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ORIGINAL RESEARCH

Can emergency physicians accurately and reliably assess acute vertigo in the emergency department?

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Abstract

***Objective*:** To validate a clinical diagnostic tool, used by emergency physicians (EPs), to diagnose the central cause of patients presenting with vertigo, and to determine interrater reliability of this tool.

***Methods*:** A convenience sample of adult patients presenting to a single academic ED with isolated vertigo (i.e. vertigo without other neurological deficits) was prospectively evaluated with STANDING (**S**pon**TA**neous **N**ystagmus, **D**irection, head **I**mpulse test, standi**NG**) by five trained EPs. The first step focused on the presence of spontaneous nystagmus, the second on the direction of nystagmus, the third on head impulse test and the fourth on gait. The local standard practice, senior audiologist evaluation corroborated by neuroimaging when deemed appropriate, was considered the reference standard. Sensitivity and specificity of STANDING were calculated. On the first 30 patients, inter-observer agreement among EPs was also assessed.

***Results*:** Five EPs with limited experience in nystagmus assessment volunteered to participate in the present study enrolling 98 patients. Their average evaluation time was 9.9 ± 2.8 min (range 6–17). Central acute vertigo was suspected in 16 (16.3%) patients. There were 13 true positives, three false positives, 81 true negatives and one false negative, with a high sensitivity (92.9%, 95% CI 70–100%) and specificity (96.4%, 95% CI 93–38%) for central acute vertigo according to senior audiologist evaluation. The Cohen's kappas of the first, second, third and fourth steps of the STANDING were 0.86, 0.93, 0.73 and 0.78, respectively. The whole test showed a good inter-observer agreement (k = 0.76, 95% CI 0.45–1).

***Conclusions*:** In the hands of EPs, STANDING showed a good inter-observer agreement and accuracy validated against the local standard of care.

Key words: *emergency physician, head impulse test, nystagmus, stroke, vertigo.*

Key findings

- Vertigo is a frequent complaint in ED.
- About 14% of patients presenting with vertigo have a central disease.
- Emergency physicians quickly perform a structured diagnostic algorithm with good reliability and accuracy.

Introduction

Vertigo, the sensation of distorted self-motion during an otherwise normal head movement,[1] is a frequent complaint in the ED.[2] It is often associated with the presence of nystagmus and is frequently caused by vestibular system disorders, such as benign paroxysmal postural vertigo (BPPV) or vestibular neuronitis (VN).[3–6] However, acute vertigo (AV) could be the manifestation of central neurological diseases, such as cerebrovascular disease, sometimes without any accompanying neurological symptoms or signs (isolated AV); in this setting, accurate nystagmus evaluation was shown to be crucial.[4,7,8] Several clinical tests to differentiate central from non-central AV have been investigated, but no one 'per se' has reached an adequate sensitivity and specificity to be used as stand-alone test.[8] Moreover, previous studies showed that emergency physicians (EPs) report in clinical charts the presence or absence of nystagmus in most patients presenting with acute dizziness, but that they do not utilise this sign to guide further diagnostic tests and disposition.[9–11] For these reasons, clinical evaluation of patients with vertigo is often difficult and rarely conclusive, usually leading to an overuse of consultations and neuroimaging tests.[9,12–14] Although experts have identified simple bedside methods that accurately differentiate central from peripheral vestibular disorders,[6,7] it remains unknown whether EPs can competently perform these tests.

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The purpose of the present study was to prospectively assess whether EPs could quickly and accurately perform a simple structured clinical algorithm (STANDING: **S**pon**TA**neous **N**ystagmus, **D**irection, head **I**mpulse test, standi**NG**) we developed to differentiate central from non-central AV in the emergency setting.

Methods

Clinical setting and selection of participants

Adult patients presenting with AV without clinically overt focal neurological deficit (isolated vertigo) were prospectively evaluated in a single academic ED. Exclusion criteria were the presence of severe cognitive impairment, the presence of vertigo mimics (i.e. orthostatic hypotension, anaemia, hypoglycaemia, cardiac arrhythmia, drug intoxication, anxiety) or severe symptoms that prevented patient's cooperation, as well as refusal to participate the study. The sample included in the present study was a convenience sample, because of the required presence on duty of at least one of the five EPs trained in STANDING.

Management strategies and reference standard

Patients presenting with dizziness underwent clinical examination by the attending EP. When the attending EP identified a patient with isolated vertigo (i.e. vertigo in the absence of any overt neurological finding), one of the five trained EPs evaluated the same patient with a simple structured clinical algorithm (STANDING). The STANDING test results were reported on a dedicated data sheet (Appendix S1) and remained unknown to the attending physician. Afterwards, within 24 h, all patients included in the study underwent a complete examination by a senior audiologist who was on duty every morning, 7 days a week. Both the attending physician and the senior audiologist were blinded to STANDING results. The STANDING results did not interfere with both attending physician and senior audiologist disposals. The reference standard was the diagnosis established by the senior audiologist corroborated by neuroimaging tests (head CT or brain magnetic resonance) when deemed appropriate. This is the standard practice in our hospital. Taking into account the pilot nature of the study, the study board decided to adopt as reference standard the standard of care in the hospital, postponing the use of a 'stronger' reference standard, such as brain magnetic resonance to all patients included or a structured clinical follow up, for a subsequent study.

The senior audiologist evaluation included nystagmus evaluation with Frenzel goggles (nystagmus direction, head shaking test, Dix–Hallpike, Rose and Pagnini tests) without Frenzel goggles (Head Impulse Test [HIT], analysis of saccades, of smooth pursuit, of the vestibular ocular reflex at low frequencies, of skew deviation) caloric tests and assessment for gait and limb ataxia. The hospital's Institutional Review Board approved the study.

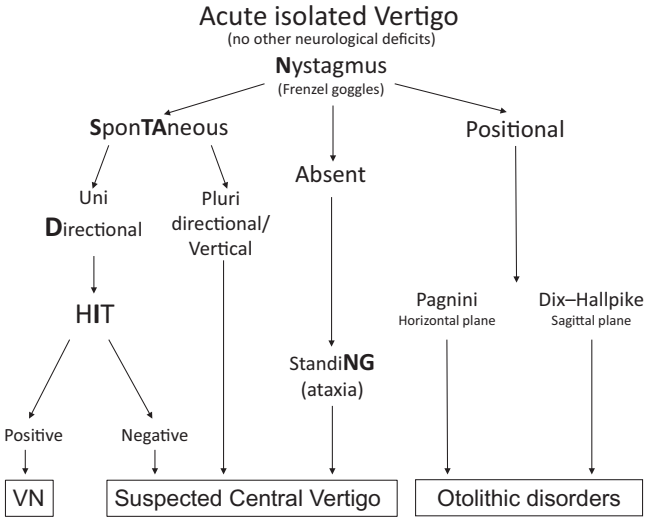

Figure 1. *Diagram of STANDING approach. HIT, Head Impulse Test; VN, vestibular neuronitis.*

STANDING test

The STANDING test is a structured diagnostic algorithm based on previously described diagnostic signs or bedside manoeuvres, which we have logically assembled in four sequential steps (Fig. 1; Video S1).

1. First, the presence of nystagmus was assessed with Frenzel goggles in a supine position after at least 5 min of rest. When no spontaneous nystagmus was present in the main gaze positions, the presence of a positional nystagmus was assessed by the Pagnini test first and then by the Dix–Hallpike test.[5] The presence of a positional, transient paroxysmal nystagmus was considered typical of BPPV (Video S2).
2. Instead, when spontaneous nystagmus was present, the direction was examined: multidirectional nystagmus, such as bidirectional gaze-evoked nystagmus (i.e. right beating nystagmus present with gaze towards the right and left beating nystagmus present with gaze towards the left side), and a vertical (up or down beating) nystagmus were considered signs of central vertigo (Video S3).
3. When the nystagmus was unidirectional (i.e. nystagmus beating on the same side independent of the gaze direction), we performed the HIT[15] (Video S4). When an acute lesion occurs on one labyrinth, the input from the opposite side is unopposed and as a result, when the head is rapidly moved towards the affected side, the eyes will be initially pushed towards that side and, immediately after, a corrective eye movement (corrective 'saccade') back to the point of reference is seen. When the corrective 'saccade' is

present, the HIT is considered positive and it indicates non-central AV, whereas a negative HIT indicates central vertigo.[16]

4. Patients showing neither spontaneous nor positional nystagmus were invited to stand and gait was evaluated (Video S5). When objective imbalance was present, they were suspected to have central disease (Fig. 1).

To explore the reliability of the test, a convenience sample of 30 patients was examined by two independent raters (SV and CC, the first two trained EPs) masked to the other examiners' findings on the exam protocol.

The trained physicians were five EPs, two with at least 5 years of work experience in ED and three with less than 5 years of experience in ED activity, with interest in stroke management. They have previous limited non-specific experience in nystagmus evaluation. Training comprised five 1 h lectures and 1 h of procedural instruction, delivered in a workshop. These were followed by 10 practice STANDING assessments in ED, proctored by a senior audiologist (PV and RP).

Statistical analysis

We express continuous variables as means ± standard deviation (SD), and dichotomous variables as percentages. We assessed the diagnostic accuracy for central AV of the STANDING test, calculating sensitivity, specificity, positive and negative predictive values with 95% confidence intervals (CIs). The inter-observer reliability of two of the five EPs was calculated by Cohen's kappa for the whole test and for each step of STANDING in the first 30 patients.

Calculations were performed using the SPSS statistical package (version 17.0, SPSS, Chicago, IL, USA).

Results

Study sample

A total of 450 patients complaining of dizziness (Fig. 2) were evaluated in our ED between May 2011 and January 2012 (0.8% of the overall presentations). Among these, 130 (28.8%) were actually vertigo mimics, four (0.8%) patients presented a severe cognitive impairment and 24 (5.3%) refused to participate in the study.

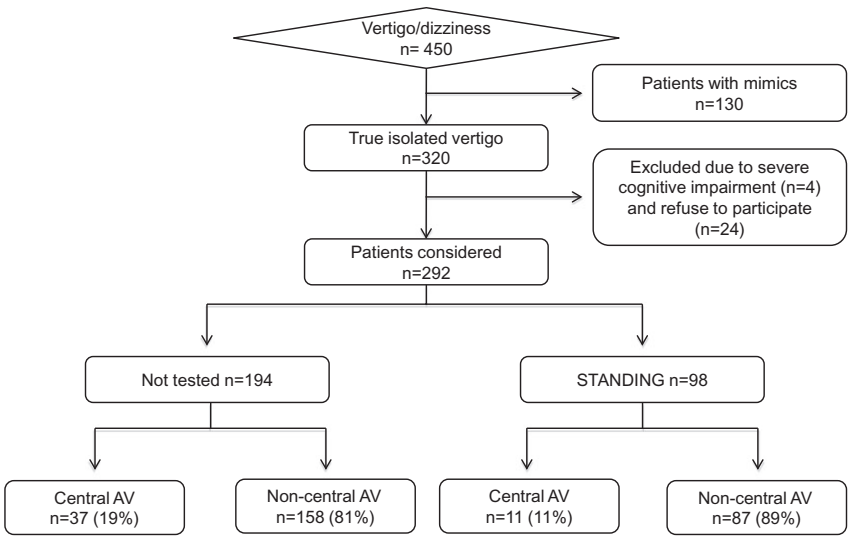

Figure 2. *Study flow-diagram. AV, acute vertigo.*

TABLE 1. *Baseline characteristics, neuroimaging tests and hospitalisation rates of ED patients presenting with acute isolated vertigo tested with and not tested by STANDING*

	STANDING $n = 98$	Not tested $n = 194$	Differences % (95% CI)
Women (%)	56 (57.1)	121 (62.4)	−5.2 (−17.9 + 7.2)
Age (mean ± SD)	60 ± 16.3	57.3 ± 11.3	+2.7 ± 22.1
CV risk factors (%)	45 (45.9)	86 (44.3)	+1.6 (−11.1 + 14.4)
Central vertigo (%)	11 (11.2)	37 (19.1)	−8 (−15.3 + 1.9)
Head CT (%)	31 (31.6)	138 (71.1)	−39.5 (−50.7 − 27)
Head MRI (%)	10 (10.2)	9 (4.6)	5.6 (−1 + 11.9)
Hospitalisation (%)	27 (27.5)	98 (50.5)	−23 (−34.1 − 10.4)

CV risk factors, at least one of the following cardiovascular risk factors: diabetes, blood hypertension, smoke, dyslipidaemia. Hospitalisation included both admission in general or neurological wards and in the observation unit.

Of the remaining 292 patients, 98 (33.6%) were evaluated by one of the five EPs using the STANDING test and were included in the study. Thus, the study population was a convenience sample, because of the required presence on duty of at least one of the five EPs trained in STANDING. The included patients had a mean age of 60 years and 57.1% were women (Table 1); at least one cardiovascular risk factor was present in 45.9% of patients. General characteristics were not significantly different between tested and not tested patients, except for brain imaging and hospitalisation rate. The final diagnosis incidence did not significantly differed between tested and not tested patients.

Fourteen patients (14.3%) out of 98 had a final diagnosis of central AV (Table 2). Eighty-four patients (85.7%) had non-central AV, most often BPPV or VN. Patients with final diagnosis of central AV were older than those with peripheral AV (69 ± 13 *vs* 59 ± 17 years, $P = 0.024$). No differences in sex and comorbidity distribution were found.

Accuracy and reliability of emergency physician assessment

Of the 98 included patients, 60 (61.2%) had paroxysmal positional nystagmus, whereas 24 (24.5%) had

TABLE 2. *Specific diagnosis in patients with isolated vertigo tested and not tested by STANDING*

	STANDING $n = 98$ (%)	Not tested $n = 194$ (%)
Central vertigo	14 (14.3)	37 (19)
Ischaemic stroke	3 (3.1)	8 (4.1)
Hemorragic stroke	1 (1.0)	2 (1.0)
Cerebral tumour	2 (2.0)	3 (1.5)
Vertebrobasilar TIA	7 (7.1)	17 (8.7)
Other central diseases	1 (1.0)	6 (3.1)
Non-central vertigo	84 (85.7)	157 (80.9)
BPPV	60 (61.2)	104 (53.6)
VN	18 (18.3)	25 (12.9)
Other causes	6 (7.1)	28 (14.4)

BPPV, benign paroxysmal postural vertigo; Other causes: Meniere's disease, migraine's vertigo; VN, vestibular neuronitis. Other central disease: hydrocephalus, multiple sclerosis, epilepsy.

spontaneous nystagmus that was pluridirectional in two (8.3%) and unidirectional in 22 (91.7%) patients. Among these, the prevalence of right and left beating nystagmus was similar (52.4% left and 47.6% right). HIT was performed in 23 patients and was negative in four (17.4%) and positive in 19 (82.6%) patients. In one (4.1%) of the 24 cases, HIT was not applicable because of patient intolerance.

Fourteen patients (14.3%) did not show either spontaneous or positional nystagmus; 10 of these patients, when invited to stand, revealed objective imbalance, and according to the protocol, they were suspected to have a central AV. The average STANDING time was 9.9 ± 2.8 min (range 6–17 min).

Overall, after performing the STANDING test, central AV was suspected by ED physicians in 16 (16.3%) out of 98 patients and was confirmed by the audiologist in 13 patients (13.3%). Three patients were false positive and one patient was false negative. Test characteristics of STANDING performed by EPs were reported in Table 3.

The reliability of STANDING between two of the five trained ED physicians was tested in the first 30 patients. The Cohen's kappa of the first (continuous *vs* positional nystagmus), second (unidirectional *vs* pluridirectional or vertical nystagmus), third (HIT) and fourth (unstable gait) steps was 0.86 (95% CI 0.69–1), 0.93 (95% CI 0.80–1), 0.73 (95% CI 0.50–0.97) and 0.78 (95% CI 0.38–1), respectively. The Cohen's kappa of the final result of the test (central *vs* non-central AV) was 0.76 (95% CI 0.45–1).

Discussion

In the present study, a structured bedside algorithm (STANDING) performed by trained EPs showed a good reliability and a high agreement with expert audiology evaluation.

Vertigo is a relatively common complaint that is often diagnosed and treated in the ED. In our study, conducted in a selected population presenting to an academic ED, we found that about 1% of the overall attendances presented with vertigo. In previous studies, similar results were found,[1,13] but the prevalence of vertigo was higher (1–10%) when all kinds of dizziness were included.[14]

Although vertigo is usually ascribable to benign aetiologies, such as peripheral vertigo, in previous studies up to 25% of patients had CNS disease[1,15] and up to 5% of acute vertigo might be due to cerebrovascular disease.[16] Also, in our cohort, a significant fraction (14.3%) had a central disease. Because of this concern, ED evaluations for vertigo are often lengthy, involve substantial use of diagnostic resources and require many specialist consultations. Although the use of neuroimaging and admission in patients with vertigo are disproportionately high, this does not correspond in improvements in overall diagnostic yield for stroke.[8,15]

To optimise both patient care and the use of healthcare resources, recently some bedside techniques have been developed to assess stroke risk in patients with acute vertigo. Early studies investigated the association between single symptoms, signs, or risk factors with the presence of CNS disease. Among them, multiple prodromal episodes of dizziness, neurologic symptoms, including diplopia,[17–19] and age >50 years[9] were strongly associated with stroke. However, these studies provided a low level of evidence[8] because of their retrospective nature.

Recently, one structured bedside clinical examination was proposed.[7] Kattah *et al.* described a 3 step bedside oculomotor examination called HINTS (Head-Impulse-Nystagmus-test of Skew) for differentiating stroke from acute peripheral vestibulopathy. The results of their study confirmed that a normal HIT is the single best bedside predictor of stroke, and showed that the HINTS appears more sensitive for stroke than early MRI. But the study was conducted by expert neuro-opthalmologists, and whether a similar approach could be accurate and reliable also in the hands of EPs was to be investigated.

Nystagmus assessment is a key diagnostic feature in patients presenting with dizziness because the presence of specific types of nystagmus might be the only indicator of a potentially serious pathology, even if CT or MRI imaging are negative.[20,21] One prior study showed that EPs report in charts the presence or absence of nystagmus in most patients presenting with acute dizziness, but that they do not utilise this sign for diagnostic purposes.[8] In our study, the STANDING showed good reliability and high accuracy in EP hands.

In a recent study, Navi *et al.*[22] reported ABCD2 score as a useful tool to differentiate cerebrovascular from non-cerebrovascular causes of dizziness. However, the ABCD2 score does

TABLE 3. *Test characteristics of the application of STANDING by the emergency physicians*

	Central acute vertigo senior audiologist	Non-central acute vertigo senior audiologist	Total
Central acute vertigo emergency physician	13	3	16
Non-central acute vertigo emergency physician	1	81	82
Total	14	84	98

Sensitivity: 92.9% (95% CI 70–100%). Specificity: 96.4% (95% CI 93–98%). Positive predictive value: 81.3% (95% CI 61–87%). Negative predictive value: 98.8% (95% CI 95–100%).

not include nystagmus examination, and a recent comparison study showed that ABCD2 sensitivity for central disease was significantly lower than that of HINTS.[23]

Limitations

Our data should be interpreted in the context of several limitations.

First, our study was limited to a single tertiary care referral centre with daily audiologist consultations, and thus it is uncertain that STANDING will yield similar results in other settings.

Second, we used a convenience sample. However, the general characteristics of the study patients were similar to the patients with isolated AV not tested by STANDING, thus limiting the selection bias.

Third, the finding of a typical pattern of peripheral nystagmus confirmed by the audiologist examination, including repositioning manoeuvres when indicated, allowed us to detect a large fraction (69%) of patients that did not need imaging evaluation and that had been discharged without further testing. We did not perform neither MRI to all patients nor a structured follow up to consider the very rare occurrence of central diseases presenting with clinical features similar to BPPV.[24] However, our purpose was to investigate the performance of STANDING in EP hands in comparison with the standard practice in our clinical setting. Although our results cannot be considered as definitive, surely this is the first study that showed that EPs, after a relatively short period of training, could disentangle themselves from the diagnostic pitfalls of vertigo with good accuracy. This result, in our opinion, is the first step towards the development of an efficient diagnostic algorithm for vertigo assessment in ED.

Conclusions

Emergency physicians with limited experience in nystagmus evaluation were able to quickly perform a structured diagnostic algorithm (STANDING) in a select group of patients with good reliability and high agreement with the local standard of care.

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Author contributions

SV, PV, CC, GP and MR conceived the study, supervised the conduct of the study and conducted the data collection. SV, FM and PN provided statistical advice on the study's design and analysed the data. PV, MO and RP revised final diagnoses. SV, CC, FM and SG drafted the manuscript, and all authors contributed substantially to its revision. SV takes responsibility for the paper as a whole.

Competing interests

None declared.

References

1. Bisdorff A, Von Brevern M, Lempert T, Newman-Toker DE. Classification of vestibular symptoms: towards an international classification of vestibular disorders. *J. Vestib. Res.* 2009; **19**: 1–13.
2. Newman-Toker DE, Hsieh YH, Camargo CA Jr, Pelletier AJ, Butchy GT, Edlow JA. Spectrum of dizziness visits to US emergency departments: cross-sectional analysis from a nationally representative sample. *Mayo Clin. Proc.* 2008; **83**: 765–75.
3. Newman-Toker DE, Cannon LM, Stofferahn ME, Rothman RE, Hsieh YH, Zee DS. Imprecision in patient reports of dizziness symptom quality: a cross-sectional study conducted in an acute care setting. *Mayo Clin. Proc.* 2007; **82**: 1329–40.
4. Kerber KA, Brown DL, Lisabeth LD, Smith MA, Morgenstern LB. Stroke among patients with dizziness, vertigo, and imbalance in the emergency department: a population-based study. *Stroke* 2006; **37**: 2484–7.
5. Herr RD, Zun L, Mathews JJ. A directed approach to the dizzy patient. *Ann. Emerg. Med.* 1989; **18**: 664–72.
6. Bhattacharyya N, Baugh RF, Orvidas L *et al*. Clinical practice guideline: benign paroxysmal positional vertigo. *Otolaryngol. Head Neck Surg.* 2008; **139**: S47–S81.
7. Kattah JC, Talkad AV, Wang DZ, Hsieh YH, Newman-Toker DE. HINTS to diagnose stroke in the acute vestibular syndrome: three-step bedside oculomotor examination more sensitive than early MRI diffusion-weighted imaging. *Stroke* 2009; **40**: 3504–10.
8. Tarnutzer AA, Berkowitz AL, Robinson KA, Hsieh YH, Newman-Toker DE. Does my dizzy patient have a stroke? A systematic review of bedside diagnosis in acute vestibular syndrome. *CMAJ* 2011; **183**: E571–E592.8.
9. Kerber KA, Meurer WJ, West BT, Fendrick AM. Dizziness presentations in U.S. emergency departments, 1995–2004. *Acad. Emerg. Med.* 2008; **15**: 744–50.

10. Kerber KA, Morgenstern LB, Meurer WJ *et al*. Nystagmus assessments documented by emergency physicians in acute dizziness presentations: a target for decision support? *Acad. Emerg. Med.* 2011; **18**: 619–26.
11. Newman-Toker DE, Camargo CA Jr, Hsieh YH, Pelletier AJ, Edlow JA. Disconnect between charted vestibular diagnoses and emergency department management decisions: a cross-sectional analysis from a nationally representative sample. *Acad. Emerg. Med.* 2009; **16**: 970–7.
12. Simmons Z, Biller J, Adams HP Jr, Dunn V, Jacoby CG. Cerebellar infarction: comparison of computed tomography and magnetic resonance imaging. *Ann. Neurol.* 1986; **19**: 291–3.
13. Edlow JA, Newman-Toker DE, Savitz SI. Diagnosis and initial management of cerebellar infarction. *Lancet Neurol.* 2008; **7**: 951–64.
14. Moulin T, Sablot D, Vidry E *et al*. Impact of emergency room neurologists on patient management and outcome. *Eur. Neurol.* 2003; **50**: 207–14.
15. Kerber KA. Vertigo and dizziness in the emergency department. *Emerg. Med. Clin. North Am.* 2009; **27**: 39–50.
16. Newman-Toker DE, Kattah JC, Alvernia JE, Wang DZ. Normal head impulse test differentiates acute cerebellar strokes from vestibular neuritis. *Neurology* 2008; **70**: 2378–85.
17. Schlaeger R, Naegelin Y, Welge-Lüssen A et al. Acute vertigo with double vision – brainstem stroke or stroke mimic? *Cerebrovasc. Dis.* 2010; **30**: 626–7.
18. Neuhauser HK. Epidemiology of vertigo. *Curr. Opin. Neurol.* 2007; **20**: 40–6.
19. Gomez CR, Cruz-Flores S, Malkoff MD, Sauer CM, Burch CM. Isolated vertigo as a manifestation of vertebrobasilar ischemia. *Neurology* 1996; **47**: 94–7.
20. Grad A, Baloh RW. Vertigo of vascular origin. Clinical and electronystagmographic features in 84 cases. *Arch. Neurol.* 1989; **46**: 281–4.
21. Saber Tehrani AS, Kattah JC, Mantokoudis G *et al*. Small strokes causing severe vertigo: frequency of false-negative MRIs and nonlacunar mechanisms. *Neurology* 2014; **83**: 169–73.
22. Navi BB, Kamel H, Shah MP *et al*. Application of the ABCD2 score to identify cerebrovascular causes of dizziness in the emergency department. *Stroke* 2012; **43**: 1484–9.
23. Newman-Toker DE, Kerber KA, Hsieh YH *et al*. HINTS outperforms ABCD2 to screen for stroke in acute continuous vertigo and dizziness. *Acad. Emerg. Med.* 2013; **20**: 986–96.
24. Nam J, Kim S, Huh Y, Kim JS. Ageotropic central positional nystagmus in nodular infarction. *Neurology* 2009; **73**: 1163.

Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Video S1. Spontaneous vs positional nystagmus.
Video S2. Step 1: Positional nystagmus.
Video S3. Step 2: Direction of nystagmus.
Video S4. Step 3: Head impulse test.
Video S5. Step 4: Standing: gait evaluation.
Appendix S1. STANDING standardised form.