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ORIGINAL COMMUNICATION

Frequency, aetiology, and impact of vestibular symptoms in the emergency department: a neglected red flag

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Abstract

Objective We aimed to determine the incidence of all vestibular symptoms in a large interdisciplinary tertiary emergency department (ED) and to assess stroke prevalence, and frequency of other life-threatening aetiologies.

Methods In this 1-year retrospective study, we manually screened all medical records of 23,608 ED visits for descriptions of vestibular symptoms. Symptoms were classified according to the International Classification of Vestibular Disorders of the Bárány Society. We evaluated all patients older than 16 years in whom vestibular symptoms were the main or accompanying complaint. We extracted clinical, radiological, and laboratory findings as well as aetiologies from medical records.

Results We identified a total of 2596 visits by 2464 patients (11% of ED visits) who reported at least one vestibular symptom. In 1677/2596 visits (64.6%), vestibular symptoms were the main reason for the ED consultation. Vestibular symptoms were classified as dizziness (43.8%), vertigo (33.9%), postural symptoms (6.5%), or more than one symptom (15.8%). In 324/2596 visits (12.5%), cerebrovascular events were the aetiology of vestibular symptoms, and in 355/2596 visits (13.7%), no diagnosis could be established. In 23.8% of visits with vestibular symptoms as the main complaint, the underlying condition was life-threatening.

Conclusion Frequency and impact of vestibular symptoms in patients visiting the ED were higher than previously reported, and life-threatening aetiologies such as strokes are common. Therefore, awareness among physicians regarding the importance of vestibular symptoms has to be improved.

Keywords Emergency department · Vestibular symptoms · Stroke · Aetiology · Impact · Frequency

Abbreviations

CT	Computed tomography
ED	Emergency department
ENT	Ear, nose, and throat
MRI	Magnetic resonance imaging

Introduction

Vestibular symptoms are a major health problem in the general population, with reported incidences ranging from 4.9 to 59.2% [1, 2]. Particularly, in patients presenting in the emergency department (ED), vestibular symptoms are common and potentially medically significant [3]. Management of patients with vestibular symptoms in the ED is challenging, as the emergency setting requires rapid decision making and resources are often limited. Cerebrovascular diseases, one of the most feared underlying diagnoses, have been described in 4% of all consultations due to vestibular symptoms [3], but were missed in 35% of cases [4], suggesting that they often remain undetected. The relative imprecision of the National Institutes of Health Stroke Scale (NIHSS) in diagnosis of posterior circulation strokes might partially explain this finding [5].

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Previous studies on vestibular symptoms in the ED focused on a narrow spectrum of patients with neuro- or cardiovascular diseases in whom vestibular symptoms were the main complaint, neglecting patients with vestibular symptoms as an accompanying complaint [6–8]. Furthermore, in most studies, inclusion criteria were based on diagnostic codes or hospital administrative data rather than on a meticulous manual search of medical records [3, 9]. Information on all-cause prevalence, aetiology, and impact of vestibular symptoms, especially stroke prevalence, among patients seen in the ED is lacking. Clinical observations in our ED suggested that vestibular symptoms are more common than previously described and hazardous health conditions, especially strokes, are underdiagnosed. We hypothesised that this might be due to a selection bias in available literature: Traditionally, diagnosis of vestibular symptoms was made based on symptom characteristics [10]. However, this approach is misleading, as symptom characteristics do not correlate with the underlying aetiology of vestibular symptoms [11, 12]. Restricting study inclusion to a certain type of vestibular symptoms, therefore, no longer seems adequate. We aimed to (a) determine the 1-year prevalence of all vestibular symptoms as a main or accompanying complaint based on the new international classification and (b) to assess frequency of strokes or other life-threatening causes among patients with vestibular symptoms.

Methods

We performed a retrospective, single-centre study at a tertiary care and stroke centre serving a population of more than 1 million inhabitants. We read and manually searched all ED medical records of patients older than 16 years who presented at our interdisciplinary ED with vestibular symptoms over the course of 1 year (from January 1 to December 31 2013). In our ED, specialised ED physicians, neurologists, and ear, nose, and throat (ENT) physicians provide round-the-clock care for all patients. For walk-in patients, a specially qualified ED nurse assesses symptoms and vital signs and assigns them either to an ED physician, neurologist, or ENT physician. If a patient is admitted by ambulance, paramedics or pre-clinical emergency physicians inform the responsible hospital ED physician prior to arrival. In these cases, the ED physician assigns patients to one of the three disciplines based upon medical history and available resources. In our hospital, all emergency consultations are held at the ED, whereas scheduled patients are directly admitted to the ward or to the ambulatory clinic. Those patients were per definition ineligible for this cross-sectional study, as they did not need urgent consultations.

All patients referred to one of the three disciplines with a permanent ED team (ED physicians, neurologists, and ENT) were screened with a symptom-oriented approach based on the Classification of Vestibular Symptoms by the Bárány Society. This classification pursues a comprehensive approach by defining vestibular symptoms as "principal symptoms thought to arise from disturbances of the vestibular system, with this system defined broadly as the sensory inputs, central processing and motor outputs that relate to balance" [13]. It allows a more consistent description of vestibular symptoms, which are classified into four main categories: vertigo, dizziness, vestibulo-visual, and postural symptoms [13]. The term "vestibular symptoms" and its subterms are, therefore, not restricted to syndromes originating from the vestibular system, but cover the whole spectrum of systemic, central, and peripheral–vestibular disturbances of balance. We searched for German and Swiss–German words and descriptions fitting the definition provided by the Bárány Society and included all visits, where patients complained of new or worsened vestibular symptoms as the main symptom or as an accompanying symptom directly related to the ED visit. We excluded patients with preexisting stable vestibular symptoms, unconscious, or aphasic patients, and those with postural symptoms due to paresis or a neuromuscular problem. Furthermore, we excluded cases with missing or incomplete patient history and patients who refused consent to evaluate their medical records for research. In cases of uncertainty, two neuro-otology adjudicators reassessed inclusion, exclusion, and coding criteria (RK, GM).

Variables were assessed in a REDCap database with yes/no and multiple choice options, as well as free text forms if necessary [14]. Patient characteristics were recorded from the first visit in 2013. Vestibular symptoms and concomitant symptoms were recorded from all visits, including when multiple ED consultations took place with the same patients. Therefore, we differentiate in this article between "patients" and "visits". We assessed baseline characteristics (including vascular risk factors, comorbidities, and all types of drugs), the exact type of vestibular symptoms, accompanying symptoms, diagnostic procedures [magnetic resonance imaging (MRI), computed tomography (CT), neurovascular sonography, blood sampling, electrocardiogram, and neuro-otologic testing], and the presumed aetiology of vestibular symptoms. We classified vestibular symptoms according to the international consensus paper developed by the Committee for the Classification of Vestibular Disorders of the Bárány Society [13]. Originally, the classification by the Bárány Society also included vestibulo-visual symptoms ("false sensations of motion or tilting of the visual surround and visual distortion" [13]). As descriptions of vestibular symptoms also depend on spoken cultural and linguistic aspects, we were not able to identify descriptions of vestibulo-visual symptoms reliably, and therefore, we did not assess them. We defined vestibular symptoms as the main complaint if they were the reason for the ED visit or if they were one of the first three symptoms mentioned in the report. The main diagnosis was based on the ED report. In our hospital, an ischaemic stroke is usually defined according to the tissue-based definition. However, in cases of high clinical suspicion of an ischaemic stroke despite normal imaging, the World Health Organization's time-based definition is applied [15]. To improve sensitivity, we use dedicated ultra-thin-slice MRI protocols and perform follow-up imaging of patients in whom a H.I.N.T.S. test suggests a central lesion despite no diffusion-weighted imaging (DWI) lesion on acute MRI. Cases without a definite diagnosis or an unweighted differential diagnosis were classified as unknown. Medically relevant diagnoses were defined as those with a potential risk of imminent mortality or high morbidity according to a modified version of the classification used by Newman-Toker et al. [3]. An immediately life-threatening disease was defined as one that requires the highest priority medical assistance and often leads to admission to the intensive, intermediate care, or stroke unit. Potentially life-threatening causes were defined as diseases that sometimes require treatment in an intensive or intermediate care unit and usually lead to hospital admission, whereas patients with diseases that pose no immediate risk of harm to life can often be treated with ambulatory care or may be admitted to a general ward. Diagnoses with a wide range of possible outcomes were not classified. A comprehensive list of aetiologies attributed to the four categories is provided in the supplementary material (S1).

At our hospital, ENT physicians and neurologists receive regular structured training on neuro-otological testing. We, therefore, limited our analysis on neuro-otological testing to cases that were evaluated by an ENT physician and/or a neurologist.

Statistical analysis

The statistical analysis of this retrospective investigation was exploratory and made use of descriptive methods implemented in R (version 3.3.1) [16]. All of the patients included were analysed as part of the Total Population, which was further subdivided into subgroups according to whether vestibular symptoms were the main symptom or an accompanying symptom. No imputation of missing values was performed. For proportions, we reported 95% confidence intervals (95% CI) according to the Clopper–Pearson method.

Standard protocol approvals, registrations, and patient consents

The study was approved by the local ethics committee and was conducted in accordance with the Declaration of Helsinki. Given the retrospective nature of the study, informed consent was provided through a hospital-wide general consent. However, patients who withdrew consent for evaluation of their medical data had to be excluded in accordance with legal requirements.

Upon request, interested researchers can obtain a limited data set from the corresponding author.

Results

We screened all medical records of the 23,608 ED visits in 2013, and 2596 visits made by 2464 patients reporting new or deteriorated vestibular symptoms were included. Baseline characteristics are shown in Table 1. Mean age was 51.83 years (SD 20.2), and 50.8% were female. Medication use prior to admission was recorded for 71.5% of patients. The main vascular risk factor was hypertension (37.1%), 28.7% of patients had neurological comorbidities; 27.6% cardiovascular diseases and 19.6% psychiatric disorders.

Overall, the incidence of vestibular symptoms was 11% (2596/23,608 visits), and in 64.6% of visits (1676/2596), vestibular symptoms were the main complaint. Detailed information on symptoms and signs is shown in Tables 2 and 3. Dizziness was the most frequent vestibular symptom. It was reported in 59.9% of visits as an accompanying symptom and in 35.1% of visits as the main symptom. Vertigo was recorded at 39.4% of visits as the main symptom and in 23.9% of visits as an accompanying symptom. In 15.8% of visits, more than one type of vestibular symptoms was reported. Postural symptoms as the sole symptom were reported in only 6.5% of visits. Other complaints included nausea in 31.7% of visits, emesis in 18.3%, headache in 30.7%, and paraesthesia in 13.3% of visits. Otological symptoms such as tinnitus, hearing loss, otalgia, sensation of pressure in the ear, and otorrhoea were each reported in less than 5% of all visits.

Detailed information on diagnostic workup is shown in Table 2. Overall, cerebral imaging (MRI and/or CT) was performed in 41.3% of visits. MRI was performed in 27.2% of all visits, whereas a CT scan was ordered in 16.8%. In 2.8% of visits, patients underwent both CT scan and MRI. In 11.5% of visits, MRI showed pathological findings (accounting for 42.3% of all MRIs performed), while CT was abnormal in 4.9% of visits (accounting for 29.1% of all CT scans performed).

In 1096 visits, a neurologist and/or an ENT physician evaluated patients and neuro-otologic assessment was recorded. A bedside hearing assessment was performed in 57.9% of all visits, but a pathological result was only found in 7.6%. Other assessments were documented in the following proportion of patients: head impulse test (23%), otoscopy (21.1%), Weber test (19.6%), Rinne test (19.1%), and positioning manoeuvres (17.3%). The most frequently observed oculomotor disturbances were spontaneous nystagmus (11.1%), pathological gaze pursuit (11%), and gaze-evoked

Table 1 Baseline data

	Total population ($n=2464$ patients)	Main symptom ($n=1589$ patients)	Accompanying symptom ($n=875$ patients)
Demographic data[a] [*n* (% [95% CI])]			
Age: mean (SD)	51.8 years (20.2 years)	53.4 years (19.8 years)	49.1 years (20.7 years)
Female(%)	1251 (50.8% [48.8–52.8])	796 (50.1% [47.6–52.6])	455 (52% [48.6–55.4])
Medication prior to admission	1761 (71.5% [69.6–73.3])	1137 (71.6% [69.3–73.8])	624 (71.3% [68.2–74.3])
Vascular risk factors[a,b] [*n* (% [95% CI])]			
Arterial hypertension	914 (37.1% [35.2–39.0])	648 (40.8% [38.4–43.2])	266 (30.4% [27.4–33.6])
Smokers (current and former)	764 (31% [29.2–32.9])	479 (30.1% [27.9–32.5])	285 (32.6% [29.5–35.8])
Dyslipidaemia	513 (20.8% [19.2–22.5])	352 (22.2% [20.1–24.3])	161 (18.4% [15.9–21.1])
Diabetes mellitus	273 (11.1% [9.9–12.4])	176 (11.1% [9.6–12.7])	97 (11.1% [9.1–13.4])
Coronary heart disease	268 (10.9% [9.7–12.2])	177 (11.1% [9.6–12.8])	91 (10.4% [8.5–12.6])
Family history of any cardiac disease	192 (7.8% [6.8–8.9])	127 (8% [6.7–9.4])	65 (7.4% [5.8–9.4])
Family history of any cerebrovascular event	97 (3.9% [3.2–4.8])	60 (3.8% [2.9–4.8])	37 (4.2% [3.0–5.8])
Peripheral artery disease	74 (3% [2.4–3.8])	37 (2.3% [1.6–3.2])	37 (4.2% [3.0–5.8])
Comorbidities[a,b] [*n* (% [95% CI])]			
Neurological diseases	711 (28.9% [27.1–30.7])	478 (30.1% [27.8–32.4])	233 (26.6% [23.7–29.7])
Cardiovascular diseases	681 (27.6% [25.9–29.5])	459 (28.9% [26.7–31.2])	222 (25.4% [22.5–28.4])
Psychiatric disorders	484 (19.6% [18.1–21.3])	330 (20.8% [18.8–22.9])	154 (17.6% [15.1–20.3])
Cancer	170 (6.9% [5.9–8.0])	100 (6.3% [5.2–7.6])	70 (8% [6.3–10.0])
Ear, nose and throat disorders	169 (6.9% [5.9–7.9])	112 (7.1% [5.8–8.4])	57 (6.5% [5.0–8.4])
Coagulopathies	22 (0.9% [0.6–1.4])	12 (0.8% [0.4–1.3])	10 (1.1% [0.6–2.1])
Vasculitis	13 (0.5% [0.3–0.9])	7 (0.4% [0.2–0.9])	6 (0.7% [0.3–1.5])

[a]If patients made more than one visit in 2013, we only considered the first one

[b]Multiple answers possible

nystagmus (11%). Other signs were each reported in less than 2% of visits. Results of the neuro-otologic testing are provided in Table 3.

Detailed information on the aetiology of the vestibular symptoms is shown in Table 4. The main cause of vestibular symptoms was cerebrovascular events, which were reported in 12.5% of visits. Other causes were dysautonomy (12.1% of visits) and infectious diseases (10.2%). For 13.7% of visits, the reason for the vestibular symptoms remained unknown. In total, 23.2% of all visits were due to an immediately life-threatening condition, while for 29.3% of visits, the disease causing the vestibular symptoms did not pose an immediate danger to life. In 24.8% of visits, vestibular symptoms were caused by a potentially, but not imminently life-threatening condition. Further details on frequency of medically significant diagnoses are provided in Table 5.

Detailed information on patient management is shown in Table 6. In 68.6% of visits, patients were referred primarily to an emergency physician, in 26.9% to a neurologist, and in 3.5% to an ENT specialist. Emergency physicians provided a second opinion in 1.5% of visits by patients with vestibular symptoms (primarily referred to another discipline), neurologists in 9%, and ENT specialists in 6.9%. In 71.6% of visits, symptomatic or even causal treatment was started after assessment in the ED, clinical follow-up was recommended after 56.5%, and 50.2% of visits led to patients being referred for further diagnostic procedures. Following 58.2% of visits, patients were sent for outpatient clinical care; 39.9% of visits required hospitalisation. Of 1035 visits by patients who were hospitalised, 57 patients were transferred to the intensive care unit, 105 to an intermediate care unit, 775 to a hospital ward (including stroke unit), and 98 to another hospital.

Discussion

In our retrospective single-centre study on rates, aetiology, and impact of vestibular symptoms in an ED, we manually screened 23,608 medical reports of visits to the ED. The main findings of the study are that: (1) vestibular symptoms were three times more frequent than previously reported [3, 9]; (2) strokes were the main cause of vestibular symptoms in ED patients; and (3) in a quarter of visits by patients with vestibular symptoms as the main symptom, the aetiology was life-threatening.

Table 2 Symptoms and signs

Number of visits (%) (n = 2596 ED visits)			
Frequency of vestibular symptoms as the main or accompanying symptom[a] [n (% [95% CI])]			
Main complaint			1676 (64.6% [62.7–66.4])
Accompanying complaint			920 (35.4% [33.6–37.3])
	Total population (n = 2596 ED visits)	Main symptom (n = 1676 ED visits)	Accompanying symptom (n = 920 ED visits)
Type of vestibular symptoms[a,b] [n (% [95% CI])]			
Dizziness	1138 (43.8% [41.9–45.8])	587 (35% [32.7–37.4])	551 (59.9% [56.6–63.1])
Vertigo	880 (33.9% [32.1–35.8])	660 (39.4% [37.0–41.8])	220 (23.9% [21.2–26.8])
Postural symptoms	169 (6.5% [5.6–7.5])	115 (6.9% [5.7–8.2])	54 (5.9% [4.4–7.6])
More than one type	409 (15.8% [14.4–17.2])	314 (18.7% [16.9–20.7])	95 (10.3% [8.4–12.5])
Coexisting symptoms[a,b,c] [n (% [95% CI])]			
Vegetative symptoms			
Nausea	822 (31.7% [29.9–33.5])	530 (31.6% [29.4–33.9])	292 (31.7% [28.7–34.9])
Emesis	475 (18.3% [16.8–19.8])	309 (18.4% [16.6–20.4])	166 (18% [15.6–12.7])
Transpiration	190 (7.3% [6.4–8.4])	134 (8% [6.7–9.4])	56 (6.1% [4.6–7.8])
Motion intolerance	96 (3.7% [3.0–4.5])	80 (4.8% [3.8–5.9])	16 (1.7% [1.0–2.8])
Neurological symptoms			
Headache	798 (30.7% [29.0–32.6])	450 (26.9% [24.7–29.0])	348 (37.8% [34.7–41.1])
Paraesthesia	345 (13.3% [12.0–14.7])	203 (12.1% [10.6–13.8])	142 (15.4% [13.2–17.9])
Paresis	208 (8% [7.0–9.1])	115 (6.9% [5.7–8.2])	93 (10.1% [8.2–12.2])
Diplopia	103 (4% [3.3–4.8])	70 (4.1% [3.3–5.3])	33 (3.6% [2.5–5.0])
Dysphagia	19 (0.7% [0.4–1.1])	13 (0.8% [0.4–1.3])	6 (0.7% [0.2–1.4])
Other	787 (30.3% [28.6–32.1])	503 (30% [27.8–32.3])	284 (30.9% [27.9–34.0)
ENT-symptoms			
Tinnitus	88 (3.4% [2.7–4.2])	56 (3.3% [2.5–4.3])	32 (3.5% [2.4–4.9])
Hearing loss	85 (3.3% [2.6–4.0])	42 (2.5% [1.8–3.4])	43 (4.7% [3.4–6.2])
Otalgia	57 (2.2% [1.7–2.8])	18 (1.1% [0.6–1.7])	39 (4.2% [3.0–5.8])
Feeling of pressure	45 (1.7% [1.3–2.3])	22 (1.3% [0.8–2.0])	23 (2.5% [1.6–3.7])
Otorrhoea	19 (0.7% [0.4–1.1])	3 (0.2% [0.0–0.5])	16 (1.7% [1.0–2.8])
Diagnostic procedures[c] [n (% [95% CI])]			
Blood test	2055 (79.2% [77.6–80.7])	1319 (78.7% [76.7–80.6])	736 (80% [77.3–82.5])
ECG	1623 (62.5% [60.6–64.4])	1115 (66.5% [64.2–68.8])	508 (55.2% [51.9–58.5])
Imaging			
MRI	707 (27.2% [25.5–29.0])	470 (28% [25.9–30.3])	237 (25.8% [23.0–28.7])
Pathological MRI	*299 (11.5% [10.3–12.8])*	*188 (11.2% [9.8–12.8])*	*111 (12.1% [10.0.–14.4])*
Normal MRI	*406 (15.6% [14.3–17.1])*	*281 (16.8% [15.0–18.6])*	*125 (13.6% [11.4–16.0])*
Result unclear	*2 (0.1% [0–0.3])*	*1 (0.1% [0.0–0.3])*	*1 (0.1% [0.0–0.6])*
CT scan	437 (16.8% [15.4–18.3])	282 (16.8% [15.1–18.7])	155 (16.9% [14.5–19.4])
Pathological CT	*127 (4.9% [4.1–5.8])*	*73 (4.4% [3.4–5.5])*	*54 (5.9% [4.4–7.6])*
Normal CT	*308 (11.9% [10.6–13.2])*	*207 (12.4% [10.8–14.0])*	*101 (11% [9.0–13.2])*
CT result unclear	*2 (0.1% [0–0.3])*	*2 (0.1% [0.0–0.4])*	*0 (0.0% [0.0–0.4])*
Neurovascular sonography	24 (0.9% [0.6–1.4])	11 (0.7% [0.3–1.2])	13 (1.4% [0.8–2.4])
Arterial blood gas analysis	124 (4.8% [4.0–5.7])	67 (4% [3.1–5.1])	57 (6.2% [4.7–8.0])
Lumbar puncture	109 (4.2% [3.5–5.0])	45 (2.7% [2.0–3.6])	64 (7% [5.4–8.8])
H.I.N.T.S.[d]	94 (3.6% [2.9–4.4])	73 (4.4% [3.4–5.5])	21 (2.3% [1.4–3.5])
EEG	45 (1.7% [1.3–2.3])	24 (1.4% [0.9–2.1])	21 (2.3% [1.4–3.5])

Italic values indicate subgroups which are part of a main category

[a]Every visit was considered for this part of the analysis

[b]Multiple answers possible

[c]Any accompanying symptom mentioned was recorded

[d]H.I.N.T.S. is a three−step bedside test including the horizontal head impulse test, observation for gaze−induced nystagmus and a cross−cover test for detection of a vertical skew deviation. It is more sensitive than MRI in for distinguishing peripheral−vestibular from central aetiologies in acute vestibular syndrome within 72 hours after symptom onset. (Kattah et. al. [17])

Table 3 Neuro-otologic testing

	Total population N = 1096	Main symptom N = 711	Accompanying symptom N = 385
Neuro-otologic testing [n (%) [95% CI]][a, b]			
Hearing test performed[c]	635 (57.9% [55.0–60.9])	424 (59.6% [55.9–63.3])	211 (54.8% [49.7–59.9])
Normal	*552 (50.4% [47.4–53.4])*	*372 (52.3% [48.6–56.1])*	*180 (46.8% [41.7–51.9])*
Pathological	*83 (7.6% [6.1–9.3])*	*52 (7.3% [5.5–9.5])*	*31 (8.1% [5.5–11.2])*
Head impulse test performed	252 (23% [20.5–25.6])	215 (30.2% [26.9–33.8])	37 (9.6% [6.9–13.0])
Normal	*180 (16.4% [14.3–18.8])*	*150 (21.1% [18.2–24.3])*	*30 (7.8% [5.3–10.9])*
Pathologic	*72 (6.6% [5.2–8.2])*	*65 (9.1% [7.1–11.5])*	*7 (1.8% [0.7–3.7])*
Otoscopy performed	231 (21.1% [18.7–23.6])	165 (23.2% [20.2–26.5])	66 (17.1% [13.5–21.3])
Normal	*182 (16.6% [14.5–18.9])*	*148 (20.8% [17.9–24.0])*	*34 (8.8% [6.2–12.1])*
Pathological	*49 (4.5% [3.3–5.9])*	*17 (2.4% [1.4–3.8])*	*32 (8.3% [5.8–11.5)*
Weber test performed	215 (19.6% [17.3–22.1])	153 (21.5% [18.6–24.7])	62 (16.1% [12.6–20.2])
Normal	*154 (14.1% [12.1–16.3])*	*124 (17.4% [14.7–20.4])*	*30 (7.8% [5.3–10.9])*
Pathological	*61 (5.6% [4.3–7.1])*	*29 (4.1% [2.8–5.8])*	*32 (8.3% [5.8–11.5])*
Rinne test performed	209 (19.1% [16.8–21.5])	151 (21.2% [18.3–24.4])	58 (15.1% [11.6–19.0])
Normal	*184 (16.8% [14.6–19.1])*	*141 (19.8% [17.0–23.0])*	*43 (11.2% [8.2–14.8])*
Pathological	*25 (2.3% [1.5–3.4])*	*10 (1.4% [0.7–2.6])*	*15 (3.9% [2.2–6.3])*
Positioning manoeuvre performed	190 (17.3% [15.1–19.7])	177 (24.9% [21.8–28.2])	13 (3.4% [1.8–5.7])
Normal	*128 (11.7% [9.8–13.7])*	*118 (16.6% [13.9–19.5])*	*10 (2.6% [1.3–4.7])*
Pathological	*62 (5.7% [4.4–7.2])*	*59 (8.3% [6.4–10.6])*	*3 (0.8% [0.2–2.3])*
Caloric testing performed	115 (10.5% [8.7–12.5])	109 (15.3% [12.8–18.2])	6 (1.6% [0.6–3.4])
Symmetrical	*56 (5.1% [3.9–6.6])*	*52 (7.3% [5.5–9.5])*	*4 (1.0% [0.3–2.6])*
Asymmetrical	*59 (5.4% [4.1–6.9])*	*57 (8.0% [6.1–10.3])*	*2 (0.5% [0.1–1.9])*
Tympanometry performed	72 (6.6% [5.2–8.2])	56 (7.9% [6.0–10.1])	16 (4.2% [2.4–6.7])
Normal	*65 (5.9% [4.6–7.5])*	*53 (7.5% [5.6–9.6])*	*12 (3.1% [1.6–5.4])*
Pathological	*7 (0.6% [0.3–1.3])*	*3 (0.4% [0.1–1.2])*	*4 (1.0% [0.3–2.6])*
Acoustic reflexes assessed	31 (2.8% [1.9–4.0])	25 (3.5% [2.3–5.2])	6 (1.6% [0.6–3.4])
Normal	*30 (2.7% [1.9–3.9])*	*24 (3.4% [2.2–5.0])*	*6 (1.6% [0.6–3.4])*
Decreased or absent	*1 (0.1% [0–0.5])*	*1 (0.1% [0.0–0.8])*	*0 (0.0% [0.0–1.0])*
Oculomotor disturbances[b]	312 (28.5% [25.8–31.2])	244 (34.3% [30.8–37.9])	68 (17.7% [14.0–21.9])
Spontaneous nystagmus	*127 (11.6% [9.8–13.6])*	*111 (15.6% [13.0–18.5])*	*16 (4.2% [2.4–6.7])*
Pathological gaze pursuit	*120 (11% [9.2–13.0])*	*86 (12.1% [9.8–14.7])*	*34 (8.8% [6.2–12.1])*
Gaze-evoked nystagmus[d]	*80 (7.3% [5.8–9.0])*	*65 (9.1% [7.1–11.5])*	*15 (3.9% [2.2–6.3])*
Pathological saccades	*20 (1.8% [1.1–2.8])*	*15 (2.1% [1.2–3.5])*	*5 (1.3% [0.4–3.0])*
VOR suppression absent	*20 (1.8% [1.1–2.8])*	*16 (2.3% [1.3–3.6])*	*4 (1.0% [0.3–2.6])*
Skew deviation	*18 (1.6% [1.0–2.6])*	*12 (1.7% [0.9–2.9])*	*6 (1.6% [0.6–3.4])*

Italic values indicate subgroups which are part of a main category

[a] N = all patients who were evaluated by an ENT physician and/or neurologist

[b] Any accompanying symptom mentioned was recorded

[c] Including pure tone audiometry and finger-rub test

[d] The number of patients with gaze-evoked nystagmus is unusually high. This may be due to confounding with physiologic end-gaze nystagmus or a result of the preselected cohort seen by neurologists or ENT physicians

Frequency

Previous studies have investigated the frequency of vestibular symptoms in visits to the ED: Kerber et al. analysed reasons for ED visits from the National Hospital Ambulatory Medical Care Survey and found that vertigo-dizziness was recorded in 2.5% of all ED visits over a period of 10 years [9]. Newman-Toker et al. used diagnostic codes and reasons for visits from the same database and found dizziness as the main reason for 3.3% of ED visits [3]. Overall, the prevalence of vertigo-dizziness increased throughout the study period and imaging was increasingly used. However, in both studies, screening was limited to diagnostic codes and reasons for ED admission. Previous

Table 4 Aetiologies

	Total population ($n = 2596$ ED visits)	Main symptom ($n = 1676$ ED visits)	Accompanying symptom ($n = 920$ ED visits)
Aetiologies[a] [*n* (% [95% CI])]			
Cerebrovascular event[a]	324 (12.5% [11.2–13.8])	220 (13.1% [11.6–14.8])	104 (11.3% [9.3–13.5])
Ischaemic stroke	*210 (8.1% [7.1–9.2])*	*146 (3.7% [7.4–10.2])*	*64 (7% [5.4–8.8])*
TIA	*90 (3.5% [2.8–4.2])*	*62 (8.7% [2.9–4.7])*	*28 (3% [2.0–4.4])*
Intracranial bleeding	*46 (1.8% [1.3–2.4])*	*23 (1.4% [0.9–2.1])*	*23 (2.5% [1.6–3.7])*
Cerebral artery dissection	*15 (0.6% [0.3–1.0])*	*13 (0.8% [0.4–1.3])*	*2 (0.2% [0.0–0.8])*
Sinus thrombosis	*3 (0.1% [0.0–0.3])*	*2 (0.1% [0.0–0.4])*	*1 (0.1% [0.0–0.6])*
Retinal infarction	*2 (0.1% [0.0–0.3])*	*1 (0.1% [0.0–0.3])*	*1 (0.1% [0.0–0.6])*
Dysautonomy[b]	314 (12.1% [10.9–13.4])	254 (15.2% [13.5–17.0])	60 (6.5% [5.0–8.3])
Infection	265 (10.2% [9.1–11.4])	111 (6.6% [5.5–7.9])	154 (16.7% [14.4–19.3])
Cardiovascular	253 (9.6% [8.6–11.0])	181 (10.8% [9.4–12.4])	72 (7.8% [6.2–9.8])
Neurological diseases other than stroke	242 (9.3% [8.2–10.5])	113 (6.7% [5.6–8.1])	129 (14% [11.8–16.4])
Peripheral–vestibular	232 (8.9% [7.9–10.1])	181 (10.8% [9.4–12.4])	51 (5.5% [4.2–7.2])
Hypovolemia and anaemia	119 (4.6% [3.8–5.5])	75 (4.5% [3.5–5.6])	44 (4.8% [3.5–6.4])
Drug-related	114 (4.4% [3.6–5.3])	75 (4.5% [3.5–5.6])	39 (4.2% [3.0–5.8])
Psychogenic/psychosomatic	96 (3.7% [3.0–4.5])	67 (4% [3.1–5.1])	29 (3.2% [2.1–4.5])
Trauma	89 (3.4% [2.8–4.2])	52 (3.1% [2.3–4.1])	37 (4% [2.9–5.5])
Intoxication	76 (2.9% [2.3–3.7])	59 (3.5% [2.7–4.5])	17 (1.9% [1.1–2.9])
Metabolic	58 (2.2% [1.7–2.9])	35 (2.1% [1.5–2.9])	23 (2.5% [1.6–3.7])
Ocular	9 (0.4% [0.2–0.7])	4 (0.2% [0.1–0.6])	5 (0.5% [0.2–1.3])
Other known aetiology	107 (4.1% [3.4–5.0])	43 (2.6% [1.9–3.4])	64 (77% [5.4–8.8])
Unknown	355 (13.7% [12.4–15.1])	241 (14.4% [12.7–16.2])	114 (12.4% [10.3–14.7])

[a]Multiple answers possible

[b]Malfunction in the autonomic nervous system which leads to transient hypoperfusion of the brain, e.g., as in a vagal or orthostatic syncope

Table 5 Impact

Severity[a,b,c] [*n* (% [95% CI])]			
No immediate harm to life	760 (29.3% [27.5–31.1])	516 (30.8% [28.6–33.1])	244 (26.5% [23.7–29.5])
Potentially life threatening	643 (24.8% [23.1–26.5])	366 (21.8% [19.9–23.9])	277 (30.1% [27.2–33.2])
Immediately life threatening	601 (23.2% [21.5–24.8])	399 (23.8% [21.8–25.9])	202 (22% [19.3–24.8])
Unclassifiable	627 (24.2% [22.5–25.9])	419 (25% [22.9–27.2])	208 (22.6% [19.9–25.5])

[a]Every visit was considered for this part of the analysis

[b]Adapted from Newman-Toker et al. [3]

[c]Multiple answers possible

studies only included vestibular symptoms if they were the main complaint or reason for the visit, even though vestibular symptoms often occur in combination with other complaints such as migraine, motion sickness, fainting, and anxiety [1]. In our study, we meticulously screened all medical records of ED patients and searched for descriptions of vestibular symptoms. This thorough search strategy revealed that, in our cohort, vestibular symptoms were reported at 11% of visits. Even when our cohort was limited to patients with vestibular symptoms as the main complaint, the rate was still 7.1%, which is twice as high as previously reported. Our finding is in line with a publication by Bisdorff et al. postulating that the prevalence of vertigo, dizziness, and unsteadiness is much higher than previously reported [1]. They also found that vestibular symptoms often occur in combination with others rather than in isolation [1].

Previous studies did not use a uniform classification of vestibular symptoms. Many terms in the medical literature refer to vestibular symptoms and reporting is often inconsistent. Therefore, the Bárány Society proposed a new classification of vestibular disorders, stating that "symptom definitions should be as purely phenomenal as

Table 6 Management

	Total population ($n=2596$ ED visits)	Main symptom ($n=1676$ ED visits)	Accompanying symptom ($n=920$ ED visits)
Specialty of first treating physician in ED[a] [*n* (% [95% CI])]			
Emergency medicine	1780 (68.6% [66.7–70.4%])	1171 (69.9% [67.6–72.1%])	609 (66.2% [63.0–69.3%])
Internal medicine	*1537 (59.2% [57.3–61.1])*	*1021 (60.9% [58.5–63.3])*	*516 (56.1% [52.8–59.3])*
Surgery	*243 (9.4% [8.3–10.6])*	*150 (9% [7.6–10.4])*	*93 (10.1% [8.2–12.2])*
Neurology	698 (26.9% [25.2–28.6])	450 (26.9% [24.7–29.0])	248 (27% [24.1–30.0])
Ear, nose and throat	91 (3.5% [2.8–4.3])	45 (2.7% [2.0–3.6])	46 (5% [3.7–6.6])
Ophthalmology	3 (0.1% [0.0–0.3])	2 (0.1% [0.0–0.4])	1 (0.1% [0.0–0.6])
Psychiatry	2 (0.1% [0.0–0.3])	1 (0.1% [0.0–0.3])	1 (0.1% [0.0–0.6])
Others	22 (0.9% [0.5–1.3])	7 (0.4% [0.2–0.9])	15 (1.6% [0.9–2.7])
Consultation by other specialists[a,b] [*n* (% [95% CI)]			
Neurology	233 (9% [7.9–10.1])	157 (9.4% [8.0–10.9])	76 (8.3% [6.6–10.2])
Ear, nose and throat	179 (6.9% [6.0–7.9])	153 (9.1% [7.8–10.6])	26 (2.8% [1.9–4.1])
Psychiatry	45 (1.7% [1.3–2.3])	32 (1.9% [1.3–2.7])	13 (1.4% [0.8–2.4])
Emergency medicine	40 (1.5% [1.1–2.1%])	24 (1.4% [0.9–2.1%])	16 (1.7% [1.0–2.8%])
Internal medicine	*35 (1.4% [0.9–1.9])*	*22 (1.3% [0.8–2.0])*	*13 (1.4% [0.8–2.4])*
Surgery	*5 (0.2% [0.1–0.5])*	*2 (0.1% [0.0–0.4])*	*3 (0.3% [0.1–1.0])*
Ophthalmology	19 (0.7% [0.4–1.1])	10 (0.6% [0.3–1.1])	9 (1% [0.5–1.9])
Others	372 (14.3% [13.0–15.7])	226 (13.5% [11.9–15.2])	146 (15.9% [13.6–18.4])
Post-ED management[a,b] [*n* (% [95% CI])]			
Therapy started	1859 (71.6% [69.8–73.3])	1142 (68.1% [65.9–70.4])	717 (77.9% [75.1–80.6])
Clinical follow-up	1467 (56.5% [54.6–58.4])	949 (56.6% [54.2–59.0])	518 (56.3% [53.0–59.5])
Further diagnostic testing	1303 (50.2% [48.3–52.1])	835 (49.8% [47.4–52.2])	468 (50.9% [47.6–54.2])
Other	418 (16.1% [14.7–17.6])	254 (15.2% [13.5–17.0])	164 (17.8% [15.4–20.5])
Unknown	18 (0.7% [0.4–1.1])	11 (0.7% [0.3–1.2])	7 (0.8% [0.3–1.6])
Post-ED treatment[a,b] [*n* (% [95% CI])]			
Ambulatory care	1512 (58.2% [56.3–60.2])	1002 (59.8% [57.4–62.1])	510 (55.4% [52.2–58.7])
Hospital ward admission	775 (29.9% [28.1–31.7])	468 (27.9% [25.8–30.1])	307 (33.4% [30.3–36.5])
Intermediate care admission	105 (4% [3.3–4.9])	66 (3.9% [3.1–5.0])	39 (4.2% [3.0–5.8])
Transfer to another hospital	98 (3.8% [3.1–4.6])	68 (4.1% [3.2–5.1])	30 (3.3% [2.2–4.6])
Intensive care unit	57 (2.2% [1.7–2.8])	39 (2.3% [1.7–3.2])	18 (2% [1.2–3.1])
Other	23 (0.9% [0.6–1.3])	12 (0.7% [0.4–1.3])	12 (1.2% [0.6–2.1])
Unknown	26 (1% [0.7–1.5])	21 (1.3% [0.8–1.9])	5 (0.5% [0.2–1.3])

[a]Every visit was considered for this part of the analysis

[b]Multiple answers possible

possible" [13]. They defined vestibular symptoms as those that come from any disturbance of "sensory inputs, central processing and motor outputs that relate to balance" [13]. These symptoms were classified as vertigo, dizziness, vestibulo-visual symptoms, and postural symptoms [13]. We adopted the proposals developed by the Bárány Society and focused on vertigo, dizziness, and postural symptoms, omitting vestibulo-visual symptoms, which are rarely reported in medical records. Dizziness was the most frequently recorded vestibular symptom in our ED, occurring in 43.8% of visits. This is in line with previously published findings [11]. However, patient reports about symptom quality are inconsistent [10] and relying on symptom quality alone might put physicians at risk for misdiagnosis. Previous studies did not use the classification of the Bárány Society, and therefore, detailed information on the type of vestibular symptoms is lacking.

Aetiology

The most frequent aetiology of vestibular symptoms recorded in our cohort were cerebrovascular events, accounting for 12.5% of all ED visits by patients with vestibular symptoms. Although stroke prevalence may have been skewed, since our hospital is a tertiary care centre for patients with suspected ischaemic stroke (referral bias), the rate of 12.5% is alarmingly high compared to previous studies, which found incidences of around 4% [3, 9]. However, even the stroke prevalence reported in our study is presumably an underestimate: currently, the most sensitive test for diagnosing an acute stroke associated with vestibular symptoms is the H.I.N.T.S. test. It was shown to be more sensitive than MRI for detection of brainstem infarctions within 48–72 h after symptom onset. Given the high sensitivity, specificity, and low resource use of H.I.N.T.S., it is still surprising that this test was seldom applied [17]. Several reasons could account for the low reported use of H.I.N.T.S. such as incomplete documentation, ignorance or the need to prioritise other investigations in the acute setting.

In contrast to H.I.N.T.S., other neuro-otological tests were performed much more frequently, even though we limited our assessment to patients who were evaluated by a neurologist and/or ENT physician. Mostly, those tests were performed in patients in whom vestibular symptoms were the main complaint. While the purpose of H.I.N.T.S. is to distinguish between central and peripheral–vestibular pathology, most other neuro-otological tests aim at confirming the suspicion of either a peripheral–vestibular or a central disorder. Strikingly, a head impulse test alone was performed in 252 patients, while a complete H.I.N.T.S. examination was only performed in 94 patients. Possible explanations include incomplete documentation in the medical records, lack of awareness of the improvement in sensitivity obtainable with the three combined tests compared to the head impulse test alone, or strict adherence to standardised diagnostic pathways for patients with a high suspicion of ischaemic stroke [5]. Various attempts have been made to establish a diagnostic pathway for patients with vestibular symptoms and suspected stroke. Recently, Yamada et al. developed the DEFENSIVE stroke scale [18], which is also highly sensitive in detecting posterior circulation strokes. However, clinical experience with this tool is limited. Nevertheless, the merit of such strategies is the low resource needs together with their high sensitivity in early detection of posterior stroke, underlining that a thorough clinical examination should take place at the beginning of every diagnostic chain for vestibular symptoms.

Despite possibly having underestimated the real-life stroke prevalence, detection rates of ischaemic strokes were comparably high in our cohort. One potential reason for this is the frequent use of MRI in our ED. While in US EDs, about 40% of patients with vestibular symptoms receive CT imaging and only a small proportion (2.3%) undergo MRI [19], MRI is the standard cerebral imaging technology for our patients with suspected ischaemic stroke and/or vestibular symptoms. It was used in more than a quarter of all patient visits, as it is readily available in our hospital. MRI is far more sensitive than CT for detecting small brain lesions [20, 21], and after a thorough specialised clinical examination including neuro-otological testing, it is, therefore, the ideal diagnostic tool if the aetiology of vestibular symptoms remains undetermined. CT imaging should only be considered in specific clinical cases (e.g., primary evaluation in head trauma associated with vestibular symptoms), and should not be used to rule out any possible central disorder. Pathological findings were present in 42.3% of MRIs and 29.1% of CTs. Thus, one pathological finding was detected per 2.4 MRIs and 3.4 CTs performed, which seems reasonable given the potential hazard and the large variety of potential differential diagnoses. Although considerations on cost-effectiveness of frequent MRI use are justified, investigating the impact on healthcare costs of imaging in patients with vestibular symptoms was beyond the scope of this study. The frequent use of MRI in our cohort may explain the lower rate of patients with vestibular symptoms of unknown origin compared to previously published studies. Nevertheless, the exact aetiology of vestibular symptoms could not be determined in 13.7% of visits, in comparison with a previously reported figure of 20% [3, 9]. This highlights that vestibular symptoms are the consequence of perceptual disturbances and cannot always be confirmed with clinical, instrumental, and imaging diagnostics.

The distribution of the underlying aetiologies cannot be compared with findings from regular multidisciplinary outpatient units treating dizziness, where peripheral–vestibular disorders account for almost half of all cases, given the completely different cohort of patients visiting an ED [22].

Impact

Vestibular symptoms are a neglected red flag: In our cohort, almost a quarter of patients with vestibular symptoms were diagnosed with an immediately life-threatening condition, compared to 15% in the previous studies [3]. The rates did not differ according to whether vestibular symptoms were the main or accompanying complaint. Stroke was the most frequent cause of an immediately life-threatening condition. Another 24.8% of patients had a potentially life-threatening condition such as hypertensive crisis, epileptic seizures or acid–base, and electrolyte disorders. Therefore, vestibular symptoms can be the tip of the iceberg of a potentially significant condition and physicians should actively search for the underlying aetiology. However, management of patients with vestibular symptoms in the ED is challenging and many physicians lack clinical skills and experience in diagnosing these patients, as a wide range of benign to life-threatening conditions has to be considered. A general ED physician evaluated two-thirds of patients, with frequent advice sought from other disciplines. This confirms that vestibular symptoms are common in patients with systemic disorders. Consequently, they are a problem that generalists should be familiar with. The high number of secondary consultations reflects the uncertainty in finding a diagnosis explaining vestibular symptoms. Furthermore, the emergency setting requires rapid decisions and resources are often limited.

Therefore, awareness of the potential threat posed by vestibular symptoms needs to be raised. Standardised approaches with questionnaires including "red flags" and risk factors, pre-specified clinical examinations including H.I.N.T.S [17] and a meticulous general and neuro-otological examination, as well as ancillary investigations may help to improve diagnostic accuracy in patients with vestibular symptoms. Therefore, standardized approaches should also include neuro-otologic assessment by a trained and experienced physician.

Strengths and limitations

The strengths of the study are the meticulous screening method and the reassessment by neuro-otology adjudicators in cases of uncertainty assuring reliability and reproducibility concerning the main outcome of frequency, aetiology and impact of vestibular symptoms, the high number of consecutively screened patients, and the detailed reporting of underlying aetiology. The retrospective nature of the study leads to several limitations: Prevalence of reported parameters might be underestimated, and due to reporting bias, we are unable to give a precise estimate of data quality. Furthermore, as this was a cross-sectional study, no follow-up data were collected. As a tertiary referral centre, we might observe higher incidences of rare or life-threatening disorders (referral bias). Given the lack of Swiss general epidemiological data on this topic, or European studies in a comparable interdisciplinary setting, we could only compare our findings to multicentre studies using health care data from the USA, where health care systems have significant structural differences from European ones. The emergency setting demands fast, standardized diagnostic concepts. Therefore, rare disorders (e.g., peripheral–vascular causes of vestibular symptoms), which might be difficult to detect during a short consultation, may be underestimated.

Conclusions

One-year prevalence of vestibular symptoms was three times higher than previously described [3, 9]. Diagnoses associated with vestibular symptoms are diverse, which poses a challenge for treating physicians. Underestimation and mis- or underdiagnosis can be potentially dangerous as vestibular symptoms often occur in patients with life-threatening diseases. Detection is a first step towards improving diagnosis in patients with vestibular symptoms. The findings of this study confirm that we need more accurate, systematic and meticulous diagnostic approaches for patients with vestibular symptoms, because the underlying causes are often life-threatening. In particular, sensitive scales for stroke diagnosis [18] are needed and their value should be further evaluated in clinical practice.

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Compliance with ethical standards

Conflicts of interest This was an investigator-initiated study with no external sponsorship. M. Goeldlin's work is supported by a "Young Talents in Clinical Research" Grant by the SAMW/Bangerter-Rhyner foundation (Grant YTCR_13/18). Dr. Bernasconi has received consulting fees from Roche, Santhera, AC Immune and PresSura Neuro. Dr. Kalla and Dr. Mantokoudis were supported by the Swiss National Science Foundation (Grant #320030_173081). Dr. Fischer is a consultant for Medtronic, Stryker and CSL Behring. He is the Co-PI of the SWIFT DIRECT trial (supported by Medtronic). He receives research grants from the Swiss Heart Foundation and the Swiss National Science Foundation.

Ethical approval The study was approved by the local ethics committee and was conducted in accordance with the Declaration of Helsinki. Given the retrospective nature of the study, informed consent was provided through a hospital-wide general consent. However, patients who withdrew consent for evaluation of their medical data had to be excluded in accordance with legal requirements.

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