

PVM01CHEATSHEET

Normal Vestibular Development

Developmental milestones, normative values, and age-appropriate assessment

WHY IT MATTERS

Vestibular function matures progressively from birth through adolescence. All vestibular test results must be interpreted against age-specific normative data — adult reference ranges are invalid in children under 8. Delays in vestibular maturation impair motor development, postural control, balance reactions, and spatial orientation. In high-risk groups (prematurity, ototoxicity, syndromic conditions), proactive surveillance is essential because affected children rarely volunteer symptoms.

VESTIBULAR ANATOMY AND FUNCTIONAL MATURATION

Structure / Reflex	Matures by	Clinical relevance
Semicircular canals (SCC)	12–18 months	Horizontal SCC adult-like by 1 year; VOR gain adult-level by 5–8 years
Sacculae (cVEMP pathway)	3–5 years	Threshold 5–10 dB higher than adults; absent response under 3 not pathological
Utricle (oVEMP pathway)	5–8 years	Low amplitude in infants; may be absent under 3 years
VOR (video head impulse)	5–8 years	Gain >0.8 reliable from age 5; covert saccades common in younger children
Caloric response	8–12 years	Hyperreactive under 5 is normal; adult norms applicable from age 10
Rotary chair VOR TC	5–7 years	Shorter time constant in under-5s; use age-specific reference ranges
Vestibulo-spinal reflex	2–3 years	Postural reactions adult-like by age 3; tandem stance matures by 7 years
VEMP normative values	Varies by age	Always apply published paediatric age-band norms — never adult values

DEVELOPMENTAL MILESTONES

Age	Motor milestone	Vestibular correlate
0–3 months	Head hold; tonic labyrinthine reflex	Primitive VOR present; gain 0.2–0.4
4–6 months	Head righting; rolling	Labyrinthine righting reflex; OKR maturing
6–12 months	Sitting; pulls to stand	VOR gain 0.6–0.8; SCC function approaching adult
12–18 months	Independent walking	Mature SCC function; saccular otolith responses present
2–5 years	Running; stairs alternate feet	cVEMP normative range established; balance reactions mature
5–8 years	Sports; tandem walking	Adult-level vHIT gain; postural control nearly mature
8–12 years	Complex coordination	Mature caloric; full vestibulo-spinal integration
Adolescence	Sport, fine motor	All vestibular test values reach adult ranges

RED FLAGS FOR VESTIBULAR DELAY

Flag	Age concern	Action
No head righting	Absent at 6 months	Vestibular + neurological review; MRI if isolated
Walking after 18 months	Without neurological cause	vHIT bilateral; bilateral BVH screen; genetics
Persistent wide-based gait	After 24 months	vHIT + cVEMP; MABC-2 balance subtests
Frequent unexplained falls (>3/week)	3–5 years	Vestibular screen; otoscopy; audiogram
NICU history + aminoglycosides	Any age	Proactive vHIT at 3–6 months corrected age
Bilateral SNHL at birth	Any	Immediate vestibular screen; genetic workup

AGE-STRATIFIED TEST FEASIBILITY

Test	0–2 yr	3–6 yr	7–12 yr	13–18 yr
vHIT (passive technique)	+ (examiner rotates)	++	+++	+++
cVEMP (bone-conducted)	++ (passive)	++	+++	+++
oVEMP	+ (limited)	++	+++	+++
Rotary chair	- (specialist modification)	+ (cooperative)	++	++
Caloric testing	- (poorly tolerated)	- to +	++	+++
MABC-2 balance subscale	-	+ (modified norms)	+++	+++
Posturography (CTSIB/SOT)	-	+ (modified)	++	+++

vHIT PAEDIATRIC NORMS

Parameter	Norm	Notes
Horizontal gain	0.8–1.2	Age-independent beyond 12 months; below 0.8 + saccades = hypofunction
Vertical gain (LARP/RALP)	0.7–1.1	Anterior canals often spared in BPPV
Covert saccades	Both indicate VOR insufficiency	More diagnostically specific than overt saccades
Technique under 3 years	Passive examiner-controlled	Sticker/picture target; gentle 100–150°/s ramp
Absent cVEMP under age 3	May be normal	Apply published paediatric age-band norms only

SURVEILLANCE PATHWAYS

- All NICU graduates with aminoglycoside exposure: vHIT screen at 3–6 months corrected age.
- Congenital SNHL: vestibular assessment concurrent with audiological assessment at diagnosis.
- Syndromic conditions (CHARGE, Usher, Pendred): specialist paediatric vestibular team at diagnosis.
- Post-meningitis: vHIT + cVEMP at 3 months post-discharge; concurrent with cochlear implant pathway if profound SNHL.
- Late walkers (>18 months, no neurological cause): vHIT bilateral as first-line test.
- All abnormal results: apply age-band norms; serial testing at 3-month intervals; document cooperation level.

VESTIBULAR REHABILITATION — WHEN AND WHO

Condition	VRT indication	Priority
Bilateral BVH (CHARGE; aminoglycoside; meningitis)	URGENT — early intervention in neuroplasticity window	Begin as soon as medically stable
Unilateral VOR loss (neuritis; trauma)	Accelerate central compensation	Within 2 weeks of acute phase
Late walking due to vestibular delay	Balance facilitation; head righting exercises	As soon as identified; daily programme taught to parents
Recurrent falls in pre-school (vestibular cause)	Balance retraining; gaze stabilisation	After formal vestibular diagnosis; specialist physiotherapist
Post-meningitis vestibular loss	Somatosensory substitution strategies	Concurrent with CI assessment if SNHL present

WHEN TO REFER

- ▶ Late walking (>18 months) without neurological cause — vestibular physician; bilateral vHIT as first test
- ▶ Bilateral SNHL at birth + suspected vestibular delay — vestibular physician + genetics concurrently
- ▶ NICU graduate with aminoglycoside exposure and delayed milestones — vestibular physician urgently
- ▶ Any confirmed bilateral VOR hypofunction in infancy — vestibular physiotherapist urgently; neuroplasticity window
- ▶ MABC-2 balance subscale <5th percentile — vestibular assessment + physiotherapy referral

♦ Vestibular development mirrors motor development — any unexplained delay in sitting, standing, or walking without a clear orthopaedic or neurological cause warrants vestibular and audiological assessment together. These systems are inseparable. A vHIT takes 5 minutes and can identify bilateral VOR impairment from 18 months of age.

♦ The most common error in paediatric vestibular reporting is applying adult normative values to children. VEMP amplitudes peak in mid-childhood. Caloric responses are hyperreactive under 5. A borderline result in a 3-year-old may be completely normal for age — always state the normative reference used and the child's age at testing.