

The vestibular system in children

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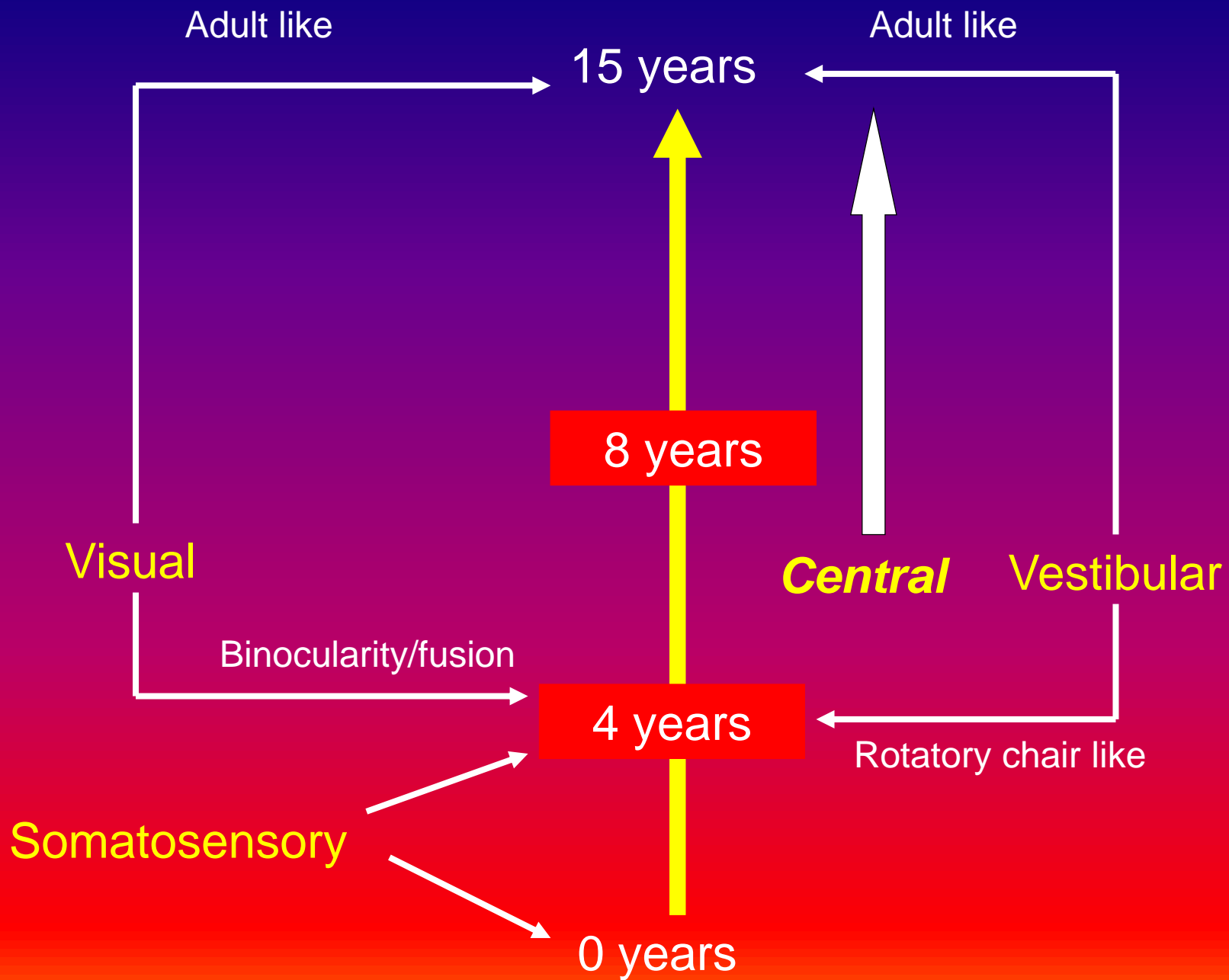
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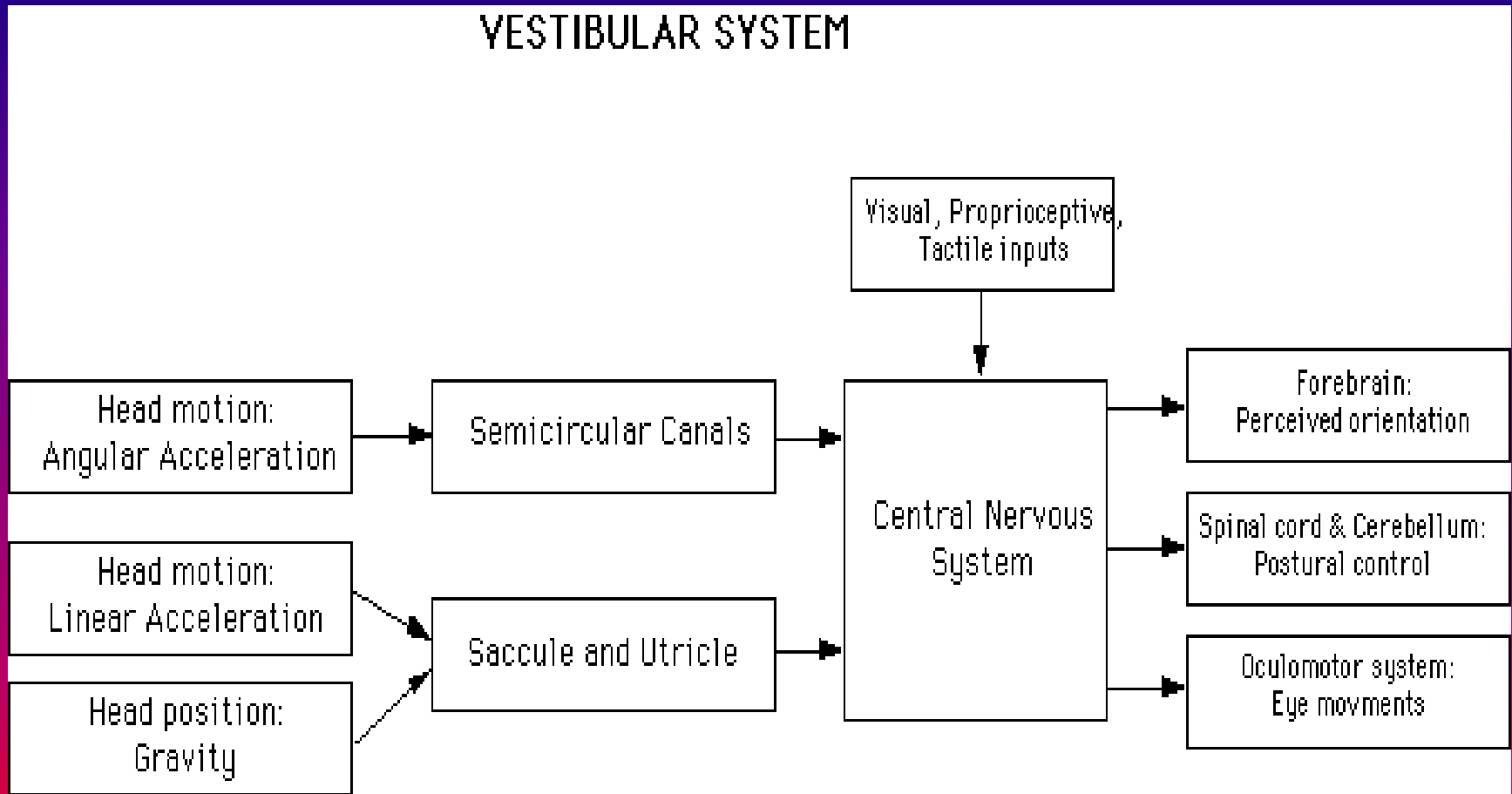
This session

- The vestibular system in children
- Assessment of balance function in children
- Paediatric vestibular disorders
- Case studies
- Conclusions

Vestibular system in children

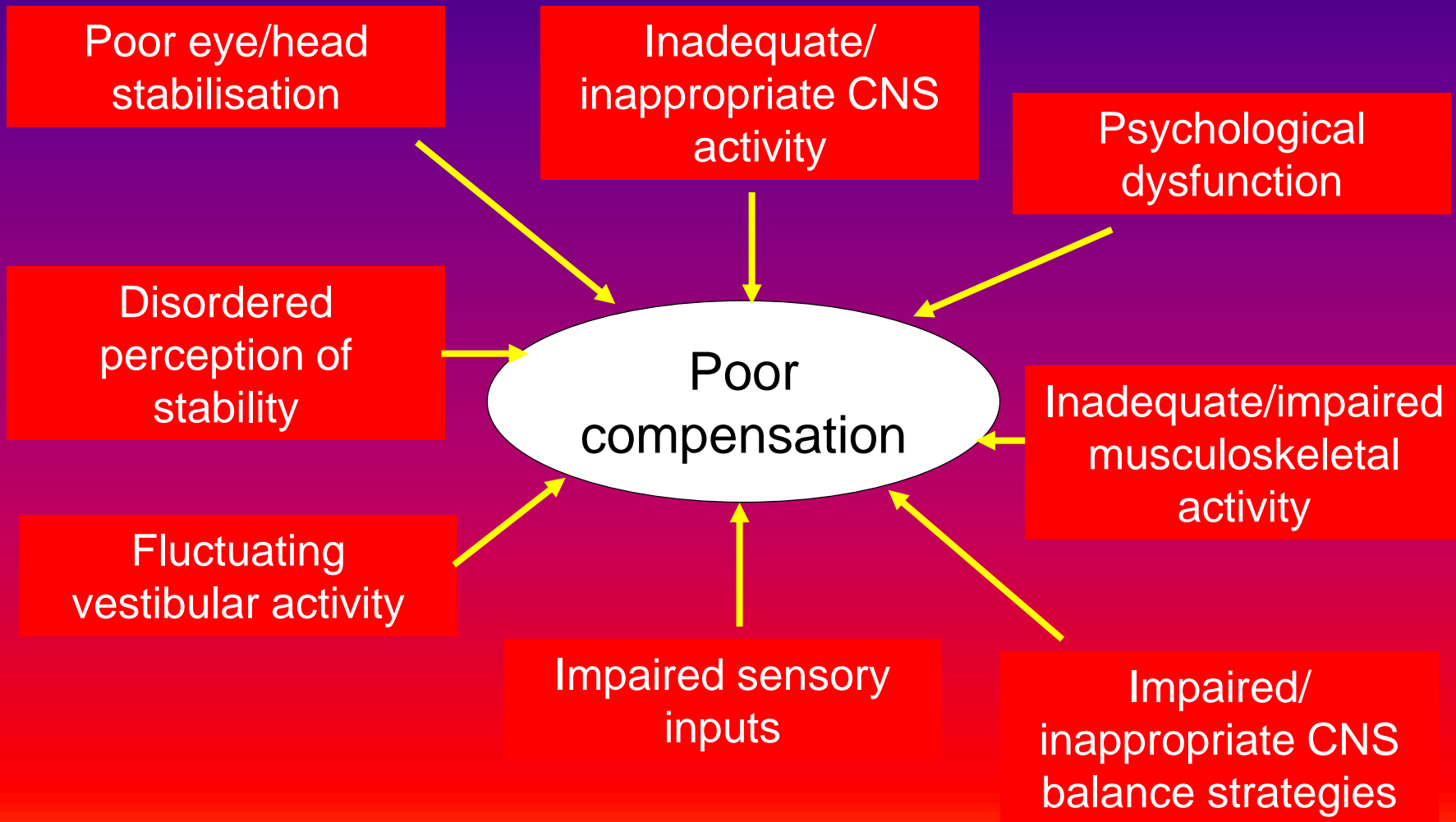


Functions



Maintains posture, produces kinetic contractions to generate ocular stability, cognitive and spatial discrimination and helps maintain muscle tone

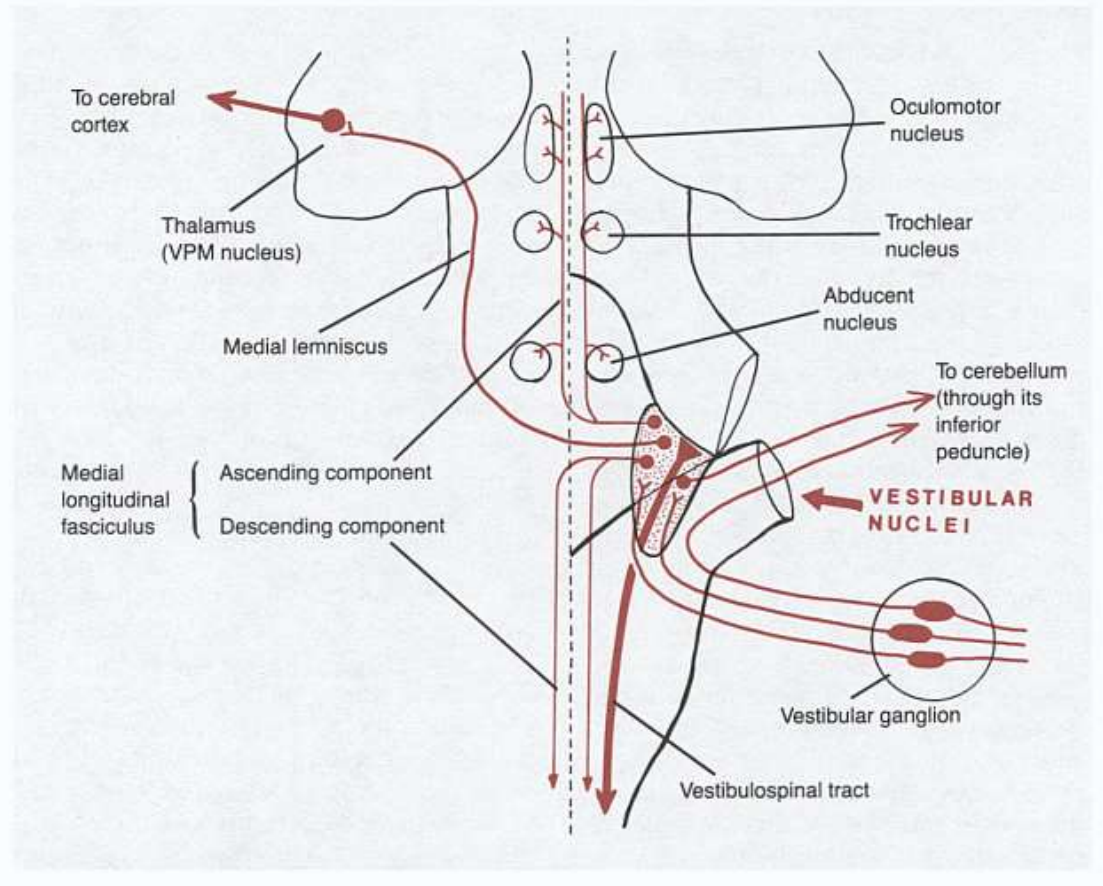
Decompensation and manifestation of balance disorders



Beyond the vestibule

The final balance perception is not just the ear but processing is a central function. This starts from the vestibular nerve and is a complex interplay between the optical system, the proprioceptive system, the motor system and the cognitive centres

Central connections of the vestibular system



Assessment of the vestibular system in children

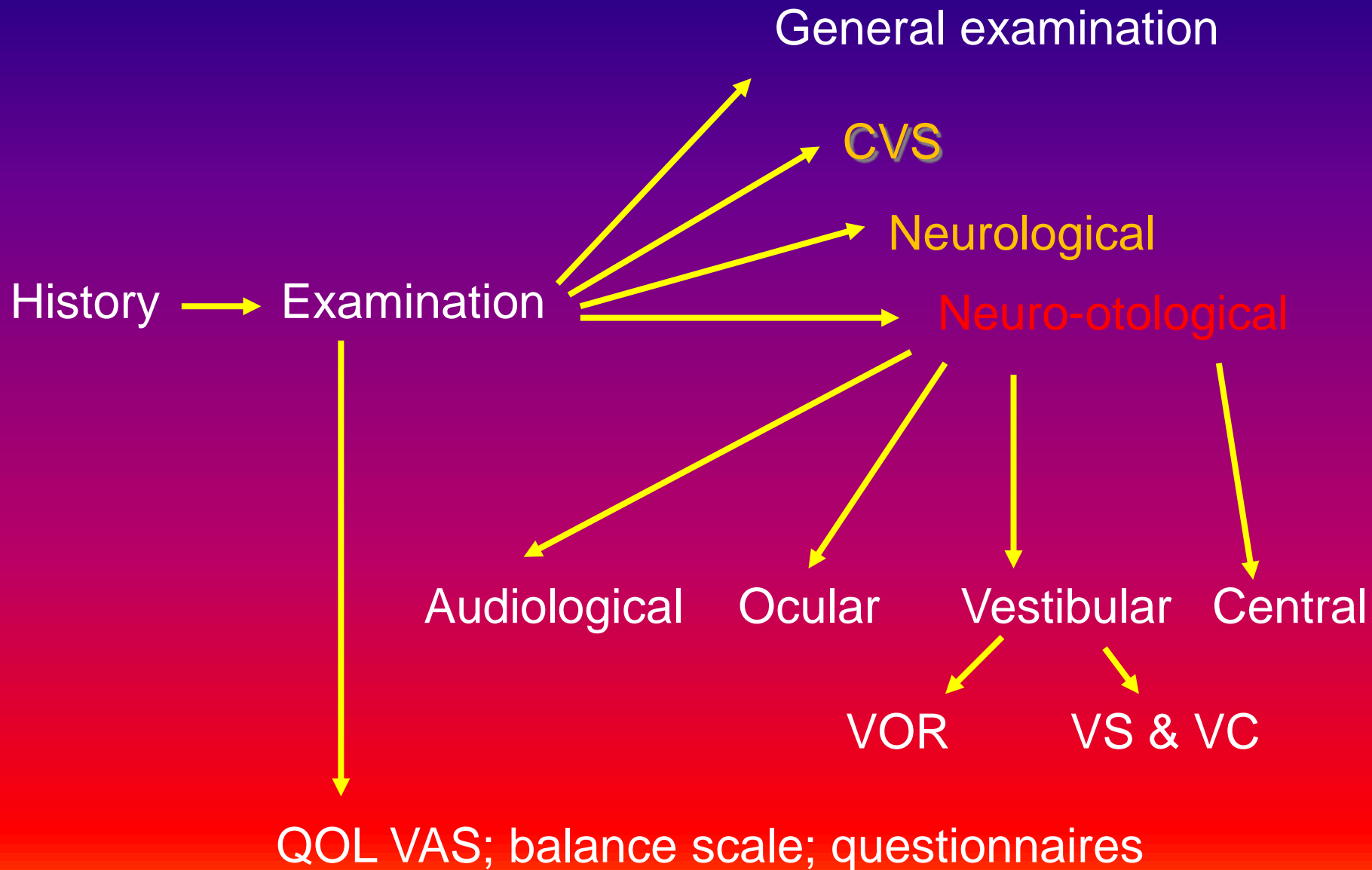
Significance

- Distinguish between central and peripheral causes of imbalance
- Formulation of effective management regimen including compensation, adaptation and habituation protocols with customised rehabilitation exercises
- Particle repositioning manoeuvres if necessary
- Exclusion/inclusion of vestibular pathology in solitary/multifactorial conditions
- *Remember the neurology and neurotology interface is far more close than what you will find in the adult population*

Presentation of balance problems

- Obvious dizziness/vertigo/lightheadedness (+ 8y)
- Fright or pallor
- Clutching
- Bumping into things
- Clumsiness
- Sudden pole axing falls
- Periodic episodes of nausea or vomiting +/- migrainous features
- Delayed motor functions
- Loss of postural control
- Difficulty with ambulating in the dark
- Abnormal movements or behavior
- Difficulties in challenging movements (swimming, dancing)
- Oscillopsia
- Difficult to track challenging visual targets
- Poor head eye coordination

The clinical algorithm



The semicircular canals

- Nystagmus
- Head impulse test
- Provocation tests
- Head shake test
- Dynamic visual acuity

The CNS

- Non vestibular nystagmus
- Pursuits and saccades
- VOR cancel

The otolith organs

- Head heave test
- Subjective visual vertical
- Ocular counter rolling

The vestibulo spinal/cervical tests

- Romberg tests
- Unterberger and Fukuda
- Gait tests
- Lateral flexion

Investigations

- Video head impulse test – measures SCC
- Caloric test – measures LSCC
- Rotatory chair tests – measure LSCC
- Ocular counter roll, subjective visual vertical, off vertical axis rotation – measure gravitational sensors
- Videonystagmography VNG – measures central and vestibular functions
- Vestibular evoked myogenic potential (VEMP) – measures gravitational sensors

- Hearing assessment
- Imaging studies – HRCT for bony labyrinth, MRI for membranous labyrinth
- Static and dynamic posturography
- Blood tests when indicated

Paediatric vestibular disorders

Aetiology	O'Reilly 2007 (chair/calorics)	Vacher 2008 (chair/calorics)	Hamilton 2015 (vHIT)	Sommerfleck 2016 (vHIT)	Dasgupta series 2017 (vHIT)
Peripheral vestibular	29.5%	18%	40%	22%	20.3%
Migraine and BPVC	24.2%	45%	24%	49%	18.5%
Traumatic head injury	9.8%	10%	6%	6.8%	3.7%
Central	9.1%	<5%	3%	2%	3.7%
Third window	<1%	<1%	6%	<1%	26%
Genetic	N/A	N/A	N/A	N/A	12.9%
Idiopathic	N/A	N/A	N/A	N/A	12.9%
Others	26.4%	21%	21%	19.2%	5.7%

A.I. duPont Hospital for Children, Wilmington, Delaware

Alder Hey Children's Hospital, Liverpool

- Peripheral vestibulopathy/third window
- Benign paroxysmal vertigo of childhood
- Motor/developmental delay
- Traumatic brain injury
- CNS structural lesions
- Behavioural/psychogenic
- Idiopathic
- Movement disorder/neurodegenerative
- Encephalopathy
- Vascular
- Peripheral neuropathy
- Oculomotor abnormality

Prevalence of 8 – 18%
between 1 to 15 years

Congenital disorders

- Malformation

- Vestibular hypoplasia or aplasia or dysplasia
- Enlarged vestibular aqueduct
- Arnold Chiari malformation

- Syndromic

- CHARGE, BOR, Pendred, Usher, Alport, Alstorm, JLN

- Non syndromic

- DFNA9, DFNA12
- DFNB2, DFNB4, DFNB12

Otologic disorders

- Infective/ inflammatory – OME, CSOM, middle ear, labyrinthitis, neuritis, meningitis
- Traumatic – head injury, perilymph fistula, iatrogenic
- Degenerative – Endolymphatic hydrops, BPPV
- Ototoxicity – Gentamycin, cisplatin, diuretics, antimalarials
- Third window disorders

Neurological disorders

- Migraine and migraine variants (BPT, BPV, hemiplegic, CV)
- Neoplastic and SOL – AN, meningioma, glioma, ependymoma, cyst, Arnold Chiari
- Cerebellum and cerebellum ataxia syndromes
- Epilepsy
- CVAs
- Demyelinating disorders
- Hereditary sensory motor ataxias
- Hypoxic ischaemic encephalopathies
- Neurodegenerative conditions
- Post infective conditions – sepsis, meningitis/encephelitis

Cardiovascular disorders

- Long QT syndromes and orthostatic hypotension

Metabolic disorders

- Diabetes, electrolyte imbalances

Ocular abnormalities

- Refractive disorders, strabismus

Psychogenic disorders

- Anxiety disorders, panic attacks

Management

- Diagnosis and explanation
- Investigation and treatment of primary cause
- Pharmacological intervention in acute spells, migraine, BPVC
- Particle repositioning in BPPV
- Customised vestibular rehabilitation exercises for recalibrating whole system and promote compensation
- Sensory integration strategies
- Psychological intervention when appropriate
- Correction of visual problems

Very much MDT with audiovestibular physicians, paediatricians, neurologists, ENT, oncologists, respiratory physicians, physiotherapists, OT, psychiatrists, audiologists and play therapists

Conclusions

- Diagnosing balance disorders in children is challenging, stimulating and rewarding as it is so complex
- Awareness is very limited in paediatric general and subspecialties; in a recent survey even in balance specialists, awareness is limited to 30% or less
- Often interpreted as a neurological problem and typical journey includes ENT, community and general paediatricians and neurologists

- Intervention makes a significant difference in many children's and parents' lives and recognition is crucial
- Is very much holistic and multidisciplinary – we are essentially treating not just the balance disorder but the child as a whole and indirectly the parents
- Medically inexplicable symptoms may be due to vestibular disorder

The Alder Hey paediatric vestibular medicine service is a nationally and internationally recognised tertiary paediatric balance service with facilities for advanced assessment and rehabilitation of children with balance disorders



Thank you