

Tests used to evaluate dizziness in primary care

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Dizziness is a nonspecific term that refers to various abnormal sensations of body orientation in space; patients often find these sensations difficult to describe. The prevalence of dizziness in the community ranges from 1.8% among young adults to over 30% among the elderly. Yearly consultation rates because of dizziness in primary care ranges from 2.5% among patients aged 25 to 44 years, to 8.3% among patients aged 65 years and older, and to 18.2% among patients aged 85 years and older.¹⁻⁵

Dizziness can be classified into four subtypes: vertigo, disequilibrium, presyncope and atypical dizziness. This classification is based on the study by Drachman and Hart.⁶ There are few studies of the distribution of the specific diseases that can cause dizziness. The following data should, therefore, be interpreted with caution (Appendix 1, available at www.cmaj.ca/cgi/content/full/cmaj.080910/DC1).^{5,7-11} In primary care patients, vertigo (prevalence 38%) is mainly caused by otolaryngical conditions; disequilibrium (prevalence 10%) is mainly caused by orthopedic, neurologic or sensory problems; presyncope (prevalence 10%) is mainly caused by cardiac or vasomotor conditions; and atypical dizziness (prevalence 17%) is mainly caused by psychiatric problems. In about 25% of patients, the type cannot be classified or the problem has multiple causes.

The prevalence of these diagnostic categories differs according to age. In younger patients, atypical dizziness and presyncope are most common. In middle-aged patients, vertigo is the most prominent. Presyncope and disequilibrium are more prevalent in elderly patients.^{5,12,13} However, elderly patients' symptoms cannot always be placed in one category because their symptoms often have multiple causes.^{5,12,13}

Practice guidelines¹⁴⁻¹⁶ advocate the use of several diagnostic tests in the evaluation of dizziness, including history-taking, pulse measurement, carotid sinus massage, nystagmus tests and the Dix-Hallpike manoeuvre. However, these recommendations are based more on opinion than on evidence.

Many tests can only be performed in secondary and tertiary care settings, although most patients are first seen in primary care. The main problem for primary care physicians is to decide which patients need additional testing, which should be referred to secondary care, which require immediate therapy, and which should receive an explanation, reassurance, advice and a "wait and see" approach.

Life-threatening conditions requiring immediate treatment are rare in patients with dizziness (Appendix 2, available at www.cmaj.ca/cgi/content/full/cmaj.080910/DC1).^{3,6,8,17} In

Key points

- Studies on diagnosing dizziness have been conducted in highly selected homogeneous groups of patients only.
- Evidence to support the diagnostic process in primary care is scarce.
- An exception is the head impulse test, with a positive test result being diagnostic of peripheral vestibular dysfunction and a negative test result diagnostic of central peripheral dysfunction.

these mainly acute conditions (mastoiditis, pacemaker failure, myocardial or brainstem/cerebellar infarction, hemorrhage and serious electrolyte disturbances), dizziness is almost never the only presenting symptom, and obtaining a careful patient history and performing a targeted physical examination is usually sufficient for triage. Further diagnostic testing should be done in a secondary care setting. Primary care physicians need to know the characteristics of the diagnostic tests that can be used as point-of-care tests for the diagnosis of the more common conditions.

We performed a systematic review of diagnostic tests that can be used to diagnose dizziness in patients in primary care. Because prevalence is important in the discriminative power of such tests, we provide epidemiologic information about target conditions in patients who present with dizziness. We have limited our review to the evaluation of these tests in patients with dizziness.

Methods

Literature search

We searched MEDLINE, EMBASE, PsycINFO, CINAHL, and GeroLit from database inception to May 2009 to identify studies of diagnostic tests for dizziness in primary care. The complete search strategy is shown in Appendix 3 (available at www.cmaj.ca/cgi/content/full/cmaj.080910/DC1). We used the search filters reported by Bachmann and colleagues.^{18,19}

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Study selection

Two reviewers (J.D., O.M.) independently selected potentially relevant studies based on titles and abstracts. If disagreement occurred, consensus was reached with a third reviewer (H.vW. or H.vdH.). We excluded studies if the title did not include “dizziness,” “disequilibrium,” “(pre)syncope” or “vertigo” or a word with the same meaning, or if it did not involve a disease that can cause dizziness (Appendix 3). We excluded articles if the abstract did not mention any diagnostic procedure, if the study population did not include patients with dizziness or if the test studied was too complex, time-consuming or expensive to be feasible in primary care (e.g., carotid sinus massage, tilt table testing, posturography and specialized imaging techniques). We included only studies published in English, French, German or Dutch.

Data extraction and quality assessment

The methodological quality of the studies was assessed by two pairs of reviewers (O.M. and H.vdH. or J.D. and H.vW.) using the Quality Assessment of Diagnostic Accuracy Studies (QUADAS) checklist.²⁰ Within each pair, both reviewers independently scored all studies with the QUADAS checklist, extracted the data and constructed 2×2 tables. Consensus was reached for any discrepancies. If an article reported the

accuracy of more than one index test, target condition or cut-off point, we report the data for these tests, target conditions and cut-off points separately.

Data synthesis and analysis

We calculated sensitivity and specificity from the 2×2 tables and plotted the results in forest plots and receiver operating characteristics plots. We pooled the results from studies involving the same tests and conditions by use of a bivariate regression model that takes into account the correlation between sensitivity and specificity. This method was recently recommended for meta-analysis of diagnostic tests.^{21,22} If we could only extract the sensitivity of the test from the original data, we calculated the mean sensitivity and weighted it for the number of patients in the study. To assess clinical usefulness, we derived likelihood ratios and pre- and post-test probabilities of the target condition in the study population.

Because we were interested in the accuracy of the diagnostic tests in primary care but most of the studies were done in secondary or tertiary care settings, we calculated pre- and post-test probabilities for a hypothetical primary care situation, assuming that the sensitivity and specificity would not be different in primary care. We estimated and retrieved the pretest probabilities of the target conditions in primary care from pertinent prevalence studies in primary care (Appendix 1).

We used STATA/SE 10.1 (StataCorp, College Station, TX, USA) to perform the bivariate analyses.

Results

The study selection process is shown in Figure 1. We identified 290 primary articles that studied diagnostic tests that can be used in the primary care of patients with dizziness. The kappa statistic was 0.81 for agreement on study selection by the two reviewers (J.D., O.M.). Based on a review of the full text, we excluded 162 articles. We assessed 128 articles using QUADAS.²⁰ After this review, we excluded 102 articles (Figure 1). Thus, we included 26 articles in this review (Table 1).^{23–48} We included one study of a psychiatric test (subtype atypical), and 25 studies of neuro-otologic tests (subtype vertigo). No studies about disequilibrium and presyncope were available. Five studies involved two or more tests, five studies reported on target conditions, and two studies evaluated two cut-off points of the same test (Table 2).

Methodologic quality

Quality assessment with the QUADAS tool is presented in Appendix 4 (available at www.cmaj.ca/cgi/content/full/cmaj.080910/DC1). Each study had at least two methodologic limitations that could introduce bias. In almost all studies, the spectrum of included patients was not representative of primary care patients.

Sensitivity, specificity and likelihood ratios

Table 2 shows the sensitivity, specificity and positive and negative likelihood ratios of the included studies. The pre- and post-test probabilities of the target condition in the study

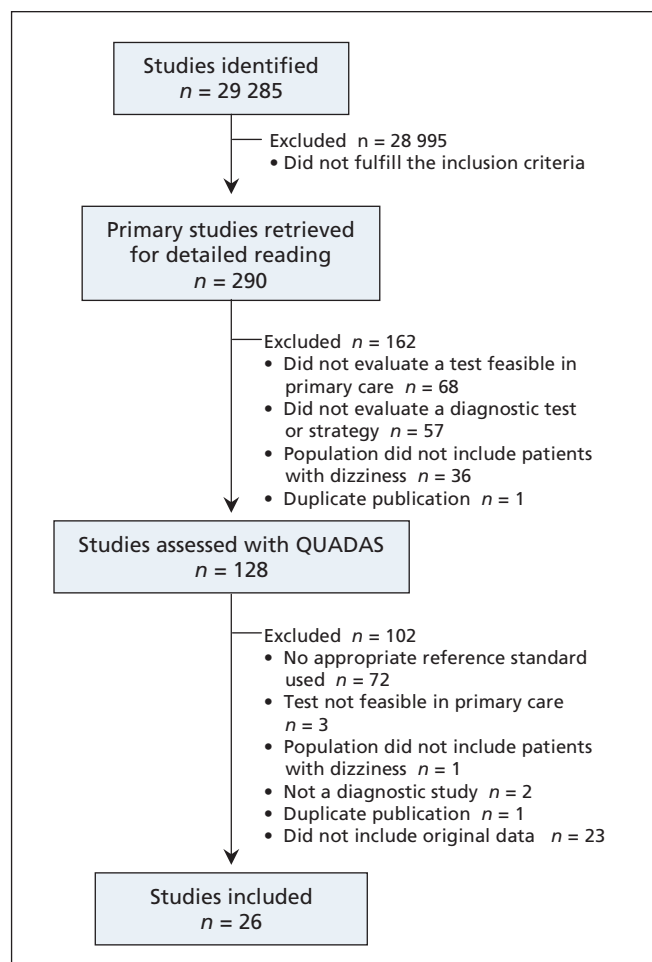


Figure 1: Flow chart of the study selection process.

Table 1: Characteristics of 26 studies of diagnostic tests of dizziness feasible in primary care (part 1)

Study	No. of participants (% women)	Age, yr, mean (range)	Study entry and inclusion criteria	Setting	Target condition	Index test; reference standard
Psychiatry, psychogenic dizziness						
Persoons et al. ⁴³	97 (66)	48 (18–75)	Random sample of dizzy patients referred to otorhinolaryngologist	Outpatient tertiary academic clinic, Belgium	Major depressive disorder; panic disorder	Depression and panic disorder parts of the patient health questionnaire; MINI interview
Neuro-otology						
<i>Questionnaires</i>						
*Kentala and Rauch ³⁶	57 (74)	47 (20–78)	Consecutive patients with dizziness	Outpatient tertiary clinic, US	Vertigo	Dizziness questionnaire; diagnosis after clinical evaluation
López-Escámez et al. ³⁷	100 (65)	NR	Nonselected patients with dizziness or vertigo	Outpatient clinic, Spain	Ménière disease	Structured questionnaire of vertigo; Ménière Disease criteria of the American Academy of Otolaryngology, Head and Neck Surgery; 10 months follow-up
von Brevern et al. ²⁴	61 (51)	NR (18 to >60)	Consecutive patients with dizziness	Outpatient tertiary clinics, Germany	BPPV	Vestibular vertigo questionnaire; Dix-Hallpike manoeuvre and/or diagnosis after clinical evaluation
Whitney et al. ⁴⁸	373 (64)	61 (15–95)	Nonselected patients with balance and/or vestibular disorder	Outpatient academic (physical therapy) clinic, US	BPPV	DHI BPPV subscore, 5 items or 2 items; Dix-Hallpike manoeuvre
<i>Symptoms and signs</i>						
Chan ²⁷	88 (52)	79 (median) (33–90)	Consecutive patients with dizziness	Outpatient tertiary clinic, China	BPPV	Spinning; episodic; positional; nausea/vomiting; Dix-Hallpike and side-lying manoeuvre
<i>Dix-Hallpike manoeuvre</i>						
Cohen ²⁹	29 (NR)	NR	Selected patients with vertigo on head movement and referred for vestibular testing	Outpatient tertiary academic clinic, US	BPPV	Battery of vestibular tests
Norré ⁴¹	85 (61)	54 (14–87)	Selected patients with vertigo on head movement	Outpatient academic clinic, Belgium	BPPV	Battery of vestibular tests
<i>Side-lying manoeuvre</i>						
Cohen ²⁹	29 (NR)	NR	Selected patients with vertigo on head movement and referred for vestibular testing	Outpatient tertiary academic clinic, US	BPPV	Battery of vestibular tests
<i>Head-shaking nystagmus</i>						
Burgio et al. ²⁵	115 (NR)	NR	Nonselected referred dizzy patients	Outpatient academic clinic, US	Peripheral vestibular dysfunction	Caloric tests and ENG

Continued

Table 1: Characteristics of 26 studies of diagnostic tests of dizziness feasible in primary care (part 2)

Study	No. of participants (% women)	Age, yr, mean (range)	Study entry and inclusion criteria	Setting	Target condition	Index test; reference standard
<i>Head-shaking nystagmus (continued)</i>						
Fujimoto et al. ³⁰	1364 (58)	48 (8–91)	Consecutive patients during routine ENG testing	Outpatient academic clinic, Canada	Peripheral vestibular dysfunction	>20% difference in right/left caloric testing
Goebel and Garcia ³¹	214 (NR)	55 (median) (9–83)	Randomly selected dizzy patients	Outpatient tertiary clinic, US	Peripheral vestibular dysfunction	Caloric tests
Guidetti et al. ³²	661 (65)	55 (14–80)	Nonselected patients with and without vertigo	Outpatient tertiary academic clinic, Italy	Peripheral vestibular dysfunction	Caloric tests
Harvey et al. ³⁴	105 (67)	52 (13–87)	Consecutive dizzy patients	Outpatient tertiary academic clinic, US	Peripheral vestibular dysfunction	Caloric tests
Jacobson et al. ³⁵	116 (NR)	NR	Consecutive dizzy patients referred for balance testing	Outpatient clinic, US	Peripheral vestibular dysfunction	Battery of vestibular tests
Mandala et al. ³⁸	65 (37)	54 (13–84)	Selected patients with vestibular neuritis	Outpatient academic clinic, Italy	Peripheral vestibular dysfunction (vestibular neuritis)	Caloric tests
Tseng and Chao ⁴⁵	258 (62)	NR (14–79)	Consecutive patients with dizziness or vertigo	Outpatient academic clinic, Taiwan	Peripheral vestibular dysfunction	Caloric tests with ENG
Vicini et al. ⁴⁶	277 (53)	47 (6–83)	NR; Referred patients with vestibular and/or neurological complaints	Outpatient academic clinics, Italy	Peripheral and central vestibular dysfunction	Battery of vestibular tests
<i>Head impulse test</i>						
Beynon et al. ²³	150 (NR)	51 (13–76)	NR; Patients with balance disorder	Outpatient clinics, UK	Peripheral vestibular dysfunction	Caloric test
Cnyrim et al. ²⁸	83 (53)	53 (NR)	Selected patients with vertigo, nystagmus and postural imbalance	Outpatient academic clinics, Germany and US	Peripheral (vestibular neuritis) and central vestibular dysfunction	Caloric tests with ENG and cranial MRI
Harvey et al. ³³	112 (65) (224 ears)	53 (13–87)	NR; dizzy patients	Outpatient academic clinic, US	Peripheral vestibular dysfunction	Caloric tests
Harvey et al. ³⁴	105 (67)	52 (13–87)	Consecutive dizzy patients	Outpatient tertiary academic clinic, US	Peripheral vestibular dysfunction	Caloric tests
Mandala et al. ³⁸	65 (37)	54 (13–84)	Selected patients with vestibular neuritis	Outpatient academic clinic, Italy	Peripheral vestibular dysfunction (vestibular neuritis)	Caloric tests

Continued

Table 1: Characteristics of 26 studies of diagnostic tests of dizziness feasible in primary care (part 3)

Study	No. of participants (% women)	Age, yr, mean (range)	Study entry and inclusion criteria	Setting	Target condition	Index test; reference standard
Newman-Toker et al. ⁴⁰	42 (35)	64 (26–92)	Consecutive referred patients with acute vertigo and high risk for stroke	Outpatient tertiary academic clinic, US	Peripheral (vestibular neuritis) and central vestibular dysfunction (brainstem or cerebellar stroke)	ENG or videonystagmography and cranial MRI
Perez and Rama-Lopez ⁴²	265 (50)	50 (NR)	Nonselected referred patients with vertigo	Outpatient academic clinic, Spain	Peripheral vestibular dysfunction	Caloric tests
<i>Vibration-induced nystagmus</i>						
Mandala et al. ³⁸	64 (37)	54 (13–84)	Selected patients with vestibular neuritis	Outpatient academic clinic, Italy	Peripheral vestibular dysfunction (vestibular neuritis)	Caloric tests
Michel et al. ³⁹	399 (NR)	NR	NR; vertiginous patients and nonvertiginous patients	Outpatient clinics, France	Peripheral vestibular dysfunction	Caloric tests
<i>Cold mini caloric test</i>						
Weinberg and Sadé ⁴⁷	124 (NR)	NR	NR; patients with vestibular neuronitis, Ménière disease, acoustic tumor or dizziness	Outpatient clinic, Israel	Peripheral vestibular dysfunction	Clinical diagnosis
<i>Head heave test</i>						
Mandala et al. ³⁸	65 (37)	54 (13–84)	Selected patients with vestibular neuritis	Outpatient academic clinic, Italy	Peripheral vestibular dysfunction (vestibular neuritis)	Caloric tests
<i>High-frequency oscillopsia test</i>						
Burgio et al. ²⁶	115 (NR)	NR	Nonselected referred dizzy patients	Outpatient academic clinic, US	Peripheral vestibular dysfunction	Caloric tests and ENG
<i>Hyperventilation-induced nystagmus</i>						
Robichaud et al. ⁴⁴	38 (66)	53 (25–72)	Selected referred dizzy patients with > 25% difference in Right/left caloric testing	Outpatient tertiary academic clinic, Canada	Peripheral vestibular dysfunction	Caloric tests
Robichaud et al. ⁴⁴	24 (54)	58 (39–78)	Patients with acoustic neurinoma	Outpatient tertiary academic clinic, Canada	Central vestibular dysfunction	Cranial MRI
<i>Positional nystagmus test</i>						
Guidetti et al. ³²	661 (65)	55 (14–80)	Nonselected patients with and without vertigo	Outpatient tertiary academic clinic, Italy	Peripheral vestibular dysfunction	Caloric tests

Table 2: Data from 26 studies that tested the accuracy of diagnostic tests for diagnosing dizziness in primary care (part 1)

Study	True-positive results	False-positive results	False-negative results	True-negative results	Sensitivity (95% CI)	Specificity (95% CI)	LR of positive result (95% CI)	LR of negative result (95% CI)
PSYCHIATRY, PSYCHOGENIC DIZZINESS								
Target condition = major depressive disorder								
<i>Patient health questionnaire</i>								
Persoons et al. ⁴³	8	5	3	81	72.7 (0.39–0.94)	94.2 (0.87–0.98)	12.51 (4.96–31.53)	0.29 (0.11–0.76)
Target condition = panic disorder								
<i>Patient health questionnaire</i>								
Persoons et al. ⁴³	16	3	1	77	94.1 (0.71–1.00)	96.3 (0.89–0.99)	25.1 (8.22–76.65)	0.06 (0.01–0.41)
NEURO-OTOLOGY								
Target condition = benign paroxysmal positional vertigo								
<i>Questionnaires</i>								
von Brevern et al. ²⁴	22	3	3	33	88.0 (0.69–0.98)	91.7 (0.78–0.98)	10.56 (3.54–31.5)	0.13 (0.05–0.38)
Whitney et al. ⁴⁸ ; DHI BPPV subscore, 5 items	62	179	22	110	73.8 (0.63–0.83)	38.1 (0.32–0.44)	1.19 (1.02–1.39)	0.69 (0.47–1.01)
Whitney et al. ⁴⁸ ; DHI BPPV subscore, 2 items	34	71	50	218	40.5 (0.30–0.52)	75.4 (0.70–0.80)	1.65 (1.19–2.29)	0.79 (0.65–0.95)
<i>Symptoms and signs</i>								
Chan ²⁷ ; spinning sensation	3	30	2	53	60.0 (0.15–0.95)	63.9 (0.53–0.74)	1.66 (0.77–3.59)	0.63 (0.21–1.86)
Chan ²⁷ ; episodic attacks of dizziness	4	61	1	22	80.0 (0.28–1.00)	26.5 (0.17–0.37)	1.09 (0.69–1.72)	0.76 (0.13–4.52)
Chan ²⁷ ; rapid head movements provoking dizziness	4	53	1	30	80.0 (0.28–1.00)	36.1 (0.26–0.47)	1.25 (0.79–2.00)	0.55 (0.09–3.27)
Chan ²⁷ ; associated with nausea and/or vomiting	1	30	4	53	20.0 (0.01–0.72)	63.9 (0.53–0.74)	0.55 (0.09–3.27)	1.25 (0.79–2.00)
<i>Dix–Hallpike manoeuvre</i>								
Cohen ²⁹	17		12		58.6 (0.39–0.77)			
Norré ⁴¹	74		11		87.1 (0.78–0.93)			
<i>Side-lying manoeuvre</i>								
Cohen ²⁹	19		10		65.5 (0.46–0.82)			
Target condition = vertigo								
<i>Questionnaire</i>								
Kentala and Rauch ³⁶	21	8	14	14	60.0 (0.42–0.76)	63.6 (0.44–0.84)	1.65 (0.89–3.05)	0.63 (0.38–1.05)
Target condition = Ménière disease								
<i>Questionnaire</i>								
López-Escámez et al. ³⁷	5	2	1	92	83.3 (0.36–1.00)	97.9 (0.93–1.00)	39.17 (9.5–161.55)	0.17 (0.03–1.02)

Continued

Table 2: Data from 26 studies that tested the accuracy of diagnostic tests for diagnosing dizziness in primary care (part 2)

Study	True-positive results	False-positive results	False-negative results	True-negative results	Sensitivity (95% CI)	Specificity (95% CI)	LR of positive result (95% CI)	LR of negative result (95% CI)
Target condition = peripheral vestibular dysfunction								
<i>Head-shaking nystagmus</i>								
Burgio et al. ²⁵	15	39	20	41	42.9 (0.26–0.61)	51.2 (0.40–0.63)	0.88 (0.56–1.37)	1.11 (0.78–1.59)
Fujimoto et al. ³⁰	130	302	129	803	50.2 (0.44–0.56)	72.7 (0.70–0.75)	1.84 (1.57–2.14)	0.69 (0.60–0.78)
Goebel and Garcia ³¹	18	26	25	145	41.9 (0.27–0.58)	84.8 (0.79–0.90)	2.75 (1.67–4.54)	0.69 (0.53–0.89)
Guidetti et al. ³²	106	13	422	120	20.1 (0.17–0.24)	90.2 (0.84–0.95)	2.05 (1.19–3.54)	0.89 (0.83–0.95)
Harvey et al. ³⁴	7	7	13	78	35.0 (0.15–0.59)	91.8 (0.84–0.97)	4.25 (1.68–10.74)	0.71 (0.51–0.98)
Jacobson et al. ³⁵	23	1	28	64	45.1 (0.31–0.60)	98.5 (0.92–1.00)	29.31 (4.10–209.83)	0.56 (0.43–0.72)
Mandala et al. ³⁸	62		3		95.4 (0.87–0.99)			
Tseng and Chao ⁴⁵	74	82	8	94	90.2 (0.82–0.96)	53.4 (0.46–0.61)	1.94 (1.63–2.30)	0.18 (0.09–0.36)
Vicini et al. ⁴⁶	31	42	60	144	34.1 (0.24–0.45)	77.4 (0.71–0.83)	1.51 (1.02–2.23)	0.85 (0.72–1.01)
<i>Head impulse test</i>								
Beynon et al. ²³	25	0	26	99	49.0 (0.35–0.63)	100 (0.96–1.00)	98.08 (6.09–1578.88)	0.51 (0.39–0.67)
Cnyrim et al. ²⁸	37	17	3	26	92.5 (0.80–0.98)	60.5 (0.44–0.75)	2.34 (1.60–3.42)	0.12 (0.04–0.38)
Harvey et al. ³³	13	6	20	185	39.4 (0.23–0.58)	96.9 (0.93–0.99)	12.54 (5.13–30.66)	0.63 (0.47–0.82)
Harvey et al. ³⁴	7	4	13	81	35.0 (0.15–0.59)	95.3 (0.88–0.99)	7.44 (2.41–22.97)	0.68 (0.49–0.94)
Mandala et al. ³⁸	54		11		83.1 (0.72–0.91)			
Newman–Toker et al. ⁴⁰	8	3	0	31	100.0 (0.63–1.00)	91.2 (0.76–0.98)	9.44 (3.45–25.84)	0.06 (0.00–0.91)
Perez and Rama–Lopez ⁴² ; asymmetry caloric test > 22%	79	12	60	114	56.8 (0.48–0.65)	90.5 (0.84–0.95)	5.97 (3.42–10.42)	0.48 (0.39–0.58)
Perez and Rama–Lopez ⁴² ; asymmetry caloric test > 42.5%	71	20	21	153	77.2 (0.67–0.85)	88.4 (0.83–0.93)	6.68 (4.36–10.20)	0.26 (0.18–0.38)
<i>Vibration-induced nystagmus</i>								
Mandala et al. ³⁸	52		12		81.3 (0.70–0.90)			
Michel et al. ³⁹	45	32	6	316	88.2 (0.76–0.96)	90.8 (0.87–0.94)	9.6 (6.8–13.55)	0.13 (0.06–0.28)
<i>Cold mini caloric test</i>								
Weinberg and Sadé ⁴⁷	51	8	3	62	94.4 (0.85–0.99)	88.6 (0.79–0.95)	8.26 (4.29–15.91)	0.06 (0.02–0.19)
<i>Head heave test</i>								
Mandala et al. ³⁸	43		22		66.2 (0.53–0.77)			

Continued

Table 2: Data from 26 studies that tested the accuracy of diagnostic tests for diagnosing dizziness in primary care (part 3)

Study	True-positive results	False-positive results	False-negative results	True-negative results	Sensitivity (95% CI)	Specificity (95% CI)	LR of positive result (95% CI)	LR of negative result (95% CI)
<i>High-frequency oscillopsia test</i>								
Burgio et al. ²⁶	14	20	21	60	40.0 (0.24–0.58)	75.0 (0.64–0.84)	1.60 (0.92–2.79)	0.80 (0.59–1.08)
<i>Hyperventilation-induced nystagmus</i>								
Robichaud et al. ⁴⁴	7		31		18.4 (0.08–0.34)			
<i>Positional nystagmus test</i>								
Guidetti et al. ³²	34	0	494	133	6.4 (0.05–0.09)	100 (0.97–1.00)	17.48 (1.09–283.25)	0.94 (0.91–0.96)
Target condition = central vestibular dysfunction								
<i>Head-shaking nystagmus</i>								
Vicini et al. ⁴⁶	42	31	144	60	22.6 (0.17–0.29)	65.9 (0.55–0.76)	0.66 (0.45–0.98)	1.17 (0.99–1.39)
<i>Head impulse test</i>								
Cnyrim et al. ²⁸	26	3	17	37	60.5 (0.44–0.75)	92.5 (0.80–0.98)	8.06 (2.64–24.58)	0.43 (0.29–0.63)
Newman–Toker et al. ⁴⁰	31	0	3	8	91.2 (0.76–0.98)	100 (0.63–1.00)	16.2 (1.09–240.08)	0.11 (0.04–0.29)
<i>Hyperventilation-induced nystagmus</i>								
Robichaud et al. ⁴⁴	14		10		58.3 (0.37–0.78)			

population and in a theoretical primary care population are shown in Appendix 5 (available at www.cmaj.ca/cgi/content/full/cmaj.080910/DC1).

Tests

The performance of all studied tests and the analyses of tests described in a single study are presented in Appendix 6 (available at www.cmaj.ca/cgi/content/full/cmaj.080910/DC1). Accurate evaluation of diagnostic tests should be based on the results of more than one study. Therefore, we describe four tests, all targeted for neuro-otologic conditions, that were evaluated in more than one study.

Dix-Hallpike manoeuvre

Both studies of the use of the Dix-Hallpike manoeuvre to diagnose benign paroxysmal positional vertigo used multiple vestibular tests as reference standards. Data from 114 patients were available, and we calculated a mean sensitivity of 80% (95% confidence interval [CI] 71%–87%).

Head-shaking nystagmus test

All nine studies of the use of the head-shaking nystagmus test used caloric measurement as part of the reference standard. Data from 4059 patients (eight studies) were available for pooled analysis (Figure 2 and Appendix 7, available at www.cmaj.ca/cgi/content/full/cmaj.080910/DC1). The pooled sensitivity was 45% (95% CI 30%–62%), the pooled specificity was 82% (95% CI 68%–90%), the pooled positive likelihood ratio (LR) was 2.47 (95% CI 1.48–4.14) and the pooled neg-

ative LR was 0.67 (95% CI 0.51–0.87). In these studies, the pooled probability of peripheral vestibular dysfunction after a positive head-shaking nystagmus test result increased from 27% to 48%, and the probability after a negative result decreased from 27% to 25%. Using an estimated prevalence of 33% for peripheral vestibular dysfunction in primary care patients with dizziness,^{7,9–11} the post-test probability of a positive head-shaking nystagmus test result was 55% and the post-test probability of a negative result was 25%.

Head impulse test

The seven studies that evaluated the head impulse test for peripheral vestibular dysfunction used caloric measurement as a reference standard. Data were available from 869 patients (six studies) for pooled analysis (Figure 3 and Appendix 8, available at www.cmaj.ca/cgi/content/full/cmaj.080910/DC1). The pooled sensitivity was 63% (95% CI 40%–81%), and the pooled specificity was 93% (95% CI 83%–98%). The pooled positive LR was 9.29 (95% CI 4.28–20.16), and the pooled negative LR was 0.40 (95% CI 0.23–0.68). In these studies, the probability of peripheral vestibular dysfunction after a positive test result increased from 33% to 82%, and the probability after a negative result decreased from 33% to 17%. Because the estimated prevalence in primary care^{7,9–11} matched the prevalence in the studied population (both 33%), the post-test probabilities were the same.

Two studies^{28,40} evaluated the accuracy of the head impulse test for central vestibular dysfunction in patients with vertigo. These studies used cranial magnetic resonance imaging as a

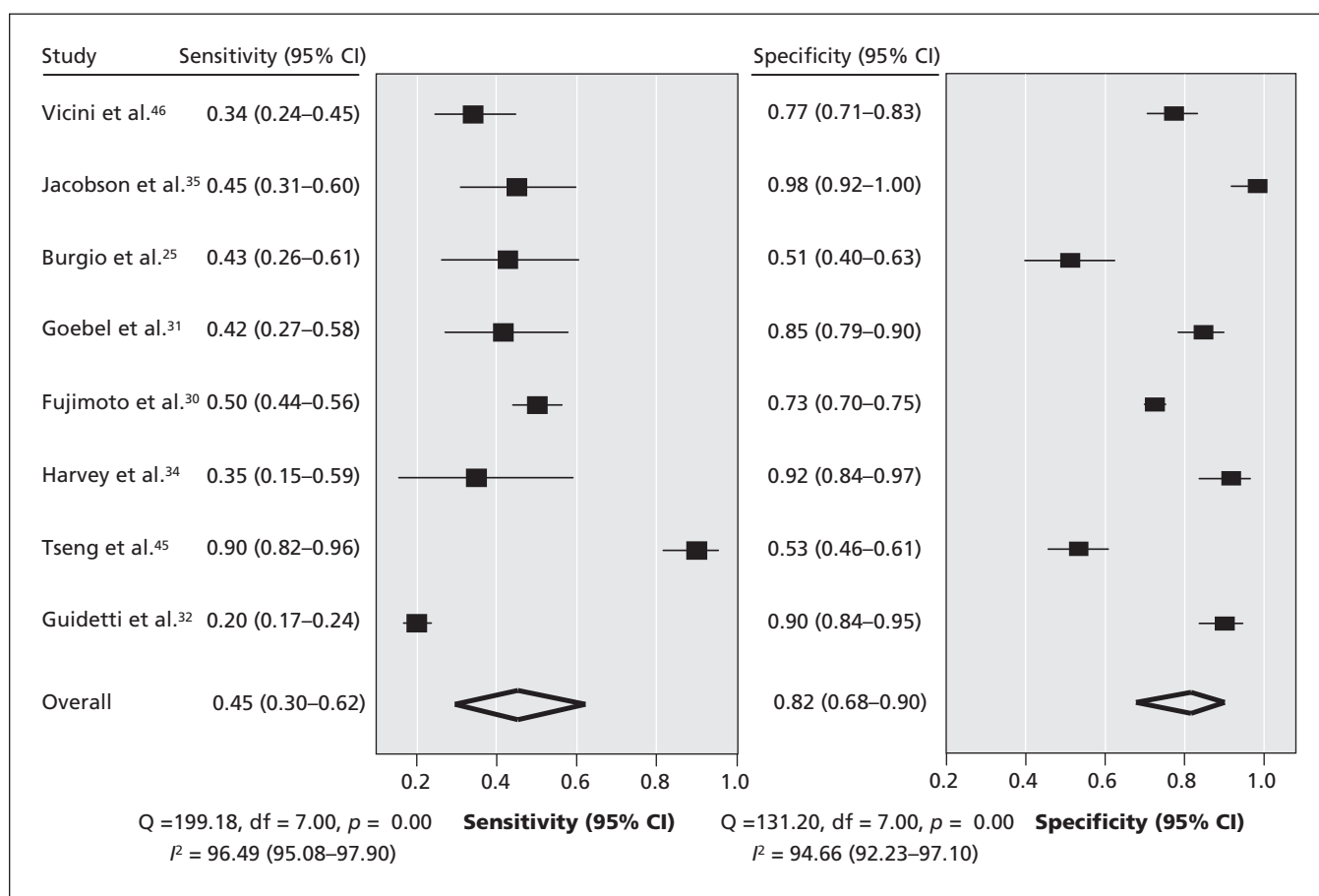


Figure 2: Sensitivity and specificity of the head-shaking nystagmus test for diagnosing unilateral vestibular dysfunction.

reference standard. Data from 125 patients were available for pooled analysis. A negative result of this test suggests a central lesion. The pooled sensitivity was 74% (95% CI 63%–83%), and the pooled specificity was 94% (95% CI 83%–99%). The probability of central vestibular dysfunction after a positive head impulse test result decreased from 62% to 31%, and the probability after a negative result increased from 62% to 95%.

Vibration-induced nystagmus test

In the two studies that evaluated vibration-induced nystagmus, data were available from 463 patients, giving a calculated sensitivity of 84% (95% CI 81%–88%). We calculated specificity based only on one study, with a positive result of the vibration-induced nystagmus test increasing the probability of peripheral vestibular dysfunction from 13% to 59%. Using the estimated prevalence of 33% for peripheral vestibular dysfunction in primary care patients with dizziness,^{7,9–11} we estimated the post-test probability of a positive vibration-induced nystagmus test result to be 83%.

Discussion

The results of our review show that the empirical validation of commonly used diagnostic tests for dizziness in primary care is poor. We found few studies that focused on dizziness.

It was only possible to perform a meta-analysis of two tests in the neuro-otological field. Although many studies were performed for tests used in diagnosing dizziness, most were not diagnostic studies, were methodologically inadequate or did not include patients with dizziness.

All of the included studies used some type of preselection of patients and were intended to diagnose specific conditions, such as Ménière disease, peripheral vestibular dysfunction, major depressive disorder or panic disorder. The main interest in primary care, however, is the differentiation between self-limiting conditions, those for which adequate treatment is available and those that are dangerous or progressive or both and require referral or immediate treatment.

Although many tests are used to diagnose dizziness in primary care, we could not find any studies that included consecutive patients with dizziness. Studies about the use of patient history, pulse measurement, heart auscultation and balance in the diagnosis of dizziness are lacking.

Although we looked for studies of tests that are feasible in primary care, all of the included studies were, at least, partially conducted in secondary or tertiary settings. As a result, the high prevalence of the target conditions in the included populations (6% for Ménière disease and 80% for vertigo) inflates the positive predictive values and decreases the negative predictive values. Furthermore, symptoms are probably

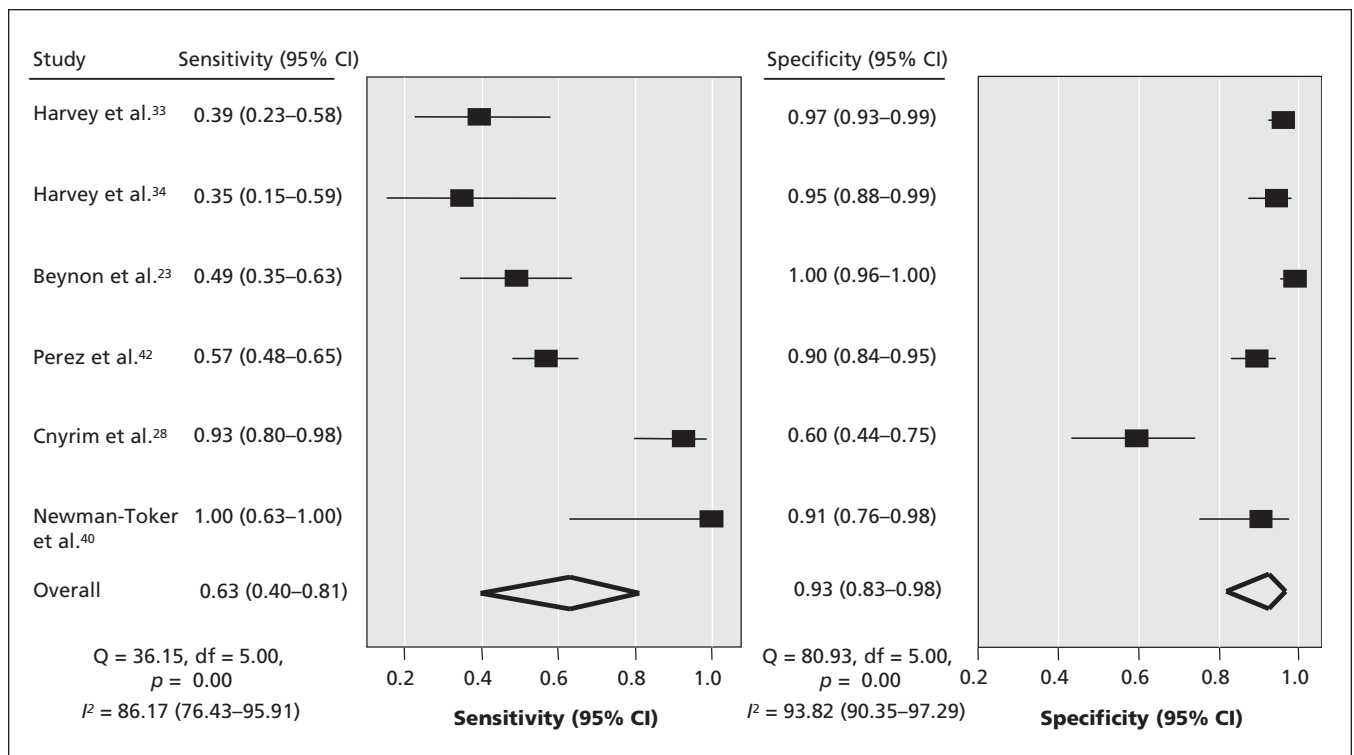


Figure 3: Sensitivity and specificity of the head impulse test for diagnosing unilateral vestibular dysfunction.

more severe or pronounced in patients referred for secondary or tertiary care, which may inflate both the sensitivity and specificity. Although we used prevalence in a hypothetical primary care population to estimate likelihood ratios, we could not correct for this phenomenon. This limits the generalizability of our results to patients in primary care. An exception may be the head-shaking nystagmus test and the head impulse test. The prevalence of peripheral vestibular dysfunction in primary care patients with dizziness was similar to that in the studied populations.

Although the prevalence of dizziness increases with age and the need for valid diagnostic tests or protocols is evident, especially for use in elderly patients, none of the studies in our review included an elderly population. As age increases, both the prevalence of dizziness and the risk of more serious causes of dizziness (stroke or cardiovascular diseases) increase. Comorbid conditions causing dizziness (e.g., diabetes, Parkinson disease) also become more prevalent.

Most tests for the diagnosis of dizziness were analyzed in a single study. The exceptions were the head-shaking nystagmus test, the head impulse test, the vibration-induced nystagmus test and the Dix-Hallpike manoeuvre. Promising tests within single test studies were the Vestibular Vertigo Questionnaire for the diagnosis of BPPV (positive LR 10.56, 95% CI 3.54–31.5), the depression part of the Patient Health Questionnaire for the diagnosis of major depressive disorder (positive LR 12.51, 95% CI 4.96–31.53) and the panic disorder part of the Patient Health Questionnaire for the diagnosis of panic disorder (positive LR 25.1, 95% CI 8.22–76.65).

Both the head-shaking nystagmus test and the head impulse test seem to be better suited for ruling in than for ruling out peripheral vestibular dysfunction. However, for conditions that are most often self-limiting (e.g., peripheral vestibular dysfunction), an increased probability from 27% to 48% after a positive test result is of limited value. The head impulse test performs better for the diagnosis of peripheral vestibular dysfunction, with an increased probability from 33% to 82% after a positive result and, based on two studies, an increased probability of central vestibular dysfunction from 62% to 95% after a negative result.

Many tests have been evaluated in patients without dizziness (e.g., peripheral neuropathy tests, visual acuity) or are included in the definition of the condition (e.g., hypoglycemia or orthostatic hypotension tests). Before the results of these studies can be used in the assessment of a certain diagnosis in a patient with dizziness, these tests must be validated in the appropriate domain. This is especially true for dizziness, because the cause is often not sufficiently supported by scientific evidence. In elderly patients, who often have more than one condition that can cause dizziness, physicians must be cautious in not treating these patients on the basis of test results that are not consistent with the patient's symptoms.

The appropriate patients to be included in studies of diagnostic tests for dizziness are those who present with dizziness as an isolated symptom and who are not at risk for the acutely life-threatening illnesses mentioned earlier. Prior selection of patients may affect test characteristics. The signs and symptoms must be described precisely, and the study design must comply with accepted methodologic criteria.^{49,50}

Additional research into the tests that can be used in primary care to diagnose dizziness or to determine which patients need further testing or treatment is highly warranted.

This article has been peer reviewed.

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Additional information about the four tests studied in this article

- **Dix-Hallpike manoeuvre**²⁹
www.dizziness-and-balance.com/disorders/bppv/dix%20hallpike.htm
- **Head-shaking nystagmus**³⁴
www.dizziness-and-balance.com/research/hsn/HeadShakingNystagmus.htm
- **Head impulse test**³⁸
<http://www.dizziness-and-balance.com/practice/head-impulse.html>
- **Vibration-induced nystagmus test**³⁸
www.dizziness-and-balance.com/practice/nystagmus/vibration_test.htm