Recognizing Posterior Circulation Transient Ischemic Attacks Presenting as Episodic Isolated Dizziness

Jonathan A. Edlow, MD*; Fernanda Bellolio, MD, MS

*Corresponding Author. E-mail: jedlow@bidmc.harvard.edu.

Diagnosing patients presenting to the emergency department with self-limited episodes of isolated dizziness (the episodic vestibular syndrome) requires a broad differential diagnosis that includes posterior circulation transient ischemic attack. Because these patients are, by definition, asymptomatic without new neurologic findings on examination, the diagnosis, largely based on history and epidemiologic context, can be challenging. We review literature that addresses the frequency of posterior circulation transient ischemic attack in this group of patients compared with other potential causes of episodic vestibular syndrome. We present ways of distinguishing posterior circulation transient ischemic attack from vestibular migraine, the most common cause of episodic vestibular syndrome. We also present a diagnostic algorithm that may help clinicians to work their way through the differential diagnosis. [Ann Emerg Med. 2024;■:1-11.]

0196-0644/$-see front matter

https://doi.org/10.1016/j.annemergmed.2024.04.006

INTRODUCTION

Three percent of emergency department (ED) patients present with dizziness or vertigo.[1] The descriptors patients endorse (eg, dizziness, vertigo, unsteadiness, lightheadedness, or others) have little diagnostic value.[2,3] The differential diagnosis is better based on patients' descriptions of the timing and triggers of their dizziness.[4] Patients with continuous dizziness have an acute vestibular syndrome. Many acutely dizzy ED patients (35% to 67%) have intermittent symptoms, constituting episodic vestibular syndrome.[5,6] Some episodes have reproducible triggers, usually head movement or standing up—the triggered episodic vestibular syndrome. Other episodes occur spontaneously, without triggers—the spontaneous episodic vestibular syndrome.[7]

Although emergency physicians may be unfamiliar with these syndromic terms, they best describe the diagnostically useful timing and triggers categories. The word "vestibular" refers to the quality of the symptom, not an anatomic localization to either the peripheral vestibular apparatus (vestibular nerve and semicircular canals) or their central vestibular connections (vestibular nuclei, cerebellum, and other central projections).

Early in their course, triggered and spontaneous episodic vestibular syndromes can be difficult to distinguish from one another and from ongoing dizziness.[8,9] Nonetheless, when identifiable, these patterns are diagnostically useful. Common causes of triggered episodic vestibular syndrome are benign paroxysmal positional vertigo and orthostatic hypotension.[7] Important causes of the spontaneous episodic vestibular syndrome are vestibular migraine and posterior circulation transient ischemic attack, migraine being far more common, occurring in ~1% of the general population.[7,10-13]

Dizziness is the most common symptom among patients diagnosed with posterior circulation cerebrovascular events.[14] Two retrospective studies report that ~12% of patients with posterior circulation stroke have prior episodes of isolated dizziness.[15,16] Prospective studies report the risk of subsequent stroke after an ED visit for isolated dizziness to be less than 1% and that episodic dizziness as a presenting symptom reduces the likelihood of a transient ischemic attack.[17,18]

Adverse stroke outcomes may be more common in posterior circulation transient ischemic attack compared with anterior circulation transient ischemic attack, even more so when intracranial atherosclerosis is present.[19,20] Five percent of patients with transient ischemic attack will have a stroke in the next 48 hours.[21] Because early secondary prevention reduces acute stroke outcomes by 80%, identifying and treating transient ischemic attack is important for stroke prevention.[22,23] The 1975 National Institutes of Health consensus criteria for transient ischemic attack explicitly excluded brief episodes of isolated dizziness.[24] Subsequently, investigators began calling these and other nonconsensus events "transient neurological

attacks," "transient ischemic attack with 'nonfocal' symptoms," and "atypical transient symptoms."[25-27] Patients presenting with isolated episodic vestibular syndrome (dizziness, vertigo, imbalance, or unsteadiness) comprise one subgroup of nonconsensus transient ischemic attacks.

Posterior circulation strokes account for 20% of all ischemic strokes.[28] Because stroke and transient ischemic attack are different parts of the spectrum of acute ischemic cerebrovascular disease, it follows that the same 20% proportion of all transient ischemic attacks should involve the posterior circulation. Thus, of the 300 to 385 thousand patients treated annually in EDs for transient ischemic attack, ~70,000 involve the posterior circulation (according to an email from Tracy Madsen, MD, sent on September 7, 2023).[29,30] Of those, we estimate that ~15% have isolated dizziness. Although the precise figure is unclear, a population-based study of 1,666 adult ED patients with dizziness reported that 9 (17%) of 53 with stroke or transient ischemic attack presented with isolated dizziness, and overall 0.7% (9/1,297) of those with isolated dizziness had a stroke/transient ischemic attack.[31] These numbers translate into potentially 10,000 patients with posterior circulation transient ischemic attacks presenting as isolated dizziness to the EDs annually. The proportion that is not correctly diagnosed and the proportion of those who experience harm is unknown. When estimating the cost of diagnosing posterior circulation transient ischemic attack, although absolute number is low, if potentially preventable strokes do occur, they can be devastating, at large societal and individual costs, financial and otherwise.

Given that vestibular migraine is not life, limb, or brain threatening and the relatively low numbers of patients with posterior circulation transient ischemic attack, legitimate questions are, "Why worry about vestibular migraine in the ED?" and "What is the cost of improving diagnosis of posterior circulation transient ischemic attack?"

Advantages of considering, suspecting, or diagnosing vestibular migraine in the ED include greater awareness of and familiarity with the diagnostic criteria, and clinical characteristics (Tables 1 and 2), which have the potential to reduce brain and vascular imaging, and hospital admissions, and facilitate more streamlined follow-up arrangements.[32] Without knowing about vestibular migraine, clinicians might naturally evaluate more patients for cerebrovascular causes. Although suspecting a benign diagnosis does not totally exclude a dangerous one, having 2 simultaneous causes of acute episodic dizziness is far less likely.

This Concepts article focuses on the approach to patients with episodic dizziness and suggests strategies to better risk stratify those with posterior circulation transient ischemic attack presenting as isolated dizziness. Overdiagnosis and overtesting for transient ischemic attack in low-risk individuals will result in low-value resource overuse, whereas underdiagnosis might result in preventable strokes and untreated vestibular migraine. This is the classic emergency medicine conundrum of finding the needle in the haystack. Greater familiarity with the characteristics of both the needle and the haystack would be expected to improve diagnostic accuracy.

APPROACH TO THE PATIENT WITH TRANSIENT EPISODES OF DIZZINESS

Benign causes of episodic dizziness, such as vestibular migraine, benign paroxysmal positional vertigo, Meniere's disease, vasovagal events, and orthostatic hypotension, are far more common than posterior circulation transient ischemic attack. Vestibular migraine is a subset of migraine and, as its name suggests, presents with both migrainous and vestibular symptoms. There are epidemiologic contexts, timing, and quality of symptoms that help differentiate vestibular migraine from posterior circulation transient ischemic attack (Table 2).

Table 1. 2022 Diagnostic criteria for vestibular migraine*.

Vestibular Migraine
1. ≥5 episodes with vestibular symptoms of moderate or severe intensity, lasting 5 min to 72 h
2. Current or history of migraine with or without aura
3. One or more migraine features with at least half of the vestibular episodes (a: headache with at least 2 of the following characteristics: unilateral, pulsating quality, moderate or severe pain intensity, aggravation by routine physical activity; b: photophobia and phonophobia, and c: visual aura)
4. Not better accounted for any other diagnosis
Probable vestibular migraine
1. ≥5 episodes with vestibular symptoms of moderate or severe intensity, lasting 5 min to 72 h
2. Only one of the above criteria 2 and 3 is fulfilled (migraine history or migraine features)
3. Not better accounted for any other diagnosis

*Adapted from Lempert 2022; J Vestibular Research.

Table 2. Clinical variables that help distinguish between vestibular migraine and posterior circulation transient ischemic attack.

Clinical Variable	Vestibular Migraine	Posterior Circulation TIA
Epidemiologic Content		
• Age	• Younger (mean age ~40 y)	• Older (usually >60 y)
• Sex	• More often female	• More often male
• Vascular risk factors	• Fewer vascular risks	• More vascular risks
• Past history of migraine	• Nearly always present	• History of migraine less common
• Family history of migraine	• Present in 50%-70%	• Far less common
• Recent head or neck trauma	• Recent trauma less likely	• If present, consider vertebral artery dissection
Timing of Symptoms		
• Onset	• Gradual in ~40%	• Usually sudden
• Duration	• Variable but often >1 h	• Variable but often <1 h
• Number of attacks over time	• Multiple prior attacks* common, occurring over months to years	• Fewer number of attacks, usually occurring over days to weeks
Symptom Quality		
• Migrainous symptoms†	• Commonly present	• Usually absent
• Positive vs Negative symptoms	• Positive symptoms	• Negative symptoms
• Concurrent headache	• Present ~50% of the time	• Less common (may occur with vertebral artery dissection)

Note: there is overlap for each clinical variable; no single factor perfectly discriminates between migraine and transient ischemic attack. Combinations of factors are far more likely to help distinguish these 2 causes of episodic dizziness or vertigo. *TIA* indicates transient ischemic attack.
*Diagnostic criteria include ≥5 attacks for a definite diagnosis of vestibular migraine.
†Photophobia, phonophobia, visual aura, nausea and vomiting.

Diagnostic difficulties in patients with acute dizziness are common and are based on misconceptions about dizziness, underuse of the physical examination, and overreliance on brain imaging.[7,8,33-40] Overall, studies report an extremely low percentage of ED patients diagnosed with "peripheral vertigo" or a "benign cause of dizziness" who later return to the ED with a stroke (event rate was ≤0.5% within 7 days and ≤0.7% at 30 days), but most do not report the proportion of patients with episodic symptoms.[41-46]

Even if it were logistically feasible, a strategy of "MRI all" would not solve the problem, and posterior circulation transient ischemic attack would still be missed.[42] Another risk mitigation strategy is consultation, but neurologists are not always available and are not immune from diagnostic difficulties. Of 475 patients with dizziness examined by neurologists in the ED, their initial diagnoses were changed at follow-up in 44% of cases.[47] Misdiagnosis of cerebellar stroke is a well-documented problem, sometimes resulting in serious disability and death.[48-51] Posterior circulation strokes and a chief complaint of dizziness are associated with missed strokes in retrospective studies, even if patients are seen by a neurologist.[47,48]

With posterior circulation transient ischemic attack, all of these problems are compounded. Because, by definition, symptoms have resolved, transient ischemic attack diagnosis is based purely on history and epidemiologic context. Studies of transient ischemic attack diagnostic discordance between emergency physicians and the neurologists' ultimate diagnosis report rates of 36% to 45%.[52,53] Interobserver disagreements are also well-documented between neurologists, and even among vascular neurologists.[54-57] In one study of 1,532 patients referred to a transient ischemic attack clinic, 22% were ultimately diagnosed with a transient ischemic attack mimic, the most common ones being migraine (20% of all patients referred to the clinic), syncope, and peripheral vestibular disorders including benign paroxysmal positional vertigo.[53,58]

Neither biomarkers nor advanced perfusion imaging are ready for prime time.[59,60] Without accurate, objective tests, neurologists' diagnosis, although imperfect, is the best reference standard we have. Given the diagnostic difficulties with dizziness, posterior circulation events, and transient ischemic attack, it should be no surprise that their intersection—diagnosing posterior circulation transient ischemic attack presenting as isolated dizziness—presents significant challenges.

SUMMARIZING THE EVIDENCE

We performed an all-field PubMed search for "atypical transient ischemic attack," "nonfocal transient ischemic attack," "transient neurological attacks," and

"nonconsensus transient ischemic attack" in April 2023, identified studies from the authors' libraries and from the references from those articles. Three classes of evidence inform our analysis, each with its own strengths and weaknesses (Table 3):

- "Forward-looking" studies of ED patients with acute dizziness discharged with a benign vestibular diagnosis that return with subsequent stroke
- "Forward-looking" studies of patients with nonconsensus transient ischemic attack with dizziness who have subsequent stroke
- "Backward-looking" studies of patients diagnosed with posterior circulation stroke that identify prior episodes of isolated dizziness

Studies of ED Dizzy Patients That "Look Forward" to Identify Subsequent Strokes

Table 4 details the 5 articles that identified patients with dizziness (not necessarily episodic) that "looked forward" to identify stroke outcomes.[41,43-46] Two of these studies were of the same cohort of 41,794 Canadian ED patients discharged with a diagnosis of a peripheral vestibular disorder.[41,43] The first compared stroke outcomes at 30 days postdischarge compared with patients with renal colic, Bell's palsy, and conjunctivitis.[41] They reported a very low risk of stroke outcomes in the patients with dizziness (76/41,794, 0.18%), but the stroke risk was nearly 10-fold higher than the control patients and 50-times higher for stroke in the first week. The companion study found that patients who had a computed tomography (CT) evaluation at their index visit were 2.3 times more likely to have a stroke compared with those who did not have a CT evaluation, suggesting that clinicians were correctly stratifying stroke risk by gestalt but then applied the wrong test.[43]

Two other US studies found that the stroke risk for patients discharged from the ED with a peripheral vestibular diagnosis was also very low (0.56% at 30 days and 0.93% at 180 days) but front-loaded in the first days after the index ED visit.[44,45] This is consistent with other temporal data on stroke following transient ischemic attack.[21] The final study in this group, from Taiwan, reported a 1% stroke outcome in discharged ED patients with dizziness or vertigo in 6 months, twice that of control patients.[46]

Overall, these studies show that ED patients discharged with a chief complaint of dizziness or a diagnosis of a peripheral vestibular condition have an incidence of stroke in days to weeks following the index ED visit of less than 1%, but a rate that is higher than nondizzy control patients. It is unclear what proportion had an episodic vestibular syndrome.

Table 3. Strengths and weakness of studies reporting posterior circulation transient ischemic attack in patients with episodic dizziness.

Study category	Strengths	Weaknesses
"Forward-looking" studies of ED patients with acute dizziness, discharged with a benign vestibular diagnosis that return with subsequent strokes	100% of patients seen in the ED for acute dizziness. More accurately reports the incidence of stroke after an episode of acute dizziness and are closer to real world ED settings.	Heterogeneity in the definitions of ED presentations with unclear syndromic details (most studies do not report the proportion of patients with EVS vs AVS).
"Forward-looking" studies of nonconsensus TIA patients with dizziness as their major symptom that return with subsequent stroke	Less heterogeneity in the inclusion (TIA and high suspicious of a vascular event). Population diluted by patients with more common causes of EVS.	Patients with suspected TIAs are more likely to have an ischemic etiology (as compared to non-ischemic). Different definitions of TIA and dizziness. Some are ED-based, others are neurology-clinic based.
"Backward-looking" studies of patients diagnosed with posterior circulation stroke that identify prior episodes of isolated dizziness	Debunks the myth that episodes of isolated dizziness do not constitute a TIA.	Study population is patients with diagnosed stroke, not patients presenting with an EVS; thus, does not allow calculation of stroke risk following an episode of dizziness. Overestimates the magnitude of risk because the patients already experienced the "bad outcome" (stroke). Limitation of selection and recall bias.

EVS, episodic vestibular syndrome; *AVS*, acute vestibular syndrome.

Table 4. Studies of ED patients discharged with a benign dizziness diagnosis that "look forward" to identify subsequent stroke.

Author, Year, Country	Description	Main Findings	Other Findings
Atzema 2016 Canada	Population-based retrospective cohort of ED patients with peripheral vestibular disorder. Control: renal colic. Primary outcome: stroke within 30 d; Secondary outcomes: 7-, 90-, and 365-days stroke, falls, or accidental injuries.	57/41,794 (0.14%) had a stroke within 7 d (RR 50.0, 95% CI 6.9-362) 76 (0.18%) had a stroke within 30 d (RR, 9.3, 95% CI 4.3-20.3)	No difference in rates of accidental injuries. BPPV was the most common diagnosis.
Grewal 2015 Canada	Same population as Atzema 2016. Analyzed if CT scan at the index visit was predictive of subsequent stroke.	Among 41,794 patients, 30-d stroke risk had a RR 2.27 (95% CI 1.12-4.62) for those with CT vs no CT.	
Kerber 2014 USA	Population-based cohort of ED patients with dizziness, vertigo, or imbalance with subsequent stroke. Outcome was stroke risk over time.	15/1,245 (1.2%) had a stroke within a year. Risk for stroke was 0.48% at 2 d and 7 d (6 events, 0.48%, 95% CI 0.22-1.07%) and 0.56% at 30 days (7 events, 0.56%, 95% CI 0.27-1.18).	Vascular risk factors were not predictive.
Kim 2011 USA	National database of ED patients with diagnosis of dizziness or vertigo. Primary outcomes: hospitalization or death for cerebrovascular disease or cardiovascular events.	274/31,159 deaths (0.93%), 231 cerebrovascular events (0.63%), and 115 cardiovascular events (0.32%) within 180 d.	
Lee 2012 Taiwan	National database of ED patients with dizziness/vertigo. Primary outcomes: subsequent cerebrovascular and cardiovascular events over 3 y compared with patients without dizziness/vertigo.	1,118/25,757 (4.3%) ED patients had dizziness/vertigo. 52/1,118 (4.7%) had vascular events compared with 1.8% without dizziness/vertigo, RR 2.0 (95% CI, 1.35-2.96). 11 strokes (1.0%) in patients with dizziness/vertigo vs 81 in those without (0.3%) at 6 months.	Stroke/TIA were more common the first month at 30.2 (95% CI, 24.4-37) per 10,000 person-months compared with cardiovascular events at 9.0 (95% CI, 6-13).

BPPV, benign paroxysmal positional vertigo; *RR*, Relative risk; *CI*, Confidence interval.

Studies of Patients With Transient Ischemic Attack With Dizziness as Their Major Symptom That Look Forward to Identify Subsequent Strokes

We identified 11 articles in this category with nonconsensus transient ischemic attacks that "look forward" to see how many develop a stroke following discharge (Table E1, available at http://www.annemergmed.com).[6,17,26,27,61-67] One study found that cerebrovascular disease is common in patients presenting with posterior circulation transient ischemic attack but stroke outcomes were not reported.[63] Three other studies of nonconsensus patients with transient ischemic attack did not separately report data about patients with vestibular symptoms.[26,64,66]

Five studies examined acute patients referred to neurology clinics with variable proportions of ED patients and duration of dizziness.[27,61,62,65,67] One showed that among patients with positional maneuvers performed, 18% had benign paroxysmal positional vertigo. Those presenting with vertigo as their major complaint were twice as likely to have a future stroke or transient ischemic attack (event rate 7.8 versus 3.5 per 100 person-years; hazard ratio (HR) 2.07, 95% confidence interval [CI] 1.11 to 3.84) compared with other neurologic complaints. Of the 214 patients followed over time, 12 (2.1%) had posterior circulation strokes.[61] In a study evaluating patients with MRI-diffusion weighted imaging (with 58% done within 48 hours of symptom onset and 31% done in the ED), 15.9%

of the 107 patients with isolated vertigo had ischemia by MRI evaluation.[67]

A British study of primary care patients reported that 210 (36.8%) of 570 nonconsensus patients with transient ischemic attack had isolated vertigo or ataxia. Ninety-day stroke outcomes were similar in classic versus nonconsensus transient ischemic attack (11.6% versus 10.6%). Of the 210 patients with dizziness as the index event, 21 (10%) had strokes within the first 10 days.[65]

In a multinational study of 1,028 patients with low-risk transient ischemic attack or minor stroke referred to a neurologist, an MRI-diffusion weighted imaging (done a median of 50 hours after symptom onset) changed an initial nonischemic diagnosis to an ischemic one in 79 (7.7%) patients.[62] Of the 103 patients with peripheral vestibular diagnoses, 4 (3.9%) had an imaging-proven stroke. In the whole cohort, patients with a positive MRI finding had a 6-fold increase in recurrent stroke within the next year.

A French study evaluated 2,398 patients referred to a same-day transient ischemic attack clinic, of whom 1,850 were thought to have a transient ischemic attack.[27] Of the 1,850, 71 (3.8%) had isolated dizziness. Only 1 (1.4%) had a definite ischemic event with positive brain imaging, and 14 (19.7%) had a transient ischemic attack without positive brain imaging. Another 13 (18.3%) had possible transient ischemic attack and 43 (60.6%) had nonischemic events. Stroke outcomes within a year were similar in the nonconsensus group compared with typical transient ischemic attack patients, although data specific to patients with dizziness were not reported.

Finally, the 2 most relevant studies recruited ED patients with an episodic vestibular syndrome.[6,17] The multicenter Canadian study by Bery et al[17] included 484 of 11,507 patients (4.2%) with isolated dizziness who were diagnosed by emergency physicians with a transient ischemic attack. They excluded patients diagnosed with peripheral vertigo or presyncope. Four (0.8%) of the 484 had a stroke diagnosed within 90 days of the index visit. Eight (1.7%) of 484 with isolated dizziness had a transient ischemic attack within 90 days compared with 612 (5.6%) of 11,024 nonisolated dizziness patients, risk ratio 0.30 (0.15-0.60).

The second study by Comolli, from a Swiss tertiary care ED that included patients with dizziness and suspected stroke, reported on 533/1,535 (34.7%) patients diagnosed with episodic vestibular syndrome.[6] Of these 533 patients, the ED diagnoses included benign paroxysmal positional vertigo in 143 (26.8%), transient ischemic attack in 55 (10.3%), and vestibular migraine in 31 (5.8%). No specific diagnosis was rendered in 239 (44.8%). Of this latter group, on follow-up, 2.4% were diagnosed with benign paroxysmal positional vertigo, 8.8% with vestibular migraine, 5.6% with stroke, and 2.4% with transient ischemic attack. Of the 49 ED-diagnosed patients with transient ischemic attack, 14.3% were diagnosed with stroke on follow-up.[6] These studies did not report misdiagnosis-related harm.

Overall, these studies show that in patients with transient episodes of isolated dizziness, anywhere from 0.8% to 15.9% have strokes in follow-up, with most studies reporting stroke outcomes in the lower end of that range, and the ones in the higher range are studies that enrolled nonconsecutive dizziness patients suspected to have had a transient ischemic attack or stroke. Most of these strokes occurred in the days to weeks following the transient ischemic attack.

Studies of Patients Diagnosed With Posterior Circulation Stroke That Look Backward to Identify Prior Episodes of Isolated Dizziness

We identified 9 studies of patients with posterior circulation stroke that look backward to identify prior episodes of isolated dizziness (Table E2, available at http://www.annemergmed.com).[14-16,60,68-72] These are the studies with the highest risk of bias because the outcome of stroke has already occurred and tend to overestimate the incidence. These patients are not reflective of "all comers to the ED."

Four studies that compared the frequency of dizziness in patients with posterior circulation versus anterior circulation stroke found an increased frequency of episodes of dizziness (defined differently in the different studies, ie, unsteadiness, imbalance, vertigo, and nonrotatory dizziness) in patients with posterior circulation events compared with patients with anterior circulation events.[15,16,60,72] In 3 studies, 12%, 14%, and 16% of patients experienced episodes of dizziness in the days to months prior to their posterior circulation stroke.[15,16,72] One population-based study of patients with stroke found higher odds of dizzy episodes in the preceding 48 hours of the index stroke among posterior circulation stroke patients (22/275, 8%) compared with anterior circulation strokes (2/759, 0.3%).[16] The dizziness was isolated in 51% to 89% of patients.[15,16] Overall, these studies show that 12% to 16% of patients presenting with posterior circulation stroke might have transient episodes of isolated dizziness prior to their stroke.

DATA SYNTHESIS AND PROPOSED DIAGNOSTIC STRATEGY

Summarizing existing literature is the first step toward understanding the current knowledge and gaps. The summaries presented in the previous section help quantify

the available evidence on the risk of posterior circulation transient ischemic attack among patients presenting with isolated dizziness. Evidence from studies of patients who have already had a stroke or those with transient ischemic attacks who have more vascular risk factors should not be used to cite incidence of stroke in an "all comer" ED population with an episode of isolated dizziness.

The difference in the incidence of posterior circulation transient ischemic attack and subsequent strokes between the different studies is explained by methodological approaches, population included clinic versus ED presentation, imaging use, time of imaging, physician specialty, consultation rates, follow-up method, timing of the follow-up, information available at the time of follow-up, among others.

We acknowledge that described studies have bias; most were observational studies conducted in a real-world setting and lack of an experimental design (similar to a randomized controlled trial). We agree that most are affected by their retrospective design and rely on discharge impressions rather than delving into ED clinical reasoning in real-time.

Confusion between cerebrovascular diagnoses, vestibular migraine, and peripheral vestibular conditions is not uncommon, even when neurologists evaluate these patients.[6,47,52,53] The Swiss study reported moderate to low agreement between the ED diagnosis and the final diagnosis at follow-up, and misdiagnosis occurred in 25% to 30% of patients with transient ischemic attack, benign paroxysmal positional vertigo and vestibular migraine, sometimes false positive and sometimes false negative.[6] Furthermore, it is not infrequent that patients with episodic vestibular syndrome have no specific diagnosis made, even in tertiary centers, and even after extensive advanced imaging.[6,59]

Despite the limitations, these data suggest 4 facts. First, posterior circulation transient ischemic attacks presenting as isolated dizziness do occur, no matter what their label

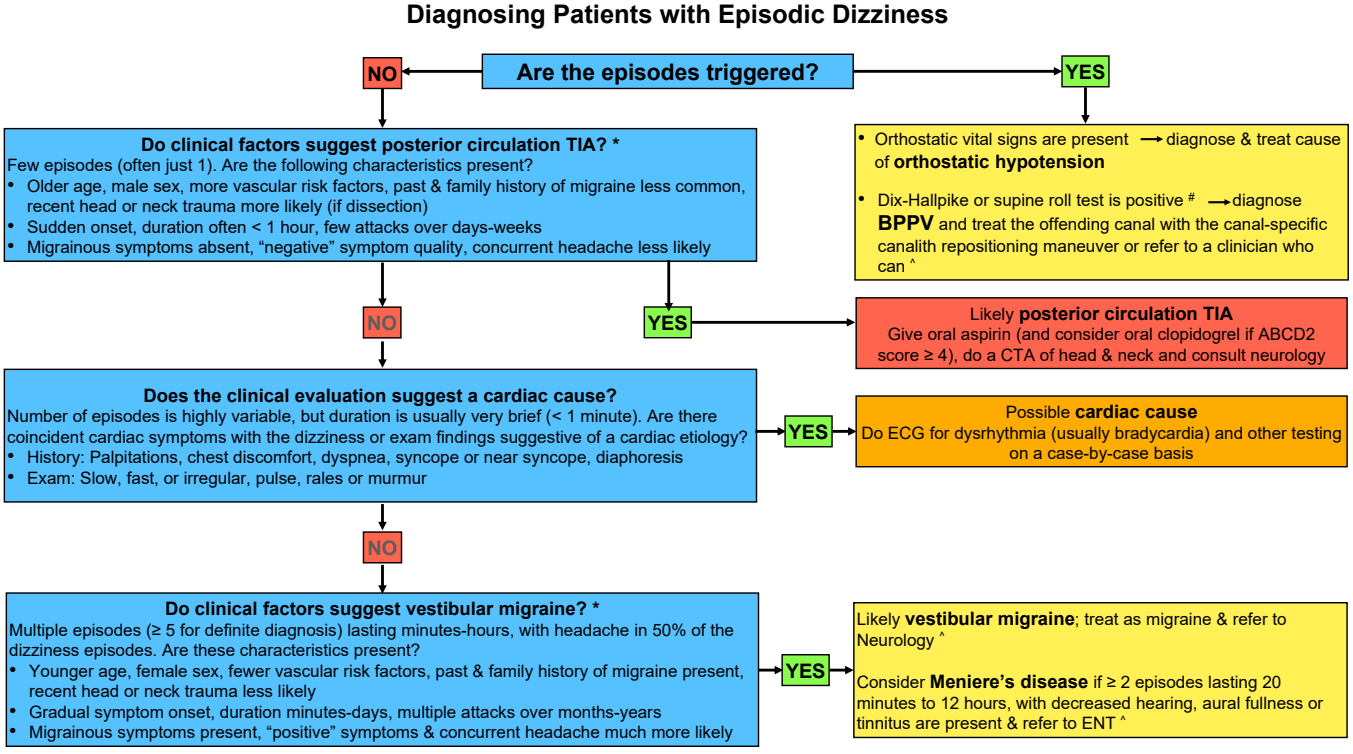

Figure. This algorithm applies to patients who have episodes of dizziness, are currently asymptomatic and have a normal (or baseline) neurological exam at the time of evaluation. It focuses on the more common causes of the episodic vestibular syndrome. Exercise caution and consider TIA in patients who present after a single episode before a clear pattern has been established. * The clinical features (see Table 2) that help to distinguish posterior circulation TIA from vestibular migraine overlap; use combinations of many elements rather than any one individual factor. Migrainous symptoms include phono- and photophobia, visual aura, nausea and vomiting. ^ Can also refer to a vestibular specialist if available. In some areas, physical therapy may be a good referral option for BPPV patients. # The nystagmus in the Dix-Hallpike test that diagnoses posterior canal BPPV is upbeating torsional nystagmus beating towards the lower ear (the side being tested). The nystagmus in the supine roll test that diagnoses horizontal canal BPPV is horizontal, usually beating towards the ground; it changes direction when the other ear is tested. If it beats away from the ground, this is consistent with apogeotropic horizontal canal BPPV, but can also be seen in central mimics. *BPPV*, benign paroxysmal positional vertigo; *ENT*, ear, nose, and throat; *CTA*, computed tomography angiography.

("transient neurological attack" or "nonconsensus transient ischemic attack"). Identifying them and starting secondary stroke prevention measures will prevent some strokes. Second, absent accurate imaging or biomarkers, clinical evaluation is all we currently have to identify these patients. Patients with concurrent neurologic symptoms (lateralized weakness or numbness, diplopia, dysarthria, dysphagia, or limb ataxia) should be evaluated for transient ischemic attack. The history should focus on the timing and quality of symptoms to assess the risk of transient ischemic attack compared with other diagnostic competitors.

Third, the current evidence base does not allow a hard-and-fast dichotomous rule. It may never. To optimize both resource usage and correct identification of patients with posterior circulation transient ischemic attack, we propose a diagnostic algorithm (Figure) with the understanding that there is overlap for each variable and that it has not been validated.

MEDICAL DECISIONMAKING

Medical decisionmaking involves working through a differential diagnosis, but for the differential to work, all plausible causes must be included. If clinicians do not consider posterior circulation transient ischemic attack in a patient with episodic vestibular syndrome, the diagnosis will not be made. Although posterior circulation transient ischemic attack is far less common than the diagnostic mimics, it has greater consequences if missed, begging the question, "Can front-line clinicians reduce an already very low number of missed diagnoses even lower, and at what cost?"

An algorithmic approach can help clinicians with the appropriate framework of reference for the disease, organize fundamental characteristics of the presentation, and provide a cognitive forcing strategy to acquire and process information.

Step 1: Determine if the episodic vestibular syndrome is triggered or not. Simple bedside tests can help diagnose benign paroxysmal positional vertigo and orthostatic hypotension. After good clinical history taking (including timing and triggers), clinicians should learn to perform the Dix-Hallpike test (for posterior canal benign paroxysmal positional vertigo) and supine roll test (for horizontal canal benign paroxysmal positional vertigo) on patients with episodic dizziness who do not have spontaneous or direction-changing gaze evoked nystagmus.[8] Positional testing takes about 2 minutes to do.[73] Orthostatic hypotension can be detected at the bedside. Loss of consciousness strongly suggests vasovagal syncope and almost never occurs with a transient ischemic attack, but milder presyncopal events can present as episodic vestibular syndrome. Making an accurate benign diagnosis makes a second simultaneous serious one unlikely.

Step 2: Think algorithmically. After a single episode of dizziness, before a pattern has emerged, consider posterior circulation transient ischemic attack, especially in patients whose profile better fits a vascular cause. The ABDC2 score is sometimes used to assess risk for a vascular cause in patients with acute dizziness.[74] We suggest using a clinical algorithm that may improve diagnosis of patients with episodic dizziness overall and reduce the very low rate of missed vascular diagnoses to an even lower number than already exists.

Step 3: Become more familiar with vestibular migraine. Misdiagnosis of vestibular migraine in dizzy patients referred to vertigo clinics occurs in more than 90% of these patients.[12,75] If vestibular migraine is strongly suspected, imaging might be safely reduced or eliminated, and initial referral to a vestibular specialist or neurologist to confirm the diagnosis may decrease overall health care costs and reduce falls.[76-78] Increased awareness of the presentation of vestibular migraine would help broaden the differential of patients with episodes of isolated dizziness.[79]

In an "all comer" ED population, a very small proportion of patients with episodes of isolated dizziness are because of posterior circulation transient ischemic attack, likely because of the presence of far more common mimics. Accurately identifying patients with transient ischemic attack requires considering the diagnosis and a clinical evaluation that focuses on the history and the epidemiologic context. Emergency clinicians should become knowledgeable in diagnosing benign paroxysmal positional vertigo and become more aware of vestibular migraine. Although the data do not allow a firm "rule," application of these concepts should allow more accurate diagnosis so that patients with posterior circulation transient ischemic attack can begin secondary stroke prevention, benign paroxysmal positional vertigo patients can be treated in the ED, and vestibular migraine patients might receive migraine specific treatment and timelier outpatient management.

Diagnosing patients with acute episodic dizziness in the ED is challenging. Focused research in this area is needed. To improve identification of posterior circulation transient ischemic attacks presenting with isolated dizziness, we need to better learn to diagnose mimics more accurately and, when they are unlikely, to consider posterior circulation transient ischemic attack, then look for it. If we only look for hay, we will never find the needle in the haystack.

Supervising editor: Clifton Callaway, MD, PhD. Specific detailed information about possible conflict of interest for individual editors is available at https://www.annemergmed.com/editors.

Author affiliations: From the Emergency Medicine (Edlow), Harvard Medical School, Boston, MA; Department of Emergency Medicine (Edlow), Beth Israel Deaconess Medical Center, Boston, MA; and the Emergency Medicine (Bellolio), Mayo Clinic, Rochester, MN.

All authors attest to meeting the four ICMJE.org authorship criteria: (1) Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND (2) Drafting the work or revising it critically for important intellectual content; AND (3) Final approval of the version to be published; AND (4) Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Funding and support: By *Annals*' policy, all authors are required to disclose any and all commercial, financial, and other relationships in any way related to the subject of this article as per ICMJE conflict of interest guidelines (see www.icmje.org). The authors have stated that no such relationships exist. The authors report this article did not receive any outside funding or support.

Publication dates: Received for publication January 25, 2024. Revision received March 26, 2024. Accepted for publication April 5, 2024.

Disclaimer: Dr. Edlow reviews medico-legal cases for both defense and plaintiff firms. Some of these cases involve patients with dizziness.

REFERENCES

1. Newman-Toker DE, Hsieh YH, Camargo CA Jr, et al. Spectrum of dizziness visits to US emergency departments: cross-sectional analysis from a nationally representative sample. *Mayo Clin Proc*. 2008;83:765-775.
2. Kerber KA, Callaghan BC, Telian SA, et al. Dizziness symptom type prevalence and overlap: a US nationally representative survey. *Am J Med*. 2017;130:1465.e5-9.
3. Newman-Toker DE, Cannon LM, Stofferahn ME, et al. Imprecision in patient reports of dizziness symptom quality: a cross-sectional study conducted in an acute care setting. *Mayo Clin Proc*. 2007;82:1329-1340.
4. Edlow JA, Gurley KL, Newman-Toker DE. A new diagnostic approach to the adult patient with acute dizziness. *J Emerg Med*. 2018;54:469-483.
5. Bi Y, Cao F. A dynamic nomogram to predict the risk of stroke in emergency department patients with acute dizziness. *Front Neurol*. 2022;13:839042.
6. Comolli L, Korda A, Zamaro E, et al. Vestibular syndromes, diagnosis and diagnostic errors in patients with dizziness presenting to the emergency department: a cross-sectional study. *BMJ Open*. 2023;13:e064057.
7. Edlow JA. Managing patients with acute episodic dizziness. *Ann Emerg Med*. 2018;72:602-610.
8. Edlow JA, Kerber KA. Benign paroxysmal positional vertigo: a practical approach for emergency physicians. *Acad Emerg Med*. 2023;30:579-588.
9. Tang L, Jiang W, Wang X. New onset episodic vertigo as a presentation of vestibular neuritis. *Front Neurol*. 2022;13:984865.
10. Dieterich M, Obermann M, Celebisoy N. Vestibular migraine: the most frequent entity of episodic vertigo. *J Neurol*. 2016;263:S82-S89.
11. Baloh RW. Vestibular migraine i: mechanisms, diagnosis, and clinical features. *Semin Neurol*. 2020;40:76-82.
12. Formeister EJ, Rizk HG, Kohn MA, et al. The epidemiology of vestibular migraine: a population-based survey study. *Otol Neurotol*. 2018;39:1037-1044.
13. Neuhauser HK, Radtke A, von Brevern M, et al. Migrainous vertigo: prevalence and impact on quality of life. *Neurology*. 2006;67:1028-1033.
14. Searls DE, Pazdera L, Korbel E, et al. Symptoms and signs of posterior circulation ischemia in the New England Medical Center posterior circulation registry. *Arch Neurol*. 2012;69:346-351.
15. Kim HA, Oh EH, Choi SY, et al. Transient vestibular symptoms preceding posterior circulation stroke: a prospective multicenter study. *Stroke*. 2021;52:e224-e228.
16. Paul NL, Simoni M, Rothwell PM, et al. Transient isolated brainstem symptoms preceding posterior circulation stroke: a population-based study. *Lancet Neurol*. 2013;12:65-71.
17. Bery AK, Sharma M, Nemnom MJ, et al. Risk of stroke is low after transient ischemic attack presentation with isolated dizziness. *CJEM*. 2022;24:844-852.
18. Perry JJ, Sivilotti ML, Emond M, et al. Prospective validation of Canadian TIA score and comparison with ABCD2 and ABCD2i for subsequent stroke risk after transient ischaemic attack: multicentre prospective cohort study. *BMJ*. 2021;372:n49.
19. Flossmann E, Rothwell PM. Prognosis of vertebrobasilar transient ischaemic attack and minor stroke. *Brain*. 2003;126:1940-1954.
20. Zhang J, Zhang K, Jia B, et al. Risk of recurrence of symptomatic intracranial atherosclerosis in posterior circulation seen to be higher than that in anterior circulation in long-term follow-up. *Front Neurol*. 2020;11:574926.
21. Johnston SC, Gress DR, Browner WS, et al. Short-term prognosis after emergency department diagnosis of TIA. *JAMA*. 2000;284:2901-2906.
22. Lavallee PC, Meseguer E, Abboud H, et al. A transient ischaemic attack clinic with round-the-clock access (SOS-TIA): feasibility and effects. *Lancet Neurol*. 2007;6:953-960.
23. Rothwell PM, Giles MF, Chandratheva A, et al. Effect of urgent treatment of transient ischaemic attack and minor stroke on early recurrent stroke (EXPRESS study): a prospective population-based sequential comparison. *Lancet*. 2007;370:1432-1442.
24. Anonymous. The Ad Hoc Committee on the classification and outline of cerebrovascular disease II. *Stroke*. 1975;6:566-616.
25. Bos MJ, van Rijn MJ, Witteman JC, et al. Incidence and prognosis of transient neurological attacks. *JAMA*. 2007;298:2877-2885.
26. Ishihara T, Sato S, Uehara T, et al. Significance of nonfocal symptoms in patients with transient ischemic attack. *Stroke*. 2018;49:1893-1898.
27. Lavallee PC, Sissani L, Labreuche J, et al. Clinical significance of isolated atypical transient symptoms in a cohort with transient ischemic attack. *Stroke*. 2017;48:1495-1500.
28. Markus HS, van der Worp HB, Rothwell PM. Posterior circulation ischaemic stroke and transient ischaemic attack: diagnosis, investigation, and secondary prevention. *Lancet Neurol*. 2013;12:989-998.
29. Edlow JA, Kim S, Pelletier AJ, et al. National study on emergency department visits for transient ischemic attack, 1992-2001. *Acad Emerg Med*. 2006;13:666-672.
30. Madsen TE, Khoury JC, Alwell K, et al. Temporal trends of sex differences in transient ischemic attack incidence within a population. *J Stroke Cerebrovasc Dis*. 2019;28:2468-2474.
31. Kerber KA, Brown DL, Lisabeth LD, et al. Stroke among patients with dizziness, vertigo, and imbalance in the emergency department: a population-based study. *Stroke*. 2006;37:2484-2487.

32. Lempert T, Olesen J, Furman J, et al. Vestibular migraine: diagnostic criteria1. *J Vestib Res*. 2022;32:1-6.
33. Dmitriew C, Bodunde O, Regis A, et al. The use and misuse of the Dix-Hallpike test in the emergency department. *CJEM*. 2021;23:613-616.
34. Dmitriew C, Regis A, Bodunde O, et al. Diagnostic accuracy of the HINTS exam in an emergency department: a retrospective chart review. *Acad Emerg Med*. 2021;28:387-393.
35. Edlow JA. Diagnosing patients with acute-onset persistent dizziness. *Ann Emerg Med*. 2018;71:625-631.
36. Gurley KL, Edlow JA. Avoiding misdiagnosis in patients with posterior circulation ischemia: a narrative review. *Acad Emerg Med*. 2019;26:1273-1284.
37. Kerber KA, Newman-Toker DE. Misdiagnosing dizzy patients: common pitfalls in clinical practice. *Neurol Clin*. 2015;33:565-575.
38. Newman-Toker DE, Camargo CA Jr, Hsieh YH, et al. Disconnect between charted vestibular diagnoses and emergency department management decisions: a cross-sectional analysis from a nationally representative sample. *Acad Emerg Med*. 2009;16:970-977.
39. Ohle R, Montpellier RA, Marchadier V, et al. Can emergency physicians accurately rule out a central cause of vertigo using the hints examination? A systematic review and meta-analysis. *Acad Emerg Med*. 2020;27:887-896.
40. Stanton VA, Hsieh YH, Camargo CA Jr, et al. Overreliance on symptom quality in diagnosing dizziness: results of a multicenter survey of emergency physicians. *Mayo Clin Proc*. 2007;82:1319-1328.
41. Atzema CL, Grewal K, Lu H, et al. Outcomes among patients discharged from the emergency department with a diagnosis of peripheral vertigo. *Ann Neurol*. 2016;79:32-41.
42. Choi JY, Kim S, Boo D, et al. Risk of future stroke in patients with a diagnosis of peripheral vertigo in the emergency department. *Eur J Neurol*. 2023;30:2062-2069.
43. Grewal K, Austin PC, Kapral MK, et al. Missed strokes using computed tomography imaging in patients with vertigo: population-based cohort study. *Stroke*. 2015;46:108-113.
44. Kerber KA, Zahuranec DB, Brown DL, et al. Stroke risk after nonstroke emergency department dizziness presentations: a population-based cohort study. *Ann Neurol*. 2014;75:899-907.
45. Kim AS, Fullerton HJ, Johnston SC. Risk of vascular events in emergency department patients discharged home with diagnosis of dizziness or vertigo. *Ann Emerg Med*. 2011;57:34-41.
46. Lee CC, Ho HC, Su YC, et al. Increased risk of vascular events in emergency room patients discharged home with diagnosis of dizziness or vertigo: a 3-year follow-up study. *PLoS One*. 2012;7:e35923.
47. Royl G, Ploner CJ, Leithner C. Dizziness in the emergency room: diagnoses and misdiagnoses. *Eur Neurol*. 2011;66:256-263.
48. Arch AE, Weisman DC, Coca S, et al. Missed ischemic stroke diagnosis in the emergency department by emergency medicine and neurology services. *Stroke*. 2016;47:668-673.
49. Calic Z, Cappelen-Smith C, Anderson CS, et al. Cerebellar Infarction and factors associated with delayed presentation and misdiagnosis. *Cerebrovasc Dis*. 2016;42:476-484.
50. Masuda Y, Tei H, Shimizu S, et al. Factors associated with the misdiagnosis of cerebellar infarction. *J Stroke Cerebrovasc Dis*. 2013;22:1125-1130.
51. Sangha N, Albright KC, Peng H, et al. Misdiagnosis of cerebellar infarctions. *Can J Neurol Sci*. 2014;41:568-571.
52. Cortel-LeBlanc MA, Sharma M, Cortel-LeBlanc A, et al. Predictors of neurologists confirming or overturning emergency physicians' diagnosis of TIA or stroke. *CJEM*. 2021;23:812-819.
53. Schrock JW, Glasenapp M, Victor A, et al. Variables associated with discordance between emergency physician and neurologist diagnoses of transient ischemic attacks in the emergency department. *Ann Emerg Med*. 2012;59:19-26.
54. Koudstaal PJ, Gerritsma JG, van Gijn J. Clinical disagreement on the diagnosis of transient ischemic attack: is the patient or the doctor to blame? *Stroke*. 1989;20:300-301.
55. Kraaijeveld CL, van Gijn J, Schouten HJ, et al. Interobserver agreement for the diagnosis of transient ischemic attacks. *Stroke*. 1984;15:723-725.
56. Tomasello F, Mariani F, Fieschi C, et al. Assessment of inter-observer differences in the Italian multicenter study on reversible cerebral ischemia. *Stroke*. 1982;13:32-35.
57. Castle J, Mlynash M, Lee K, et al. Agreement regarding diagnosis of transient ischemic attack fairly low among stroke-trained neurologists. *Stroke*. 2010;41:1367-1370.
58. Nadarajan V, Perry RJ, Johnson J, et al. Transient ischaemic attacks: mimics and chameleons. *Pract Neurol*. 2014;14:23-31.
59. Choi JH, Park MG, Choi SY, et al. Acute transient vestibular syndrome: prevalence of stroke and efficacy of bedside evaluation. *Stroke*. 2017;48:556-562.
60. Compter A, Kappelle LJ, Algra A, et al. Nonfocal symptoms are more frequent in patients with vertebral artery than carotid artery stenosis. *Cerebrovasc Dis*. 2013;35:378-384.
61. Blasberg TF, Wolf L, Henke C, et al. Isolated transient vertigo: posterior circulation ischemia or benign origin? *BMC Neurol*. 2017;17:111.
62. Coutts SB, Moreau F, Asdaghi N, et al. Rate and prognosis of brain ischemia in patients with lower-risk transient or persistent minor neurologic events. *JAMA Neurol*. 2019;76:1439-1445.
63. Marquardt L, Kuker W, Chandratheva A, et al. Incidence and prognosis of $>$ or $=$ 50% symptomatic vertebral or basilar artery stenosis: prospective population-based study. *Brain*. 2009;132:982-988.
64. Shima H, Taguchi H, Niwa Y, et al. Stroke risk in patients with suspected transient ischemic attacks with focal and nonfocal symptoms: a prospective study. *J Stroke Cerebrovasc Dis*. 2022;31:106185.
65. Tuna MA, Rothwell PM. Oxford Vascular Study. Diagnosis of non-consensus transient ischaemic attacks with focal, negative, and non-progressive symptoms: population-based validation by investigation and prognosis. *Lancet*. 2021;397:902-912.
66. van Rooij FG, Vermeer SE, Goraj BM, et al. Diffusion-weighted imaging in transient neurological attacks. *Ann Neurol*. 2015;78:1005-1010.
67. Whiteley WN, MacRaild A, Wang Y, et al. Clinical diagnosis and magnetic resonance imaging in patients with transient and minor neurological symptoms: a prospective cohort study. *Stroke*. 2022;53:3419-3428.
68. Gomez CR, Cruz-Flores S, Malkoff MD, et al. Isolated vertigo as a manifestation of vertebrobasilar ischemia. *Neurology*. 1996;47:94-97.
69. Grad A, Baloh RW. Vertigo of vascular origin. Clinical and electronystagmographic features in 84 cases. *Arch Neurol*. 1989;46:281-284.
70. Hoshino T, Nagao T, Mizuno S, et al. Transient neurological attack before vertebrobasilar stroke. *J Neurol Sci*. 2013;325:39-42.
71. Moubayed SP, Saliba I. Vertebrobasilar insufficiency presenting as isolated positional vertigo or dizziness: a double-blind retrospective cohort study. *Laryngoscope*. 2009;119:2071-2076.
72. Plas GJ, Booij HA, Brouwers PJ, et al. Nonfocal symptoms in patients with transient ischemic attack or ischemic stroke: occurrence, clinical determinants, and association with cardiac history. *Cerebrovasc Dis*. 2016;42:439-445.
73. Vanni S, Nazerian P, Pecci R, et al. Timing for nystagmus evaluation by STANDING or HINTS in patients with vertigo/dizziness in the emergency department. *Acad Emerg Med*. 2023;30:592-594.
74. Kerber KA, Meurer WJ, Brown DL, et al. Stroke risk stratification in acute dizziness presentations: a prospective imaging-based study. *Neurology*. 2015;85:1869-1878.
75. Geser R, Straumann D. Referral and final diagnoses of patients assessed in an academic vertigo center. *Front Neurol*. 2012;3:169.

76. Agrawal Y, Carey JP, Della Santina CC, et al. Disorders of balance and vestibular function in US adults: data from the National Health and Nutrition Examination Survey, 2001-2004. *Arch Intern Med*. 2009;169:938-944.
77. Huang RJ, Smith SL, Brezina L, et al. A comparison of falls and dizziness handicap by vestibular diagnosis. *Am J Audiol*. 2021;30:1048-1057.
78. Beh SC, Masrour S, Smith SV, et al. The spectrum of vestibular migraine: clinical features, triggers, and examination findings. *Headache*. 2019;59:727-740.
79. Rocha MF, Sacks B, Al-Lamki A, et al. Acute vestibular migraine: a ghost diagnosis in patients with acute vertigo. *J Neurol*. 2023;270:6155-6158.