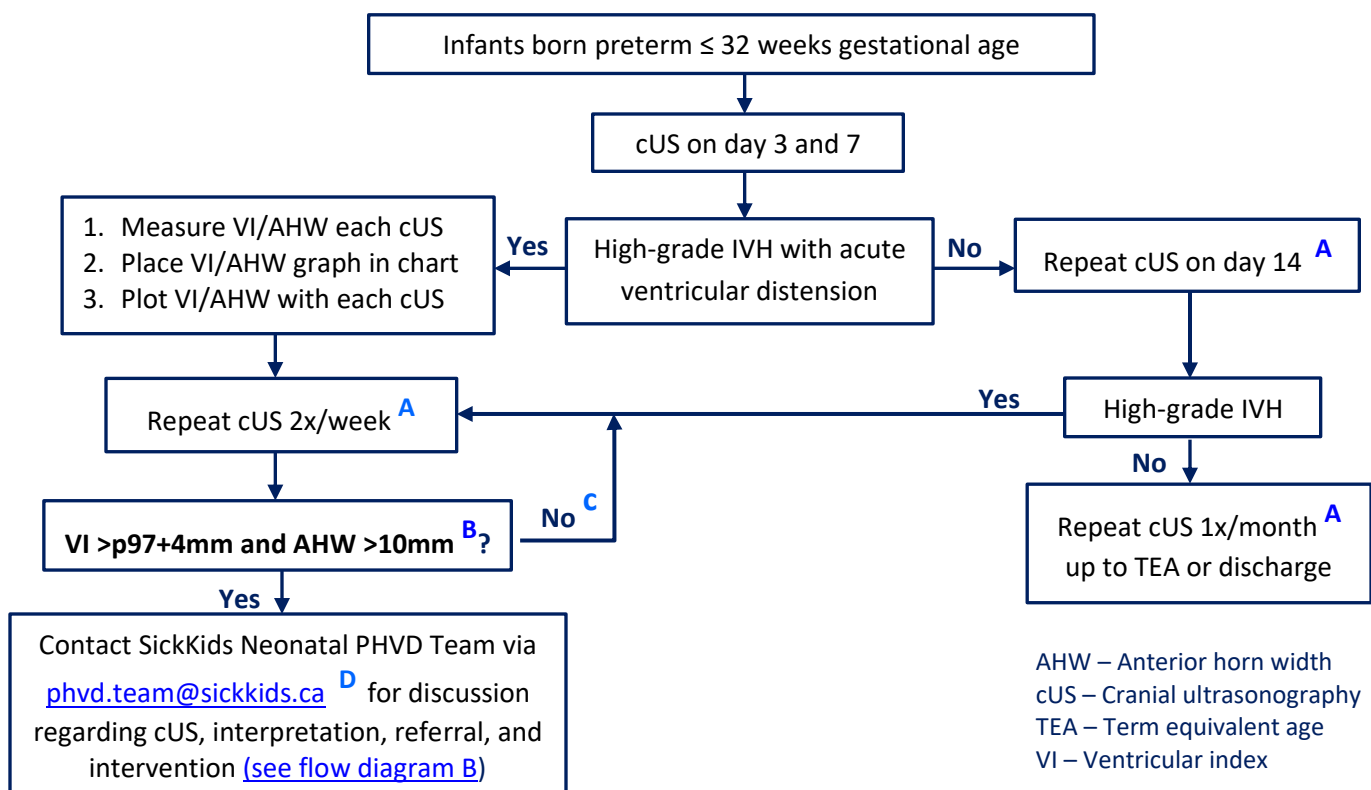
Grading Intraventricular Hemorrhages

Germinal Matrix Hemorrhage (GMH) and Intraventricular Hemorrhage (IVH) Grades (Mohammad (2021))	
I	Germinal matrix hemorrhage
II	Intraventricular hemorrhage
III	Intraventricular hemorrhage occupying >50% of the lateral ventricle with acute distension of the ventricle (AHW > 6 mm). Note: Presence of a periventricular hemorrhagic infarction (PVHI) should be noted separately. PVHI is considered a result of venous outflow congestion. PVHI was previously called IVH grade IV.

[See Appendix B for Abbreviations Table](#)

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2.0 Flow Diagram A: Monitoring Preterm Infants at Risk for Post-hemorrhagic Ventricular Dilatation



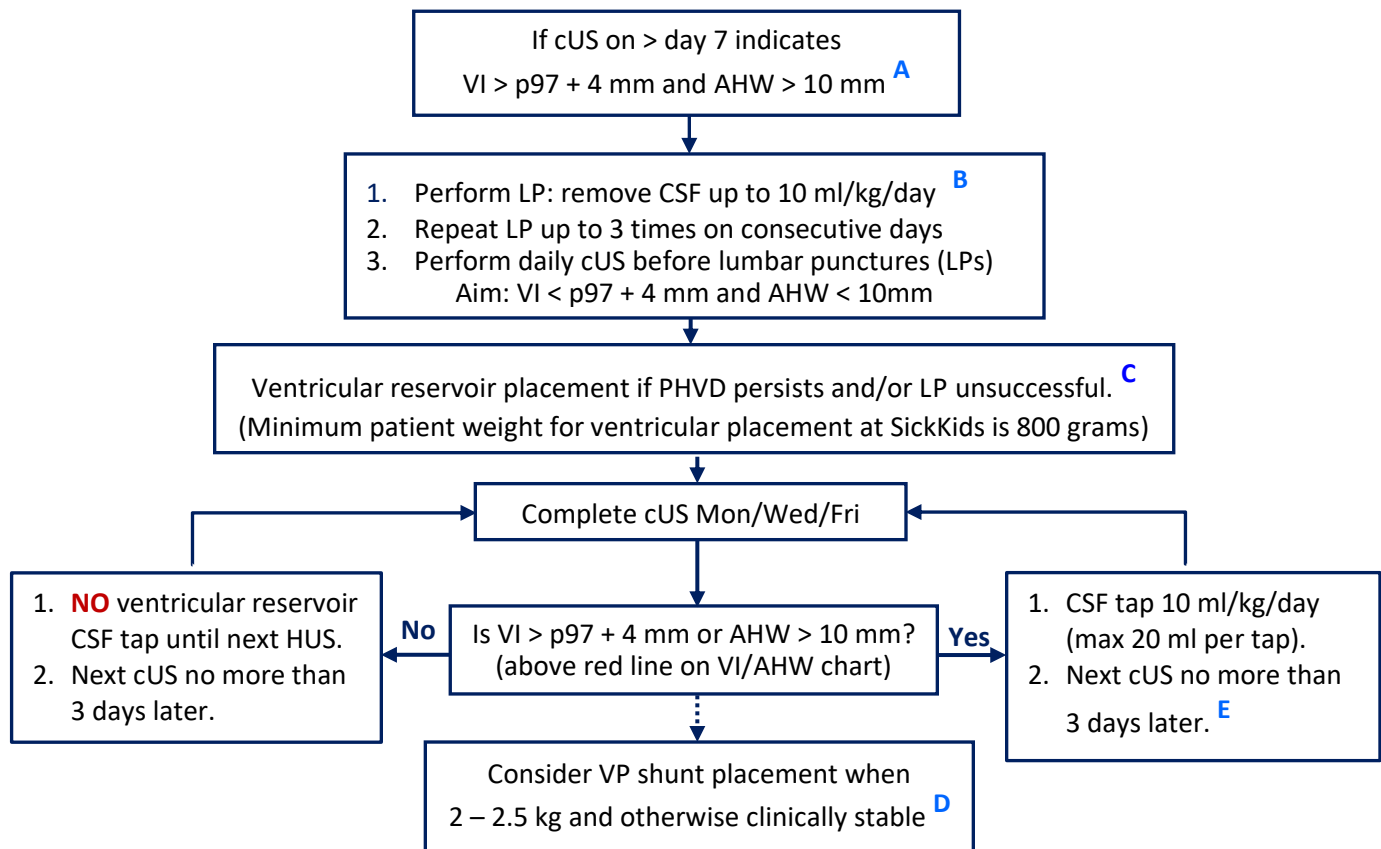
A.	Increase cUS frequency if sudden clinical deterioration (e.g., shock, pneumothorax, NEC, sepsis, resuscitation), signs of increased intracranial pressure (ICP; see below), or a sudden drop in hemoglobin level.
B.	VI and AHW measurements thresholds as described by El-Dib et al (<i>Ed-Dib 2020</i>) [see charts]. Complete VI and AHW measurements for both lateral ventricles. Also review for enlargement of the 3 rd and 4 th ventricles.
C.	If after 2 weeks of biweekly cUS there is stabilization or resolution of PHVD, gradually reduce cUS frequency to once every 2 weeks and then to once monthly, until 34 weeks gestation, unless there are other co-morbidities that would warrant closer follow up.
D.	Referring centers should contact the SickKids Neonatal PHVD Team at phvd.team@sickkids.ca for consultation and advice. If transfer is recommended, call SickKids NICU through CitiCall (+1-800-668-4357) for referral.

Additional Notes

- This diagram and intervention decisions are predominantly guided by repeat cUS scans and ventricular measurements.
- **In case of suspected PHVD**, perform cUS scan on the day of admission and subsequently on the established routine cUS days.
- **Increased ICP**: signs of increased ICP such as a change in level of consciousness, apnea events, vomiting, abnormal eye movements, seizures, full fontanel and an excessive increase in head circumference are very late signs of progressive PHVD in preterm infants due to a compliant skull (*Muller 1992; Ingram 2014*). Therefore, these signs are not reliable measures for the detection and management of PHVD.
- **Neuroimaging rounds**: SickKids neuroimaging rounds are usually scheduled on Mondays and Thursdays.

3.0 Flow Diagram B: Management of Post-hemorrhagic Ventricular Dilatation (PHVD) in Preterm Infants (as guided by SickKids PHVD Team)

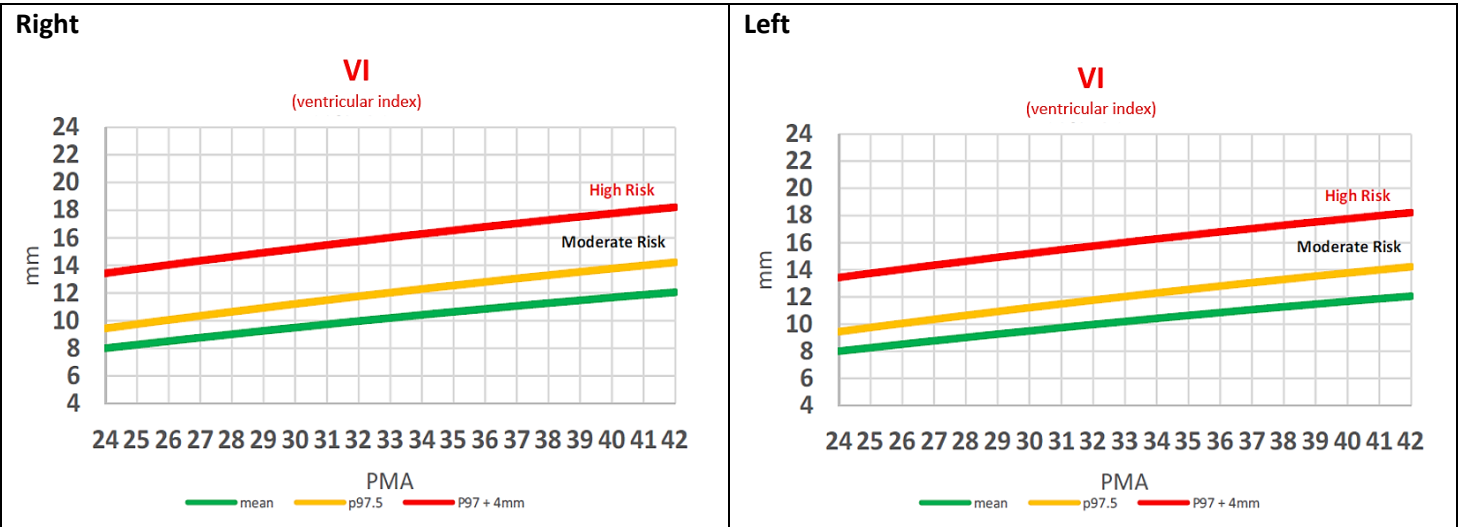
- All infants following transfer to SickKids NICU will undergo further neuroimaging with brain MRI using the NICU-MRI scanner.
- Steps and interventions are guided by cranial ultrasound measurements of ventricular index (VI) and anterior horn width (AHW).
- **Frequency of PHVD cranial ultrasounds**
 - Two times per week after detection of PHVD.
 - Three times per week if PHVD interventions are ongoing.
 - If stabilization and/or a decrease in ventricular size develops, frequency of cUS can be gradually reduced.



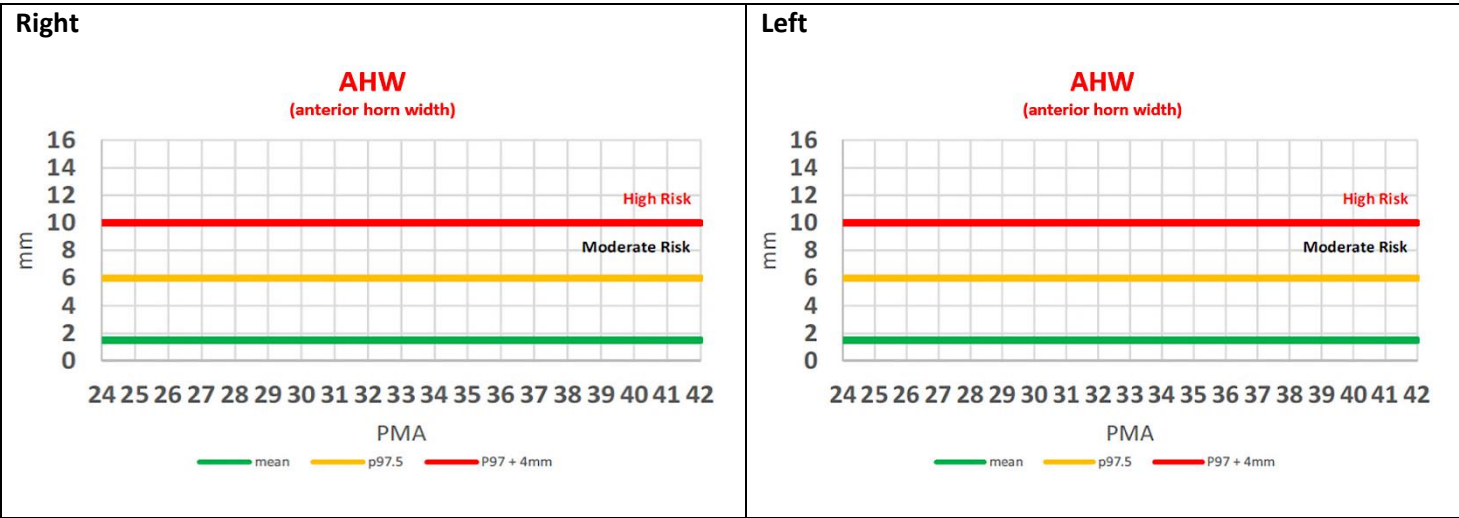
A.	NO interventions within first week of life as at this stage acute ventricular distension is not classified as PHVD.
B.	NO LP if aqueduct stenosis (enlargement of 3 rd ventricle with small 4 th ventricle). Rule out aqueduct stenosis before lumbar puncture performed or LP can be omitted, and ventricular reservoir placed. A separate guideline (Ventricular Reservoir Tapping) is available for the management of ventricular reservoirs, including CSF taps, hygiene precautions and CSF analysis.
C.	Placement of a reservoir may be delayed if the patient is unstable for surgery or there are co-morbidities such as infection, meningitis or abdominal issues such as a necrotizing enterocolitis. Timing of insertion will be determined by Neurosurgery and Neonatology clearance.
D.	Continue ventricular reservoirs taps until infant meets VP shunt placement criteria. Once the infant is 2 kg, neurosurgical team to regularly review readiness for VP shunt placement (every 1 – 2 weeks).
E.	Taps may need to be held if there are signs of over drainage such as a sunken fontanel or over riding sutures. In some cases, taps may need to happen twice daily if there is significant progression of PHVD which is not resolving with daily taps. This is at the digression of the PHVD Team.

4.0 Appendix A: Ventricular Index and Anterior Horn Width Measurements

Ventricular Measurement Risk Zones



Anterior Horn Width Measurement Risk Zones

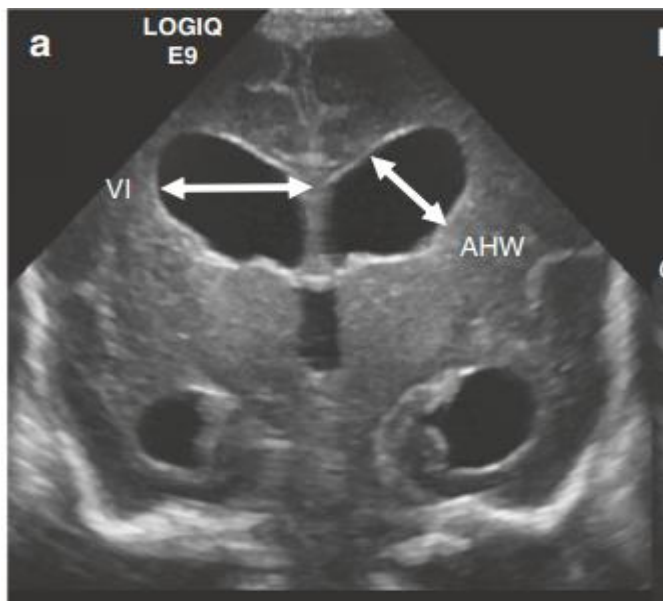


Ventricular Measurements

El-Dib M et al. Management of post-hemorrhagic ventricular dilatation in the infant born preterm. J Pediatr 2020; 226.

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Coronal Images of Ventricular Index (VI) and Anterior Horn Width (AHW)



- Coronal cranial ultrasound view with arrows showing the ventricular index (VI) and anterior horn width (ADW).
- VI is measured in the coronal plane just posterior of the foramen of Monro as the largest width from the midline of the brain to the most lateral wall of the ventricle.
- AHW is measured in the same coronal plan as the largest diagonal width between the walls of the frontal horns of the lateral ventricles (at approximately a 45-degree angle).
- Both the right and right ventricle should be measured.

Leijser L et al. Pediatr Res 90, 403–410 (2021)

5.0 Appendix B: Abbreviations

AHW	Anterior horn width	IVH	Intraventricular hemorrhage
CSF	Cerebrospinal fluid	LP	Lumbar puncture
DOL	Day of life	PHVD	Post-hemorrhagic ventricular dilatation
GA	Gestational age	PVHI	Periventricular hemorrhagic infarction
GMH	Germinal matrix hemorrhage	VI	Ventricular index
cUS	Cranial ultrasound	VP	Ventriculoperitoneal
ICP	Intracranial pressure		

6.0 Attachments

6.1 [Ventricular Measurements](#)

6.2 [Ventricular Reservoir Tapping](#)

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