The Newcastle upon Tyne Hospitals NHS Foundation Trust

Newcastle Neonatal Services Guideline
Post-Haemorrhagic Ventricular Dilatation Guideline

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1 Introduction

PHVD is a term that represents the progressive ventricular dilatation resulting from the presence of intraventricular haemorrhage (IVH) and encompasses other terms, such as post-haemorrhagic hydrocephalus (PHHC). PHVD can be associated poor neurodevelopmental outcome particularly in those requiring intervention. (1)

Severe forms of IVH continue to occur in up to 15% of infants born extremely premature and more than one-half of these infants develop post-haemorrhagic ventricular dilatation (PHVD) (2,3). 53% of neonates with post-haemorrhagic parenchymal infarction will develop PHVD. (4)

There is wide variation in diagnosis and management of PHVD among the units in UK therefore it important to base management of evidence based guidelines.

The ELVIS trial (2020), in a post hoc analysis concluded earlier intervention was associated with a lower odd of death or severe neuro-developmental disability in preterm infants with PHVD. (15)

2 Guideline scope

This guideline is intended for use of medical and nursing staff on neonatal intensive care (Ward 35, RVI).

3 Guideline

Cranial ultrasound is performed routinely in preterm infants less than 32 weeks gestation due to the risk of IVH.

PHVD can progress slowly or rapidly. In infants with slow progression, stabilization or regression occurs in 65%. In 30–35% of infants, there is rapid progression in ventricular size over days to weeks. (3)

Ther is no clear consensus on the timing of intervention for PHVD with some using sequential cranial USS measurements to guide management while others relying on head circumference measurements and clinical signs. However, the ventricular sizes have to increase considerably before affecting the anterior fontenelle pressure or

head circumference. Also, a poor correlation was found between the Evans ratio (the ratio of bifrontal horn diameter to the biparietal bone diameter) and the head circumference. (8)
Therefore, a more objective approach would be to take ventricular measurement by cranial USS along with regular head circumference.

3.1 Cranial USS Measurements:

Ventricular index - defined by Levene and Starte, is the most commonly used measurement and is assessed in the coronal view. The VI is the distance between the midline (falx) and the lateral border of the lateral ventricle at the level of foramen of Monro. (5)

Other measurements- Anterior Horn Width (AHW) and the Thalamo-Occipital Distance (TOD), and have been shown to be sensitive correlates of the risk of developing ongoing PHVD. (6)

3.2 Definition:

A) VI above 97th percentile on the Levene's chart

B) 1. AHW - diagonal width of anterior horn measured at its widest point in the coronal plane (Normal ≤ 6 mm).

2. TOD - distance between the outermost part of thalamus at its junction with choroid plexus and outer most part of the occipital horn in parasagittal plane (Normal ≤ 25 mm)

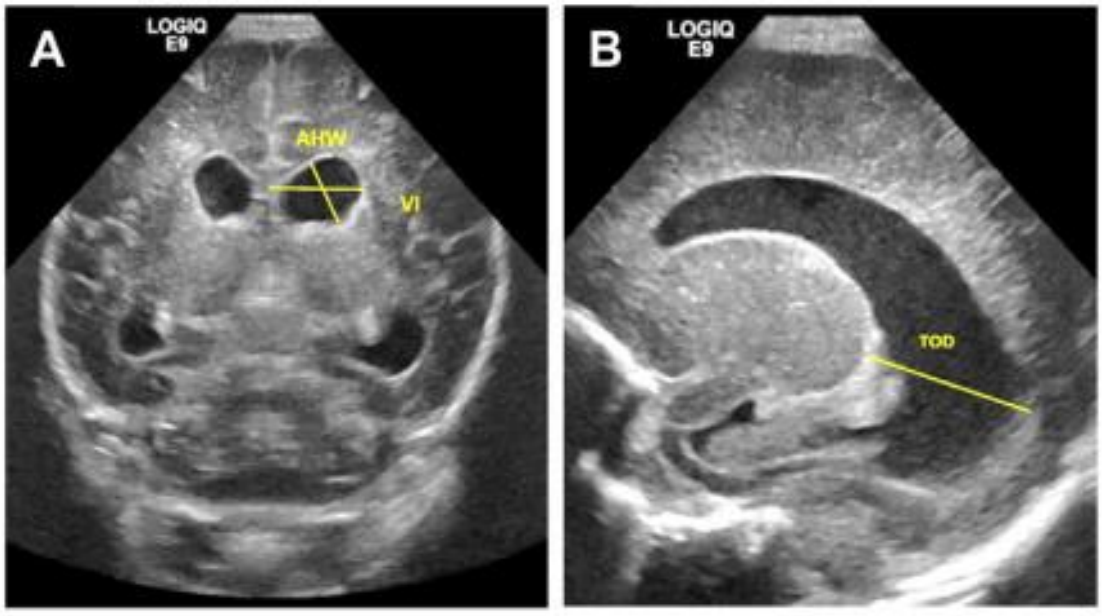


Figure1:

3.3 **Mechanism**:

- Several mechanisms have between proposed. But the common one is acute obstruction of ventricles by a blood clot secondary to IVH in the cerebral aqueduct of the outlet of the 4th ventricle.
- Prolonged period of raised intra-ventricular pressure with periventricular oedema and persistent dilatation of the ventricle, results in mechanical compression of white and grey matter and thought to result in damage of neuronal pathways.(7)

3.4 **Diagnosis**:

Clinical - Bulging fontanelle, separation of sutures, apnea, vomiting, lethargy, poor tone and poor feeding are some of the signs and symptoms of raised ICP.

The ventricular sizes have to increase considerably before affecting the anterior fontenelle pressure or head circumference. (8) Therefore, a more objective approach would be to take ventricular measurement along with regular head circumference.

Things to do to monitor PHVD –

Head circumference twice a week
Cranial ultrasound once to twice a week depending on rate of ventricular dilatation.

Cranial USS measurements

Ventricular index –

- PHVD is defined as ventricular index above the 97th percentile for GA on Levene's chart (5)
- Has been shown to be superior to head circumference measurements. (9,10)
- Used across Europe and UK as an established criterion for diagnosis of PHVD. (11)
- Help in timing of therapeutic intervention and predicting neurological outcome. (12)

Recent ventricular measurements
AHW and TOD are more recent measurement to monitor PHVD. Reference ranges for 25-42 weeks gestation have been reported. (6,12)

AHW:
- *Diagonal* width of anterior horn measured at its widest point in the coronal plane.
- Suggested to a sensitive indicator or ventricular dilatation. (12)

TOD:

- Distance between the outermost part of thalamus at its junction with choroid plexus and outer most part of the occipital horn in parasagittal plane (14)
- El-Dib M report ventricular risk zone based on gestation. (13)
- Brouwer M et al reported reference values for TOD. (6)

3.5 Treatment

A multi-centre RCT concluded that there was a beneficial effect of early intervention for PHVD on reducing mortality and severe neurodevelopmental disability, after adjusting for gestational age and severity of IVH and cerebellar haemorrhage. Lumbar punctures was initiated after either a low threshold (VI of >p97 and AHW of >6 mm) or high threshold (VI of >p97 + 4 mm and AHW of >10 mm). (15)

A large multi-centre observational study have reported poorer neurodevelopment outcome in those who required a shunt. It is hypothesized that prolonged ventricular dilatation results in permanent white matter injury. (16)

3.5.1. Non- surgical management

- In cases of progressive ventriculomegaly i.e., when the VI crosses the 97th + 4mm, two therapeutic lumbar punctures, or a ventricular tap, are recommended.

- Minimum of 10ml/kg of CSF is needed to be removed to have a significant effect on ventricular size. Limit the volume of CSF removed to a maximum of 15 ml/kg at 1ml/kg/min.

- Ventricular tapping has been associated with increased development of CSF infection and loculated hydrocephalus (17)

- Consider discussion with neurosurgeon for possible surgical intervention.

(See Table 1 and Graph 1 to guide management)

3.5.2 Surgical intervention

The aim of surgical CSF diversion is to reduce intraventricular pressure in neonates with progressive PHVD (>97th + 4mm). This is under the premise that progressive PHVD is indicative of raised ICP reducing ventricular pressure will preserve the developing periventricular white matter leading to improvements in ND outcome.

The neuro surgical and neonatal team will consider the appropriateness and timing of surgical interventions.

Surgical interventions can either be temporary or ‘permanent’.
Some temporary measures include –

- External ventricular drain

- Ventricular access device – ventricular catheter with reservoir placed in the subcutaneous area. This can be used to aspirate 10 ml/kg/day of CSF to reduce ICP as needed. Up to 30% cases of PHVD resolve. (18) It is associated with infection and CSF leaks.
- Ventriculo-subgaleal shunt

Permanent intervention – ventriculoperitoneal shunt.

3.5.3 Management threshold

Green Zone	Yellow Zone	Red Zone
Key Criteria: Ventricular size with the following • VI ≤ 97th percentile & • AHW ≤ 6 mm And Absence of the following clinical criteria: • HC growth > 2 cm per week • Separated sutures • Bulging fontanelles Management: • Observation in NICU • cUS twice a week until stable for 2 weeks then every 1-2 weeks till 34 weeks PMA • MRI at Term Equivalent	Key Criteria: Ventricular size with the following • VI > 97th percentile & • AHW > 6 mm &/or TOD > 25 mm And Absence of the following clinical criteria: • HC growth > 2 cm per week • Separated sutures • Bulging fontanelles Management: • Referral to a regional center for neurosurgical review • Consider LP 2-3 times • cUS 2-3X a week until stable for 2 weeks then every 1-2 weeks till 34 weeks PMA • Neurosurgical intervention when no stabilization occurs • MRI at Term Equivalent	Key Criteria: Ventricular size with the following • VI > 97th percentile + 4mm & • AHW > 10 mm &/or TOD > 25 mm Or Any of the following clinical criteria • HC growth > 2 cm per week • Separated sutures • Bulging fontanelles Management: • Consider LP 2-3 times • Neurosurgical intervention including either temporizing measures or VP shunt • MRI at Term Equivalent

Table 1: Management threshold

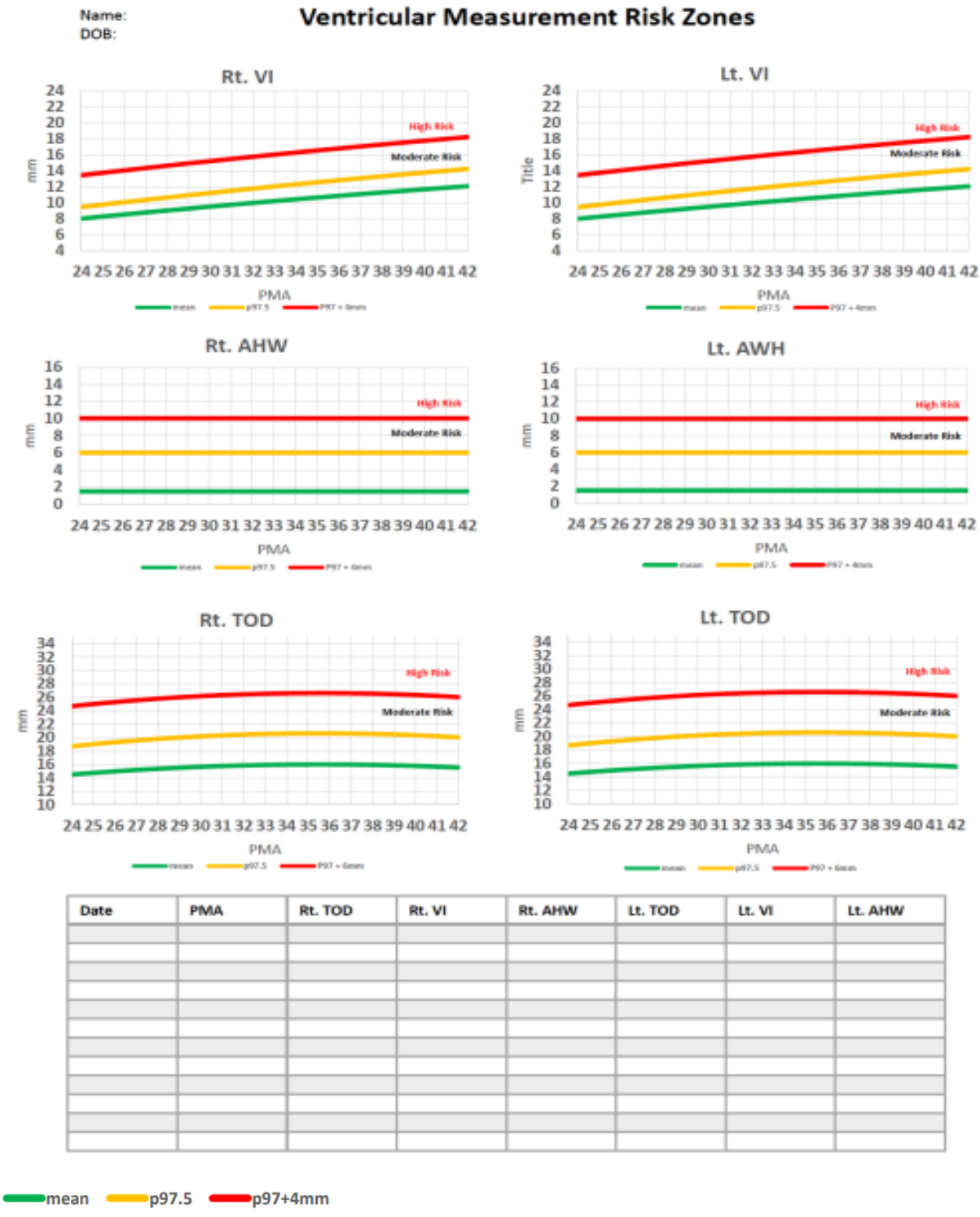
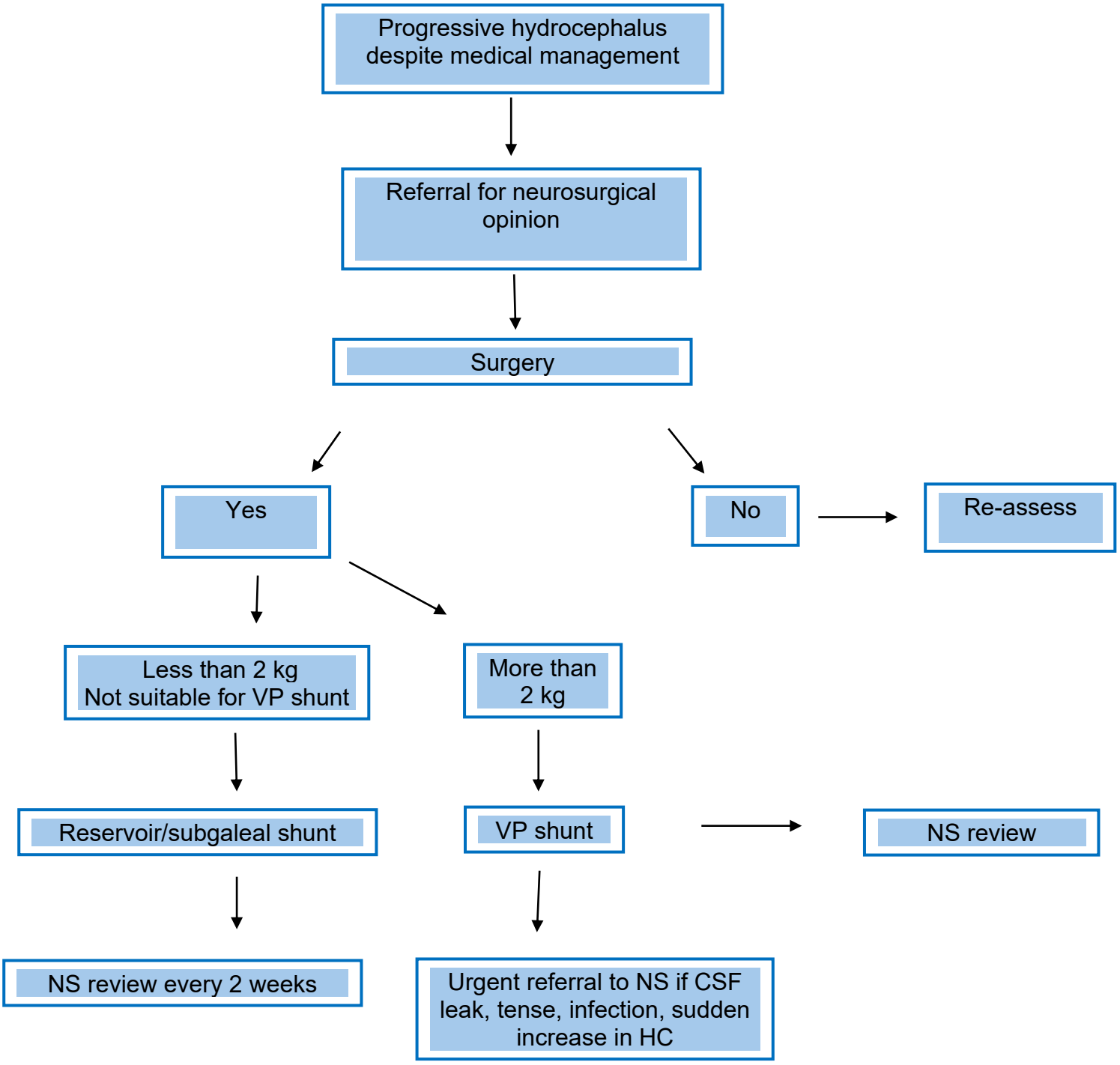


Figure 2: USS measurement threshold graph

Ref - 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.

Surgical management pathway

This is a suggested surgical management pathway but is case dependent and will be discussed with the neurosurgical team.



4 Monitoring

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