

The Differential Diagnosis of Vertigo in Children

A Systematic Review of 2726 Cases

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Objectives: Vertigo is a relatively common complaint in children with 5.3% of pediatric patients complaining of this symptom. Although the causes of vertigo have been well established in adults, the diagnoses in children have not been well described. The aims of this systematic review are to discover the current information regarding etiologies of vertigo in children and to determine the most common diagnoses that present with vertigo in pediatric patients.

Methods: PubMed, Scopus, and Embase were searched using the PRISMA guidelines. The inclusion and exclusion criteria were established a priori. All results were analyzed using a Bayesian methodology for point estimation and credible interval calculation.

Results: From the database searches, 1419 titles were reviewed. Twenty-two studies met inclusion criteria. From these studies, a total of 2726 children aged 2 months to 19 years were reported. The top 4 diagnoses associated with childhood vertigo include vestibular migraine (23.8%; credible interval, 22.3%–25.5%), benign paroxysmal vertigo of childhood (13.7%; credible interval, 12.4%–15%), idiopathic or no identified association (11.7%; credible interval, 10.5%–12.9%), and labyrinthitis/vestibular neuronitis (8.47%, credible interval, 7.46%–9.55%) accounting for approximately 57% of cases. Less common diagnoses included Meniere disease and central nervous system tumors.

Conclusions: Although the most common causes of pediatric vertigo include vestibular migraine and benign paroxysmal vertigo of childhood, the etiologies are myriad. Rates and credible intervals are provided to permit a probabilistic diagnostic approach to these children.

Key Words: vertigo, differential diagnosis, etiology

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Vertigo is defined as the “illusion of environmental motion,” classically described as “spinning” or “whirling.”¹ Those who experience vertigo often describe feeling as if the room is spinning around them.¹

The prevalence of dizziness and balance problems is 5.3% in the school-aged population. In adolescents, up to 72% of students from a 12th-grade class reported experiencing at least 1 episode of vertigo within the last 3 months.² The etiologies associated with vertigo in the pediatric age group are vast, ranging from otitis media to benign paroxysmal peripheral vertigo to migraine headaches.³

To date, many etiologies of childhood vertigo have been identified but not cataloged in an organized and useful way. Raucci et al⁴ reviewed 5 years of pediatric ED visits for vertigo but from only 1 tertiary care center. A systematic review in 2014 identified the main pathologies associated with vertigo in children; that study lacks methods of full text article inclusion and only included a small number of studies in the final analysis.⁵ The literature search for that review was also completed before

the most recent study containing a large number of subjects. The objectives of the present systematic review and meta-analysis were (1) to identify the most common disorders associated with childhood vertigo and (2) to provide estimates of the relative rates for each etiology along with the associated uncertainty.

METHODS

The Preferred Reporting Items in Systematic Reviews and Meta-analyses guidelines were followed.⁶ The PubMed search was completed on November 14, 2016, without any language filters. The Embase and Scopus searches were completed on January 13, 2017. The inclusion criteria were as follows: (1) retrospective chart reviews and prospective case reviews of more than 10 cases; (2) patients younger than the age of 19 years; and (3) an English abstract. Studies that included children with a pre-established diagnosis of a condition associated with vertigo were excluded.

Search Strategy and Data Extraction

The Medline database search strategy (“vertigo” AND “children”) produced 1415 titles. The same strategy was used to search the Embase and Scopus databases. Two previously unidentified studies from Embase and 2 from Scopus that qualified for inclusion criteria were identified. The total number of studies included for review was 1419. Data were extracted using a predetermined data extraction tool. Data extraction was done by the first author (M.D.) and reviewed by the second author (M.T.D.).

Statistical Analysis

A Bayesian methodology for point estimation and credible interval calculation was used.⁷ The studies were ordered chronologically, and the rate from the first study was expressed as a beta probability mass and used as the conjugate prior for the next study, expressed as a Bernoulli function. The resulting posterior beta probability mass was used as the conjugate prior for the next study, and the process was reiterated until all of the studies had been included. From the last posterior distribution, the overall estimate of the proportion was determined along with symmetrical 95% credible intervals. All calculations were performed with the base package in R.

RESULTS

Literature Search

Of the 1419 articles reviewed, 906 titles were eliminated after screening for duplication and title analysis. Any title that did not involve diagnosis of vertigo was removed. Of the 513 abstracts remaining, 297 did not meet inclusion criteria. Full text reviews of 216 studies eliminated 111 (inadequate sample size and review articles). Of the remaining 105 studies, 83 studies were excluded (Fig. 1). The remaining 22 studies covered the time span of 1977 to 2017, included 2726 children, and formed the basis for this review (Table 1). Figure 1 describes the process of inclusion of studies.

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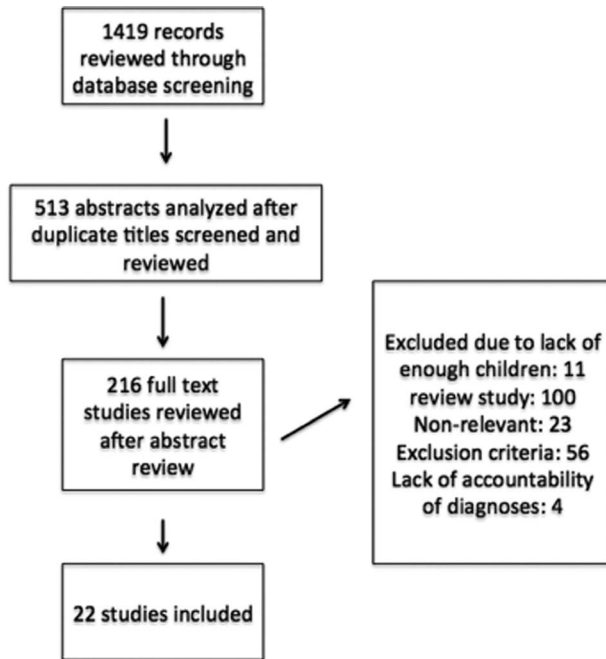


FIGURE 1. Results of literature search.

Data Analysis

The diagnoses with a rate estimate of approximately 1% or more are shown in Table 2. The most common disorders associated with childhood vertigo include vestibular migraine (VM)

TABLE 1. Included Studies

Study	Country	Sample Size
Sommerfleck et al, ⁸ 2016	Argentina	206
Rauci et al, ⁴ 2016	Italy	605
Batu et al, ⁹ 2015	Turkey	100
Lee et al, ¹⁰ 2014	Republic of Korea	105
Langhagen et al, ¹¹ 2015	Germany	112
Zainun et al, ¹² 2012	Malaysia	65
Gruber et al, ¹³ 2012	Israel	35
O'Reilly et al, ¹⁴ 2011	United States of America	132
Szirmai 2010 ¹⁵	Hungary	145
Balatsouras et al, ¹⁶ 2007	Greece	54
Erbek et al, ¹⁷ 2006	Turkey	50
Ravid et al, ¹⁸ 2003	United States of America	62
Choung et al, ¹⁹ 2003	South Korea	55
Weisleder and Fife, ²⁰ 2001	United States of America	31
D'Agostino et al, ²¹ 1997	Italy	282
Bower and Cotton, ²² 1995	United States of America	34
Eviatar et al, ²³ 1986	United States of America	22
Blayney and Colman, ²⁴ 1984	Wales	27
Eviatar and Eviatar, ²⁵ 1977	United States of America	50
Rosdan et al, ²⁶ 2015	Malaysia	24
Lee et al, ²⁷ 2017	South Korea	411
Riina et al, ²⁸ 2005	Finland	119
	No. subjects	2726

(23.8%; credible interval, 22.3%–25.5%), benign paroxysmal vertigo of childhood (BPVC) (13.7%; credible interval, 12.4%–15%), idiopathic or no identified association (11.7%; credible interval, 10.5%–12.9%), labyrinthitis/vestibular neuronitis (8.47%; credible interval, 7.46%–9.55%), and posttraumatic vertigo (8.36%; credible interval, 7.35%–9.43%). Syncope/orthostatic hypotension (6.79%; credible interval, 5.87%–7.76%) psychogenic causes, including malingering and neurosis (6.27%; credible interval, 5.39%–7.21%), Meniere disease (3.01%; credible interval, 2.4%–3.68%), seizure (2.82%; credible interval, 1.83%–2.87%), benign paroxysmal positional vertigo (2.14%; credible interval, 2.07%–3.28%), otitis media with effusion (2.09%; credible interval, 1.59%–2.66%), and bilateral vestibulopathy (2.09%; credible interval, 1.59%–2.66%) were the next most likely diagnoses. Central nervous system (CNS) tumor (1.21%; credible interval, 0.835%–1.65%) and airway infection (1.14%; credible interval, 0.774%–1.57%) occurred at a percentage of approximately 1%. Associations with rate estimates of less than 1% are shown in Table 3. Associated disorders that occurred only once in the final database are listed in Table 4.

DISCUSSION

Vertigo is a common complaint among children. In this report, VM, BPVC, and labyrinthitis/vestibular neuronitis accounted for 46% of cases and, in most cases, can be identified by physical examination.

Limitations

The main limitations to this study are the lack of accepted clinical definitions for many of the entities associated with childhood vertigo, the lack of a common diagnostic protocol across studies, and the lack of sufficient data to subset etiologies by age. The diagnosis of vertigo was determined by a physician and based on clinical examination in all studies but one, which used a pediatric dizziness questionnaire completed by patient and guardian.¹⁸ Although the exact criteria for each diagnosis and the details of the evaluation were not stated in every study. In 6 studies, the diagnosis of migraine used the International Headache

TABLE 2. Most Common Diagnoses

Disorder	95% Credibility Interval		
	Rate Estimate (%)	UCredL	LCredL
VM	23.8	25.5	22.3
BPVC	13.7	15	12.4
Idiopathic	11.7	12.9	10.5
Labyrinthitis/vestibular neuronitis	8.47	9.55	7.46
Posttraumatic vertigo	8.36	9.43	7.35
Syncope/orthostatic hypotension	6.79	7.76	5.87
Psychogenic	6.27	7.21	5.39
Meniere disease	3.01	3.68	2.4
Seizure	2.82	3.48	2.24
Benign paroxysmal peripheral vertigo	2.64	3.28	2.07
Otitis media with effusion	2.09	2.66	1.59
Bilateral vestibulopathy	2.09	2.66	1.59
CNS tumor	1.21	1.65	0.835
Airway infection	1.14	1.57	0.774

UCredL indicates upper credibility limit; LCredL, lower credibility limit.

Society guidelines.^{4,8,10,11,17,19} This guideline was published in 1988, and 6 of the studies were published between 1977 and 1991, before the time when the classification scheme would have been widely disseminated.³⁰ The remaining studies used physician experience to make the diagnosis of VM.

The International Headache Society recently published guidelines for the diagnosis of BPVC; however, only one study explicitly stated that these guidelines were used.⁸ The remaining studies used physician experience to make this diagnosis.

The lack of a unified diagnostic plan across studies suggests that some of the less common etiologies of vertigo may be underrepresented and that the number of undiagnosed cases may be overestimated.

Nevertheless, 2 conclusions can be drawn with some degree of certainty. First, the top 2 diagnosed conditions, VM (23.8%; credible interval, 22.3%–25.5%) and BPVC (13.7%; credible interval, 12.4%–15%), are by far the most likely diagnoses, accounting for approximately 37% of cases. A recent systematic review of vertigo in children identified 724 subjects, finding BPVC as the most common diagnosis (18.7% of cases) and migraine-associated vertigo as the second most common diagnosis (17.7%).⁵ This study differs from the present study in scope and in methodology, but none the less has comparable findings. Wiener-Vacher presented 2000 patients and, much like the present study, found that VM occurred at a percentage of 25%, BPVC at 20%; however, no data were released regarding the exact number of patients or diagnoses.³¹ Attempts to contact the author of this study were unsuccessful. However, given the reasonably close conclusions of the 2 studies mentioned previously and the present

TABLE 3. Diagnoses at <1%

Disorder	95% Credibility Interval		
	Rate Estimate (%)	UCredL	LCredL
Ototoxic drug	0.917	1.31	0.595
Demyelinating disease	0.917	1.31	0.595
Ataxia	0.77	1.13	0.478
Motor/dev delay	0.55	0.861	0.308
Motion sickness	0.477	0.768	0.254
Idiopathic sensorineural hearing loss	0.293	0.529	0.127
Delayed endolymphatic hydrops	0.22	0.428	0.0808
Complicated cholesteatoma	0.147	0.321	0.04
Perilymphatic fistula	0.147	0.321	0.04
Whiplash	0.147	0.321	0.04
Movement/neurodegenerative	0.147	0.321	0.04
Autoimmune hearing loss	0.11	0.265	0.0227
Metabolic disorder	0.11	0.265	0.0227
Postmeningitic	0.11	0.265	0.0227
Hypertension	0.11	0.265	0.0227
Kinetoses	0.0734	0.204	0.00889
Patulous eustachian tubes	0.0734	0.204	0.00889
Cytomegalovirus infection	0.0734	0.204	0.00889
Vascular	0.0734	0.204	0.00889
Encephalopathy	0.0734	0.204	0.00889
Congenital vestibular hypofunction	0.0734	0.204	0.00889

UCredL indicates upper credibility limit; LCredL, lower credibility limit; dev, developmental.

TABLE 4. Diagnoses With 1 Occurrence

CI recalibration
SSC dehiscence
Familial vertigo/ataxia syndrome
Congenital deafness
Lightning
Amblyopia
Astigmatism
Ear wax
Mal de débarquement
Insulin shock-related vertigo
Sinusitis-related vertigo
Chiari 1 malformation
Postoperative vertigo
CATCH 22 syndrome
Ophthalmic vertigo
Epstein-Barr Viral Infection
Oculomotor abnormality
Peripheral neuropathy
Mal de débarquement: illusion of movement felt as an after-effect of travel on ship, airplane, automobile, or plane ²⁹

SSC indicates superior semicircular canal dehiscence; CI, cochlear implant.

study, VM and BPVC can be considered the top 2 diagnoses with considerable confidence.

Second, life-threatening disorders such as CNS tumors and cardiac arrhythmias appear at an extremely low rate. CNS tumors, encephalopathy, and demyelinating disease all occurred at rates of approximately 1% or less. Together, these observations suggest that vertigo in children does not commonly represent a life-threatening or serious illness.

CONCLUSIONS

Vertigo is a common problem in childhood. Although the etiologies are myriad, the 4 most commonly identified associations are benign entities. An estimate of prior probability and uncertainty for each entity is provided as a roadmap for the evaluation of these patients. By combining these data with specific characteristics of diagnostic testing, the treating physician can estimate the probability of a specific diagnosis.³² In this way, diagnostic accuracy can be improved and diagnostic testing can be focused.

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