吳俊良個人簡歷

現職 ：

國立成功大學醫學院醫學系耳鼻喉學科副教授

國立成功大學附設醫院耳鼻喉部主治醫師兼耳科主任

台灣耳鳴學會常務理事

學經歷 ：

中國醫藥大學醫學士(1982-1989)

國立成功大學附設醫院耳鼻喉部部主任(2009 - 2015)

台灣耳鼻喉科醫學會理事 (2007-2016)

台灣耳鼻喉科醫學會聽語委員會召集人 (2007-2010 & 2013-2016)

Curriculum Vitae

Full Name: Yi-Lu Li

Position Title:

Attending Physician, Department of Otolaryngology, National Cheng Kung University Hospital, College of Medicine, National Cheng Kung University, Tainan, Taiwan

Office Address: No.138, Sheng Li Rd., Tainan County, 704, Taiwan

Education:

Institution and Location	Degree	Year Conferred	Field of Study
National Cheng Kung University, Tainan, Taiwan	Ph.D. Student	Aug. 2019 to present	Clinical Medicine Research
Kaohsiung Medical University, Kaohsiung, Taiwan	M.D.	2011 (Sep. 2004-Jun. 2011)	Medicine

Research and Carrier Experience:

Position	Institution/ Employer and Location	Date of Employment
Attending Physician	Department of Otolaryngology, National Cheng Kung University Hospital, Tainan, Taiwan	August 2018 to present
Attending Physician	Department of Otolaryngology, Kuo General Hospital, Tainan, Taiwan	August 2018 – July 2019
Resident	Department of Otolaryngology, National Cheng Kung University Hospital, Tainan, Taiwan	August 2012 – July 2018
Post-graduate Year	National Cheng Kung University Hospital, Tainan, Taiwan	August 2011 – July 2012

Special Qualifications and Certifications:

1. Best Paper Award in 12th International Tinnitus Research Initiative Conference, Taipei, May 17th-19th, 2019.
2. Instructor for Temporal Bone Dissection Course in National Cheng Kung University Hospital, Tainan, Taiwan. March 6th and 7th, 13th and 14th, 2021.

3. Instructor for Temporal Bone Dissection Course in National Cheng Kung University Hospital, Tainan, Taiwan. April 20th and 21th, 2019.
4. Certificate of Completion: Attending Training on the Advanced Bionics Ultra Cochlear Implant System. October 31th, 2018.
5. Certificate of Achievement: Dissector for Endoscopic Ear Surgery Course in the Royal Prince Alfred Hospital, University of Sydney, Sydney, Australia. September 15th and 16th, 2018.
6. Certificate of Training for Temporal Bone Surgical Dissection Course in University of Michigan, Ann Arbor, USA. March 21th -25th, 2016.
7. Certificate of Training for 2016 FESS and Endoscopic Skull Base Course. June 25th, 2016.
8. Award of Best Resident in Clinical Teaching, National Cheng Kung University Hospital, 2016.
9. Certificate of Attendance to 12th Asia Pacific Symposium on Cochlear Implants and Related Science (APSCI 2019), Tokyo, Japan. November 27th- 30th, 2019.
10. Certificate of Attendance to AAO-HNSF 2019 Annual Meeting & OTO Experience, New Orleans, USA. September 15th-18th , 2019.
11. Certificate of Attendance to 10th Asia Pacific Symposium on Cochlear Implants and Related Science. (APSCI 2015, Beijing, China) April 30th-May 3th, 2015.
12. Certificate of Attendance to ENT head and Neck Ultrasound Education. May 21th, 2016.

Publications:

1. Wu CN, Luo SD, Chen SF, Huang CW, Chiang PL, Hwang CF, Yang CH, Ho CH, Cheng WD, Lin CY, Li YL. Applicability of Oculomotor Tests for Predicting Central Vestibular Disorder Using Principal Component Analysis. *J Pers Med.* 2022 Feb 2;12(2):203. doi: 10.3390/jpm12020203.
2. Chen PY, Tsai CY, Wu JL, Li YL, Wu CM, Chen KC, Hwang CF, Wu HP, Lin HC, Cheng YF, Lo MY, Liu TC, Yang TH, Chen PL, Hsu CJ, Wu CC. Hearing Features and Cochlear Implantation Outcomes in Patients With Pathogenic MYO15A Variants: a Multicenter Observational Study. *Ear Hearing*. 2021 Dec 29. doi: 10.1097/AUD.0000000000001171. Epub ahead of print. PMID: 34974475.
3. Li YL, Hsu YC, Lin CY, Wu JL. Sleep disturbance and psychological distress in adult patients with tinnitus. *Journal of the Formosan Medical Association.* 2021Aug 5;S0929-6646(21)00353-3. doi: 10.1016/j.jfma.2021.07.022. Epub ahead of print.
4. Hung D. SY, Lee WT, Li YL, Wu JL. A Transcanal Endoscopic Approach for

Management of Pulsatile Tinnitus due to High-Riding Dehiscent Jugular Bulb. *Ear, Nose & Throat Journal*. 2021 Sep 24;1455613211043683. Epub ahead of print.

5. Li YL, Lee WT, Wu JL. Endoscopy-assisted Transmeatal Cochlear Implantation In Multiple Ear Deformities. *Journal of International Advanced Otology*. 2021; 17(4):376-379.
6. Li YL, Lin YH, Yang HM, Chen YJ, Wu JL. Tone production and perception and intelligibility of produced speech in Mandarin-speaking cochlear implanted children. *International Journal of Audiology* 2018; 57(2):135-142.
7. Li YL, Lee HH, Liu SH, Kao CC, Lin SL, Wu JL. The Efficacy of New Wireless Contralateral Routing of Signal Hearing Aids in Subjects with Single-sided Deafness. *The Journal of Taiwan Otolaryngology-Head and Neck Surgery.* 2014; 49 (2): 107-115. [in Traditional Chinese]

Conference Presentations:

1. Li YL, Lee WT, Wu JL. Transmeatal Endoscopic Cochlear Implantation in Multiple Ear Deformities: A Case Report. 12th APSCI, Tokyo, Japan, November, 2019.
2. Chen CS, Li YL, Wu JL. 1-year Post-connection Results for Sequentially Bilateral Cochlear Implanted Children. 12th APSCI, Tokyo, Japan, November, 2019.
3. Li YL, Lin CY, Wu JL. Sleep Difficulty and Psychological Distress in Tinnitus Patients. AAO-HNSF 2019 Annual Meeting and OTO Experience, New Orleans, USA, September, 2019.
4. Li YL, Lin CY, Wu JL. Psychological Complaints in Tinnitus Patients with Sleep Disturbance. 12th International Tinnitus Research Initiative Conference, Taipei, May, 2019.
5. Hung SY, Li YL. Repair of Traumatic Perilymph Fistula via Transcanal Endoscopic Approach - Case report. 106th Annual Meeting of Taiwan Otolaryngological Society, May, 2019
6. Li YL, Lin CY, Wu JL. 5-HTTLPR Affects Sleep Quality and Autonomic Function among Chronic Tinnitus Patients. 103th Annual Meeting of Taiwan Otolaryngological Society, November, 2017
7. Li YL, Lin CY, Wu JL. Sleep Questionnaire Predicts Sleep Quality in Chronic Tinnitus. 100th Annual Meeting of Taiwan Otolaryngological Society, May, 2016
8. Li YL, Lin YH, Yang HM, Chen YJ, Wu JL. The Effect of Tone Perception and Production on Speech Intelligibility in Mandarin-speaking Cochlear Implanted Children. 10th APSCI, Beijing, May, 2015

9. Li YL, Lin YH, Yang HM, Chen YJ, Wu JL. The Effect of Tone Perception and Production on Speech Intelligibility in Mandarin-speaking Cochlear Implanted Children. 97th Annual Meeting of Taiwan Otolaryngological Society, November, 2014
10. Li YL, Lu ZH, Chang KC, Liao HC: Mammary Analogue Secretory Carcinoma in the Parotid Gland – Case Reports. 96th Annual Meeting of Taiwan Otolaryngological Society, May, 2014
11. Li YL, Lee HH, Liu SH, Kao CC, Lin SL, Wu JL. The Effect of Contralateral Routing of Signals (CROS) Aids Improving Hearing Quality in Population with Single-Sided Deafness (SSD). 95th Annual Meeting of Taiwan Otolaryngological Society, December, 2013
12. Li YL, Liao HC, Huang C. Rosai-Dorfman disease – A Case Report. 94th Annual Meeting of Taiwan Otolaryngological Society, May, 2013

第6次頭暈讀書會

Pediatric Vertigo And Dizziness

李苡潞 吳俊良

成大醫院耳鼻喉部

AUGUST 27, 2022

Outline

- Introduction
- Etiologies and distribution with age
- Evaluation
- Management
- Cases discussion
- Take-Home message

Introduction

- Prevalence in pediatric population:
  - **0.4%-5.6%** of dizziness and imbalance related to otologic and neuro-otologic diagnoses
  - **15%** of school-children have experienced disequilibrium at least once

- Brodsky et al. *Otolaryngol. Neck Surg.* 2020.

- The vestibular system (and the neural pathway in particular) is not fully developed until the early teen years.
- Pediatric patients also have a high ability of adaptation and compensation due to higher neural plasticity.

- Cumberworth et al. *J. Laryngol. Otol.* 2007.

Causes of Dizziness in Children and Adolescents

	Dizziness with vertigo	Dizziness without vertigo (Pseudovertigo)
Life-threatening	CNS infection Head trauma Poisoning or adverse medication effect Stroke Brain tumor	Arrhythmia Heat stroke Hypoglycemia Poisoning or adverse medication effect
Common	**Benign paroxysmal vertigo of childhood** Labyrinthitis (vestibular neuritis) **Migraine** Motion sickness Otitis media complicated by labyrinthitis	Anemia Anxiety Ataxia Depression Hyperventilation Orthostatic hypotension Pregnancy Presyncope

Causes of Dizziness in Children and Adolescents

	Dizziness with vertigo	Dizziness without vertigo (Pseudovertigo)
Other	Benign paroxysmal positional vertigo Cholesteatoma Congenital defects Mastoiditis Meniere disease Middle ear trauma Multiple sclerosis Perilymph fistula Ramsay Hunt syndrome Seizure	**Somatic symptom disorder**

Benign Paroxysmal Vertigo of Childhood (BPVC)

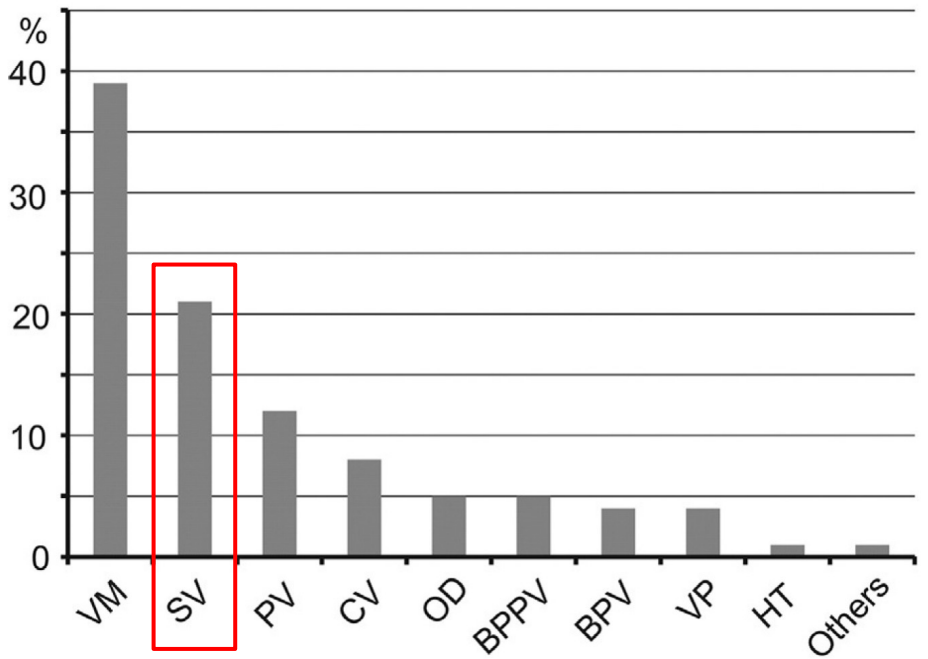
- Similar to BPPV in adult but specific to children (mostly < 8 years)
  - Short duration of **< 1 minute**
  - **Latent period** before the onset of vertigo
  - **Fatigability**
  - **Trigger** (rapid head postural change) or positional nystagmus (*not always*)
- s/s: sudden episodic sensations of spinning (vertigo) without hearing loss or tinnitus, loss of balance and staggering, expressions of fear, pallor, diaphoresis and occasional vomiting
- Normal neurological examination, audiometry, vestibular function and even EEG
- Episodes would reoccur several times a month for several years
- No accompanying migraine features at present, but may be a precursor of migraine.
  - 2/3 of BPVC develops migraine in later life

OUTDATED!

- Batson. *Paediatr Child Health*. 2004.

Functional Dizziness

- *"somatoform dizziness", "phobic postural vertigo", "psychiatric/psychogenic dizziness",* and *"chronic subjective dizziness"*
- Present with chronic dizziness and normal findings on clinical examination and vestibular testing
- Symptoms worsen in certain situations (e.g., at school, in department stores)
- Somatoform vertigo in combination with migraine was the most frequent diagnosis in adolescent girls with dizziness
- Psychiatric comorbidity adversely impacts treatment outcome



400 children aged 1-18 years in Germany

- Jahn K. *Handb Clin Neurol.* 2016.

Management of Functional Dizziness

- Appropriate diagnostic work-up
- Providing information on the illness to both patients and parents
- Desensitization to visual and self-motion by vestibular rehabilitation, regular walks, and sports
- Behavioral therapy

Update of Etiologies

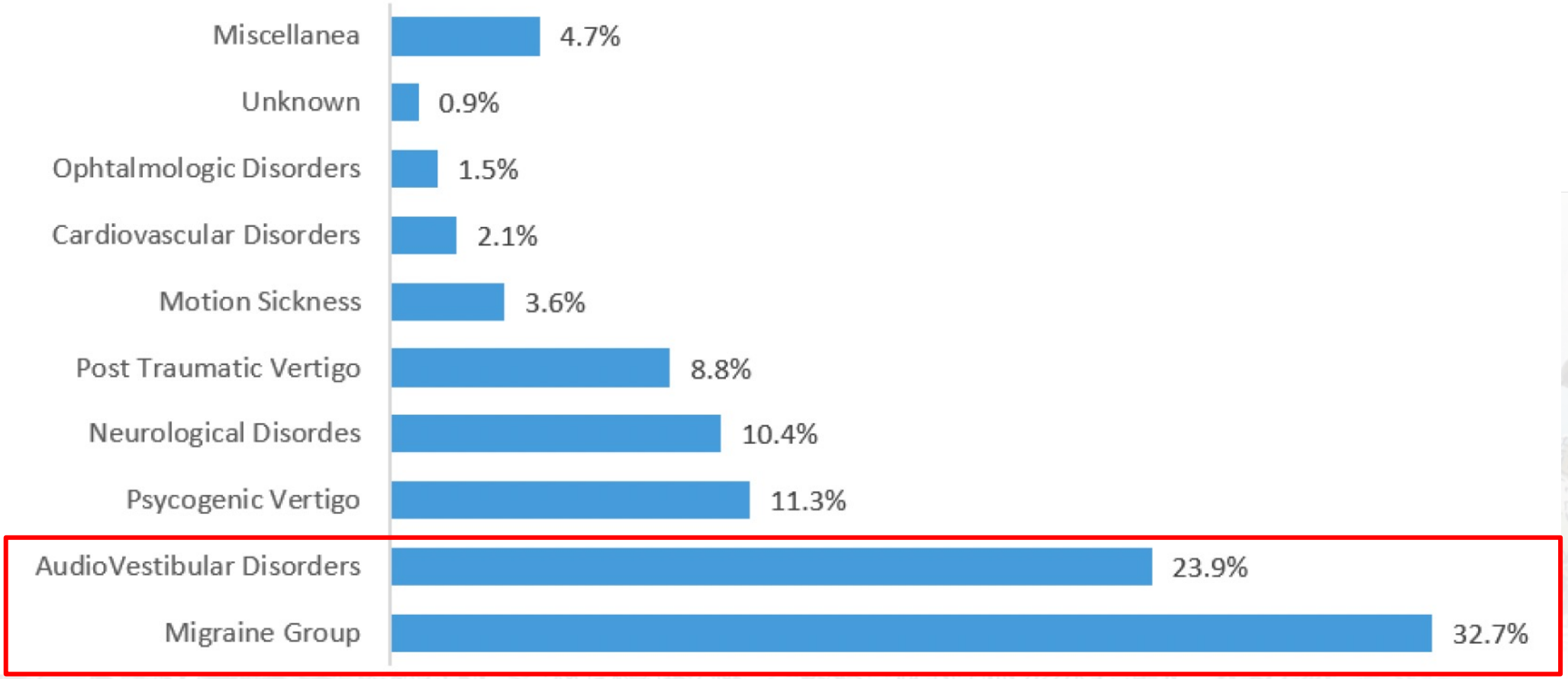
- A systematic review in 2021, evaluating 2470 children in total.
- Inclusion criteria:
  - Original studies on Cohort of patients > 50; Studies on pediatric population; Studies including audio-vestibular diagnoses; Studies published after 2011.

Authors	Year	Country	#	Sex	Age
Haripriya GR et al. [10]	2021	India	89	♂53, ♀36	3–18 years
Gedik-Soyuyuce O et al. [11]	2021	Turkey	203	♂82, ♀121	1–17years
Balzanelli C et al. [12]	2021	Italy	423	♂171, ♀252	Up to 15 years
Wang A et al. [13]	2020	USA	1021	♂397, ♀624	9 months–21 years
Duarte JA et al. [14]	2020	Brazil	117	♂53, ♀64	2–17 years
Lee JD et al. [15]	2017	South Korea	411	♂181, ♀230	Up to 18 years
Sommerfleck PA et al. [16]	2016	Argentina	206	♂107, ♀99	1–18 years
Summary	2016–2021		2470	♂1044, ♀1426 ♂:♀= 1:1.3	9 months to 21 years

= number of patients included in each study; ♂= male; ♀= female.

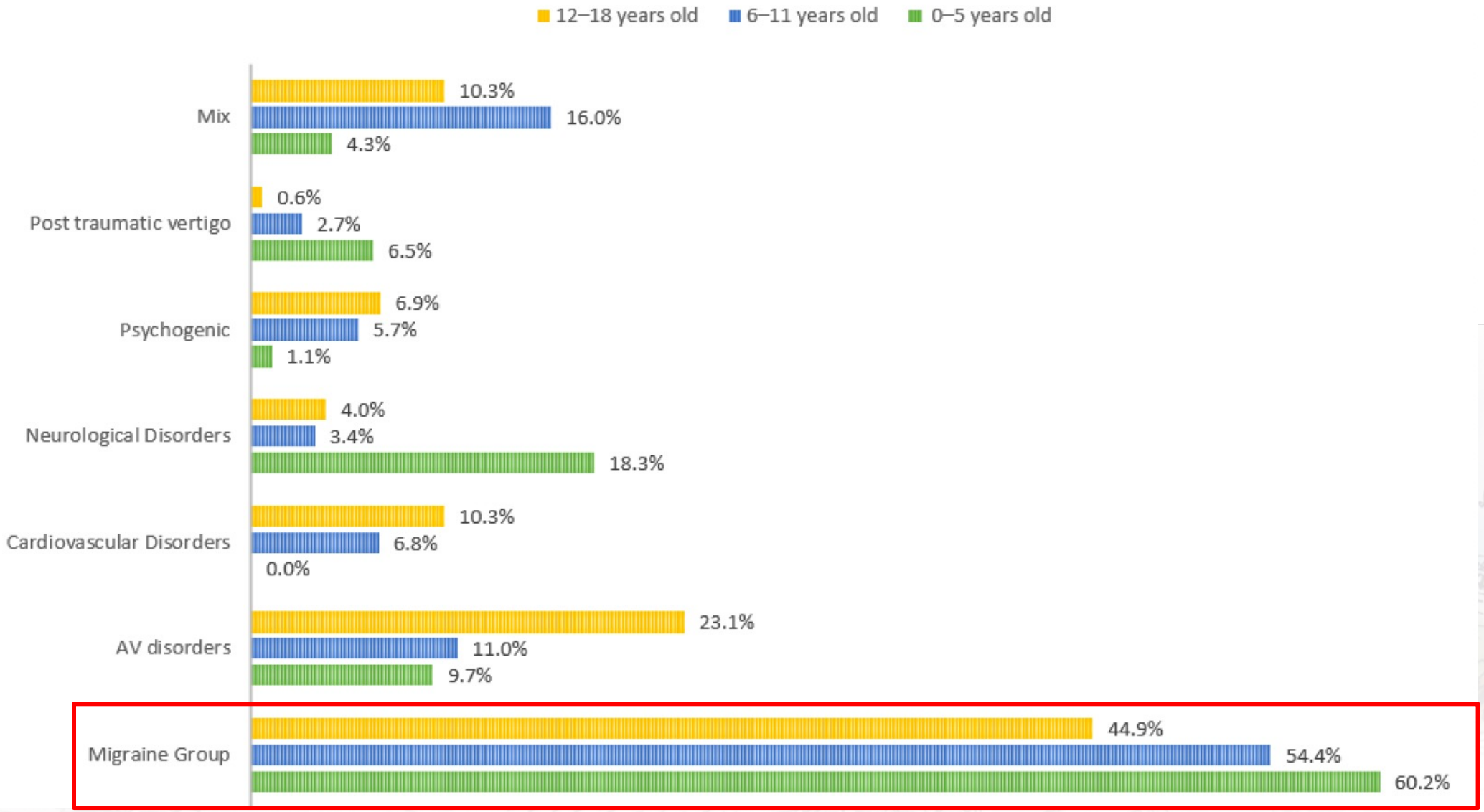
- Fancello V et al. *Children*. 2021.

Overall Distribution of Different Etiologies



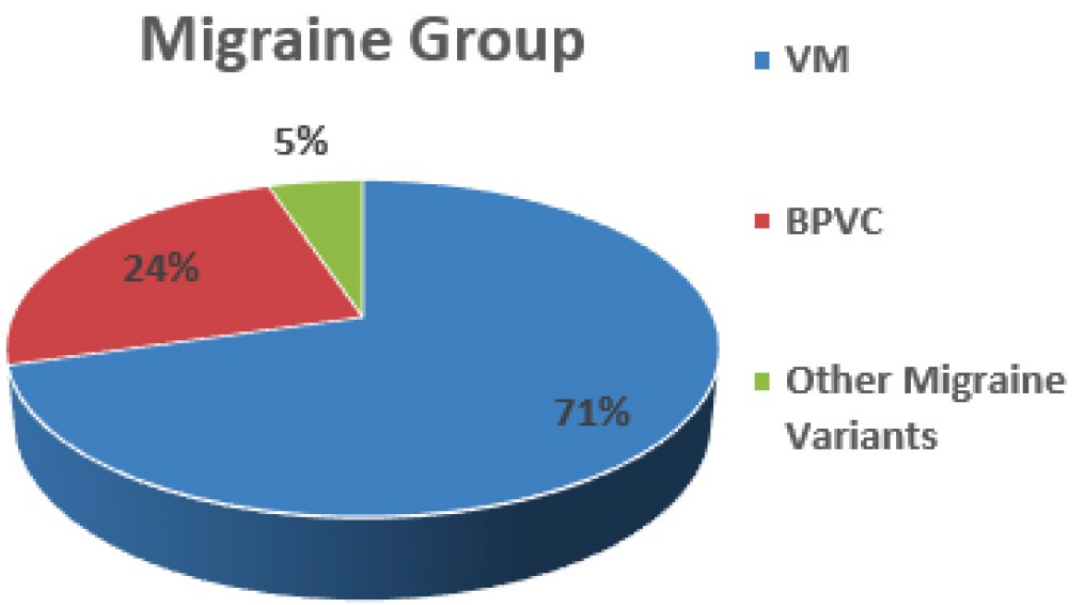
- Fancello V et al. *Children*. 2021.

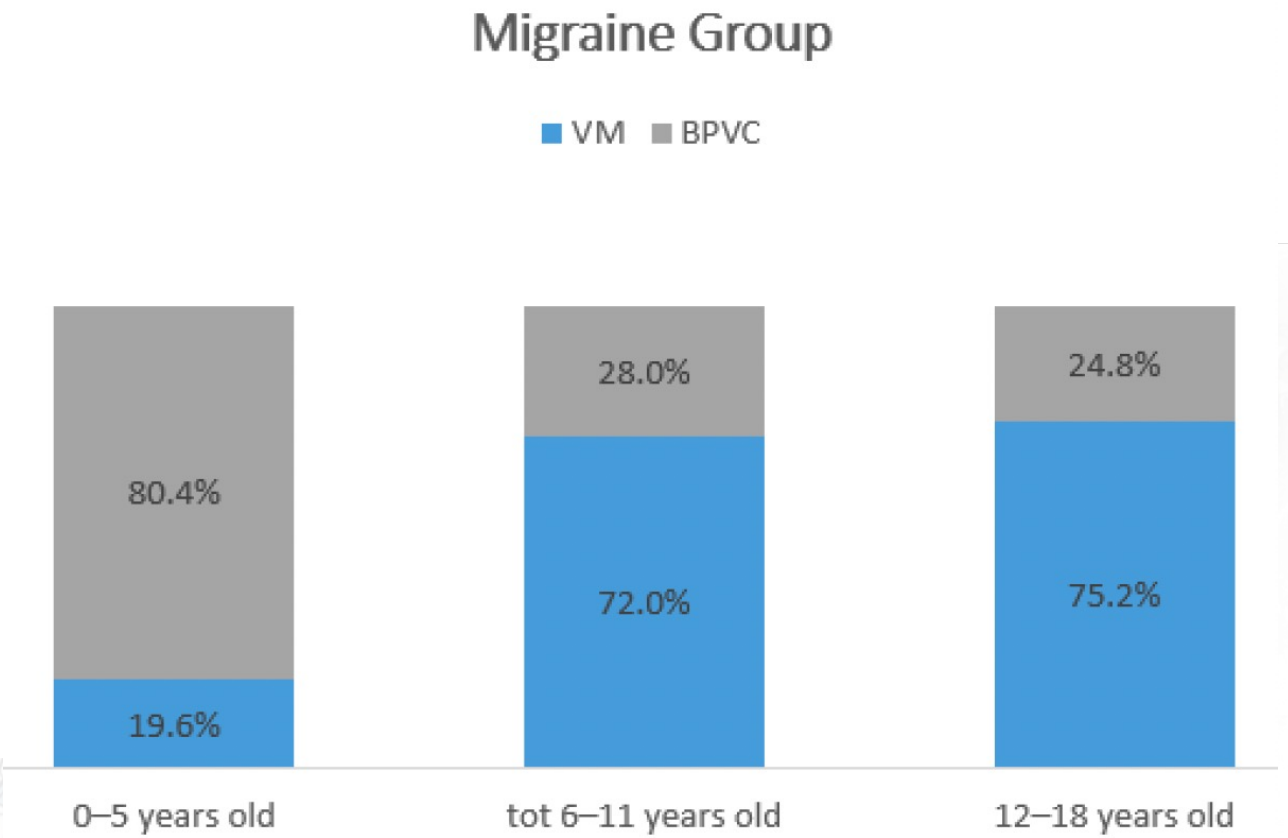
AGE DISTRIBUTION OF DIAGNOSES



- Fancello V et al. *Children*. 2021.

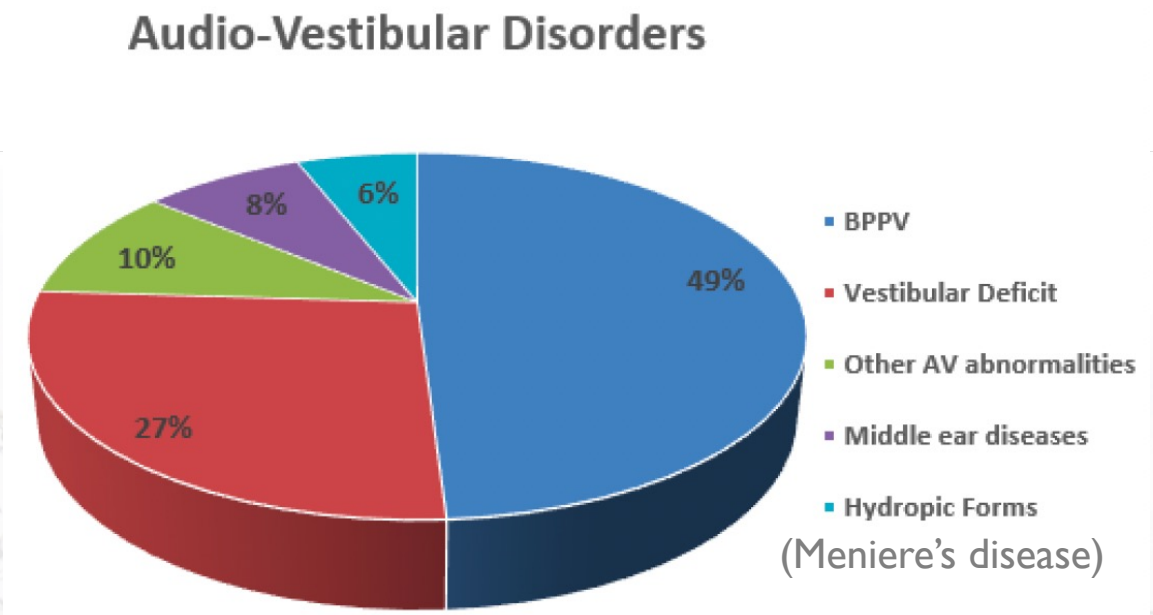
Migraine Group



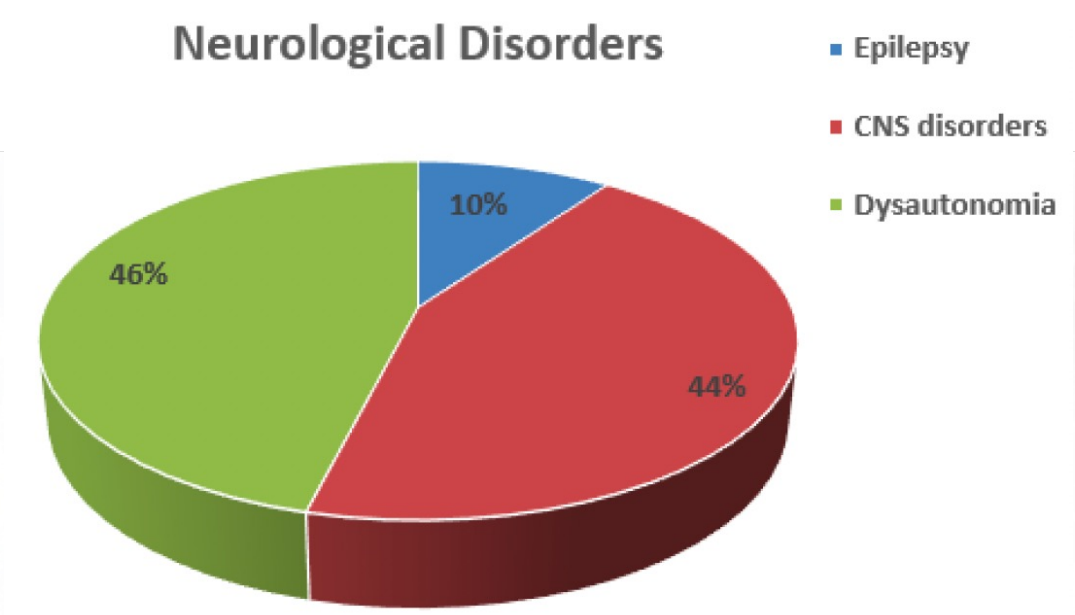


- Fancello V et al. *Children*. 2021.

Audio-Vestibular Disorders & Neurological Disorders



(Meniere's disease)



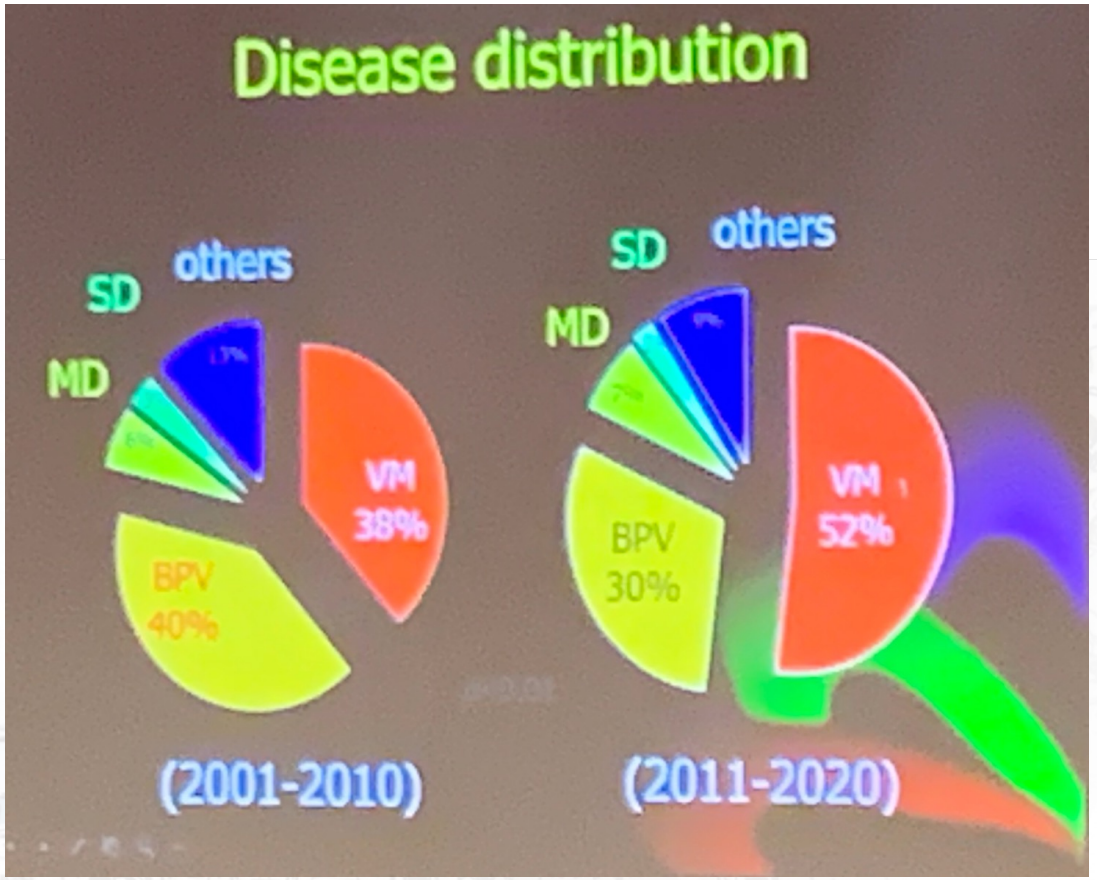
- Fancello V et al. *Children*. 2021.

NTUH Experience

	2001-2010	2011-2020	*p* value
Overall cases	17,123	20,404	<0.0001
Pediatric cases	480 (2.8%)	256 (1.3%)	<0.0001
Sex (M/F)	222/258	113/143	>0.005
Age (3-15Y)	10	11	>0.005

Decreased prevalence of pediatric dizziness/vertigo may be due to the declining annual birth rate.

Most (80%) pediatric vertigo/dizziness were referred to VM or BPV of childhood
→ "vestibular migraine of childhood"



- Young YH. *112th TOS, 2022 July*

Vestibular Migraine of Childhood (VMC)

(Barany Society and the International Headache Society)

- Diagnostic criteria
  - A. At least **five** episodes with vestibular symptoms of moderate or severe intensity, lasting between five minutes and 72 hours
  - B. A current or past history of migraine *with or without aura*
  - C. At least **half of episodes** are associated with at least one of the following three migraine features:
  - D. Age < 18 years
  - E. Not better accounted for by another headache disorder, vestibular disorder, or other condition

1. Headache with at least two of the following four characteristics:
   a) One sided location
   b) Pulsating quality
   c) Moderate or severe pain intensity
   d) Aggravation by routine physical activity
2. Photophobia and phonophobia
3. Visual aura

The most intense symptom (and common complaint) in pediatric migraine is usually gastrointestinal upset and fever rather than headache or visual disturbances.

- *van de Berg et al. J Vestibular Research* 2021.

Probable Vestibular Migraine of Childhood (probable VMC)

(Barany Society and the International Headache Society)

- Diagnostic criteria

A. At least **three** episodes with vestibular symptoms of moderate or severe intensity, lasting between five minutes and 72 hours

B. Only **one** of the criteria B and C for Vestibular Migraine of Childhood

C. Age < 18 years

D. Not better accounted for by another headache disorder, vestibular disorder, or other condition

B. A current or past history of migraine *with or without aura*

C. At least **half of episodes** are associated with at least one of the following three migraine features:

1. Headache with at least two of the following four characteristics:
   a) One sided location
   b) Pulsating quality
   c) Moderate or severe pain intensity
   d) Aggravation by routine physical activity
2. Photophobia and phonophobia
3. Visual aura

- *van de Berg et al. J Vestibular Research* 2021.

Recurrent Vertigo of Childhood (RVC)

(Barany Society and the International Headache Society)

- Diagnostic criteria

A. At least **three** episodes with vestibular symptoms of moderate or severe intensity, lasting between one minutes and 72 hours

B. None of the criteria B and C for Vestibular Migraine of Childhood

C. Age < 18 years

D. Not better accounted for by another headache disorder, vestibular disorder, or other condition

B. A current or past history of migraine *with or without aura*

C. At least **half of episodes** are associated with at least one of the following three migraine features:

1. Headache with at least two of the following four characteristics:
   a) One sided location
   b) Pulsating quality
   c) Moderate or severe pain intensity
   d) Aggravation by routine physical activity
2. Photophobia and phonophobia
3. Visual aura

- *van de Berg et al. J Vestibular Research* 2021.

Meniere's Disease (MD) & Sudden Deafness (SD)

Meniere's disease in children

- Incidence: 2.3%
- Positive family history: 33%
- Bilateral affliction: 67%

Sudden deafness in children

- Incidence: 7% → 2%
  - Related to Global MMR vaccination policy ?
- Causes:
  - Viral infection
  - Vascular insufficiency
  - Autoimmune disorders

MR Imaging using HYDROPS-Mi2 technique helps differentiate endolymphatic hydrops from sudden deafness in hearing handicapped children with acute hearing loss.

- Young YH. *112th TOS, 2022 July*

Persistent Postural-Perceptual Dizziness (PPPD)

(Barany Society and the International Headache Society)

- Diagnostic criteria

A. One or more symptoms of dizziness, unsteadiness, or non-spinning vertigo are present on most days for 3 months or more.
   1. Symptoms last for **prolonged** (**hours-long**) periods of time, but may wax and wane in severity.
   2. Symptoms need not be present continuously throughout the entire day.

B. Persistent symptoms occur without specific provocation, but are exacerbated by three factors:
   1. Upright posture,
   2. Active or passive motion without regard to direction or position, and
   3. Exposure to moving visual stimuli or complex visual patterns.

C. The disorder is **precipitated by conditions** that cause vertigo, unsteadiness, dizziness, or problems with balance including acute, episodic, or chronic vestibular syndromes, other neurologic or medical illnesses, or psychological distress.
   1. When the precipitant is an acute or episodic condition, symptoms settle into the pattern of criterion A as the precipitant resolves, but they may occur intermittently at first, and then consolidate into a persistent course.
   2. When the precipitant is a chronic syndrome, symptoms may develop slowly at first and worsen gradually.

D. Symptoms cause **significant distress** or **functional impairment**.

E. Symptoms are not better accounted for by another disease or disorder.

- *Staab* et al. *J Vestibular Research 2017.*

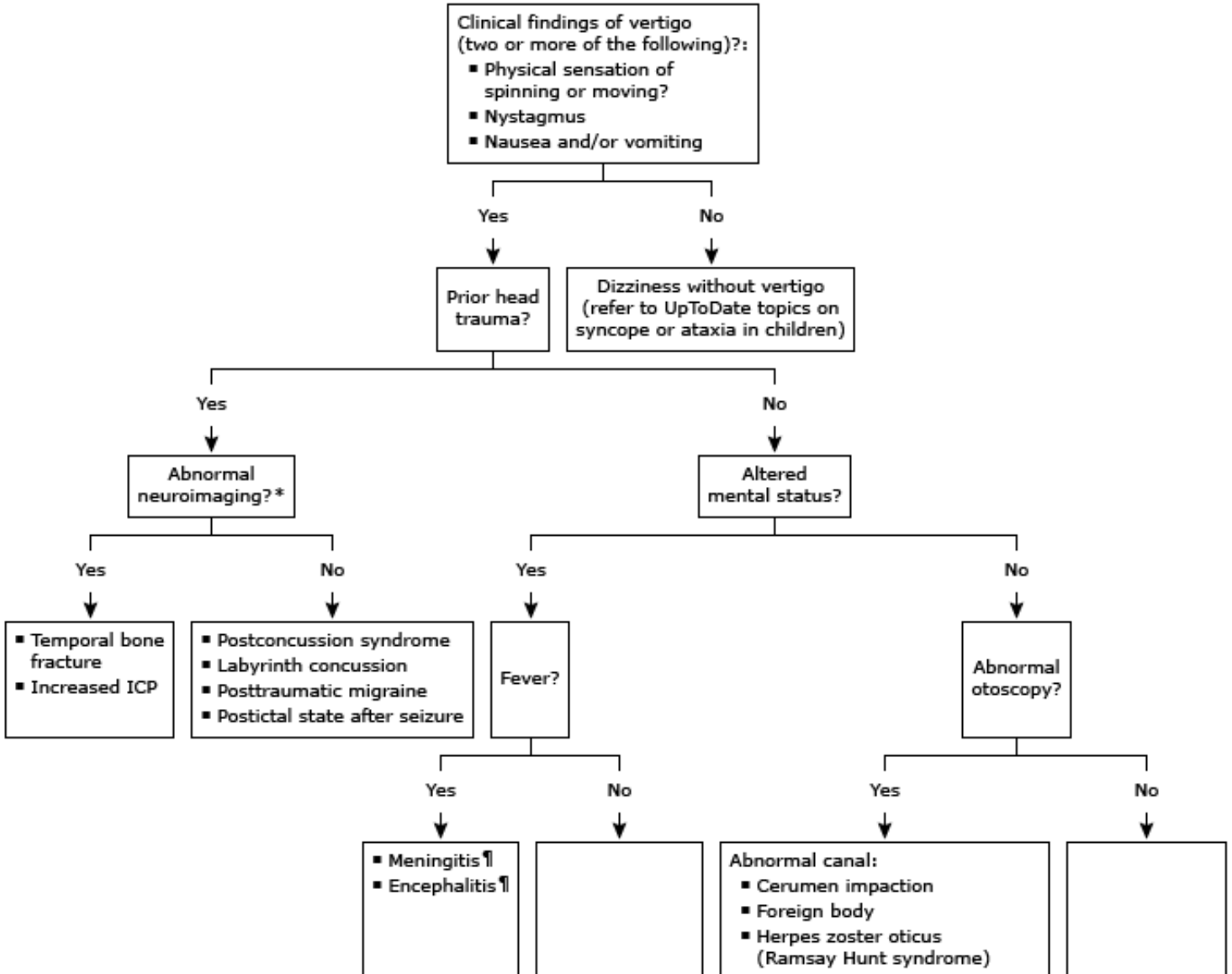
Features of PPV, SMD, VV, and CSD that informed the definition of PPPD

	PPV [13]	SMD [39]	VV [15]	CSD [79, 81]
Primary Symptoms (criteria A.1–3)				
Dizziness	✓✓	✓	✓✓ [22, 23]	✓✓
Unsteadiness	✓✓	✓✓	✓✓	✓✓
Non-spinning vertigo	✓✓	✓✓	✓✓	✓
Temporal profile (Criteria A.1–3)				
	Fluctuating with momentary flares	Situational (provoked)	Situational (provoked), Persistent [23]	Persistent with diurnal variability [27]
Provocative factors (Criteria B.1–3)				
Upright posture	✓✓			✓ [75]
Active or passive motion	✓	✓	✓	✓✓
Moving visual stimuli or complex patterns	✓	✓	✓✓	✓✓
Precipitants (Criterion C.1)				
Vestibular syndromes	✓	✓	✓	✓
Other medical illnesses	✓			✓
Psychological distress	✓	✓		✓
Course of illness (Criteria C.1.a-b)				
	Long-standing, waxing/waning [18]	May be long-standing	May be long-standing	Chronic
Physical exam and laboratory findings (Criterion E)				
	Normal	Somatosensory dependence on posturography [41]	Central or peripheral vestibular deficits	Abnormalities related to comorbid conditions [75]
Features not incorporated into PPPD				
Anxiety	Part of PPV	Associated with SMD [41]	Associated with prolonged VV [23]	May be comorbid with CSD [80]
Depression	Part of PPV			May be comorbid with CSD [80]
Personality traits	Obsessive-compulsive traits are part of PPV			Neurotic, introverted traits may be risk factors for CSD [76]

- *Staab* et al. *J Vestibular Research 2017.*

UpToDate®

Approach to the child with true vertigo



History Taking of Dizzy Children

Ask for	Comments	Possible Disease		
Type of vertigo/dizziness	Rotatory vertigo, imbalance, gait instability	Peripheral lesions		
	Lightheadness	VM, VBI, PPPD		
Duration of symptoms (Attacks lasting)	Seconds	BPPV		
	Minutes	MD	VM	
	Hours	MD	VM	
	Days		VM	Labyrinthitis
	Months and years	PPPD, Cerebellar ataxia, Tumor		
Provoking factors	Change of head position	BPPV		
	Coughing, sneezing	Perilymph fistula, SCD		
	Specific foods	VM		
Additional symptoms	Hearing loss, tinnitus or pressure in the ear	MD, SD		
	Headache	VM		

- Jahn K. *Handb Clin Neurol.* 2016.

Vestibular Function Test

- Caloric test
- Vestibular evoked myogenic potential (VEMP)
  - Cervical VEMP (cVEMP)
  - Ocular VEMP (oVEMP)
- Rotary chair
- Posturography
- Head impulse test (HIT)
  - at the bedside
  - utilizing video head impulse test (vHIT)

The Functional Development of Vestibular System in Growing Children

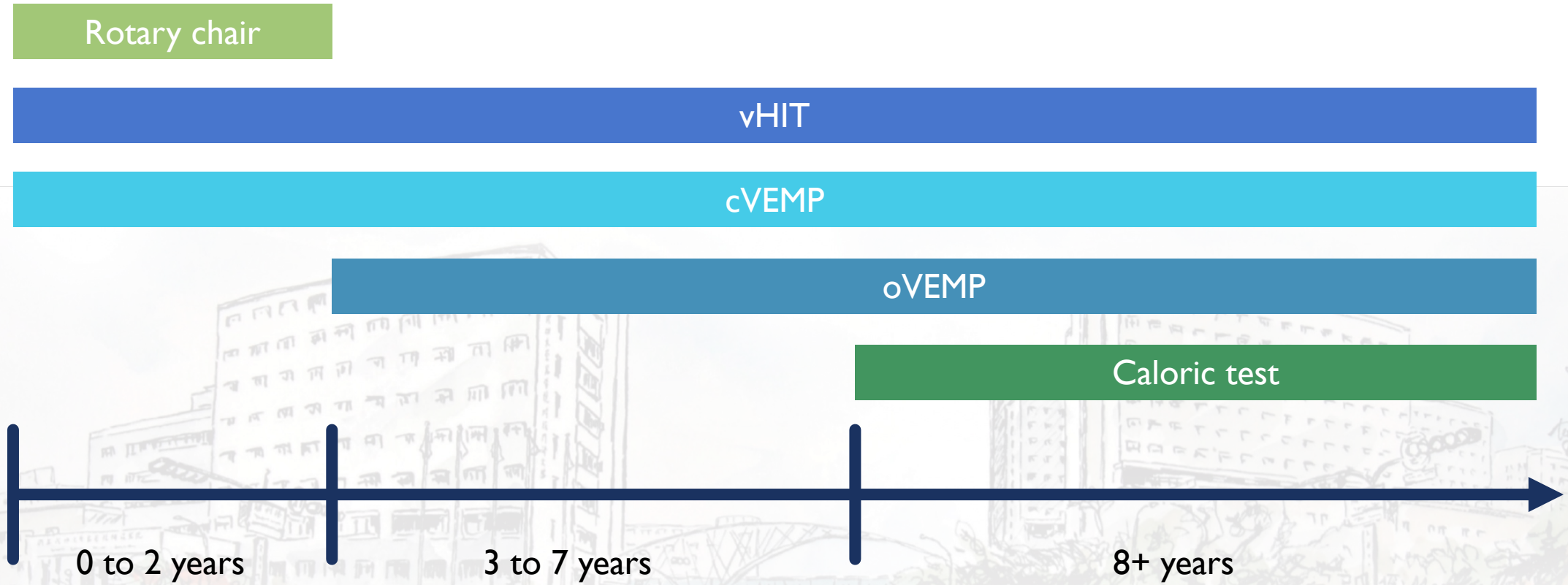
Table 1
Assessment for the functional development of vestibular system in growing children.

Test	Newborn	<3 Y	3–14 Y	Approach to adult level
Rotational test	+	+	+	1 Y
Caloric test	+	+	+	2 Y
Ocular VEMP test	–	±	+	3 Y
Foam posturography	–	–	+	12 Y
Cervical VEMP test	+	+	+	Adolescent

+: Performable; –: un-performable; ± performable after 2 Y.

- Young YH. *Int J Pediatr Otorhinolaryngol.* 2015.

Age-Oriented Vestibular Function Testing



- Janky & Rodriguez. *Semin Hear.* 2018.

Management – Peripheral Cause

Therapy of peripheral vestibular vertigo and dizziness in childhood

Clinical syndrome	Therapeutic options
Benign paroxysmal positional vertigo (BPPV) • Posterior canal (up to 90%) • Horizontal canal (about 10%) • Anterior canal (<1%)	Specific release maneuvers • Epley maneuver • Lempert (BBQ) maneuver
Acute unilateral vestibular failure Labyrinthitis • Viral • Bacterial (in meningitis) • Serous (otitis) • Autoimmune (e.g., Cogan's syndrome) Traumatic Vestibular neuritis	General measures Days 1–3: symptomatic treatment with vestibular suppressants (e.g., dimenhydrinate) Early mobilization to support central compensation Therapy based on the specific cause: • Viral: in herpes zoster oticus: acyclovir 3 × 5 mg/kg/day • Bacterial: antibiotics • Serous: treatment of otitis (antibiotics) • Autoimmune: prednisolone, 1 mg/kg/day, dose reduction depends on response • Vestibular neuritis: prednisolone, 1 mg/kg/day, reduction by 20% every third day

- Jahn K. *Handb Clin Neurol.* 2016.

Management – Peripheral Cause

Therapy of peripheral vestibular vertigo and dizziness in childhood

Clinical syndrome	Therapeutic options
Vestibular paroxysmia	Carbamazepine, 2–6 mg/kg/day Oxcarbazepine, 4–8 mg/kg/day
Perilymph fistula • From middle to inner ear (posttraumatic, postinfectious, cholesteatoma) • From inner ear to the middle cranial fossa (superior canal dehiscence)	• Therapy of underlying disease • Conservative therapy with avoidance of provocation • Surgery infrequently necessary
Bilateral vestibulopathy • Congenital • Postinfectious (meningitis) • Toxic (aminoglycosides) • Malnutrition (vitamin B_{12}, folic acid) • Autoimmune • Degenerative (spinocerebellar ataxia) • Neoplastic (e.g., bilateral vestibular schwannoma) • Idiopathic	• Balance training to support sensory substitution by visual and somatosensory systems • Treatment of the specific cause

- Jahn K. *Handb Clin Neurol.* 2016.

Management – Central cause

Treatment of central vestibular vertigo and dizziness in childhood

Clinical syndrome	Therapeutic options
Central lesion	
Neoplastic (e.g., cerebellar/brainstem tumor)	Therapy based on the etiology
Degenerative/hereditary (e.g., spinocerebellar ataxia, episodic ataxia)	**Episodic ataxia type II** Acetazolamide, 5–10 mg/kg/day 4-Aminopyridine, 5 mg (qd, bid, tid, experience in children based on single cases)
Inflammatory (e.g., brainstem encephalitis)	**Downbeat/upbeat nystagmus**
Vascular (e.g., malformation)	4-Aminopyridine (see above)
Traumatic (e.g., brainstem concussion)	
Epileptic (e.g., vestibular aura)	

- Jahn K. *Handb Clin Neurol.* 2016.

Management – Central Cause

Treatment of central vestibular vertigo and dizziness in childhood

Clinical syndrome	Therapeutic options
Migraine-related	
Benign paroxysmal vertigo of childhood Vestibular migraine Basilar-type migraine (migraine with brainstem aura)	Drug prophylaxis rarely necessary because of the benign course; prophylaxis in cases with frequent or severe attacks (falls) possible (see below) Avoidance of provoking factors (alimentary, stress, lack of sleep); relaxation techniques; sufficient physical activity (sports); sufficient fluid intake Drug prophylaxis recommended with frequent (>3/month) and/or severe attacks (>72 hours) • Magnesium aspartate, 200–400 mg/day • Propranolol, 1–2 mg/kg/day • Metoprolol succinate, 0.5–1 mg/kg/day • Topiramate, 1–2 mg/kg/day • Amitriptyline, 0.5–1 mg/kg/day • Valproic acid, 10–20 mg/kg/day • Levetiracetam, 20–30 mg/kg/day
Motion sickness	Behavioral prophylaxis by visual control (looking out of the car), avoidance of heavy meals before traveling,sufficient fresh air, distraction Drug prophylaxis • Dimenhydrinate, 1–2 mg/kg, every 6 hours

- Jahn K. *Handb Clin Neurol.* 2016.

Drugs used or evaluated in vestibular migraine and recurrent vertigo of childhood (off-label)

	Mechanism(s) of Action	Dosage Suggested	Route of Administration
Antiepileptics			
Levetiracetam	Not completely clear. It seems to act on intraneuronal calcium levels, inhibiting N-type calcium currents and lowering calcium release. Modulation of GABA and glycine gated currents. Binding to synaptic vesicle protein 2A.	20–40 mg/kg/day [27–29] in children aged 4–17 in a clinical trial for migraine prophylaxis (*off-label*) Not approved in children under 12 years old (the USA, seizures). Not approved under 16 years in Italy.	OS
Topiramate	Reduction in voltage-gated sodium channel currents. Activation of potassium and $GABA_A$ receptor currents. Blocking of AMPA/kainate receptors. Weak inhibitor of carbonic anhydrase.	No trials on vestibular migraine patients but used for migraine prophylaxis (*on-label*). 1–4 mg/kg/day in two doses [21,27,30] titrated slowly in 8–12 weeks. It may be given in children ≥2 years, but is approved for migraines in patients ≥12 years in the USA. Children ≥12 years: 50 mg BID with a gradual titration [31].	OS
Valproic acid	Possible increase in GABA levels	Migraine prophylaxis (*off-label*) 10–30 mg/kg/day [27,30,32]. Risk of serious adverse events in children <3 years: use only if there is urgent need and in monotherapy.	OS
Antidepressants			
Amitriptyline	Anticholinergic and antiadrenergic properties. Inhibition of norepinephrine and serotonin uptake.	No placebo-controlled trial, but some data have been collected. Used in clinical practice for migraine prophylaxis (*off-label*). A total of 0.5–1 mg/kg/day. Because of its side effects, slow titration in 8–12 weeks to the goal dose of 1 mg/kg/day (dose increase in 0.25 mg/kg/day every two weeks) [27,30]. Not recommended in patients under 12 of age [33] [a].	OS
Antihistamines			
Cyproheptadine	Antagonist of H1 receptor [34]. Serotonin antagonist [35] and anticholinergic effect [36].	Migraine prophylaxis (*off-label*). A total of 0.2–1.5 mg/kg/day (0.2 mg/kg/day is considered the most common dosage) mainly in children under 6 years of age [30]. Use in children ≥2 years only.	OS
Flunarizine	Antagonist of H1 receptor and calcium antagonist [37].	Migraine prophylaxis (*off-label*)—5–10 mg/day [27,30,38] [b].	OS

If not differently specified, data reported can be found in Summary of Product Characteristics (SmPC). AMPA, α-amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid; GABA, gamma-aminobutyric acid; OS, oral. [a] = contraindicated in children under 18 years in Italy. [b] = contraindicated in children under 18 years in Italy, not available in the USA.

Cypromin
2-6 years

- Viola *et al. Children* 2022.

Drugs used or evaluated in vestibular migraine and recurrent vertigo of childhood (off-label)

Triptans
≧ 6 years

	Mechanism(s) of Action	Dosage Suggested	Route of Administration
β-blockers			
Propranolol	Non-selective, beta-adrenergic receptor-blocking agent	Migraine prophylaxis (*off-label*) in children aged 3–15 years—1–4 mg/kg/day [21,27,30,39,40] [a].	OS
Triptans			
Almotriptan	Agonist of 5HT1D receptor	Tested in adolescents 12–17 years at 12.5 mg [41]. Approved for migraine treatment in patients of 12–17 years with a history of migraines with or without aura, and who have migraine attacks that usually last 4 h or more: dosage 6.25–12.5 mg [b].	OS
Rizatriptan	Agonist of 5HT1B and 5HT1D receptors	Migraine treatment (*on-label*, the USA). <40 kg: 5 mg. ≥40 kg: 10 mg [42,43] in patients 6–17 years old (OS) [b].	OS
Zolmitriptan	Agonist of 5HT1B and 5HT1D receptors. It has also a minor action on 5HT1A	Migraine treatment A 2.5 mg (OS) dosage showed good results in children of 6–13 years [44] [a] in clinical trials (*off-label*).	OS, NS
		A total of 5 mg (NS) in patients of 12–17 years [45] [b] is approved for migraine treatment (*on-label*, the USA).	
Other drugs			
Coenzyme Q10	Antioxidant action. It also favors mitochondria physiology [21].	Migraine prophylaxis:100 mg in children ≥3 years [46].	OS
Magnesium aspartate	Serotoninergic action [47–49]	Migraine prophylaxis: 50/200 mg twice a day, respectively [49]. A total of 200–400 mg or 9 mg/kg divided three times daily in children of 3–17 years [30,50].	OS

If not differently specified, data reported can be found in SmPC, AMPA, α-amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid; BSA, body surface area; GABA, gamma-aminobutyric acid; IM, intramuscular; IV, intravenous; OS, oral; TD, transdermal. [a] = contraindicated in children under 18 years in Italy and the USA, [b] = contraindicated in children under 18 years in Italy.

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Drugs used or evaluated in vestibular migraine and recurrent vertigo of childhood (no trials)

	Mechanism(s) of Action	Dosage Suggested	Route of Administration
β-blockers			
Metoprolol	Selective β1 receptor blocker	0.5–1 mg/kg/day [50] for migraine prophylaxis. Safety and effectiveness of metoprolol succinate have not been established in patients <6 years of age [51] [a].	OS
Other drugs			
Riboflavin	It favors mitochondria energy cycle [21]	Migraine prophylaxis: 200–400 mg [21] in children/adolescents 9–19 years in a retrospective study.	OS

If not differently specified, data reported can be found in SmPC, AMPA, α-amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid; BSA, body surface area; GABA, gamma-aminobutyric acid; IM, intramuscular; IV, intravenous; OS, oral; TD, transdermal. [a] = contraindicated in children under 18 years in Italy and the USA.

- Viola *et al. Children* 2022.

Rationale, current clinical indications, and dosages of peripheral vestibular vertigo drugs in children

(indication to use)

	Mechanism(s) of Action	Current Clinical Indications	Dosage Suggested	Route of Administration
Anticholinergics				
Scopolamine	Non-selective muscarinic blocker [140]	Motion sickness (avoid in children under 10 years of age) [141].	1 mg (TD) [141] 0.006 mg/kg (IM) [141] dose, repeat every 6–8 h.	IM, IV, TD, OS, nasal spray [141]
Antihistamines				
Dimenhydrinate	Antagonist of H1 receptor [142]	Motion sickness. No clinical trials in VN and MD, although suggested by some authors [50,73,141].	2–6 years: 25–75 mg (OS). 7–12 years: 25–150 mg (OS) or 1–2 chewing gum of 25 mg [92]. 1.25 mg/kg of body weight or 37.5 mg/m 2 of body surface area four times daily (IM, maximum 300 mg) [143]. 1–2 mg/kg in VN [50].	IM, OS (cps. chewing gum) [92,143]
Meclizine	Antagonist of H1 receptor [144]	Motion sickness (use carefully under 12 years, not available in Italy) [103,141,145].	25–50 mg daily in children over 12 years [106,146,147].	OS [146]
Promethazine	Antagonist of H1 receptor. Antidopaminergic and anticholinergic properties [121,122]	Motion sickness (in the USA, off-label in Italy) [148].	12.5 mg to 50 mg. There is also a syrup form of 6.25 mg/5 mL (OS) [123,124]. In pediatrics, dosing adjustments are needed in function of the patient weight and the indication. For children, promethazine hydrochloride tablets, syrup, or rectal suppositories, 12.5 to 25 mg, twice daily, may be administered [149]. Contraindicated under 2 years of age [127,128]. 2–5 years: 5–7.5 mg. 5–10 years: 7.5–12.5 mg. 25 mg in general population (IM) [129].	OS, IM [129]

IM, intramuscular; IV, intravenous; MD, Meniere's Disease; OS, oral; TD, transdermal; VN, vestibular neuritis.

- Viola *et al. Children* 2022.

Rationale, current clinical indications, and dosages of peripheral vestibular vertigo drugs in children

(off-label compounds)

	Mechanism(s) of Action	Current Clinical Indications	Dosage Suggested	Route of Administration
Antihistamines				
Cinnarizine	Antihistaminic, antiserotonergic, antidopaminergic, and calcium channel-blocking activities [130].	Motion sickness (more properly in balance disorders, not available in the USA) [130,150].	30–75 mg 2 h before the start of the trip, repeating lower doses of 15 to 50 mg every 8 h (in adults). No information of possible dosage in 12–18 years. Children 5–12 years: 15–25 mg 2 h before departure; repeated doses of 7.5–15 mg if necessary [136] [a].	OS
Cyproheptadine	Antagonist of H1 receptor [34]. Serotonin antagonist [35] and anticholinergic effect [36].	Motion sickness [103]	Not specified in dedicated paper. *SmPC dosages below.* Adults: 4–20 mg daily, 2–6 years: 2 mg twice or thrice daily (max 12 mg), 7–14 years: 4 mg thrice daily (max 16 mg) [151].	OS
Flunarizine	Antagonist of H1 receptor and calcium antagonist [37].	MD	2.5–5.0 mg daily in one clinical trial for MD (24 children <15 of age) [73].	OS

MD, Meniere's Disease; OS, oral; TD, transdermal; VN, vestibular neuritis. [a] = contraindicated in children Italy and the USA.

- Viola *et al. Children* 2022.

Rationale, current clinical indications, and dosages of peripheral vestibular vertigo drugs in children

(potentially useful drugs, with no trials in children)

	Mechanism(s) of Action	Current Clinical Indications	Dosage Suggested	Route of Administration
Diuretics				
Bendroflumethiazide	Inhibition of sodium chloride co-transporter in the distal convoluted tubule [83,152].	MD [82]	1.25 mg daily in a case report [82] (6-year-old child).	OS
Hydrochlorothiazide	Inhibition of sodium chloride co-transporter in the distal convoluted tubule [83,152].	MD [76,82]	6.25 mg [82] (7-year-old child) [a].	OS [83]
Spironolactone	Mineralocorticoid receptor antagonist [153].	MD [76]	Not specified in dedicated papers [b].	OS [87,153]
Other drugs				
Griffonia simplicifolia/Mg	Serotoninergic action [47–49]	Motion sickness [49]	Pediatric dosing data are not available. 50/200 mg twice a day, respectively, in adults [49].	OS
Hydrocortisone	Anti-inflammatory effect, acting on gene transcription [154]	MD (low evidence) [60,73,75] and VN [155]	Pediatric dosing data are not available. Further studies are needed in population under 18 years. Oral formulations are available for adults in 5 mg and 20 mg doses. (20–40 mg maintenance dose) [154]. Dosage is generally based on weight [156].	OS
Isosorbide dinitrate	Vasodilator and hypotensive effect [78]	MD [73,75,79]	Pediatric dosing data are not available; 5–80 mg daily in adults formulation [78].	OS
Methylprednisolone	Anti-inflammatory effect, acting on gene transcription [157]	VN [155] and MD (low evidence) [60]	Pediatric dosing data are not available; 4–48 mg in general population. Dosage is generally based on weight [156,158].	OS [56]
Ondansetron	5HT3 antagonist [83,159]	Motion sickness [103]	Pediatric dosing data are not available; 5 mg/m^2 or maximum three doses of 0.1–0.15 mg/kg every 4 h (IV, max intravenous dose 4–8 mg). BSA <0.6 m^2 (≤10 kg): 2 mg twice daily, BSA ≥ 0.6 m^2 (>10 kg): 4 mg twice daily (OS, max daily dose 32 mg) [83].	IV, OS [83]

BSA, body surface area; IM, intramuscular; IV, intravenous; MD, Meniere's Disease; OS, oral; VN, vestibular neuritis. [a] = contraindicated in children Italy and the USA, [b] = contraindicated in children in the USA.

- Viola *et al. Children* 2022.

CASES DISCUSSION

Case 1

(First visit: 07.01.22)

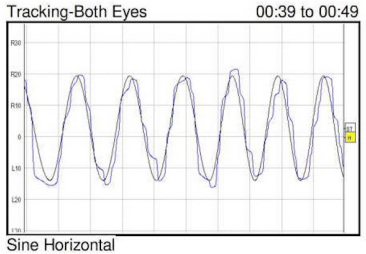
- 14 y/o girl, Height 160 cm, Weight 51 kg
- Intermittent spinning sensation noted for 1 month
  - Duration: 5-6 minutes earthquake-like
  - Precipitation factor: head motion and postural change
- Denied hearing loss, tinnitus, ear discomfort, headache, nausea/vomiting, limb weakness, premenstrual period, head trauma, recent URI
- Stress in life: lacking sleep due to school exam
- Similar episode occurred 6 months ago

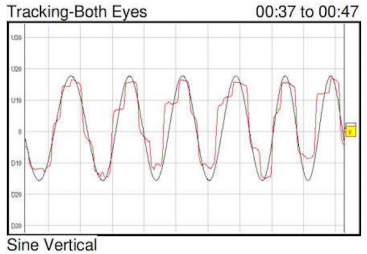
- PE & NE:
  - Otoscopy: normal eardrum and ear canal
  - No spontaneous or gaze-evoked nystagmus
  - Dix-Hallpike & head roll test: no nystagmus
  - F-N-F test: no dysmetria
  - Romberg test & Tandem gait: no imbalance
- PTA: normal hearing

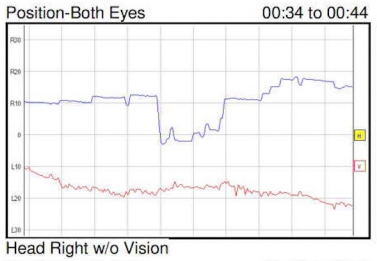
- **Functional dizziness** or **VMC**
- Management:
  - Diphenidol 25mg 1tab TID PO
  - Flunarizine 5mg 1tab HS PO
  - Encourage sufficient sleep and water intake

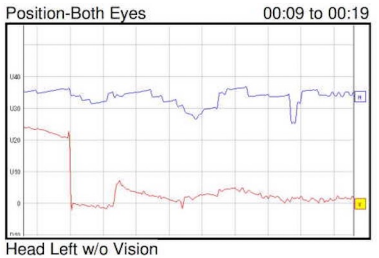
Vestibular Function Test – Videonystagmography (VNG)

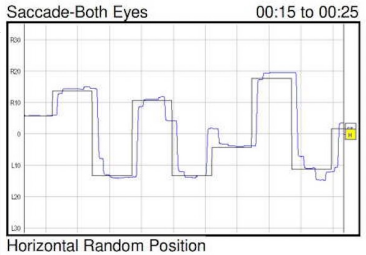
(07.13.22)

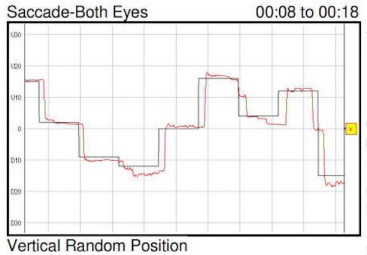


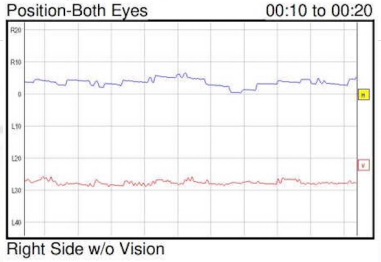


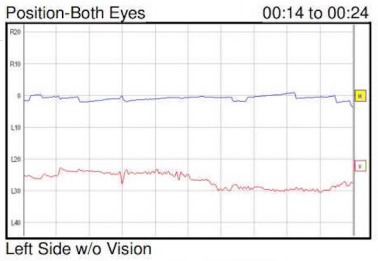


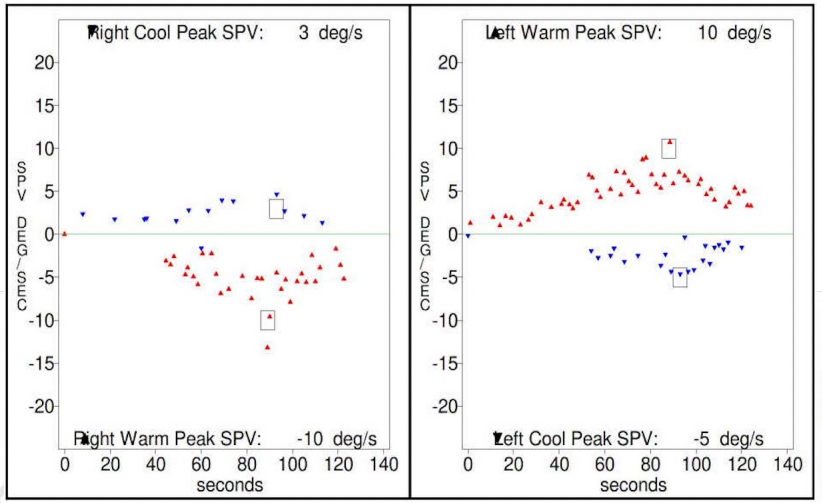










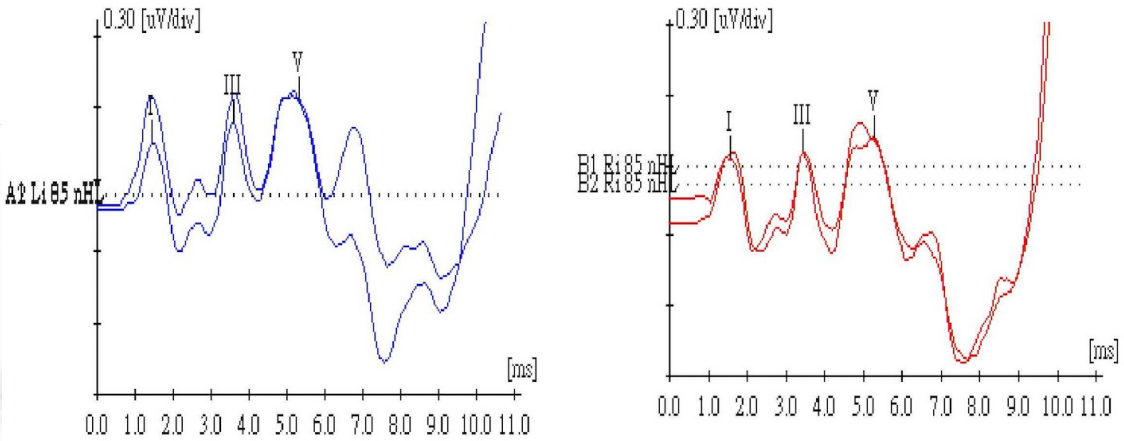


- no nystagmus was noted in gaze test with vision
- right beating nystagmus was noted when gazing to right side without vision
- smooth pursuit and saccade was noted
- right side-dominant geotropic nystagmus was noted in positional test
- Caloric test: decreased bilateral responses with canal paresis 7% in right ear

Congenital bilateral vestibular neuropathy ?
Retrocochlear lesion?

Follow-up

ABR: normal wave I, III, V latency (07.27.22)



Collection Parameters						Latencies (ms)					Interlatencies (ms)		
Wave	*Transducer*	*Ear*	*Intensity*	*Type*	*Frequency*	*I*	*II*	*III*	*IV*	*V*	*I-III*	*III-V*	*I-V*
A1	Headphones	**Left**	85dB nHL	Click	N/A								
A2	Headphones	**Left**	85dB nHL	Click	N/A	**1.46**		**3.58**		**5.33**	**2.12**	**1.75**	**3.87**
B1	Headphones	**Right**	85dB nHL	Click	N/A	**1.58**		**3.46**		**5.29**	**1.87**	**1.83**	**3.71**
B2	Headphones	**Right**	85dB nHL	Click	N/A								

(08.05.22)

- Dix-Hallpike & head roll test: no nystagmus
- Symptoms improved by medication and sleep

- Suggest observation and lifestyle adjustment
- May arrange cVEMP and oVEMP or brain MRI is s/s relapse or worsening

Case 2

(First visit: 03.04.22)

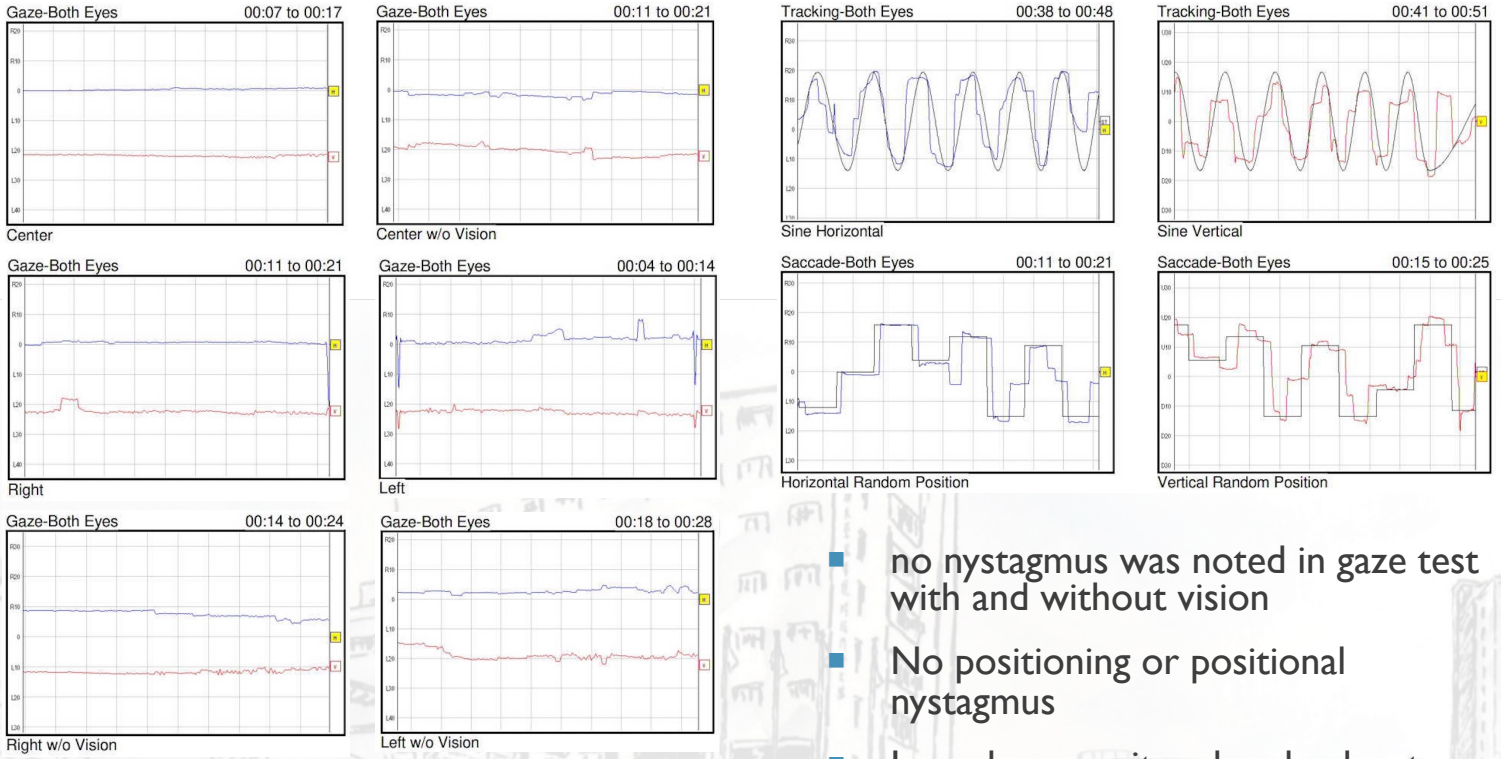
- 11 y/o boy, Height 144.5 cm, Weight 58 kg
- Intermittent dizziness, almost everyday, for about 2 months
  - Duration: all day long
  - Precipitation factor: nil
- without spinning sensation, hearing loss, tinnitus, vomiting or posture related
- motion sickness on vehicles
- intermittent throbbing headache (left parietal area) and nausea, with photophobia and phonophobia, without aura
- Father (52 y/o) was diagnosed systemic type myathenia gravis recently

- PE & NE:
  - Otoscopy: normal eardrum and ear canal
  - No spontaneous or gaze-evoked nystagmus
  - Dix-Hallpike & head roll test: no nystagmus
  - CN II – XII: normal
  - Muscle power: 5/5
  - F-N-F test: no dysmetria
  - Romberg test & Tandem gait: Borderline unsteady
- PTA: normal hearing

- **VMC**
- Management:
  - Diphenidol 25mg 1tab TID PO
  - Arrange VNG, suggest visit Ped. Neurologist

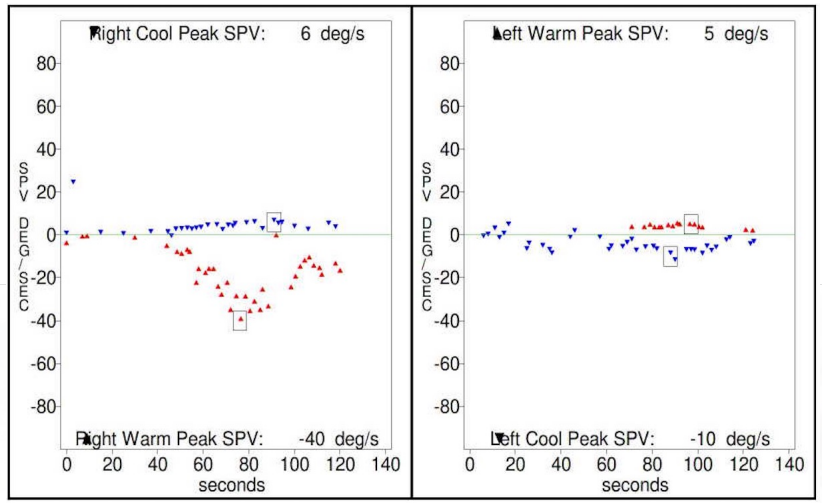
Vestibular Function Test – Videonystagmography (VNG)

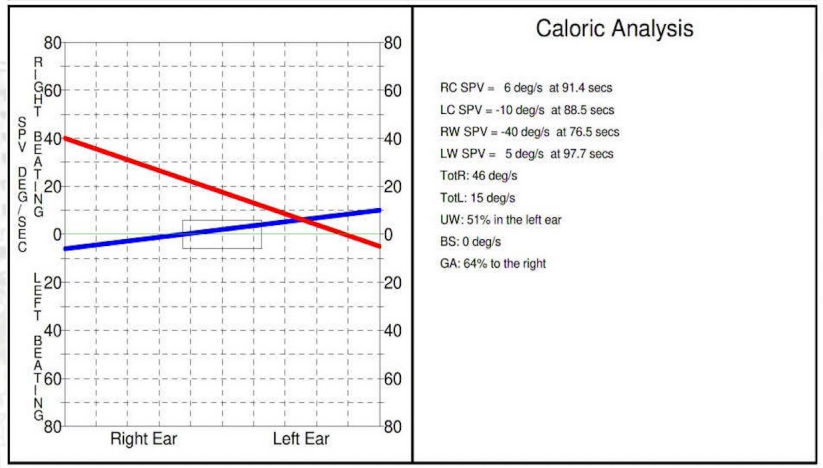
(03.23.22)



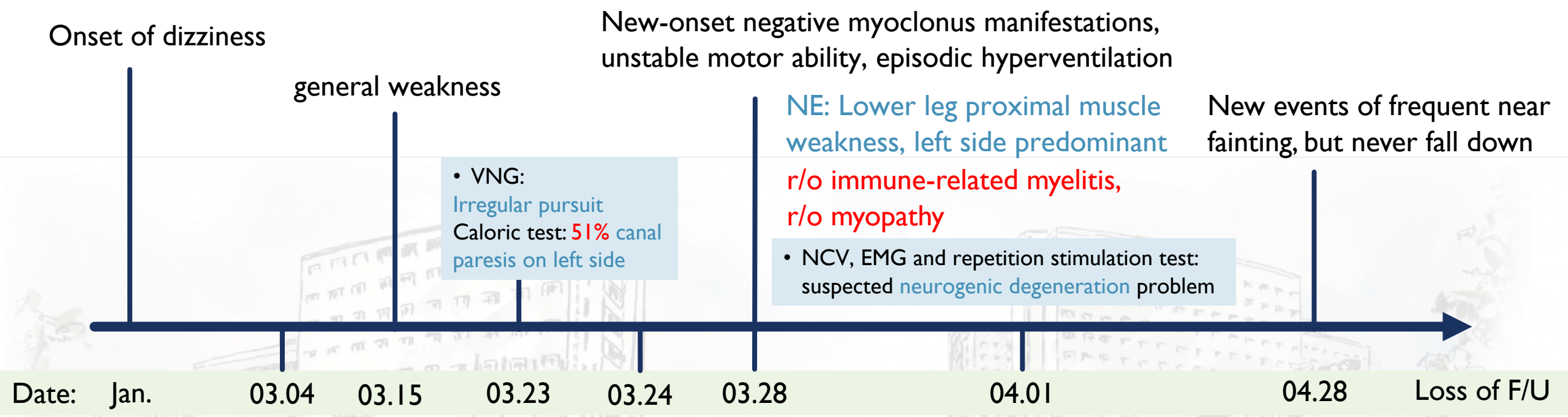
Left vestibular neuropathy, central lesion can't be excluded

- no nystagmus was noted in gaze test with and without vision
- No positioning or positional nystagmus
- Irregular pursuit and undershoot was noted in vertical saccade
- Caloric test: decreased bilateral responses with canal paresis 7% in right ear





Clinical Course



Take-Home Message

- Vestibular Migraine in Childhood (VMC) is the most common cause of pediatric vertigo and dizziness in any age group.
  - The prevalence of BPPV and Meniere's disease increase in early teens.
  - Somatoform vertigo (functional dizziness) is also a common condition, particularly in adolescence.
- Diagnosis should be made through comprehensive evaluation including history taking and vestibular functional test.
  - HIT and cVEMP are applicable for all children, posturography and oVEMP are suitable for children aged > 3 years, and caloric test should be avoided until age > 8.
- Lifestyle adjustment and vestibular rehabilitation are effective as well as pharmacotherapy
  - Prophylactic drug is recommended if frequent (≧3/month) and/or severe attacks (>72hr)

Thank you for your time and attention!
Welcome for questions and comments.