

The Neurological Examination

From Practice to Evidence

Husain Alkhalidy · Department of Internal Medicine, King Khalid University, Abha · September 2026

Part 1 — The examination

Setting up. The neurological examination is the one examination that cannot sensibly be done the same way for every patient. A complete screen of every cranial nerve, every myotome and every dermatome takes longer than a consultation and, as Part 2 shows, finds less than an examination aimed by the history. The history produces a hypothesis — a hemisphere, the brainstem, the cord at a level, a root, a nerve, the junction, the muscle — and the examination is built to confirm or refute it, with a short screen of the rest. The examination begins before the patient knows it has: how they walk in, whether they turn in one piece, the face at rest and when they speak, the voice, the hand they offer, and whether they attend to both sides of the room.

Higher functions

- **Level of consciousness.** The Glasgow Coma Scale, scored as three components rather than a sum, with the best response recorded and the stimulus named. In the drowsy or confused patient, attention first — the months of the year backwards — because an inattentive patient cannot be tested for anything else, and inattention is the core of delirium.
- **Delirium and cognition.** Use an instrument rather than an impression: the Confusion Assessment Method or the 4AT for delirium; the Mini-Cog, the Mini-Mental State Examination or the Montreal Cognitive Assessment for cognition, with the caveat that education and language shift every cut-off.
- **Speech and language.** Dysarthria is a motor problem; dysphasia is a language problem, and the two are separated in a minute: spontaneous fluency, comprehension of a three-stage command, repetition of a phrase, naming of objects, reading and writing. Non-fluent speech with preserved comprehension localises anteriorly; fluent nonsense with poor comprehension localises posteriorly.
- **Parietal signs.** Sensory and visual inattention by double simultaneous stimulation, dressing and constructional apraxia, right-left disorientation, astereognosis and graphaesthesia. Neglect is the finding students most often miss because the patient does not complain of it.

Cranial nerves

- **Smell** when the history asks — head injury, anosmia, frontal tumour.
- **Vision.** Acuity with glasses, each eye; fields by confrontation, each eye, with a red target for the central field; pupils for size, symmetry, the direct and consensual light response and the swinging-light test for a relative afferent defect; and the fundi, which in practice means dilating

the pupil or using a camera, because an undilated look through a direct ophthalmoscope is the part of the examination most often skipped and least often informative.

- **Eye movements.** Pursuit in an H, then saccades between two targets, with the patient reporting diplopia; note nystagmus and its direction in each position of gaze, ptosis and fatiguability, and the alignment of the eyes with the cover test. In the acutely dizzy patient with continuous vertigo and nystagmus, the three-part HINTS examination — the horizontal head impulse test, the direction of the nystagmus on lateral gaze, and the alternate cover test for skew deviation — is performed and its three results recorded separately.
- **Trigeminal.** Light touch and pinprick in the three divisions, the corneal reflex only when it matters, the masseters and pterygoids, and the jaw jerk.
- **Facial.** Raise the eyebrows, screw up the eyes, show the teeth, blow out the cheeks. Sparing of the forehead marks an upper motor neurone lesion; involvement of the forehead, hyperacusis and taste marks the nerve itself.
- **Hearing and balance.** A whispered number at arm's length with the other ear masked; Rinne and Weber with a 512 Hz fork to separate conductive from sensorineural loss; the head impulse test as above.
- **Lower cranial nerves.** Palatal elevation and its symmetry, the quality of the voice and the cough, the gag reflex only when swallowing is in question, the sternocleidomastoid and trapezius against resistance, and the tongue at rest for wasting and fasciculation, then protruded for deviation.

The motor system

- **Inspection.** Wasting and its distribution, fasciculation watched for a full minute in good light, involuntary movements — tremor at rest, on posture and on action; chorea; myoclonus; dystonia — and posture of the limbs.
- **Pronator drift.** Arms outstretched, palms up, eyes closed, for thirty seconds. Downward drift with pronation is the most sensitive bedside sign of a mild pyramidal lesion; drift without pronation and with a give-way quality points elsewhere. Forearm rolling and rapid finger tapping test the same system.
- **Tone.** At the wrist, elbow, knee and ankle, with the patient relaxed and distracted; spasticity is velocity-dependent with a catch, rigidity is constant through the range and brought out by movement of the other limb, and ankle clonus is sought with a brisk sustained dorsiflexion.
- **Power.** Graded on the Medical Research Council scale of 0 to 5, joint by joint, and then described as a pattern: pyramidal (extensors weak in the arm, flexors in the leg), proximal (girdles, as in myopathy), distal (as in neuropathy), by root, by nerve, or global. A grade of 4 covers most of the clinically useful range and is better described than numbered.
- **Reflexes.** Biceps, supinator, triceps, knee and ankle, graded on the NINDS scale of 0 to 4, with reinforcement before calling a reflex absent. Then the Hoffmann sign, the jaw jerk, and the plantar response with a firm stroke along the lateral sole and across the ball of the foot — watching the first movement of the great toe, not the withdrawal that follows.

- **Coordination.** Finger–nose with the target held at full reach, heel–shin, rapid alternating movements, and rebound; intention tremor and past-pointing are cerebellar, while a coordination test that is merely slow is more often weakness or bradykinesia.

Sensation

Sensation is examined last and to a hypothesis, because it is the least reliable part of the examination and the most exhausting for the patient. Pinprick and light touch first, comparing side to side and proximal to distal, then vibration with a 128 Hz fork at the great toe and the malleolus, and joint position sense at the toe. A ten-gram monofilament at the standard plantar sites is the screening test for the diabetic foot. The distribution decides the lesion: a glove-and-stockings loss is a neuropathy, a dermatome is a root, a level with a band of hyperaesthesia is the cord, a hemisensory loss with the face is above the brainstem, and a loss of one modality with sparing of another — pain and temperature on one side, vibration and position on the other — is a hemicord. Romberg is a test of proprioception, not of the cerebellum: a patient who cannot stand with the feet together and the eyes open has a cerebellar or vestibular problem, and one who is steady until the eyes close has lost position sense.

Gait and balance

The patient is watched walking away, turning and walking back; then heel-to-toe, on the heels and on the toes, and rising from a chair without the hands. The pull test for postural instability, the timed up-and-go and gait speed over four metres take a minute between them and carry more prognostic information than most of what precedes them. The gaits are patterns: hemiplegic circumduction, the scissoring of a spastic paraparesis, the wide-based lurch of the cerebellum, the high-stepping foot drop, the stamping of sensory ataxia, the shuffling festination and reduced arm swing of parkinsonism, the waddle of a proximal myopathy, and the magnetic, apraxic gait of normal-pressure hydrocephalus.

The special tests

- **Meningism.** Neck stiffness by passive flexion, Kernig's sign, Brudzinski's sign, and jolt accentuation of the headache — recorded separately, and none of them treated as a reason not to do the lumbar puncture.
- **The root.** The straight-leg raise, with the angle and the side of the pain, and the crossed straight-leg raise; the femoral stretch for the upper lumbar roots.
- **The junction.** Fatiguable ptosis on sustained upgaze, and the ice-pack test — two minutes of ice over the closed lid, then a measured change in the ptosis.
- **The nerve.** Tinel's and Phalen's tests at the wrist, the hand diagram, and sensation in the median territory, in that order of usefulness reversed.
- **The functional examination.** Hoover's sign, drift without pronation, give-way weakness and a sensory loss that stops at the midline are positive findings of a functional disorder, sought and recorded, not a diagnosis by exclusion.

Putting the signs together

The neurological examination localises before it diagnoses. The pattern is the level; the history supplies the tempo, and the two together give the diagnosis.

Level	The signs that place it
Upper motor neurone	Pyramidal pattern of weakness; increased tone with clonus; brisk reflexes; extensor plantar; pronator drift; no wasting or fasciculation.
Lower motor neurone	Wasting and fasciculation; flaccid tone; reduced or absent reflexes; flexor plantar; weakness in a root, nerve or generalised distribution.
Cerebral hemisphere	Contralateral face-arm-leg weakness with upper motor neurone signs; dysphasia if dominant, neglect if non-dominant; homonymous field defect; gaze preference towards the lesion.
Brainstem	Crossed signs — an ipsilateral cranial nerve palsy with contralateral long-tract signs; internuclear ophthalmoplegia; a Horner's syndrome; direction-changing nystagmus; a positive HINTS pattern.
Cerebellum	Ipsilateral limb ataxia, intention tremor and dysdiadochokinesis; a wide-based gait; nystagmus; staccato dysarthria; hypotonia.
Spinal cord	A sensory level; bilateral upper motor neurone signs below it with lower motor neurone signs at it; bladder involvement; a hemicord dissociation when one-sided.
Root	Pain and sensory loss in a dermatome; weakness in a myotome; a lost reflex; a positive straight-leg raise.
Peripheral nerve	Sensory loss and weakness confined to one nerve's territory, or a symmetrical distal glove-and-stocking loss with absent ankle jerks in a polyneuropathy.
Neuromuscular junction	Fatiguable weakness — ptosis, diplopia, bulbar and proximal — with normal reflexes and sensation, and a positive ice-pack test.
Muscle	Symmetrical proximal weakness with wasting, a waddling gait, preserved sensation, and reflexes that are normal until late.
Parkinsonism	Bradykinesia with decrement on repetitive movement; cogwheel rigidity; rest tremor, usually asymmetrical; reduced arm swing, festination and a positive pull test.

Part 2 — What the literature says

How well do examiners agree?

The neurological examination has a rule of its own: **signs that are watched are reproducible, signs that are elicited are not**. In a study of 30 patients examined independently by two neurologists, the observable signs — gait, inspection for wasting and tremor, cerebellar tests, coordination — gave a mean kappa of 0.70, and the elicitable ones — tone, power, reflexes, sensation — a mean of 0.41; agreement on sensation alone was only fair [1]. Hansen and colleagues found the same gradient by seniority, with kappa values of 0.40 to 0.67 among neurologists and 0.22 to 0.81 among trainees examining the same patients [2].

Sign	Agreement (κ)	Comment
Tendon reflexes (grade)	≤ 0.35 to 'moderate'	Three neurologists disagreed by two or more grades on 28 per cent of reflexes and on the presence of asymmetry in 45 per cent of pairs [3]; agreement never rose above fair on either the Mayo or the NINDS scale in a second study [4]; the NINDS scale reached moderate-to-substantial agreement after training, better in the legs than the arms [5]
Plantar response	≈ 0.55	Six neurologists on 34 subjects: κ 0.55 for the Babinski manoeuvre, the best of the four plantar variants [6]; other series 0.55 – 0.62
Hoffmann sign	0.72 – 0.84	Substantial in a 2025 cervical cord compression cohort [7]
Pronator drift, forearm rolling	≈ 0.73	Among the most reliable upper motor neurone signs in acute stroke, with hyperreflexia and the Babinski and Chaddock signs [8]
Tone	moderate	Spasticity and rigidity are felt, not seen, and the distraction of the patient is never the same twice [1]
Power (MRC grade)	substantial	Better than tone or reflexes; the disagreement lives inside grade 4 [1]
Sensation	fair	The least reliable part of the examination in every study that has measured it [1, 2]
Gait, coordination, inspection	0.70 – almost perfect	The observable signs [1]
Glasgow Coma Scale	> 0.6 in 85 per cent of good studies	Systematic review of 53 studies; training and a structured approach raise it [9]
NIH Stroke Scale (total)	ICC 0.94	Two items stay poor even with certification: ataxia and facial paresis ($\kappa < 0.40$) [10]; a 2025 animated certification system reported item kappas from 0.25 to 0.90 [11]
Meningeal signs	—	Reliability is not the problem; sensitivity is (see below)

Two consequences follow. A scale with a defined stimulus and a defined response — the coma scale, the stroke scale — becomes reliable once examiners are trained to it, and unreliable items can be identified and taught. And the elicited signs that the examination leans on hardest, the reflexes and the sensory map, are the ones a second examiner is least likely to reproduce, which is why they should be recorded as patterns and asymmetries rather than as grades.

How accurate are the signs? The Rational Clinical Examination series and after

Question	Finding	Likelihood ratio or accuracy	Source
Is this patient having a stroke?	Any of acute facial paresis, arm drift or abnormal speech (physician-assessed)	LR+ 5.5 (3.3 – 9.1)	Goldstein & Simel 2005 [12]
	Prehospital FAST versus BE-FAST (pooled, 9 studies, 6,151)	FAST sensitivity 0.77, specificity 0.60; BE-FAST	Meta-analysis 2022 [13]

Question	Finding	Likelihood ratio or accuracy	Source
	patients)	sensitivity 0.68, specificity 0.85; BE-FAST more sensitive for posterior circulation stroke	
Is this stroke haemorrhagic?	Coma, neck stiffness, seizures with the deficit, severe hypertension, vomiting, headache	Each raises the probability; none is diagnostic — imaging is required	Runchey & McGee 2010 [14]
Is this acute vertigo a stroke?	HINTS — abnormal pattern on any of head impulse, nystagmus, skew	Sensitivity 100 per cent, specificity 96 per cent in expert hands, better than MRI in the first 48 hours	Kattah 2009 [15]
	HINTS performed by emergency physicians	Sensitivity 83 per cent, specificity 44 per cent — not enough to rule out stroke; neurologists 97 and 95 per cent	Meta-analysis 2020 [16]; scoping review 2025 [17]
Does this adult have meningitis?	Kernig's sign · Brudzinski's sign · nuchal rigidity	Sensitivity 5 per cent · 5 per cent · 30 per cent in 297 adults before lumbar puncture	Thomas 2002 [18]
	Pooled: nuchal rigidity and jolt accentuation · Kernig and Brudzinski	Sensitivity 40 – 60 per cent · 20 – 30 per cent; specificity 65 – 75 · 85 – 95 per cent	Meta-analysis 2019 [19]
Does this patient have Parkinson disease?	Rigidity with bradykinesia	LR+ 4.5, LR– 0.12	Rao 2003 [20]
	Tremor · shuffling gait · micrographia · loss of balance	LR+ 1.3 – 17 · 3.3 – 15 · 2.8 – 5.9 · 1.6 – 6.6	
Does this patient have myasthenia gravis?	Ice-pack test for ptosis	LR+ 12.6, LR– 0.16 (pooled)	Scherer 2005 [21]; meta-analysis [22]
Does this patient have carpal tunnel syndrome?	Hypalgesia in the median territory · hand diagram · Tinel · Phalen	LR+ 3.1 · 2.4 · 1.4 · 1.3	D'Arcy & McGee 2000 [23]
Does this diabetic patient have large-fibre neuropathy?	Vibration with a 128 Hz fork · 10 g monofilament	LR+ 16 – 35 · 11 – 16; a normal monofilament LR– 0.09 – 0.54	Kanji 2010 [24]
Is this back pain a disc herniation?	Straight-leg raise · crossed straight-leg raise	Sensitivity 92 per cent, specificity 28 per cent · sensitivity 28 per cent, specificity 90 per cent	Cochrane 2010 [25]
Does this patient have delirium?	Confusion Assessment Method	LR+ 9.6, LR– 0.16	Wong 2010 [26]
	4AT	Sensitivity 76 per cent, specificity 94 per cent in a randomised comparison; pooled 88 and 88 per cent	Shenkin 2019 [27]; meta-analysis 2021 [28]

Question	Finding	Likelihood ratio or accuracy	Source
Does this patient have dementia?	Mini-Cog · MMSE below 25	Sensitivity 76 · 79 per cent; specificity 89 · 88 per cent	Holsinger 2007 [29]
Will my patient fall?	A fall in the past year · abnormal gait or balance on examination	LR 2.3 – 2.8 · 1.7 – 2.4 (pre-test probability 27 per cent a year over 65)	Ganz 2007 [30]
Is there papilloedema?	Direct ophthalmoscopy by emergency physicians	Performed in 14 per cent of patients; 13 per cent had a relevant fundus finding on photography, all missed	FOTO-ED 2011 – 2013 [31, 32]

The pattern repeats the cardiovascular chapter's. **Signs that rule in are strong** — rigidity with bradykinesia, a positive ice-pack test, a crossed straight-leg raise, a positive HINTS pattern in the right hands — **and signs that rule out are weak**, with two exceptions that matter: a normal monofilament in the diabetic foot and a normal HINTS in an expert's hands. And the meningeal signs, taught for a century as the bedside test for meningitis, miss most of the patients who have it; they are useful when present and worthless when absent.

The examiner is the limiting reagent

Neurology is the specialty trainees rate as the hardest and the one they feel least competent in; the word for it, neurophobia, has its own literature, with half of students in the original US survey and two-thirds in a recent Chinese cohort meeting the definition [33, 34]. That anxiety shows in the examination. The HINTS data above are the clearest example: the same three manoeuvres are a better test than MRI in the hands of a neuro-otologist and an unsafe one in the hands of an emergency physician who has not been trained to them [15, 16]. The randomised trial by Kamel and colleagues turned the question round and asked whether the traditional complete screen was even the right approach: sixteen students examined patients with focal deficits either by a full screening examination or by one directed at the history, and the hypothesis-driven examination was more sensitive (78 versus 56 per cent), found more of the specific abnormalities (61 versus 53 per cent), and was a minute faster, at the cost of specificity [35]. The examination that finds the lesion is the one that was looking for it.

Technique changes the answer

- **Reflexes** become moderately reliable once examiners agree a scale and train to it; without that they do not [3 – 5]. Record asymmetry and pattern, which are the clinically useful outputs, rather than a grade the next examiner will not reproduce.
- **The coma scale** is reliable when it is scored as three components with the stimulus stated, and after training; the summed score hides the disagreement [9].
- **The stroke scale** needs certification, and even certified raters disagree on ataxia and facial weakness; those two items should be read with that in mind [10, 11].

- **HINTS** is a trained skill. It should be applied only to the acute vestibular syndrome — continuous vertigo with nystagmus — and its three components recorded separately; an untrained head impulse test is the commonest reason for a false reassurance [16, 17].
- **The plantar response** depends on the stimulus: a firm stroke along the lateral sole with attention to the first movement of the great toe is the manoeuvre that gave the best agreement among the variants [6].
- **Sensation** is examined to a hypothesis, from the abnormal area outward to a boundary, with the patient's eyes closed; a screening sensory examination in an asymptomatic limb produces findings no second examiner will confirm [1].
- **The fundus** is examined through a dilated pupil or a camera; the undilated direct ophthalmoscope in a bright room is the technique that produced a 14 per cent examination rate and a 100 per cent miss rate [31, 32].

What has changed, 2020 – 2026

The dizzy patient has become the test case for the whole examination. Meta-analyses in 2020 and 2024 confirmed that HINTS in emergency hands cannot exclude a posterior circulation stroke, while a 2025 scoping review found that seven in ten of the published HINTS examinations were performed by neurologists or neuro-otologists, so the published accuracy belongs to them [16, 17]. The response has been to instrument the examination: portable video-oculography goggles and, more recently, smartphone cameras record the head impulse and the nystagmus quantitatively, and the AVERT trial randomised emergency patients with acute dizziness to video-oculography-guided triage against standard care to test whether the device can give non-experts the expert's accuracy [36, 37]. The eye movements have not changed; the examiner has been replaced by a sensor.

The examination has learned to travel. Bedside and remote examination by two consultant neurologists over an audio-visual link gave comparable results in 43 acute emergency patients [38]; the NIH Stroke Scale scored remotely agrees with the bedside score to a weighted kappa of 0.91, though commands, facial palsy and ataxia remain the weak items [39]; and smartphone video is adequate for telestroke scoring [40]. The limit is the elicited sign: tone, reflexes and subtle gait findings do not survive the camera, which is the same boundary the agreement studies drew between observable and elicitable signs [1]. A 2025 animated certification application for the stroke scale, built with motion capture, now trains raters for the remote examination explicitly [11].

The devices have moved from validation to screening. Non-mydratic fundus photography, read by a neuro-ophthalmologist or increasingly by an algorithm, has displaced the ophthalmoscope wherever it has been tried [31, 32]. Smartphone-derived voice, finger-tapping and gait features identify early Parkinson disease with an area under the curve of about 0.86 in a 2025 multimodal model, and instrumented gait analysis with vertical ground-reaction force gives explainable, subject-wise validated markers of the disease and its progression [41, 42]. Two-smartphone markerless motion capture reproduces laboratory gait measures in neurological patients [43]. None of these examines the patient; each measures what the examination used to estimate.

The scales have been sharpened. The 4AT, needing no training and two minutes, matched the Confusion Assessment Method in a randomised diagnostic comparison and pools to a sensitivity and specificity of 88 per cent [27, 28]; the BE-FAST mnemonic added balance and eyes to the stroke screen to catch the posterior circulation, at a cost in sensitivity for the anterior [13]; and the meningeal signs were re-pooled in 2019 with the same verdict as 2002 [19].

Part 3 — Practical synthesis for teaching

- Teach the examination as hypothesis-driven from the first day, with a short screen for the rest; the randomised trial says the directed examination finds more, and the agreement studies say the undirected sensory screen finds things that are not there.
- Weight the observable signs — gait, drift, wasting, fasciculation, tremor, coordination, the face, the eye movements — and teach students to watch before they touch. These are the signs a second examiner will confirm and the signs that survive a video link.
- Record elicited signs as patterns and asymmetries: 'brisk on the left with an extensor plantar', not 'reflexes 3+'. The grade is not reproducible; the asymmetry sometimes is.
- Teach the scales with their training: the coma scale by components, the stroke scale with certification, the 4AT for delirium. A scale without its training is a number with a wide confidence interval.
- Teach HINTS as a specialist skill with a narrow indication, and be explicit that a normal result from an untrained examiner does not exclude a stroke. Where video-oculography is available, let the student see their own head impulse test measured.
- Retire the ophthalmoscope in the undilated eye in favour of the camera, and teach the meningeal signs honestly: present, they help; absent, they change nothing.
- Be honest about the numbers and about neurophobia. Students who know that sensation is only fairly reproducible, that two neurologists disagree on a reflex a quarter of the time, and that the great teaching signs of meningitis have a sensitivity of 5 per cent examine more carefully and more humbly — and stop being afraid of a subject whose examination is, once the numbers are on the table, simpler than it looked.

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Caveats

The agreement figures for tone, power and sensation are the qualitative bands reported by the Clinical Medicine study rather than pooled kappa values, and are given as such. Where a reference is cited by title and address only, the search results did not return an author list or a volume; check before distribution. The likelihood ratios for the individual findings in the haemorrhagic-stroke review are not reproduced because the abstract retrieved gave only the conclusion. The 2025 cervical cord study is the source for the Hoffmann sign kappa; older series are not pooled.