H.1.1.2 HINTs test

Study	Chen 2011[127]
Study type	Cohort study
Number of studies (number of participants	1 (n=24)

Study	Chen 2011[127]
Country and setting	Australia. Emergency department.
Funding	Not stated (the authors have no conflict of interest to disclose)
Duration of study	1 year
Age, gender, family origin	Mean age: 64 years (SD 13 years; range 42-83 years) Gender: 63% M/37% F Family origin: Not stated
Patient characteristics	People who presented with acute isolated vertigo to the emergency department were identified by referral. The indications for referral were uncertain diagnosis, presence of vascular risk factors (smoking, hypertension, diabetes, dyslipidaemia, atrial fibrillation and recent neck trauma) and failure of symptoms improvement for safe discharge. Inclusion criteria: acute prolonged rotatory vertigo associated with nausea or vomiting, without other brainstem signs. Exclusion criteria: tinnitus; antecedent viral illness; prior diagnosis or attacks suggestive of Meniere's disease; vestibular migraine; corticospinal tract dysfunction; appendicular and truncal cerebellar signs; hemianopia or other visual field defect; Horner's syndrome; sensory disturbance; facial palsy; bulbar dysfunction and dysarthria; dense motor signs – 3, 4 or 6 nerve palsy, internuclear ophthalmoplegia, gaze palsy. n=20 vestibular group: all VN (n=10/10) had positive h-HIT and unidirectional nystagmus, but 1 patient had SD and abnormal vertical smooth pursuit (SP). In all the strokes (n=10/10), 1 of the following signs suggesting of central lesion was present: negative h-HIT, central-type nystagmus, SD or abnormal vSP. n=4 cochleovestibular group, all had normal DWI, but 3 patients had central ocular motor signs (abnormal vertical SP and SD)
Index test	4-step ocular motor signs examination (h-HIT, directionality of nystagmus, SD and vertical smooth pursuit)
Reference standard	Neuroimaging (MRI with diffusion-weighted imaging, DWI)
Target condition	Stroke
Results: TP FP FN	 10 4 0

Study	Chen 2011[127]
TN	10
Sensitivity	100%
Specificity	90%
Other measures as agreed with the Committee: PPV NPV Positive likelihood ratio Negative likelihood ratio Area under the curve	
General limitations (according to QUADAS-2)	Very high risk of bias because of patient selection (very small sample size; sampling from a high-risk population)

Study	Kattah 2009[259]
Study type	Prospective cross-sectional
Number of studies (number of participants	1 (n=101)
Country and setting	USA. Hospital.
Funding	Grants from the National Institute for Health and Agency for Healthcare Research and Quality
Duration of study	9 years
Age, gender, family origin	Mean age: 62 years (SD 13 years; range 26-92 years) Gender: 65% M/35% F Family origin: Not stated

Study	Kattah 2009[259]
Patient characteristics	Inclusion: people with acute vestibular syndrome (AVS), characterised by the rapid onset (over seconds to hours) of vertigo, nausea or vomiting, and gait unsteadiness in association with head-motion intolerance and nystagmus lasting days to weeks; people with at least 1 stroke risk factor (such as smoking, hypertension, diabetes, hyperlipidaemia, atrial fibrillation, eclampsia, hypercoagulable state, recent cervical trauma, or prior stroke or myocardial infarction) Exclusion: people with a history of recurrent vertigo with or without auditory symptoms n=25 peripheral lesion, n=76 central lesion (69 ischemic strokes, 4 haemorrhages, 2 demyelinating disease, 1 anticonvulsant toxicity)
Index test	HINTS (normal h-HIT, direction-changing nystagmus and skew deviation)
Reference standard	Neuroimaging (MRI with diffusion-weighted imaging, DWI)
Target condition	Central lesion
Results: TP FP FN TN Sensitivity Specificity Other measures as agreed with the Committee: PPV NPV Positive likelihood ratio Negative likelihood ratio Area under the curve	 76 1 0 24 100% 96% 25 (3.66-170.59) 0.00 (0.00-0.11)

Study	Kattah 2009[259]
General limitations (according to QUADAS-2)	Very high risk of bias because of patient selection (sampling from a high-risk population) and index test (in most cases, the index test results were interpreted with knowledge of the results of the reference standard)

Study	Kerber 2015[263]
Study type	Prospective cohort study
Number of studies (number of participants	1 (n=272; n=202 had full HINTS test)
Country and setting	USA. Tertiary medical centre.
Funding	Grant from the Agency for Healthcare Research and Quality
Duration of study	4 years
Age, gender, family origin	Median age, years (IQR): people with stroke, 60.6 (51.0-71.3); people without stroke 56.1 (48.6-66.5) Gender: 47% M/53% F Family origin: 78% White non-Hispanic; 13% Black non-Hispanic; 5% Asian; 10% Hispanic; 1% Other race or culture
Patient characteristics	Inclusion criteria: Dizziness as a principal reason for the medical encounter; continuous dizziness symptoms at the time of the study examination; nystagmus (spontaneous or gaze-evoked) or objective and subjective new imbalance when walking. The minimum requirement for objective imbalance was the inability to take 10 steps in tandem without a side step, after up to 2 attempts. Exclusion criteria: Age<18 years, prisoners, people not fluent in English or unable to provide informed consent because of cognitive or psychiatric impairment; more than 14 days since onset of continuous dizziness at the time of study examination;

Study	Kerber 2015[263]
	chronic recurrent dizziness (defined as ≥5 prior episodes similar in quality, intensity, and duration to the current symptoms, with at least 1 episode more than 1 year prior and 1 within the past year); history of multiple sclerosis; dizziness thought to be the result of trauma, orthostatic hypotension, medication or drug intoxication, or a known medical or neurologic disorder (for example, hepatic encephalopathy, hydrocephalus); posterior canal benign paroxysmal positional vertigo (that is, characteristic transient upbeat-torsional nystagmus on the Dix–Hallpike test performed and interpreted by a study clinician) unless spontaneous or gaze-evoked nystagmus was also present; moderate to severe, new, CNS examination abnormalities (for example, hemiparesis, hemisensory loss, axial ataxia, gaze palsy); people with a contraindication to MRI. People with possible or only mild abnormalities (for example, small deviations on coordination testing, mild dysarthria, or sensory symptoms) were not excluded. Screening examinations performed and interpreted by a study or treating clinician. The examiner's judgment was used to determine whether the finding was consistent with a CNS abnormality and whether the severity was more than a possible or mild abnormality. n=29 (11%) with acute stroke confirmed by MRI n=243 (89%) without acute stroke confirmed by MRI n=202 had full HINTS test
Index test	HINTS (normal h-HIT, direction-changing nystagmus, and skew deviation)
Reference standard	MRI
Target condition	Stroke
Results: TP FP FN TN Sensitivity (calculated) Specificity (calculated)	 20 100 4 78 83 (63-95)% 44 (36-51)%

Study	Kerber 2015[263]
Other measures as agreed with the Committee: PPV NPV Positive likelihood ratio Negative likelihood ratio Area under the curve General limitations (according to QUADAS-2)	 0.77 (0.69-0.84) High risk of bias (unclear whether the index test results were interpreted with knowledge of the results of the reference standard)

Study	Newman-Toker 2013[351]
Study type	Cross-sectional study
Number of studies (number of participants	1 (n=190)
Country and setting	USA. Emergency department.
Funding	No commercial support has been accepted related to the development or publication of these activities. A grant from the Swiss National Science Foundation supported the efforts of Dr Mantokoudis.
Duration of study	3 months
Age, gender, family origin	Median age: 61.0 years (range 18-92 years; IQR 52.0-70.0) Gender: 60.5% M/39.5% F Family origin: 90% White non-Hispanic; 6.3% Black or African American; 3.7% Other race or culture
Patient characteristics	Inclusion criteria: people with at least 1 hour of acute, persistent, continuous vertigo or dizziness with spontaneous or gaze-evoked nystagmus, plus nausea or vomiting, head motion intolerance, and new gait unsteadiness (that is, AVS), presenting

Study	Newman-Toker 2013[351]
	within 1 week of symptom onset. People were required to have 1 or more stroke risk factor (such as smoking, hypertension, diabetes, hyperlipidaemia, atrial fibrillation, eclampsia, hypercoagulable state, recent cervical trauma, prior stroke, or myocardial infarction). Exclusion criteria: if the symptom(s) abated prior to 24 hours (n=0), as the technical definition of AVS requires 24 hours of symptoms; history of multiple attacks of recurrent vertigo or dizziness compatible with Meniere's disease, vestibular migraine, idiopathic recurrent vertigo, or if they were successfully treated for benign paroxysmal positional vertigo (BPPV) by Canalith Repositioning Procedure; lethargy sufficient to prevent participation in examination. Men and women with AVS were equally likely to have vestibular neuritis (35.7% versus 33.3%, chi-square p=0.74). Men were slightly more likely than women to have stroke were (64.3% versus 52.0%, chi-square p=0.09), and women were much more likely to have other central causes (0.0% versus 14.7%, chi-square p<0.001). n=66 (34.7%) vestibular neuritis n=113 (59.5%) posterior fossa stroke (n=105 (92.2%) infarction; n=8 (7.1%) haemorrhage
Index test	HINTS (normal h-HIT, direction-changing nystagmus, and skew deviation)
Reference standard	Neuroimaging (MRI with diffusion-weighted imaging, DWI)
Target condition	Stroke
Results: TP FP FN TN Sensitivity Specificity	 109 1 4 65 96.5 (91.7-98.9)% 84.4 (75.0-91.3)%

Study	Newman-Toker 2013[351]
Other measures as agreed with the Committee: PPV NPV Positive likelihood ratio Negative likelihood ratio Area under the curve	 6.19 (3.86-10.42) 0.04 (0.02-0.11) 0.995 (0.985-1.000)
General limitations (according to QUADAS-2)	Very high risk of bias because of patient selection (sampling from a high-risk population) and index test (in some cases, the index test results were interpreted with knowledge of the results of the reference standard)