GUIDELINE

Ventricular Dilatation

Scope (Staff):	Nursing and Medical Staff
Scope (Area):	NICU KEMH, NICU PCH, NETS WA

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Aim

To improve monitoring of ventricular dilatation and reduce the risk of trauma to the brain and iatrogenic Cerebrospinal Fluid (CSF) infection.

Risk

Ventricular dilatation is associated with a high risk of poor motor and cognitive neurodevelopmental outcomes. Including increased risk of cerebral palsy, epilepsy, sensory deficits, deafness, blindness in infancy and childhood persisting into adulthood as intellectual impairment, memory deficits and behavioural issues.

Post-Haemorrhagic Ventricular Dilatation (PHVD)

PHVD represents progressive ventricular dilatation following severe intraventricular haemorrhage (IVH), i.e. grade 3 and 4. Severe IVH's are seen in approximately 15% of extremely preterm infants with more than half of these infants subsequently developing PHVD. PHVD also encompasses other terms, such as post-haemorrhagic hydrocephalus.

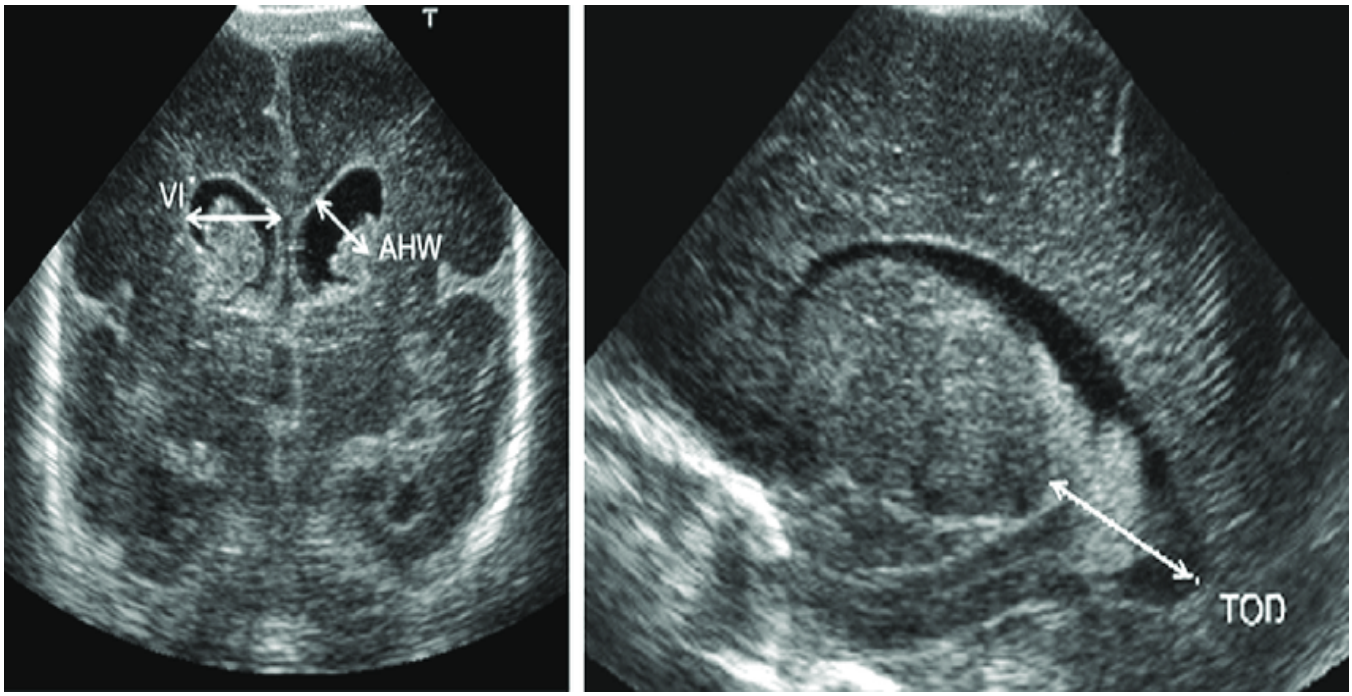
Pathophysiology

Post-haemorrhagic ventricular dilatation (PHVD) can adversely affect the preterm infant brain through several mechanisms, including cerebral ischaemia, mechanical distortion of brain tissue, and neuroinflammation. Ventricular dilatation typically develops 7 to 14 days after the initial haemorrhage because of an imbalance between cerebrospinal fluid (CSF) production and absorption. The progression of PHVD may be either gradual or rapid. In approximately 65% of infants with slowly progressive PHVD, ventricular enlargement stabilises or regresses spontaneously. However, 30% to 35% of affected infants experience rapid ventricular expansion over a period of days to weeks.

Management

- Bedside cranial ultrasound (CUS) is the modality used to diagnose PHVD. Our routine cranial US screening involves CUS on days of life 1,7 and 28 in those born at a gestation <32 weeks.
- The most commonly used CUS indices are the "Ventricular Index" (VI), "Anterior Horn Width" (AHW) and Thalamo-Occipital Distance (TOD).
- VI is the distance between the midline (falx) and the lateral border of the lateral ventricle at the level of foramen of Monro (Figure).
- AHW is also measured in the coronal view just anterior to the thalamic notch (Figure).
- TOD measures the occipital horn in the parasagittal plane and is of additional value because there can be a discrepancy in size between the anterior and occipital horns of the lateral ventricle. (Figure). The AHW and TOD measures indicate the 'ballooning' shape of the lateral ventricles, and correlate best with 3-dimensional volumetric ultrasound measurements.

Fig: CUS showing measurement of VI, AHW and TOD

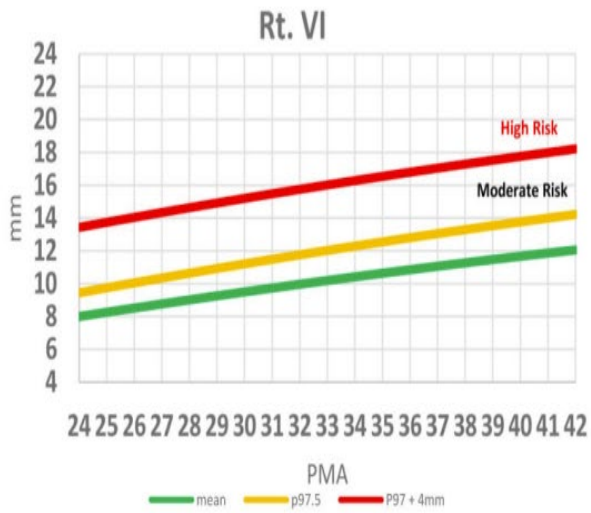


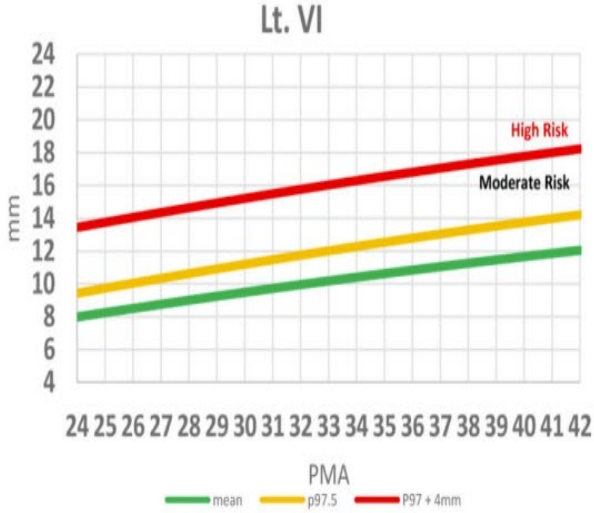
- The indices measured (in mm) then should be plotted on the percentile charts depicted below as per the day of life on the x-axis. There are 3 lines in these percentile charts.
  - The green line is the mean index for that day of life.
  - The yellow line is at the **97th centile** for that index.
  - The red line is at the **97th centile +4 mm** for that index.
- Depending on the plot as per the day of life, the index would fall into either the GREEN, YELLOW, or RED ZONES.
  - Green zone: Refers to the part of the graph below the yellow line
  - Yellow zone: Refers to the part of the graph between the yellow and the red lines
  - Red zone: Refers to the part of the graph above the red line

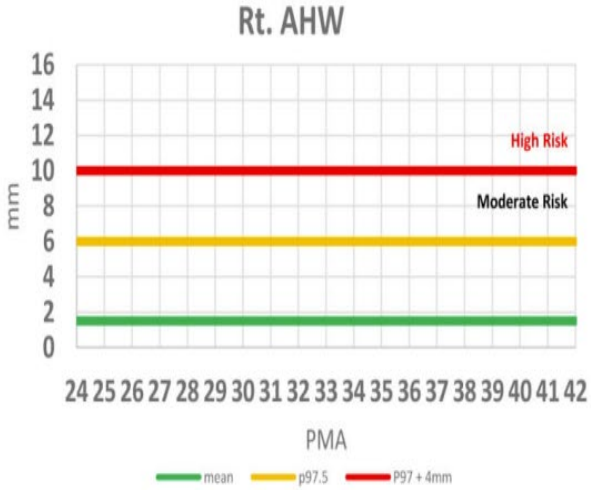
Click icon to download this **ready reckoner app** to plot:

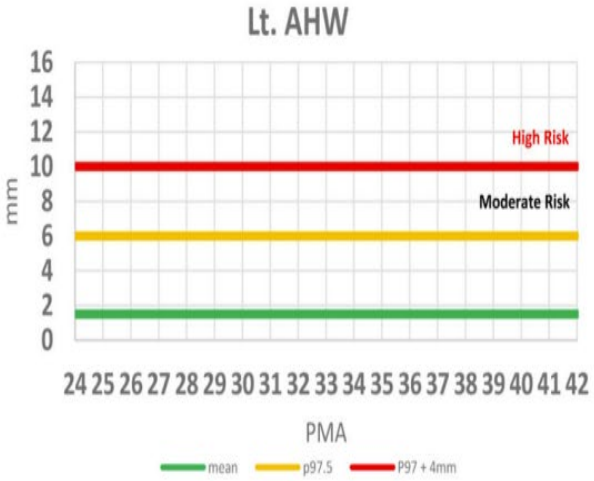
Name:
DOB:

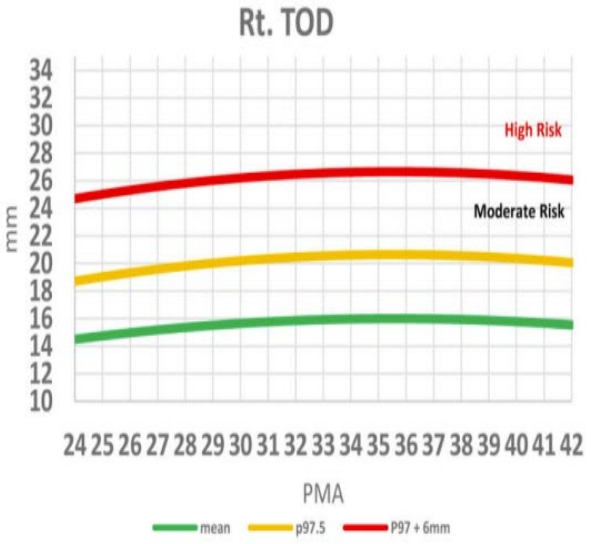
Ventricular Measurement Risk Zones

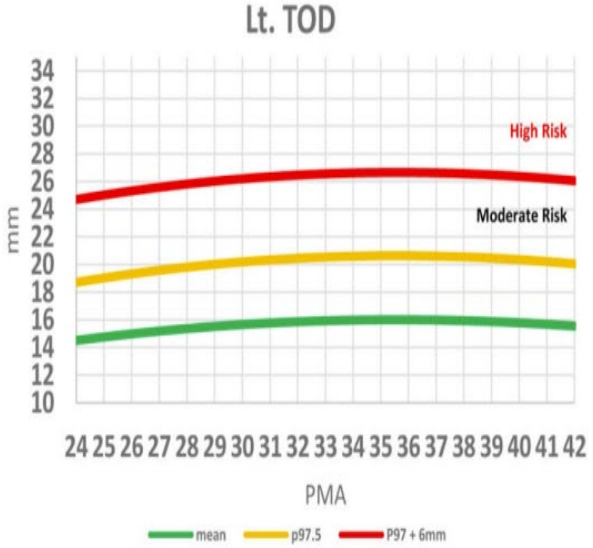












RISK ZONES	IDENTIFICATION	INTERVENTION
Low-risk **Green zone** (Refers to the part of the graph below the yellow line)	Infants with IVH with VI ≤ 97th percentile, AHW ≤ 6 mm and TOD ≤ 20 mm. • And Absence of the following ***clinical*** criteria (rapid increased in HC >2 cm per week, separated sutures or bulging fontanelles) and evidence of PHVD • And No clinical signs of increased intracranial pressure (ICP).	Monitor closely (weekly head circumference) If associated with severe IVH (grades 3 and 4) and ventricular dilatation, then request for cranial ultrasound (CUS) at least twice weekly. This should be done until the ventricles are stable for 2 weeks and then CUS every 2 weeks until 34 weeks PMA. Arrange Term equivalent MRI (TE-MRI).
Moderate-risk **Yellow zone** (Refers to the part of the graph between the yellow and the red lines)	Infants with IVH and VI between 97th percentile and 97th percentile +4 mm, AHW between 6mm and10mm and /or TOD between 20mm and 25 mm. • And Absence of the following ***clinical*** criteria (rapid increase in HC >2 cm per week, separated sutures or bulging fontanelles) and evidence of PHVD • And no clinical signs of increased intracranial pressure (ICP).	Monitor closely (weekly head circumference) Neurosurgery and Neurology referral. Shared decision-making for further intervention is required between Neonatology, Neurosurgery and Neurology. CUS at least twice weekly until ventricles are stable for 2 weeks and every 1-2 weeks till 34 weeks GA Arrange for TE-MRI May benefit from LPs 2-3 times done over 1 week, aiming for removing 10 ml/kg of CSF, if the infant is hemodynamically stable. LP not to be performed > 1 time/day
High-risk **Red zone** (Refers to the part of the graph above the red line)	Infants with VI>97th percentile+ 4mm, AHW >10 mm and TOD >25 mm. • And/or Infants with ***clinical*** criteria (rapid increase in HC >2 cm per week, separated sutures or bulging fontanelles) and evidence of PHVD • And/or Clinical signs of increased intracranial pressure (ICP).	Monitor closely (weekly head circumference) Urgent Neurosurgery and Neurology referral Shared decision-making for further intervention is required between Neonatology, Neurosurgery and Neurology. CUS at least twice weekly until ventricles are stable for 2 weeks and every 1-2 weeks. Arrange for TE-MRI May benefit from 2-3 LPs done over 1 week, aiming for removing 10 ml/kg of CSF, if the infant is hemodynamically stable. LP not to be performed > 1 time/day Consider repeat CUS next day post LP Planning for temporizing/definitive neurosurgical interventions if serial LP s are not effective.

- The onus to request for additional CUS (outside the routine) shall be with the treating neonatal team at KEMH and PCH NICU's. Most of these scans should be organized during the working days in the week.
- The need to do any additional scans on weekend/public holidays/after-hours that can alter the management should be discussed by the neonatal consultant with the neurosurgical and radiology consultant.

Serial lumbar punctures

Appropriate as per the table above prior to other surgical interventions

Ventricular Tap

A ventricular tap is indicated to:

- Drain cerebrospinal fluid in non-communicating hydrocephalus. Give parents Hydrocephalus information leaflet if relevant
- Diagnose ventriculitis
- Administer intraventricular drugs

A ventricular tap is performed by medical staff deemed competent in the procedure and is a surgical aseptic procedure. **It is usually done by the neurosurgical trainees. Please discuss with the neurosurgeons if an infant requires a ventricular tap.**

Prior to a ventricular tap, an ultrasound should be performed to confirm ventriculomegaly and measurements taken to confirm the depth and direction of needle insertion. Refer to Ventriculoperitoneal (VP) Shunt or CSF Reservoir Insertion section below for further information on management.

Equipment & Procedure

- Shave pack / Skin prep as per gestation
- Sterile drapes / Dressing pack
- Lumbar puncture needle (size 22G or 23G)
- Specimen bottles - appropriate bottles for specific tests

Procedure
1. The infant must have continuous monitoring and have resuscitation equipment at hand.
2. Sucrose can be given for analgesia.
3. Shave the scalp overlying the lateral angle of the anterior fontanelle taking care not to injure the skin.

Procedure
4. Clean a wide area of the head with appropriate solution. Aseptic Technique
5. Position the infant supine with the top of the infant's head facing toward the operator.
6. With left hand index and thumb, move skin over point of entry such that when tap done and the needle is removed, the skin moves back to original position, and the track of the needle is broken.
7. Insert the spinal needle into the lateral angle of the fontanelle and advance it toward the inner angle of the ipsilateral eye. The needle should be inserted smoothly without change of direction to minimise trauma to the brain.
8. Once the ventricle has been penetrated, the stylet is removed, and the CSF should drip out rather than be aspirated.
9. Once the required amount of CSF is obtained the needle should be removed and pressure applied to the area to prevent leakage of CSF.
10. Clean the area with 1% chlorhexidine and let dry.
11. The infant's tolerance of the procedure should be noted in the infant's progress notes.

Ventriculoperitoneal (VP) Shunt or Ventricular Access Device (VAD) Insertion

Insertion of a Ventriculoperitoneal (VP) shunt or a VAD is indicated for the management of infantile hydrocephalus. Hydrocephalus is defined as excess cerebrospinal fluid (CSF) accumulation in the brain due to disturbance of the formation, flow or absorption of CSF. If VI and AHW remain well above normal values and neonate requires >3-5 serial LPs, LPs fail to decrease VI and AHW or are not well tolerated, VAD placement should be discussed with the neurosurgeons.

Infantile hydrocephalus is associated with the following:

- Aqueduct Stenosis, Spina Bifida and Chiari II malformation.
- Dandy-Walker syndrome, Encephaloceles, Viral or Parasitic infections, Arachnoid Cysts, Intracranial Neoplasm's and Vascular Problems.
- Perinatal Intraventricular Haemorrhage (IVH) and Meningitis.
- Trauma, closed head injury.

(Intraventricular Haemorrhage, Aqueduct Stenosis and myelomeningocele are the most frequent of these causes).

Key Points

- Antibiotic prophylaxis with Vancomycin (15mg/kg/dose 8 hourly) should be commenced **2 hours prior to surgery** and then continued for 48 hours.
- Cefotaxime (50 mg/kg/dose 6 hourly) to be given intra-operatively
- Parents should receive education and written information regarding the signs and symptoms of shunt infection or blockage, as well as guidance on caring for their infant at home following discharge. This will enable parents to identify the signs of infection and malfunction of the shunt early. VP shunt – Care at home

Shunt Characterisation

The VP Shunts that are used are antibiotic impregnated (Rifampicin and Clindamycin). Studies have shown that antibiotic impregnated catheters decrease the risk of CSF shunt infections. Shunts usually consist of three parts:

1. **Proximal end** that is radiopaque and is placed into the ventricle of the brain. This end has multiple small perforations.
2. **Valve** - this allows for unidirectional flow. Some shunts can be adjusted to various opening pressures (called programmable shunts). Usually has a reservoir that allows for checking shunt pressure and sampling CSF.
3. **Distal end** that is placed into the peritoneum by tracking the tubing subcutaneously.

Neuroendoscopic lavage (NEL):

Favourable outcomes with potential reduction in risk of shunt dependence and lower risk of infection compared to VADs.

Ventricular subgaleal shunt (VSGS):

VSGS is a safe and effective temporising treatment for post-haemorrhagic hydrocephalus secondary to IVH in premature neonates, with low rates of infection (9%), revision (4%), catheter obstruction (2%), migration (1%), CSF leakage (6%), and procedure-related mortality (1%), although 75% of infants subsequently require permanent ventriculoperitoneal shunt placement.

Endoscopic third ventriculostomy (ETV)

Not preferred for managing PHVD as low success rates.

Pre-Operative Investigations and Management

Preferably start 7 days prior to surgery. However, urgent shunt surgeries should not be postponed for the sake of pre-operative investigations.

Procedure
1. All Infants requiring shunt surgery for open spina bifida must be managed with **Latex Free** care. Including latex free products i.e. dummies, dressing etc.
2. Screen nasal and any skin lesions for the presence of Methicillin Resistant Staphylococcus aureus (MRSA) and Methicillin Sensitive Staphylococcus Aureus (MSSA) Consult with a clinical microbiologist if results are positive before proceeding to surgery.
3. Decolonisation process: Pre-operative chlorhexidine wash with 1% chlorhexidine and Mupirocin 2% nasal ointment to be attended prior to theatre. See Chlorhexidine Wash Procedure & Pre-Operative Care
4. **Two hours prior to surgery**, administer IV Vancomycin 15 mg/kg, to be discussed with theatre staff at handover
5. Cefotaxime 50 mg/kg to be administered **intra-operatively**

Intra-Operative Management

During surgery, after induction of anaesthesia, ensure that Vancomycin has been completed and flushed through the line. Then administer IV Cefotaxime 50 mg/kg. If Vancomycin has not been administered pre-operatively, reverse the order of antibiotics given. Intra-operative antibiotics have been shown to reduce the risk of shunt or reservoir infections.

Post-Operative Management

Also refer to Post-Operative Handover and Post-Operative Care guidelines.

Specific Care
1. Continue antibiotics for 48 hours post-operatively, Cefotaxime 50 mg/kg to be given 6 hourly or as per monograph. First dose to be given 6 hours post the administration of the intra-operative dose.
2. Administer IV Vancomycin at 15 mg/kg/dose 8 hourly irrespective of gestation. First dose to be given 8 hours post the administration of the intra-operative dose.
3. Hourly neurological observations for 24 hours to be commenced on return to the unit. Use MR494 Neonatal Neurological Observations Chart.
4. Ensure head and abdominal dressings remain dry and intact. Observe for the accumulation of CSF beneath the skin leading to soft 'boggy' swelling near the surgical wound on the scalp. A CSF leak or blockage is associated with the increased risk of shunt infection. **If swelling is noted, call the neurosurgeon for review immediately**

Specific Care
5. Scalp and abdominal dressings are to be taken down 48-72 hours post-surgery. Remove the dressings only after discussing with the neurosurgeons. Dressings can be removed earlier if the wound is soaked through with blood or there is concern for the wound.
6. After the dressing is removed, clean the area surrounding the surgical sites with 1% chlorhexidine wipes three times a day for three days or until discharged (if before 3 days). To minimise the colonisation of bacteria near the surgical wound.
7. Keep the wound dry for 7 days. Sponging around the area is allowed, if the wound becomes wet then, dry off immediately. If the dressing becomes wet, then change the dressings. All sutures are dissolvable.
8. Continue with Latex Free care if indicated.

Related CAHS internal policies, procedures, and guidelines

Neonatal Clinical Guidelines

- Aseptic Technique in the Neonatal Unit
- Chlorhexidine Wash Procedure
- Post-Operative Care
- Post-Operative Handover
- Pre-Operative Care
- Neonatology Medication Protocols

References and related external legislation, policies, and guidelines

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This document can be made available in alternative formats on request.

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