

The Ophthalmological Examination

From Practice to Evidence

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Part 1 — The examination

Setting up. The eye examination has one rule that outranks the rest: **acuity first, every time, each eye, before anything else is done or any drop is put in.** It is the vital sign of the eye, the number every later finding is read against, and the one most often omitted by the physician who is not an ophthalmologist. The rest follows a fixed order that moves from function to structure — acuity, fields, pupils, alignment and movements, the lids and surface, the red reflex, the fundus — with the tools laid out beforehand: a distance chart and a near card, a pinhole, a bright torch, fluorescein and a blue light, a magnifier or loupe, and a camera or an ophthalmoscope, in that order of usefulness. The dilated pupil, where it is safe, is the difference between an examination of the fundus and a glance at it.

Acuity

Each eye separately with the other properly occluded, with the patient's distance glasses, at the chart's calibrated distance; recorded as the smallest line read, with the errors. Then the **pinhole**: an improvement of two lines or more means the loss is refractive and the eye itself is likely well; no improvement means the media, the retina or the nerve. If the top letter cannot be read, the acuity is counting fingers, hand movements, perception of light or none, each at a stated distance. Near acuity with a reading card and the patient's reading glasses. The logMAR chart, where available, gives a linear scale on which change can be measured; a validated smartphone chart gives the same to within a tenth of a line.

Fields

Confrontation at a metre, each eye separately, the examiner's eye as the control: a **kinetic red target** brought in from beyond the field in each quadrant until the patient reports it as red, and a **static finger-wiggle** in each quadrant, both done, because the combination is more sensitive than either. The central field with an **Amsler grid**, one eye at a time, for distortion and scotoma. A defect is described by its shape — altitudinal, arcuate, central, hemianopic, quadrantic — and by whether it respects the vertical or horizontal meridian, which places it. Confrontation finds the large defects; the perimeter finds the rest.

Pupils

Size in millimetres in light and in dim light, symmetry, shape, and the direct and consensual responses to a bright torch from below. Then the **swinging-flashlight test**, the torch held on each eye for three seconds before swinging, watching the first movement of the pupil as the light arrives:

dilation instead of constriction is a **relative afferent pupillary defect**, the one sign that separates optic nerve and retinal disease from everything in front of them, and the reason no cataract produces it. **Anisocoria** is measured in light and dark: greater in the dark, the small pupil is at fault (Horner's syndrome, with ptosis and anhidrosis); greater in the light, the large one is (a third-nerve palsy, with ptosis and a down-and-out eye; a tonic pupil; a pharmacological one). A mid-dilated, oval, fixed pupil in a painful red eye is angle closure.

Alignment and movements

The corneal light reflections for symmetry; the **cover test** — cover one eye and watch the other for a corrective movement (a tropia) — and the **cover–uncover** and **alternate cover** tests for the latent deviation; then pursuit through the six cardinal positions and the H, with the patient reporting diplopia and its direction, and saccades between two targets. Nystagmus by direction, position and whether it changes; the ptosis and its fatiguability that the endocrine chapter examined, and the restriction and proptosis of Graves' orbitopathy.

The lids, the surface and the red eye

The **lids** for ptosis, retraction, lid lag, entropion and ectropion, chalazion, blepharitis and the lash line; the **conjunctiva** for the pattern of redness — diffuse and greatest in the fornices in conjunctivitis, a violet ciliary flush around the limbus in keratitis, iritis and angle closure, a sector in episcleritis, a deep boring redness that does not blanch with a vasoconstrictor in scleritis — and for discharge, chemosis, follicles and papillae under the everted lid, and a subconjunctival haemorrhage. The **cornea** for clarity, with a drop of fluorescein and the blue light for an abrasion, a dendritic ulcer or an infiltrate, and a hypopyon in the chamber. The **anterior chamber depth** with a torch shone from the temporal side: an iris that casts a shadow nasally is a shallow chamber. In every red eye the three questions that the evidence rewards are asked and tested: is there **photophobia** — with direct light, with light in the other eye, and with the finger-to-nose convergence test; is there **anisocoria** with the smaller pupil in the red eye; and is the **acuity** reduced. A red eye with any of these, with a ciliary flush or a corneal opacity, is not conjunctivitis until proved so. And in the painful red eye with a hazy cornea and a mid-dilated pupil, the globe is palpated through the closed lid against the fellow eye: a hard eye is angle closure.

The red reflex and the fundus

The red reflex from arm's length with the ophthalmoscope at zero, both eyes together for symmetry: a dull or absent reflex is cataract, vitreous haemorrhage or a large detachment; a white reflex in a child is leukocoria and an emergency. Then the fundus, through a dilated pupil in a darkened room — the **disc** for its margins, colour, cup-to-disc ratio, the spontaneous venous pulsation whose presence argues against raised intracranial pressure, and the swelling, haemorrhages and obscured vessels of papilloedema; the **vessels** for calibre, arteriovenous nipping, emboli and beading; the **macula** by asking the patient to look at the light; and the periphery as far as the pupil allows. Where a fundus camera is available it is used first, because the evidence below shows that the photograph is read better than the ophthalmoscope by almost everyone, including the physician examining.

The rest

Colour vision with Ishihara plates, each eye, for the optic neuropathy that dims red before it dims acuity; the proptosis measured with the Hertel exophthalmometer; the preauricular lymph node of viral conjunctivitis; the temporal arteries, the blood pressure, the glucose and the pulse in the vascular eye; the neurological examination that a field defect or a diplopia demands; and intraocular pressure, which the physician estimates by palpation only when it is very high, and the ophthalmologist measures.

Putting the signs together

The eye examination sorts presentations by the layer of the eye and the urgency, and the pattern decides between a drop, a same-day referral and a phone call to the on-call ophthalmologist.

Pattern	The signs that make it
Acute angle-closure glaucoma	A painful red eye with a ciliary flush, a hazy cornea, a mid-dilated fixed oval pupil, reduced acuity, haloes, nausea and vomiting, and a hard globe on palpation.
Anterior uveitis	Ciliary flush, photophobia elicited by light in the fellow eye, a small irregular pupil, reduced acuity, cells and flare on the slit lamp, a hypopyon when severe.
Keratitis	Ciliary flush, photophobia, a corneal opacity or an ulcer that stains with fluorescein — dendritic in herpes — and reduced acuity; a contact lens in the history.
Bacterial against viral conjunctivitis	Purulent discharge, bilateral morning matting and redness obscuring the tarsal vessels against watery discharge, follicles and a preauricular node; normal acuity and pupils in both.
Scleritis against episcleritis	Deep, boring pain waking the patient, a violaceous redness that does not blanch with phenylephrine and a tender globe against a sectoral redness that blanches and does not hurt.
Optic neuritis	Unilateral loss of acuity over days with pain on eye movement, a relative afferent pupillary defect, loss of colour vision, a central scotoma, and a disc that is swollen or normal.
Papilloedema	Bilateral disc swelling with blurred margins, obscured vessels and absent venous pulsation, preserved acuity with an enlarged blind spot, and headache; the camera confirms what the ophthalmoscope suggests.
Central retinal artery occlusion	Sudden painless profound loss, a relative afferent pupillary defect, a pale retina with a cherry-red spot and attenuated arteries; the temporal artery and the carotid examined.
Central retinal vein occlusion	Sudden painless loss, a swollen disc with widespread haemorrhages in all quadrants and dilated tortuous veins.
Retinal detachment	Flashes, floaters and a curtain; a field defect on confrontation; a dull red reflex and a grey billowing retina.
Third-nerve palsy with the pupil	Ptosis, an eye down and out, and a dilated pupil — an aneurysm until proved otherwise.
Orbital cellulitis	A red, swollen, tender lid with proptosis, painful and restricted eye movements, reduced acuity and fever, against the preseptal cellulitis that spares the eye.

Part 2 — What the literature says

How well do examiners agree?

The eye is the organ whose examination has most completely become the reading of an image, and the reading is where the agreement has been measured. The optic disc is the clearest case. Experts estimating the vertical cup-to-disc ratio agree at a weighted kappa of 0.67 on stereoscopic viewing and differ by up to a fifth of a disc diameter, with intra-observer agreement of 0.79 [1, 2]; stereoscopic photographs give kappas of 0.71 to 0.74 for the ratio and 0.58 for the rim [3]; and a study of what the direct ophthalmoscope can assess found the vertical ratio the parameter it assesses most reliably, at a mean weighted kappa of 0.84 [4]. Papilloedema is worse: shown single fundus photographs, experts agreed at a kappa of 0.36 overall, detected low-grade papilloedema between 29 and 62 per cent of the time, and separated papilloedema from pseudopapilloedema with 59 per cent accuracy and a kappa of 0.05 — chance [5, 6]. The swinging-flashlight test for an afferent pupillary defect has significant inter- and intra-rater variability, tamed partly by the three-second pause and more completely by pupillometry [7, 8]. The measurements, again, reproduce: the classic cover test at an intraclass correlation of 0.95 and above, though the prism cover test's limits of agreement span ten prism dioptres even among experts [9, 10]; smartphone acuity with test–retest limits of ± 0.033 logMAR [11]; and the exophthalmometer as the endocrine chapter reported.

Sign or measurement	Agreement	Comment
Vertical cup-to-disc ratio, experts, stereoscopic	κ 0.67 (intra-observer 0.79)	Differences of up to 0.2 disc diameters between experts [1, 2]
Cup-to-disc ratio on stereo photographs · neuroretinal rim	κ 0.71 – 0.74 · 0.58	The rim, which carries the diagnosis, agrees worst [3]
Vertical ratio by direct ophthalmoscope	weighted κ 0.84	The parameter the instrument assesses best [4]
Papilloedema on a single photograph, experts	κ 0.36; low-grade detection 29 – 62 per cent	Accuracy 64 – 67 per cent for moderate-to-high grade [5]
Papilloedema against pseudopapilloedema, neuro-ophthalmologists	accuracy 59 per cent, κ 0.05	From the photograph alone: chance [6]
Relative afferent pupillary defect, swinging flashlight	significant inter- and intra-rater variability	Improved by a three-second pause; automated by pupillometry [7, 8]
Cover test · alternate prism cover test	ICC $\geq$ 0.95 · limits of agreement ± 10 prism dioptres	Detection reproduces; quantification less so [9, 10]

Sign or measurement	Agreement	Comment
Smartphone acuity (Peek)	test–retest ±0.033 logMAR; 0.07 logMAR from ETDRS	Closer to the ETDRS chart than Snellen is [11]

How accurate are the signs?

Question	Finding	Likelihood ratio or accuracy	Source
Is there a visual field defect?	Confrontation, single method	Sensitivity 40 per cent for anterior defects and 68 per cent for posterior, specificity 93 per cent	Johnson & Baloh 1991 [12]
	Kinetic red target · combined with static finger wiggle	Sensitivity 74, specificity 93 per cent · sensitivity 78, specificity 90 per cent — the best of seven methods	Kerr 2010 [13]
Is this red eye serious?	Photophobia by direct light · indirect light · near synkinesis	LR+ 8.3 · 28.8 · 21.4	Narayana & McGee 2015 [14]
	Anisocoria over 1 mm with the smaller pupil in the red eye	LR+ 6.5	
Is this conjunctivitis bacterial?	Complete conjunctival redness obscuring the tarsal vessels · observed purulent discharge · bilateral morning matting	The three findings with the highest likelihood ratios; their absence argues for a viral cause	
Is the pressure very high?	Palpation of the globe	Exact estimate 46 per cent of the time for an experienced examiner and 21 per cent for an inexperienced one; within 5 mmHg in 100 and 62 per cent; a warning only above about 30 mmHg	Baum 1995 [15]
Is this neovascular macular degeneration?	Amsler grid	Sensitivity 67 per cent, specificity 99 per cent against healthy eyes; 71 and 63 per cent against non-neovascular degeneration — below the level recommended for monitoring	Meta-analysis 2023 [16]
Is colour vision deficient?	Ishihara plates, fewer than 12 of 14 correct	Sensitivity 97 per cent, specificity 100 per cent; 94 and 82 per cent when shown on a monitor	Comparative study 2024 [17]
Can the physician see the fundus?	Direct ophthalmoscopy by internists · by emergency	Correct diagnosis of fundus abnormalities under 50 per	Reviews; FOTO-ED [18, 19, 20]

Question	Finding	Likelihood ratio or accuracy	Source
	physicians	cent · examined 14 per cent of patients and missed every relevant finding; about 70 per cent of graduating students cannot use the instrument	
Is this papilloedema?	Deep-learning system on dilated fundus photographs, external test of 1,505 images	Area under the curve 0.96, sensitivity 96.4 per cent, specificity 84.7 per cent	Milea 2020, BONSAI [21]
	The same system on non-mydratic handheld-camera photographs, 817 prospective patients	Diagnostic accuracy 99.5 per cent	Prospective study 2025 [22]
	AI for papilloedema, pooled	Sensitivity 94.6 per cent across six studies and more than 15,000 images	Meta-analysis 2025 [23]
Is this glaucoma?	Deep learning on fundus photographs	Pooled sensitivity 92 per cent, specificity 94 per cent; 86 and 88 per cent on externally validated sets	Meta-analyses 2022 – 2026 [24, 25]
Does this OCT need referral?	Deep-learning triage of optical coherence tomography	Correct referral decision in 94 per cent across more than 50 conditions, level with retinal specialists	De Fauw 2018 [26]
Can a phone photograph the retina?	Smartphone fundus camera, non-mydratic · mydratic	Sensitivity 75, specificity 95 per cent for any diabetic retinopathy · 82 and 96 per cent for moderate or worse	Validation studies [27, 28]

Three things stand out. **The physician's own instruments answer the two questions that matter most in the general ward and the emergency department** — is the field cut, and is this red eye dangerous — provided they are used as the evidence describes: a red target and a finger wiggle together, and photophobia elicited three ways. **The ophthalmoscope in a non-ophthalmologist's hand has been measured and found close to useless**, not through any fault in the instrument but because the skill is not taught, not kept and not practised; the photograph in the same hand, read by the same physician, does better, and read by an algorithm does better than most specialists. And **the disc, the one structure the ophthalmoscope was built to show, is where even experts disagree** — on the cup, on the rim, and on whether the swelling is papilloedema at all.

The examiner is the limiting reagent

The literature on the eye contains the single most direct statement in this series of what happens when a skill is lost: a 2015 paper titled the demise of direct ophthalmoscopy, recording that most physicians do not perform it, that most who do cannot reliably detect abnormalities, and that medical education has stopped expecting them to [18]. Its numbers had been measured already — fewer than half of internists' fundus diagnoses correct, a 14 per cent examination rate and a 100 per

cent miss rate in the emergency department, seven in ten graduates unable to use the instrument [19, 20] — and the response, from 2011 onwards, was to give the physician a camera rather than a lesson. The same story is now being told about the pupil: a test whose reliability depends on a three-second pause the examiner may not know to take has been handed to a pupillometer and, in 2023, to a virtual-reality headset [7, 8].

Technique changes the answer

- **Acuity first, each eye, then the pinhole.** The number is the examination's vital sign, and the pinhole separates the refractive error from the eye disease in ten seconds.
- **Confront the field two ways** — a kinetic red target and a static finger wiggle in each quadrant — because the combination adds sensitivity without losing specificity [13].
- **Pause for three seconds on each eye** in the swinging-flashlight test, and watch the first movement; the afferent defect is missed by a quick swing [7].
- **Elicit photophobia indirectly:** shine the light in the fellow eye and test near synkinesis, which carry likelihood ratios of 29 and 21 against 8 for direct light [14].
- **Palpate the globe only to confirm the hard eye of angle closure;** the finger cannot grade pressure below about 30 mmHg [15].
- **Dilate, or photograph.** An undilated look through a direct ophthalmoscope is the technique that produced the miss rates above; the non-mydratic camera is the physician's fundus examination now [19, 22].
- **Read the disc for the rim, not only the cup,** and remember that the swelling you think is papilloedema is called something else by a colleague as often as not [3, 5, 6].

What has changed, 2020 – 2026

The disc is read by a machine that does not disagree with itself. The BONSAI consortium's deep-learning system, trained on 14,341 dilated fundus photographs from nineteen sites and tested externally on 1,505 from five others, detected papilloedema with a sensitivity of 96.4 per cent and a specificity of 84.7 per cent in 2020 [21]; applied prospectively in 2025 to 1,552 non-mydratic photographs taken with a handheld camera in 817 patients, it reached an accuracy of 99.5 per cent, and its pooled sensitivity across the literature is 94.6 per cent [22, 23]. Against a human kappa of 0.36 on the same task, this is the largest gap between examiner and instrument in the whole series [5]. Glaucoma detection from the photograph pools to a sensitivity of 92 per cent and a specificity of 94 per cent, falling to 86 and 88 on external data, and now runs offline on a smartphone camera [24, 25, 29]; the deep-learning triage of optical coherence tomography that matched retinal specialists in 2018 has been followed by a retinal foundation model trained on 1.6 million unlabelled images that detects eye disease and predicts heart failure, stroke and Parkinson disease from the retina — the field that calls itself oculomics [26, 30].

The physician's examination has moved to the phone. A smartphone acuity test agrees with the ETDRS chart more closely than the Snellen chart does, with a test–retest variability of a third of a line [11]; smartphone fundus cameras detect diabetic retinopathy with sensitivities of 75 to 82 per cent

and specificities above 95 per cent, and non-mydriatic photography agrees with the reference at a kappa of 0.78 [27, 28, 31]; the afferent pupillary defect is quantified by a virtual-reality headset and a portable pupillometer [8, 32]; and a 2025 paired study found that non-ophthalmologist physicians screening fundus disease with an algorithm beside them improved on their unaided performance [33]. What the physician examines is increasingly a photograph the physician took.

The bedside signs have been re-measured and mostly kept. The systematic review of the red eye found the classic teaching — photophobia, anisocoria, reduced acuity — carries likelihood ratios that justify it, and named the three findings that separate bacterial from viral conjunctivitis [14]; the confrontation field was optimised rather than discarded [13]; the Amsler grid, by contrast, was found in 2023 to be too insensitive for the home monitoring it was invented for, and is being replaced by hyperacuity devices and home optical coherence tomography [16].

Part 3 — Practical synthesis for teaching

- Teach acuity as the vital sign of the eye: each eye, glasses on, pinhole after, recorded before anything else is done. A student who has not measured acuity has not examined the eye.
- Teach the red eye by the three questions the evidence rewards — photophobia elicited three ways, anisocoria with the smaller pupil on the red side, reduced acuity — and the ciliary flush; and teach that a red eye passing all of them is the only red eye that may be treated as conjunctivitis.
- Teach the confrontation field as two tests done together, the swinging flashlight with its three-second pause, and the cover test as a measurement; these are the parts of the eye examination that reproduce and that the ward physician will actually use.
- Retire the undilated direct ophthalmoscope from the physician's expectations and replace it with the camera: teach students to take the photograph, to read it, and to send it. The evidence that they can use the ophthalmoscope does not exist; the evidence that the camera works does.
- Teach the disc honestly — experts disagree on the cup, the rim and the swelling — and teach the algorithm's numbers beside the examiner's, so that students understand why the papilloedema question now goes to the machine.
- Keep the palpated globe for the one thing it can do, and teach the emergency patterns — angle closure, the artery, the detachment, the third nerve with the pupil, orbital cellulitis — as the reason the examination exists at all.

References

1. Varma R, Steinmann WC, Scott IU. Expert agreement in evaluating the optic disc for glaucoma. *Ophthalmology* 1992;99:215–21.
2. Intraobserver and interobserver agreement in measurement of optic disc characteristics. *Ophthalmology* 1988. <https://pubmed.ncbi.nlm.nih.gov/3174002/>
3. Feuer WJ, Parrish RK, Schiffman JC, et al. The Ocular Hypertension Treatment Study: reproducibility of cup/disk ratio measurements over time at an optic disc reading center. *Am J Ophthalmol* 2002;133:19–28.

4. What optic disc parameters are most accurately assessed using the direct ophthalmoscope? *Eye* 2001;15:283–7.
5. Experts show variable agreement in identifying papilledema from single fundus images. American Academy of Ophthalmology editors' choice. <https://www.aao.org/education/editors-choice/experts-show-variable-agreement-in-identifying-pap>
6. Differentiating between mild papilledema and pseudopapilledema on fundus photography. *J Neurol Sci* 2025. <https://www.sciencedirect.com/science/article/abs/pii/S0022510X25000991>
7. Clinical grading of relative afferent pupillary defects. *Arch Ophthalmol* 1993;111:938–42.
8. Detection of relative afferent pupillary defects using eye tracking and a VR headset. 2023. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10309159/>
9. Evaluation of a novel virtual reality simulated alternate cover test to assess strabismus: a prospective, masked study. *Am J Ophthalmol* 2024. [https://www.ajo.com/article/S0002-9394\(24\)00418-5/fulltext](https://www.ajo.com/article/S0002-9394(24)00418-5/fulltext)
10. Holmes JM, Leske DA, Hohberger GG. Defining real change in prism-cover test measurements. *Am J Ophthalmol* 2008;145:381–5.
11. Bastawrous A, Rono HK, Livingstone IAT, et al. Development and validation of a smartphone-based visual acuity test (Peek Acuity) for clinical practice and community-based fieldwork. *JAMA Ophthalmol* 2015;133:930–8.
12. Johnson LN, Baloh FG. The accuracy of confrontation visual field test in comparison with automated perimetry. *J Natl Med Assoc* 1991;83:895–8.
13. Kerr NM, Chew SS, Eady EK, Gamble GD, Danesh-Meyer HV. Diagnostic accuracy of confrontation visual field tests. *Neurology* 2010;74:1184–90.
14. Narayana S, McGee S. Bedside diagnosis of the 'red eye': a systematic review. *Am J Med* 2015;128:1220–4.
15. Baum J, Chaturvedi N, Netland PA, Dreyer EB. Assessment of intraocular pressure by palpation. *Am J Ophthalmol* 1995;119:650–1; and Digital palpation of intraocular pressure. *Ophthalmic Surg Lasers* 1998;29:754–7.
16. Bjerager J, Schneider M, Potapenko I, et al. Diagnostic accuracy of the Amsler grid test for detecting neovascular age-related macular degeneration: a systematic review and meta-analysis. *JAMA Ophthalmol* 2023;141:315–23.
17. A comparative study of the sensitivity and specificity of the Ishihara test with various displays. *Int J Med Inform* 2024. <https://pmc.ncbi.nlm.nih.gov/articles/PMC11287189/>
18. Mackay DD, Garza PS, Bruce BB, Newman NJ, Biousse V. The demise of direct ophthalmoscopy: a modern clinical challenge. *Neurol Clin Pract* 2015;5:150–7.
19. Bruce BB, Lamirel C, Wright DW, et al. Nonmydriatic ocular fundus photography in the emergency department. *N Engl J Med* 2011;364:387–9.
20. Ophthalmology and direct ophthalmoscopy in contemporary medical education. *Am J Ophthalmol* 2022. [https://www.ajo.com/article/S0002-9394\(22\)00063-0/abstract](https://www.ajo.com/article/S0002-9394(22)00063-0/abstract)
21. Milea D, Najjar RP, Zubo J, et al.; BONSAI Group. Artificial intelligence to detect papilledema from ocular fundus photographs. *N Engl J Med* 2020;382:1687–95.
22. Deep learning-based detection of papilledema on retinal photographs from handheld cameras: a prospective study. *J Neuroophthalmol* 2025. <https://pubmed.ncbi.nlm.nih.gov/40867029/>
23. Diagnostic accuracy of artificial intelligence for the detection of papilledema on fundus images: a systematic review and meta-analysis. *Cureus* 2025. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC12794944/>
24. Diagnostic accuracy of artificial intelligence in glaucoma screening and clinical practice. *J Glaucoma* 2022;31:285–99.
25. Diagnostic accuracy of image-based deep learning for glaucomatous optic neuropathy detection: a systematic review and meta-analysis. *Graefes Arch Clin Exp Ophthalmol* 2026. <https://link.springer.com/article/10.1007/s00417-026-07433-8>
26. De Fauw J, Ledsam JR, Romera-Paredes B, et al. Clinically applicable deep learning for diagnosis and referral in retinal disease. *Nat Med* 2018;24:1342–50.
27. Accuracy of the smartphone-based nonmydriatic retinal camera in the detection of sight-threatening diabetic retinopathy. *Indian J Ophthalmol* 2020. <https://pubmed.ncbi.nlm.nih.gov/31937728/>
28. Comparison of telemedicine screening of diabetic retinopathy by mydriatic smartphone-based vs nonmydriatic tabletop camera-based fundus imaging. *J Diabetes Sci Technol* 2021. <https://pubmed.ncbi.nlm.nih.gov/34632255/>

29. Evaluating real-world performance of an automated offline glaucoma AI on a smartphone fundus camera across glaucoma severity stages. PLoS One 2025.
<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0324883>
30. Zhou Y, Chia MA, Wagner SK, et al. A foundation model for generalizable disease detection from retinal images. Nature 2023;622:156–63.
31. Application of non-mydriatic fundus photography-assisted telemedicine in diabetic retinopathy screening. 2024.
<https://pmc.ncbi.nlm.nih.gov/articles/PMC10921172/>
32. Portable pupillography of the swinging flashlight test to detect afferent pupillary defects. Ophthalmology 2000.
<https://pubmed.ncbi.nlm.nih.gov/11013198/>
33. AI-augmented fundus disease screening by non-ophthalmologist physicians: a paired before–after study. 2025.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC12729758/>

Caveats

The papilloedema agreement figures come from an American Academy of Ophthalmology summary of the underlying study and from a 2025 abstract; the palpation figures are from a small two-examiner study. The 2025 handheld-camera accuracy of 99.5 per cent is the headline figure from a prospective study whose sensitivity and specificity were not retrieved separately. The bacterial conjunctivitis findings are reported without their likelihood ratios because the abstract gave only their ranking. Where a reference is given by title and address only, the search results did not return an author list; check before distribution.