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AIER Standards

Lessons from one of the world's largest eye care providers

The Ophthalmologist was recently fortunate to attend the AIER Eye Hospital Group's International Refractive Surgery Symposium in Chengdu, China (May 23, 2026), followed by a week-long tour of AIER hospitals in Chengdu, Wuhan, and Changsha.

For someone accustomed to viewing ophthalmology through a Western lens, the experience was literally eye-opening. China's eye care landscape is vast, complex, and evolving rapidly – and AIER occupies a remarkable position within it.

The numbers alone are striking. AIER provides eye care services across Asia, Europe, and North America, with 750 institutions in mainland China, eight in Hong Kong, more than 123 overseas sites, and over 50,000 employees worldwide, including more than 7,000 ophthalmologists and optometrists.

Its clinical volumes are even more impressive. In 2023, AIER managed approximately 15.1 million outpatient visits and performed more than 1.1 million surgeries. AIER is not simply a hospital group; it is a large-scale ophthalmology platform that guides millions of patients through diagnosis, treatment, surgery, and follow-up.

At this scale, standards are essential. AIER's "hierarchical chain structure" is designed to improve outcomes, raise service standards, and strengthen communication between patients and clinicians. AIER's size is not only about reach. It is also about repetition, measurement, comparison, and control.

In the West, as populations age, cataract backlogs persist, workforces tighten, and demand for retinal care increases, can eye care continue to operate as a patchwork of disconnected services? Or should we think more seriously about how scale can help spread standards, expertise, data, and efficiency?

The lesson from AIER is not simply "be bigger." It is that high patient volumes do not have to mean fragmented care.

We will share more from our visit in the coming months. For now, one thing is clear: there is much to learn from a system that has made scale and standards inseparable.

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Magnesium & DR Risk

Study suggests low magnesium levels could be linked to increased diabetic retinopathy risk in patients with type 2 diabetes

Credit: AdobeStock.com

Could a routinely measured electrolyte offer new insight into diabetic eye disease? An updated systematic review and meta-analysis published in Nutrients (1) suggests that low serum magnesium levels are significantly associated with diabetic retinopathy (DR) in patients with type 2 diabetes – raising the possibility of a simple, modifiable risk factor in clinical care.

Diabetic retinopathy remains a leading cause of preventable vision loss, driven by complex microvascular changes linked to chronic hyperglycaemia, oxidative stress, and inflammation. Magnesium, an essential intracellular cation involved in over 300 enzymatic processes – including insulin signalling and vascular regulation – has increasingly been implicated in these pathways.

The analysis, which pooled data from 17 observational studies involving more than 2,200 patients (1100 with DR and 1132 diabetic controls without retinopathy), found that individuals with diabetic retinopathy had significantly lower circulating magnesium levels than the control group.

This association extended across multiple subgroups analyzed in the review – reduced magnesium levels were consistently observed regardless of study design or geographic region, suggesting the relationship is robust across populations.

The study also points to a potential link between magnesium deficiency and disease severity. Patients with proliferative diabetic retinopathy (PDR) exhibited even lower magnesium levels compared with those with non-proliferative disease (NPDR), supporting a possible dose–response relationship. This finding aligns with known pathophysiology: hypomagnesaemia has been associated with increased oxidative stress, endothelial dysfunction, and upregulation of angiogenic factors such as VEGF – all central to DR progression.

From a mechanistic standpoint, magnesium plays a key role in maintaining retinal homeostasis. It supports ATP production, regulates ion transport, and modulates neuronal excitability within the retina. Reduced levels may exacerbate intracellular calcium influx and oxidative damage, contributing to microvascular and neurodegenerative changes characteristic of diabetic retinopathy.

Clinically, the therapeutic appeal is clear. Magnesium is inexpensive, widely available, and easily measured – making it a potentially attractive biomarker for risk stratification. As such, the study authors suggest that routine assessment of magnesium levels in patients with type 2 diabetes could help identify those at higher risk of retinopathy development or progression.

However, caution is warranted. The evidence remains observational, and the overall certainty was graded as low, largely due to significant heterogeneity across studies and the inherent limitations of non-randomized designs. Factors such as dietary intake, renal function, and glycaemic control were not consistently reported, which may influence magnesium status.

The key unanswered question is whether correcting magnesium deficiency can alter clinical outcomes. While supplementation has shown benefits in improving glycaemic control and reducing oxidative stress in diabetes, no trials to date have directly assessed its impact on diabetic retinopathy progression. As research continues to explore the intersection between metabolism and retinal health, magnesium may emerge as a simple addition to the clinician's toolkit in managing diabetic eye disease.

Reference

1. *E Kubbara et al., "Association Between Levels of Magnesium and Diabetic Retinopathy in Diabetic Patients with Type 2 Diabetes Mellitus: An Updated Systematic Review and Meta-Analysis," Nutrients, 18, 1162 (2026). PMID: 41978212.*

Chatbots Enter Retinal Care

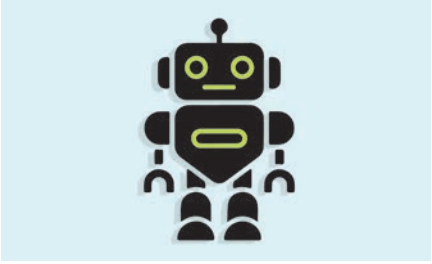
New research shows how conversational AI can improve patient understanding and engagement in retinal detachment pathways

Patient education remains a cornerstone of successful ophthalmic care, and yet traditional patient information leaflets (PILs) are often poorly suited to real-world needs: they are static, text-heavy, and inaccessible to many patients with low vision, limited health literacy, or language barriers.

A recent Journal of Artificial Intelligence and Robotics study (1) proposes a compelling alternative: a multilingual, voice-enabled chatbot built on a retrieval-augmented generation (RAG) framework. Designed specifically for retinal detachment education, the system integrates curated, clinician-approved knowledge with large language models (LLMs) to deliver personalized, conversational guidance.

Unlike generic AI tools, the chatbot grounds its responses in a verified knowledge base, reducing the risk of hallucination while maintaining flexibility. Responses include source-linked content and adapt dynamically to user queries, enabling a shift from one-way information delivery to interactive dialogue.

The system supports speech-to-text input and multilingual text-to-speech output, allowing patients to engage in their preferred language and modality. This is particularly relevant in ophthalmology, where visual impairment can limit engagement with written materials. The interface also incorporates screen-reader compatibility and high-contrast design, addressing common accessibility gaps in digital health tools.



To test the chatbot, the study benchmarked three leading LLMs – GPT-4o, Claude Opus, and Gemini 1.5 Pro – within an identical RAG pipeline using 50 clinician-derived retinal detachment questions. GPT-4o emerged as the strongest performer across all evaluation metrics, indicating superior alignment with reference answers in both structure and meaning. Notably, GPT-4o also demonstrated the greatest consistency, with tighter score distributions and fewer low-performing outliers. This reliability is critical in clinical contexts, where variability in information delivery can undermine patient trust and safety. Gemini performed well semantically but showed greater variability, while Claude exhibited the lowest overall performance and higher inconsistency.

Importantly, the chatbot remains a research prototype and has not yet undergone clinical validation with patients. The study authors highlight the need for real-world studies further assessing usability, trust, and impact on outcomes, as well as regulatory considerations under frameworks such as UK GDPR and MHRA guidance.

Nevertheless, as ophthalmology services face increasing demand and reduced consultation time, AI-driven conversational tools could augment patient communication – offering scalable, personalized, and accessible education that extends beyond the clinic.

Reference

1. *F Kalabi et al., "Transforming patient education on retinal detachment: A multilingual voice-enabled retrieval-augmented generation chatbot," Journal of Artificial Intelligence and Robotics study, 3, 1 (2026).*

The Smart Contact Lens Evolves

New research shows how microstructured contact lenses can track eye movements with remarkable accuracy using standard cameras

Despite advances in camera-based systems, achieving accurate, high-precision eye tracking remains constrained by power demands, illumination requirements, and computational complexity.

A new Advanced Functional Materials study (1) proposes an alternative: a passive contact lens embedded with microscopic moiré patterns that enables precise eye tracking using standard imaging hardware.

The system avoids several longstanding limitations of contact lens–based trackers – complex fabrication, added bulk, or even anaesthesia for use – to offer a lightweight, potentially scalable alternative.

Challenges for the technology remain, but the underlying principle is compelling. By shifting the burden of complexity from electronics to optics, moiré-based contact lenses could offer a new route to precise, low-power eye tracking.

Reference

1. *IM Fradkin et al., "Contact Lens with Moiré Patterns for High-Precision Eye Tracking," Advanced Functional Materials, 36, 29 (2026).*

From Babylon to Berlin

Iraqi-born ophthalmologist Hasan Chichan reflects on bridging the divide between modern retina care and humanitarian medicine

By Hasan Chichan

When I was a boy in Iraq, my grandmother told me that Babylon was where the world first learned to write things down. The astronomers there mapped the sky on clay tablets. The physicians wrote their diagnoses in cuneiform. They believed knowledge had to outlive the person carrying it. I think about this a lot, especially when I am traveling.

For the last 18 months I have been moving between two worlds. One is a German operating theater, where the lights are calibrated, the IOL inventory is barcoded, and the next case starts when a button is pressed. The other is a tent, or a converted classroom, or a borrowed clinic somewhere in Iraq, Morocco, Egypt, or India, where the lights sometimes flicker and the patient in front of you may have been waiting there since before dawn or since before the war.

It is the same job. I keep telling myself it is the same job.

From Babylon to Berlin

I am a product of European ophthalmology. My training is German and Swiss. My fellowship was British. My board is European, my surgical fellowship American. The precision with which I was taught to operate the half-millimeter tolerances, the post-op metrics, the audit culture is something I will never apologize for and never give up.

But I am also Iraqi. I grew up close enough to Babylon that the word "civilization" was never an abstraction; it was a place name. When I started doing humanitarian missions a few years ago, I expected to feel like a visitor. Instead, what I kept feeling was that the disease in front of me was the same disease I had just left in Düsseldorf. Only this version of the disease was seen at a later stage. Much later.

Cataracts that should have come out at 4/10 vision were instead coming out at hand motions. Diabetic retinopathy that we manage in Germany with quarterly anti-VEGF injections was reaching me as tractional detachments. Dry AMD that I would have entered into a clinical pathway at the early stage was already, by the time I saw the patient, a story about grandchildren whose faces had become blurry shapes years ago.

The lesson is not that the missions need more surgeons. The lesson is that, by the time most of the world meets an ophthalmologist, surgery is already the consolation prize.

Fifty before lunch

In total, I have personally performed over seven hundred surgeries during missions in the past 18 months. The number sounds dramatic. It is also, in context, almost beside the point.

"By the time most of the world meets an ophthalmologist, surgery is already the consolation prize."

What we have been trying to build is not a parade of itinerant surgeons but a system. Triage clinics that begin two days before the operating starts, so that the wrong patients are gently turned away and the right ones are ready. Parallel theaters with shared scrub teams, standardized IOL stocks, pre-printed consent forms in the local language. A defined pathway from the slit lamp to recovery so that 50 cataracts before lunch is not a miracle, it is a Tuesday.

There is a particular kind of focus that the high-volume day demands. You stop

thinking about the case in front of you as one of 50, and you start thinking about it the way you would think about your only patient that morning, because for the patient it is a major event in their lives. The fatigue catches up later, usually on the drive back to wherever we are sleeping.

The harder, slower work is the part you cannot capture in photographs. Every mission ends with a named local surgeon - usually two - who can run the next clinic without us. We leave behind the protocols, the audit forms, the suppliers, and sometimes the equipment. The mission is a success only when the next mission to that town no longer needs us.

I learned this discipline, frankly, from the German system. I am simply applying it where it has historically been considered impossible.

The space between healthy and lost

The missions have changed how I think about my Tuesdays in Germany too.

The phrase that haunts me most in the consulting room is "wait and watch." We say it to patients with intermediate AMD. We say it to patients with early diabetic macular changes. We say it to parents of children with progressing myopia. But what we really mean is: we have nothing safe to offer you yet, so come back when things are worse.

That is the gap I have spent the last few years trying to close.

Photobiomodulation - PBM to those of us who use it - is a non-thermal therapy that delivers red and near-infrared light, in the 630–800 nm window, to the retina. It does not burn anything. It works at the level of the mitochondria, where cytochrome c oxidase absorbs the photons and the cell responds with more ATP, less oxidative stress, and a quieter inflammatory signal. In early dry AMD it is now the first regenerative modality with regulatory approval. The clinical signal is modest, but it exists and, crucially, it exists before photoreceptors are gone.

Subthreshold nanosecond laser (SNL) is the same idea from a different angle: a very short, very low-energy pulse that does not coagulate the retina, but seems to nudge the RPE into self-repair. Our Cologne cohort, published in 2021, looked at 64 treated eyes against 77 controls in early and intermediate AMD, and saw a measurable reduction in drusen area and number at six months. It is not a cure. It is something to do, safely, in the years when we used to have nothing.

I wrote a review of photobiomodulation last year, with colleagues from Düsseldorf and from Babylon, because I wanted to put a fair, sober summary of the evidence in front of clinicians who, like me, were tired of telling people "wait and watch."

What the missions taught the laboratory

The strange truth is that you can feel the absence of an early-intervention therapy more clearly in a rural clinic in Iraq than you can in a modern clinic in Berlin. In Berlin, "wait and watch" is annoying, an inconvenience. But in Babylon, "wait and watch" often means go home and lose your sight, because the patient cannot reasonably come back. The further the patient lives from a referral center, the more catastrophic our lack of an early-stage tool becomes.

This is the real argument, I think, for bringing modalities like PBM and SNL not only into European retina clinics but eventually into the protocols of the missions themselves. They are non-invasive. They are scalable. They do not require an operating theater. They are exactly the kind of tools that a sustainable, locally run program could one day absorb.

We are not there yet. The evidence base is still maturing and the hardware is still expensive. But the direction is clear, and the clinical urgency — for me — is sharpest in the places furthest from the major teaching hospitals.

Being named to The Ophthalmologist's Power List this year was, in some ways, unsettling. I am 35. I do not feel finished. What I have come to believe, though, is that the laboratory in Germany and the operating tent in Babylon are not two careers running in parallel. They are the same patient, met at different points in their disease, and the project of my professional life is to close the distance between them.

"I am a product of European ophthalmology. My training is German and Swiss. My fellowship was British. My board is European, my surgical fellowship American."

Sight is not negotiable. Neither is the time it takes to lose it.

Hasan Chichan is a consultant ophthalmologist and ophthalmic surgeon based in Germany, Clinical Lead for High-Volume Humanitarian Missions, and one of The Ophthalmologist's 2026 Power List Top 10. He trained in Cologne, Berlin, Zürich and London, and divides his clinical work between Germany and surgical missions across Iraq, Morocco, Egypt and India.

References

1. *H Chichan et al., "Photobiomodulation in ocular therapy: current status and future perspectives," Int J Ophthalmol., 18:351 (2025).*
2. *H Chichan et al., "Subthreshold nanosecond laser, from trials to real-life clinical practice: a cohort study," Clin Ophthalmol., 15:1887 (2021).*

Elara 900 – Part 1: Clarity in Focus

Part 1 of a three-part series on Elara 900 looks at how clinicians are championing a new kind of slit lamp

In this first article of a three-part series, we look at how a new generation of slit lamp technology is promoting a reassessment of what clinical observation can mean in everyday practice. Haag-Streit's Elara 900 has been positioned as "the slit lamp, reinvented." What began as a simple promise – *"see more, work smarter"* – is now supported by clinical data indicating improved visualization quality and a stronger foundation for confident slit-lamp observation and diagnosis.

From optics to observation

The white paper underpinning this article[1] explores a central hypothesis: that illumination itself – independent of optical quality – can play a decisive role in clinical observation.

This is a notable departure from conventional thinking. Traditional slit lamps rely on fixed-spectrum light sources, meaning clinicians must adapt their technique to the device. The Elara 900 takes a different approach, introducing a projector-based "P-Type" illumination system capable of dynamically modulating light across the visible spectrum. Combined with Haag-Streit's Swiss-made optics – long regarded as a benchmark for clarity and light transmission – the system is designed to deliver a superior clinical view across both anterior and posterior segment examinations.

A clinical view you can trust

The Elara 900 integrates its optical and illumination components into a single, fully optimized system rather than relying on modular configurations that must be manually balanced. The Galilean microscope offers a five-step magnification range from 6.3× to 40×, enabling clinicians to move seamlessly between overview and detail. A motorized yellow filter and selectable illumination modes allow contrast enhancement tailored to specific examination scenarios – providing a natural, high-contrast view that supports confident detection of subtle ocular changes, even under challenging conditions.


Prof. Gerd Auffarth


Dr. Sunil Mamou

What the data suggest

To explore whether this technological approach translates into real-world benefits, Haag-Streit conducted usability evaluations across multiple clinical environments, which were part of a pre-launch study. Examiner data from international congresses was also pooled into the evaluation.

Across these datasets, a consistent pattern emerged when the Elara 900 was compared to a Haag-Streit BQ 900:

- **77.6% of clinicians reported improved binocular visualization** (Figure 1)
- **No respondents reported inferior visualization with Elara 900**
- **Higher ratings were recorded for optical precision, detail resolution, and illumination quality** (Figure 2)

In the Heidelberg Hospital study, led by Professor Gerd Auffarth, where clinicians evaluated the device in routine practice:

- **100% rated imaging quality as superior**
- **75% preferred it for fundus visualization**
- **90% selected it as their preferred slit lamp overall**

These findings suggest that improvements in illumination and system

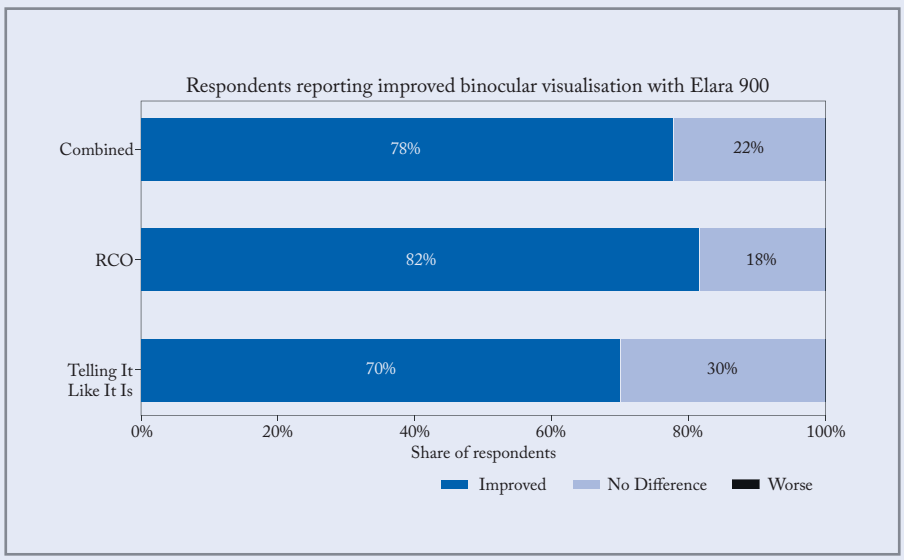


Figure 1: Share of respondents reporting improved binocular visualization with Elara 900 versus BQ 900 across congress questionnaire datasets ("Telling It Like It Is" Congress n = 20; RCO Congress n = 38; combined n = 58).[1]

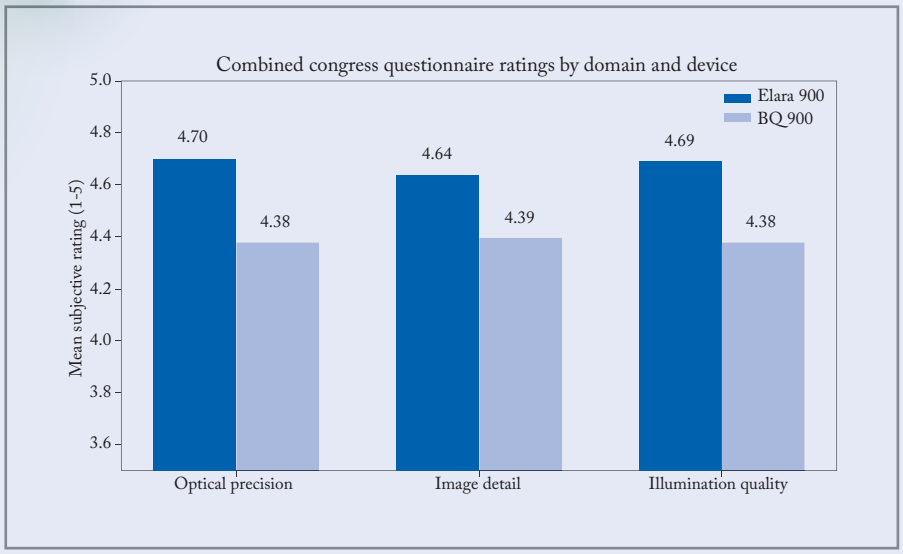


Figure 2: Mean ratings from the combined congress questionnaire on a five-point satisfaction scale for the Elara 900 & the BQ 900, across three clinical observation domains.[1]

"[As] soon as I examined the patient for the first time, the view just popped." Dr. Sunil Mamtora, Bristol Eye Hospital, UK

integration may translate into a tangible enhancement in clinical observation – supporting the idea of *"see more – diagnose with confidence."*

"The view just popped"

For many clinicians, the difference is immediately perceptible.

This impression appears closely linked to the Elara 900's projector illumination system, which projects light at the pixel level rather than forming beams through traditional apertures – enhancing the visibility of fine structures across the eye, from corneal microfeatures to deeper retinal layers.

The right light for every detail

The ability to modulate spectral output is central to the Elara 900's design. Unlike conventional slit lamps with fixed illumination profiles, the system can emit light across the visible spectrum and adjust color temperature depending on the pathology being examined. Shorter wavelengths enhance surface detail; longer wavelengths penetrate deeper tissues – allowing clinicians to adapt illumination in real time to optimize contrast and visibility. Additional capabilities, such as infrared illumination for Meibomian gland assessment,* further extend the system's versatility within routine workflows.

Efficiency without compromise

Visualization is only part of the picture. The Elara 900 also introduces the option for "preset"-driven examinations, enabling clinicians to combine multiple adjustments – slit width, illumination intensity, magnification, filter settings – into a single action. This streamlines the examination process and reduces repetitive manual input, allowing clinicians to focus more on the patient rather than the instrument.

See, save, share

Clinical observation does not end at the point of examination. The Elara 900 incorporates dual integrated cameras capable of capturing high-resolution images and videos, even in 3D** and 4K, enabling clinicians to preserve and review findings with exceptional detail – supporting follow-up, referrals, and collaborative care. Stereoscopic visualization also enhances teaching, allowing colleagues and trainees to experience examinations with greater depth and realism.

A step change – or an evolution?

The Elara 900 is perhaps best understood not as a radical reinvention, but as a carefully considered integration: optics, illumination, and workflow brought together into a single system designed to support how clinicians work.

Illuminating the future

The findings presented in the white paper are exploratory, and further studies will be needed to quantify their impact on diagnostic accuracy and clinical outcomes. But they point toward an important conclusion: that illumination – alongside optics – may represent a critical and previously underappreciated dimension of clinical observation.

If so, the implications extend beyond a single device. They suggest a future in which slit lamp technology is defined not only by how well it allows clinicians to look – but by how intelligently it helps them see.

** Availability may vary by region.*
*** 3D licence required*

Learn more about Elara 900:

Read the full white paper:

Reference

1. *Elara 900 WHITE PAPER. REF 1193 1421004 09000*

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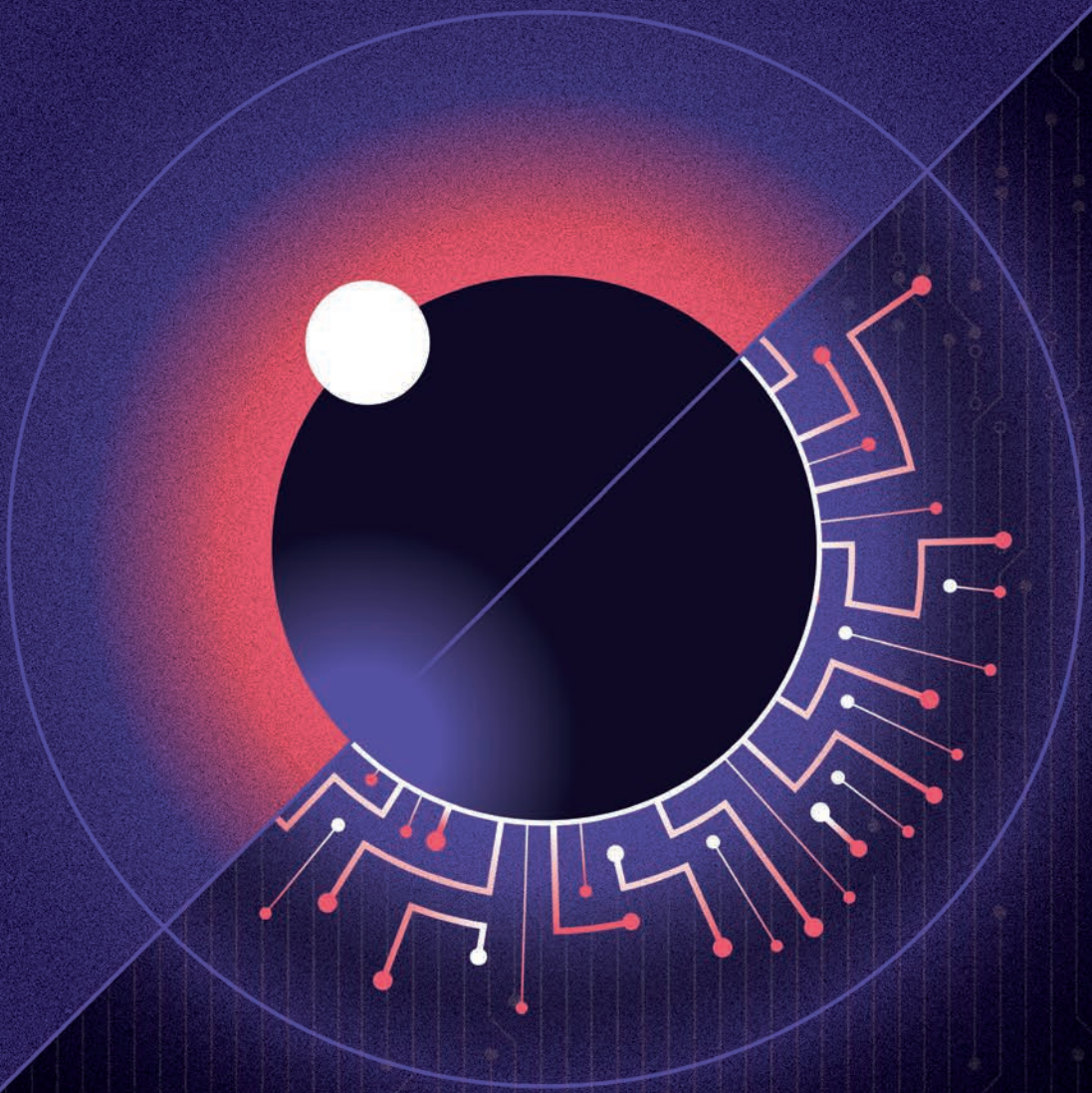
AI: From Hype to Real-World Clinical Value



Examining ophthalmic AI through the lens of clinical value rather than technical novelty

By Kai Jin and Andrzej Grzybowski

Artificial intelligence (AI) has attracted exceptional interest in ophthalmology because the specialty sits at the intersection of high-volume imaging, pattern recognition, and unmet screening demand. The landmark deep-learning study by Gulshan and colleagues (1) showed that retinal fundus photographs could be classified for diabetic retinopathy with expert-level performance, helping define ophthalmology as an early proving ground for medical AI. Soon after, deep learning systems for OCT-based referral decisions suggested that AI could support more complex triage pathways beyond single-disease screening (2). These studies fueled a decade of optimism that ophthalmology would become one of the first specialties to realize broad clinical gains from AI.

The optimism was not misplaced, but it was incomplete. Much of the early literature focused on retrospective discrimination metrics, especially the area under the receiver operating characteristic curve, sensitivity, and specificity. These metrics matter, but they do not answer the questions that determine real-world clinical value. Does the system expand access to care? Does it reduce clinician workload without increasing downstream errors? Does it improve triage speed, treatment timeliness, or health equity? Does it work across cameras, institutions, disease prevalence settings, and patient populations different from the development set? A model that performs well on a curated test set may still fail clinically if it is ungradable too often, is difficult to integrate into workflow, produces outputs clinicians do not trust, or increases false-positive referrals that overwhelm specialist capacity.

This distinction between technical promise and clinical usefulness is now central to the field. In ophthalmology, AI is no longer a purely experimental idea. Autonomous diabetic retinopathy screening systems have undergone prospective evaluation, achieved regulatory authorization, and entered real clinical workflows (3-7). At the same time, utilization remains modest, and many promising ophthalmic AI tools remain far from routine deployment (7). The gap between capability and adoption is where hype accumulates.

This review examines ophthalmic AI through the lens of real-world clinical value rather than technical novelty. The central argument is straightforward: the field should stop asking only whether AI can classify images accurately and start asking whether it improves the delivery of eye care in measurable, durable, and equitable ways.

WHERE OPHTHALMIC AI ALREADY DELIVERS VALUE

Diabetic retinopathy screening is the clearest success case

If one application has moved furthest from hype to practice, it is diabetic retinopathy (DR) screening. The reasons are structural as much as technical. DR is common, early treatment matters, image acquisition is standardized, and screening often happens outside specialist clinics where workforce shortages are greatest. These characteristics create a clinically meaningful use case for automation.

The early development literature established technical feasibility. Gulshan et al. showed strong diagnostic performance for referable DR on fundus photographs (1). Subsequent community and smartphone-based work demonstrated that AI-enabled DR screening could operate beyond tertiary eye hospitals, including settings with constrained infrastructure (4). The decisive shift, however, came from prospective and autonomous evaluation. Abramoff et al. reported a pivotal trial of an autonomous AI diagnostic system in primary care offices (3), showing that ophthalmic AI could function as a regulated clinical device rather than only as a research model. Ipp et al. later showed high sensitivity and specificity for autonomous detection of both more-than-mild DR and vision-threatening DR in a prospective multicenter study, with high imageability after a dilate-if-needed protocol (5).

Importantly, the translation story does not stop at accuracy. In a cluster-randomized trial, autonomous AI deployment increased specialist clinic productivity, providing rare interventional evidence that AI can improve operational performance in routine care (6). This is much closer to real-world value than retrospective benchmark gains. In addition, recent utilization data from the US show that AI-based DR detection is no longer hypothetical, even if adoption remains limited. Since 2021, claims-based use has increased, but uptake is still low relative to the size of the eligible diabetic population (7). That finding is sobering: regulatory authorization and positive trials do not automatically create scale.

Taken together, DR screening shows what meaningful ophthalmic AI translation looks like: a clinically important problem, prospective validation, regulatory pathway, workflow fit, and early operational benefit. It also shows that implementation science, reimbursement, and adoption are now the limiting factors.

OCT triage and retinal referral are highly promising but still more site-dependent

AI for OCT interpretation has also produced influential results. De Fauw et al. developed a deep-learning system for diagnosis and referral in retinal disease that used OCT input and generated clinically actionable referral recommendations (2). Conceptually, this work mattered because it moved ophthalmic AI beyond binary screening toward richer, multi-condition triage. In principle, such systems could help prioritize retina referrals, support virtual clinics, and reduce bottlenecks in high-volume services.

However, OCT-based AI has been harder to generalize than DR screening in primary care. OCT devices vary by vendor,

Table 1. Representative ophthalmic AI use cases and current translational maturity

Use case	*Main input*	*Strongest current evidence*	*Current translational maturity*	*Main barrier to wider adoption*
Autonomous diabetic retinopathy screening	Fundus photography	Prospective multicenter studies, regulatory clearance, early real-world deployment (3,5-7)	High	Reimbursement, implementation scale, referral integration
OCT-based retinal triage	OCT volumes	Strong retrospective and referral studies (2)	Moderate	Device heterogeneity, workflow integration, prospective multicenter implementation
Rural/community retinal screening	Ultra-widefield or smartphone fundus imaging	Community and rural screening studies (4,8)	Moderate	Infrastructure, image quality assurance, local referral pathways
Myopic maculopathy classification	Fundus photography	Public challenge and multicenter evaluation (9)	Moderate-early	Management-linked prospective validation
Retinopathy of prematurity support	Wide-field neonatal fundus imaging	Early deep-learning classification studies (10)	Early	Safety thresholds, expert oversight, medicolegal risk
LLM-supported documentation/education	Text or multimodal clinical data	Early observational and commentary-level evidence (12)	Early	Hallucination, governance, privacy, supervision

acquisition protocols differ, annotation is labor-intensive, and referral decisions may depend on local pathways rather than on image features alone. As a result, many OCT models remain strong demonstrations of capability without yet producing the same depth of prospective multicenter implementation evidence seen in autonomous DR screening. Their value is likely to emerge first in tightly integrated health systems or teleophthalmology networks where acquisition quality, referral thresholds, and specialist escalation pathways are already standardized.

AI may improve access in community and underserved settings

A second domain of tangible value is outreach and community screening. Cui et al. showed strong deep-learning performance for ultra-widefield fundus imaging in rural screening settings, reinforcing the idea that ophthalmic AI can help extend specialist-grade triage to regions with limited ophthalmologist availability (8). Similar logic underpins smartphone-based and offline DR systems, which may be especially relevant in low-resource settings where network dependence and specialist grading are major constraints (4).

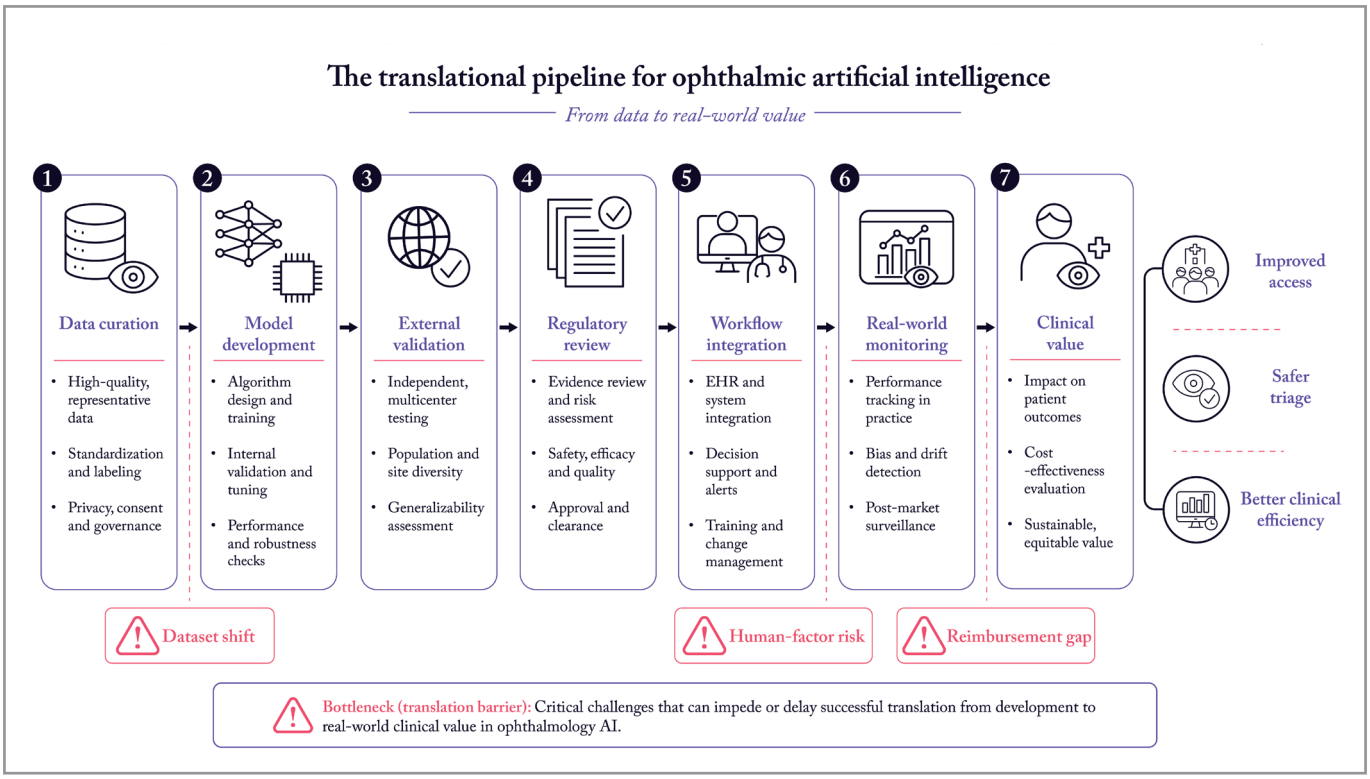
The key point is that AI value is contextual. A modestly accurate model that functions reliably in a rural or primary care pathway may be more clinically valuable than a technically superior model that requires expensive hardware, specialist oversight, and ideal image capture. Ophthalmology should therefore judge AI not only by discrimination metrics but also by whether it lowers the threshold for reaching currently underserved populations.

WHERE THE HYPE STILL EXCEEDS THE EVIDENCE

Many models are still retrospective, narrow, and fragile

Despite the growth of the literature, most ophthalmic AI studies remain retrospective and development-focused. Many are trained and tested on data captured under similar conditions, sometimes from the same institutions or device ecosystems. This raises familiar concerns: spectrum bias, label leakage, limited external validity, and performance erosion under distribution shift. Even when external

Figure 1. From algorithm performance to real-world clinical value in ophthalmology



Conceptual translation pathway showing how ophthalmic AI moves from dataset development to bedside value. The figure highlights where many models stall: external validity, workflow mismatch, and lack of prospective evidence.

test sets are used, the externality may be weaker than it appears if image acquisition standards, disease prevalence, or referral definitions remain closely aligned with the development environment.

This is one reason clinical adoption lags behind publication volume. An ophthalmologist does not need another high-performing model in principle; they need a system that works when images are imperfect, patients are complex, and clinic schedules are full. This is also why recent reporting guidance matters. TRIPOD+AI, CONSORT-AI, and SPIRIT-AI all emphasize transparent description of data provenance, model behavior, human-AI interaction, and prospective evaluation (13-15). These frameworks are not bureaucratic add-ons; they are essential if ophthalmic AI is to move from research claims to trustworthy clinical tools.

Human factors remain underappreciated

A second source of hype is the assumption that better model performance automatically leads to better human performance. That assumption is unsafe. In practice, clinicians and allied eye-care professionals do not respond to AI outputs mechanically. They weigh confidence displays, visual explanations, time pressure, prior beliefs, and workflow demands. Carmichael et al. showed that ambiguous deep-learning outputs can influence diagnostic decisions in nontrivial ways, highlighting the risk that poorly designed AI interfaces may confuse rather than assist users (11).

This matters because many ophthalmic AI systems are likely to function as decision support, not as fully autonomous devices. If output formats are vague, overconfident, or poorly calibrated, they may increase cognitive burden or induce automation bias. In other words, the clinical unit of analysis is often not the algorithm alone but the human-AI team. Ophthalmology needs more prospective studies that evaluate that team directly.

Large language models are useful, but their clinical role is narrower than the hype suggests

The newest wave of enthusiasm centers on large language models (LLMs). In ophthalmology, LLMs can already support drafting clinic communications, summarizing records, generating patient education materials, and organizing literature. These are plausible near-term use cases because they target language-intensive but lower-risk tasks. By contrast, unsupervised diagnostic reasoning from free text or multimodal input remains much less mature.

Young and Zhao argued that LLMs have reached the shoreline of ophthalmology, but not yet the interior of routine clinical decision-making (12). That framing is useful. For now, LLMs

should be treated as assistive tools whose outputs require oversight, especially where hallucination, omitted nuance, or fabricated citations could mislead clinicians and patients. Their real-world value is likely to emerge incrementally through workflow support rather than abrupt replacement of specialist judgment.

A PRACTICAL FRAMEWORK FOR REAL-WORLD CLINICAL VALUE

To move beyond hype, ophthalmic AI should be judged against five translational questions:

1. Is the clinical problem important and poorly served by the current pathway?

AI adds the most value where disease burden is high, delay matters, and specialist access is constrained. DR screening is the clearest example. By contrast, deploying AI into already efficient, specialist-rich workflows may yield little incremental benefit unless it meaningfully reduces workload or improves triage accuracy.

2. Does the model solve the right task?

Many ophthalmic AI models predict image labels; fewer solve operational decisions. Yet clinicians often need referral prioritization, interval prediction, treatment urgency classification, or longitudinal risk stratification rather than disease/no-disease outputs alone. Qian et al. showed impressive diagnostic performance for AI algorithms in myopic maculopathy classification, but the path to clinical value will depend on whether those outputs alter management decisions in real settings (9). The same principle applies to retinopathy of prematurity, where automated classification may be valuable only if it improves access to timely expert review without creating unsafe false reassurance (10).

3. Has the system been tested prospectively in workflow?

The strongest ophthalmic AI evidence comes from studies that evaluate the system where it will actually be used. Prospective design, multicenter sampling, pragmatic endpoints, and workflow-level outcomes should become standard. Productivity gains, referral completion, time to treatment, imageability, false referral burden, and missed disease rates are often more informative than small changes in area under the curve.

4. Does the system work equitably across settings and populations?

Ophthalmology should resist adopting systems that perform well only in narrow subgroups or well-resourced centers. Device variation, pigmentation differences, coexisting ocular disease, and differences in image quality may all affect performance. Equity is not a downstream issue to be checked after deployment; it is part of whether a tool has clinical value at all.

5. Is there a plan for governance after deployment?

Clinical value is not fixed at launch. Models drift, workflows change, cameras are replaced, and prevalence shifts. The FDA's AI-enabled device framework and recent transparency principles signal the direction of travel: lifecycle oversight, user-facing transparency, and clearer communication about intended use and limitations (16, 17). Ophthalmology programs implementing AI need post-deployment monitoring, escalation pathways for failure cases, and mechanisms for periodic recalibration or retraining.

WHAT THE NEXT PHASE SHOULD LOOK LIKE

The next phase of ophthalmic AI should be less about proving that deep learning can recognize eye disease and more about proving where it changes care for the better. Three priorities stand out.

First, prospective comparative studies should measure service outcomes, not only algorithmic outcomes. For example, does AI reduce missed follow-up, shorten treatment delays, increase screening completion, or allow retina clinics to absorb more urgent referrals without sacrificing quality? The cluster-randomized evidence from autonomous DR screening provides a model for this type of study (6).

Second, reporting quality must improve. Ophthalmology should expect AI studies to align with TRIPOD+AI for prediction modeling and CONSORT-AI/SPIRIT-AI for interventional evaluation (13-15). Poorly described datasets, opaque exclusion criteria, or vague descriptions of human oversight should no longer be acceptable in a field that seeks bedside impact.

Third, the field should broaden its concept of value. Not every useful AI tool will be autonomous or diagnostic. Some of the most scalable gains may come from image quality control, worklist prioritization, documentation assistance, patient messaging, and clinical trial enrichment. These uses may not be as glamorous as "doctor-level diagnosis," but they may create more reliable value in everyday eye care.

CONCLUSION

Artificial intelligence in ophthalmology has progressed beyond pure hype, but only in selected domains. The field's most convincing success to date is autonomous diabetic retinopathy screening, where prospective validation, regulatory authorization,

Table 2. A practical checklist for judging whether an ophthalmic AI tool has real-world clinical value

Domain	*Question*	*Minimum evidence expected before broad clinical use*
Clinical need	Does the tool address a meaningful bottleneck or unmet need?	Clear target population and workflow problem
Technical validity	Does performance hold across sites, devices, and populations?	External validation across heterogeneous settings
Workflow fit	Can the tool be used without disrupting care delivery?	Usability and implementation testing in routine practice
Human factors	Do users interpret outputs correctly and safely?	Prospective human-AI interaction studies
Outcome relevance	Does it improve access, efficiency, referral quality, or patient outcomes?	Pragmatic or prospective comparative evidence
Governance	Is there post-deployment monitoring and transparency?	Defined monitoring, escalation, and update plan
Equity	Does the system perform fairly across subgroups?	Prespecified subgroup and imageability analyses

and early workflow benefits now support genuine clinical value. Outside that area, many ophthalmic AI systems remain promising yet insufficiently proven. Their limitations are no longer mainly computational; they are translational. Weak external validation, incomplete reporting, workflow mismatch, human-factor risks, uncertain reimbursement, and insufficient post-deployment governance continue to prevent many strong models from becoming strong clinical tools.

The practical standard for the next decade should be simple. Ophthalmic AI deserves adoption when it improves access, accuracy, efficiency, equity, or outcomes in routine care more than existing alternatives do, and when those gains are demonstrated prospectively rather than assumed from retrospective performance. If the field keeps that standard in view, it can move from excitement about what AI might do to evidence about where it already matters.

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METIS HU: A New Surgical Perspective

The METIS 3D Digital Heads-Up Module provides surgeons with exactly what they need from a next-generation ophthalmic microscope upgrade

With long operating days requiring intense concentration, fine precision, and prolonged static posture, musculoskeletal issues are an all-too-familiar experience for surgeons, particularly ophthalmologists performing countless anterior and posterior segment surgeries.

Responding to this challenge, Haag-Streit has introduced the METIS 3D Digital Heads-Up Module (METIS HU).

Dr. Christopher Riemann

Dr. Edward Meier

The result is a genuine paradigm shift, enabling surgeons to operate via a large 3D display rather than traditional eyepieces, with the flexibility to switch between viewing modes.

Bespoke surgical performance

METIS HU comes complete with an integrated digital 3D visualization platform, creating a state-of-the-art solution for these daily ergonomic challenges and providing an enhanced optical-digital experience for surgeons.

Expanding upon Haag-Streit's trusted high-end ophthalmic microscope, the METIS 900, METIS HU has been specifically designed to support the everyday needs of ophthalmologists. By incorporating advanced 3D 4K camera technology along with a 55" 3D 4K monitor and a compact monitor cart, Haag-Streit's latest offering allows surgeons to transform their workspace into a "surgical cockpit" for improved visualization and ergonomics.

Enhancing the surgical view

Combining innovative 3D 4K camera technology that can constantly adapt to varying light conditions with a 4K OLED monitor, METIS HU supports ophthalmic surgery with stunning detail and clarity.

"Whether in the anterior segment, posterior segment, or with combined surgery, screen-based surgery with METIS HU is simply a delight," says Dr. Christopher Riemann of the Cincinnati Eye Institute, Ohio. "The resolution is superb, and the unique feature of being able to actively adjust the camera settings intraoperatively provides a level of control that surgeons will love. We can't fix what we can't see – but with METIS HU we can see beautifully!"

Upgraded ergonomics

The ergonomics of surgical microscopy are of paramount concern to surgeons who spend a large portion of their operating time in environments not necessarily conducive to good posture.

"Years of studying the effects of posture with the surgical microscope have shown us firsthand the toll that sub-optimal ergonomics can take on the neck and back, especially with ophthalmic surgeons," says Mike Luley, Director of Global Product Management, Surgical at Haag-Streit. "The message is clear: proper ergonomics are not simply nice to have – they're essential to the health of the surgeon."

Looking to address these very real, long-standing issues, METIS HU offers a "heads-up" approach. Surgeons can now benefit from sitting in an upright position, with a compact design that provides a clear view of the high-definition screen without requiring excessive head tilting.

"Haag-Streit has always championed better surgical ergonomics," explains Luley, "and we have developed our METIS 900 microscope with ergonomic features such as the uniquely engineered optical vertiscope that extends the position of the inclined oculars outwards

towards the surgeon."

Luley adds: "Moreover, the METIS HU monitor can be positioned to suit the comfort level of the surgeon. Together, METIS HU provides surgeons with an exciting new way to operate using innovative "heads-up" technology while also taking advantage of a more comfortable and ergonomic way to work."

Dr. Edward Meier, ophthalmologist and director of Apex Eye Clinical Research in Cincinnati, Ohio, confirms: "As a purpose-built, 'heads-up' scope, the ergonomics are fantastic. At the end of a long day, my neck and back are much less tired than when using a traditional microscope."

Conversely, if surgeons don't want to dispense with their current setup altogether, then METIS HU offers the freedom to choose between digital and analog optical configurations. With a convenient and easy-to-use conversion process, the surgeon at the helm of the METIS HU is in full control of how the surgical device works for them.

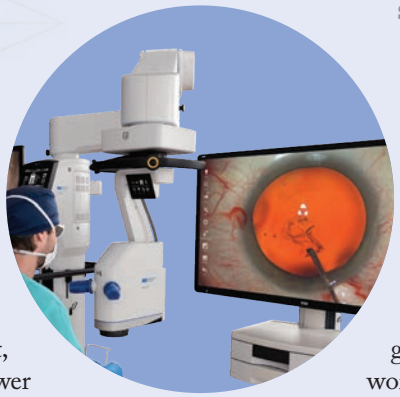
Improved workflow & integrated digitalization

METIS 900 reimagines workflows on the surgical microscope by providing surgeons with the ability to efficiently control all aspects – both through the traditional 14-function foot switch and via innovative hand switches that provide ten additional buttons for full control of the microscope setup. Complex microscope operations are easily performed, and custom-tailored to the surgeon's needs.

METIS HU extends this workflow with powerful new digital features that further boost workflow efficiency. Surgeons can now monitor system configurations, adapt their tailored settings, and navigate to the on-screen help "menu" with a simple, sterile touch. Similarly, using the foot switch, surgeons can activate digital quick zoom to visualize fine anatomical details and toggle image inversion without the need for additional system add-ons.

Increased patient comfort

A major benefit of METIS HU is lower illumination levels – the system's enhanced technology enables surgeons to work at lower light levels compared to an analog setup. As a result, patients benefit from lower light toxicity and enjoy greater comfort during surgery.



Along with lower light levels for increased patient comfort, surgeons can now use digital brightness, which is decoupled from the microscope light, to achieve the appropriate brightness levels that they require.

"The METIS HU has wonderful image clarity that is as good as a regular light path microscope," says Dr. Meier. "One of the best things is that you can use digital illumination to brighten the image while using a much dimmer microscope light. This is much more comfortable for the patient while still delivering an excellent view and red reflex."

Immersive learning environment

With its advanced 3D 4K camera technology and 55" 3D 4K monitor, METIS HU helps to foster an immersive learning environment for the rest of OR staff. Assistants, trainees, and other clinical personnel are able to observe surgical procedures in real-time with the surgeons, and, again, with the simple touch of a hand switch or the tap of a foot, the operating surgeon is able to simultaneously capture high-quality 3D videos and images as they work, and easily share their findings with colleagues for further analysis and review. This includes allowing multiple 3D monitors to be linked in a teaching environment, so that remote observation can be achieved in real time.

Digital dashboard

From the convenience of the microscope's large 27" touchscreen display, clinicians can easily control and personalize their METIS HU setup. Designed with surgeons and their teams in mind, METIS HU interfaces with Haag-Streit's latest Microscope Imaging & Operation System (MIOS 6) – a single-user interface with interactive menus to guide a surgeon's surgical workflow. This allows for customization of microscope settings and surgeon profiles, to the recording and sharing of patient data, all from one central control point.

Digital red-free filter

With advanced digital processing, METIS HU ensures that color, contrast, and brightness are continually optimized to deliver clear, natural images for spectacular 3D visualization. Surgeons can switch seamlessly between various filters, such as "red-free," to enhance contrast and visibility of retinal structures, creating better visualization that aids efficiency and safety in a wide variety of operating scenarios.

Attuned to the surgical future

Predicated on the understanding that clinician feedback is of crucial importance to manufacturers, METIS HU confirms that Haag-Streit is listening to what clinicians are saying, offering action-oriented solutions that demonstrate an indelible commitment to continuous improvement throughout the industry.

Availability of the METIS 3D Digital Heads-Up Module may vary by region. Please contact your local Haag-Streit Distributor for details.

To find out more, please scan the QR code, or visit *https://us.haag-streit.com/Campaigns/metis-hu/module*

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Look closer. See further.

ANTERIOR SEGMENT

Beyond the Diopter: Evolving Your Framework for Refractive Surgery Planning

Corneal health, axial length, and long-term ocular preservation are helpful guides for every refractive conversation

By José F. Alfonso

In its simplest form, a refractive surgery consultation is a structured conversation with a patient about their candidacy for surgical intervention. More specifically, there are two interlocking parts of the process: a comprehensive evaluation of the eye and a goal-oriented dialogue about the patient's visual needs, desires, and expectations. As refractive surgeons, it is our responsibility to approach each consultation not as a transaction, but as the first step in a long-term relationship with a patient's ocular health, accounting for not only where their eyes are currently but also where they may be decades from now.

The shift away from refractive error as the primary decision variable toward corneal health, axial length, and long-term ocular preservation represents, to me, one of the most meaningful conceptual advances in refractive surgery over the past decade. It changes not only which patients we recommend for surgery, but also how we speak with them, what we promise, and how we set expectations for a lifetime of visual health rather than a single correction event.

Start with the eye, not the prescription

A comprehensive ocular evaluation has two fundamental objectives:

1. assess the eye's overall health, including the ocular surface and tear film, cornea, crystalline lens, stability of the refractive error over time, and
2. evaluate visual quality, including higher-order aberrations, contrast sensitivity, and ocular dominance.

Getting to know about the patient's life, occupation, and hobbies is also important to understand what they ask of their vision at varying ranges, and in both daytime and nighttime environments.

What is conspicuously absent from the list is a diopter threshold. In our practice, we do not recommend one refractive surgery procedure over another based on prescription alone. Rather, we consider the relationship between keratometry, axial length, and refraction with and without cycloplegia. We measure endothelial cell count, assess corneal biomechanics, and perform both anterior and posterior segment OCT. In other words, we look at the whole eye.

A case for corneal preservation

The most critical measurement for patients with myopia is axial length. For anything greater than 25 mm, implantation of an EVO ICL (STAAR Surgical) is preferred in our clinic regardless of the associated refractive error. We have more than 30 years of follow-up dictating an average axial length progression of at least 0.25 mm for 66% of patients in the following 20 years after surgery. This is roughly equivalent to 0.75 D of myopia.

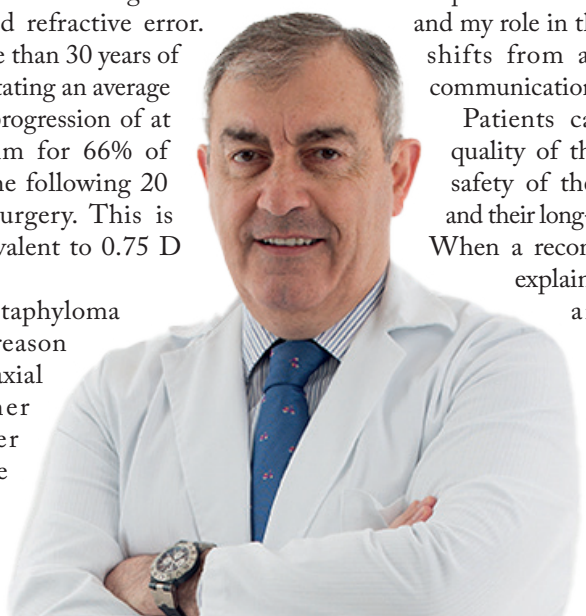
Posterior staphyloma is another reason to consider axial length rather than diopter value as the primary criterion for Implantable Collamer Lens (ICL). On posterior segment OCT, a macular plane tilt greater than 30º can produce 1 to 2 lines of visual acuity loss and meaningful degradation of contrast sensitivity and night vision. In a patient who already carries this anatomical burden, aggressive corneal reshaping may compound rather than solve the problem. A flat cornea on top of a retinal staphyloma is a formula for dissatisfied patients.

When properly conceived, refractive surgery is a longitudinal strategy instead of a one-time transaction. However, corneal ablation is not without consequence. Removing tissue from a cornea that is already biomechanically stressed forecloses options that may be desirable later. That loss is rarely apparent at the time of the original surgery. By contrast, a patient who receives an ICL in their 30s preserves a cornea for laser enhancement if myopia progresses or for a presbyopia-correcting IOL when they later develop a cataract. Protecting corneal tissue now, in many ways, protects the patient's visual future.

Guiding patients through the procedural conversation

By the time I sit down to discuss surgical options with a patient, the refractive evaluation has usually already answered the central question. I have a clear picture of which procedure best fits their eye, and my role in the consultation shifts from assessment to communication.

Patients care about the quality of their vision, the safety of the intervention, and their long-term outcomes. When a recommendation is explained thoroughly and honestly, most patients are receptive, even when the procedure differs from



what they expected walking in. The following reflects our preferred decision framework.

Healthy cornea, normal biomechanics, and axial length under 25 mm. LASIK, PRK, and SMILE are all appropriate options provided the refractive error falls comfortably within the predictable range for laser vision correction. In these cases, the final choice may legitimately incorporate the patient's preferences for recovery time, lifestyle demands, and tolerance for dry eye risk.

Axial length exceeding 25 mm or any concern about corneal biomechanical reserve. EVO ICL is presented as the primary recommendation for the reasons discussed previously: corneal preservation, protection against myopia progression, and safeguarding future surgical options.

Hyperopia. Corneal ablation for high hyperopic corrections carries increased visual quality penalties compared to ICL, including greater induction of higher-order aberrations and long-term refractive regression (1, 2). For this reason, anterior chamber depth (ACD) is the primary criterion guiding our recommendation. Anything greater than 3 mm is an indication for ICL regardless of the magnitude of hyperopia. In select cases, ICL may be considered for an eye with an ACD of 2.8 mm following specific informed consent. The principle is consistent: the measurement drives the decision, not the prescription.

Astigmatism. We have a saying in our practice: astigmatism is a bad travel companion. It is addressed on the cornea whenever possible. Two possible solutions are limbal relaxing incisions in combination with ICL and a bioptics procedure paired with the ICL. Toric ICLs are available and effective, but our preference is to correct cylinder at the cornea and reserve a phakic IOL for spherical correction.

Quality-of-life outcomes

The goal of refractive surgery extends beyond eliminating glasses and/or contact lenses. The right procedure should give a patient the greatest possible functional freedom across the whole arc of their visual life. For patients between the ages of 45 and 55, this consideration leads us to favor ICL over refractive lensectomy when the anatomy supports it. Removing a healthy crystalline lens carries retinal risks, particularly in eyes with long axial lengths (3). EVO Viva ICL, designed specifically for this population, is an important advance in this direction.

I also try to be honest with patients about what surgery cannot guarantee. A patient with an axial length of 27 mm and a posterior staphyloma may have excellent functional vision after ICL implantation, but they carry an elevated risk of myopic macular degeneration, glaucoma, and retinal pathology that no refractive procedure changes (4). Understanding that myopia is a disease rather than a refractive inconvenience helps shape the entire conversation, elevating what we are doing from cosmetic surgery to meaningful clinical intervention.

Clinical and strategic implications

Surgeons who embrace a broader framework for refractive surgery planning may find that it expands their refractive practice in ways that purely diopter-based thinking does not. There is a substantial population of patients with axial lengths between 25 and 26 mm whose myopia may be anywhere from -2.00 to -10.00 D. Under traditional criteria, many of these patients might never be referred for ICL consultation or might self-select for laser vision correction based on a cursory review of their prescription. An axial-length–guided approach captures these patients and gives them a more diverse pool of options.

The same logic applies at the other end of the refractive spectrum. A patient with low hyperopia and a deep anterior chamber who wants spectacle independence is not automatically best served by surface ablation. When we evaluate them on the full biometric picture, an ICL may deliver superior optical quality and long-term stability.

To me - and for surgeons building or refining a refractive program - these conversations are worth having. A practical first step is evaluating your diagnostic infrastructure. Corneal tomography, anterior and posterior segment OCT, axial length measurement, corneal biomechanics assessment, and endothelial cell count should be routine components of the evaluation. This also encompasses cultivating the intellectual habit of reviewing all results before thinking about refractive error.

The second step is conceptual. We are long overdue for a reframing of refractive surgery education. The traditional divisions of corneal and lens-based surgery should give way to a unified concept of surgery, with therapeutic and refractive objectives applied in sequence or combination as an individual patient requires. When we are able to achieve this, we are better positioned to treat the cornea and lens as a functional unit across the full timeline of a patient's visual life.

Conclusion

Refractive surgery has achieved extraordinary levels of safety, predictability, and efficacy. The next step is to deploy all the tools we have at our disposal with the wisdom that comes from thinking beyond the prescription and seeing the patient in front of us as a whole eye, a full life, and a long future. In my experience, those patients who see their surgeon thinking about their cornea at age 60, not just their acuity at age 35, tend to be more trusting, engaged, and satisfied with their outcomes.

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See references online

RETINA

Seeing ROP Clearly

How AI and XR simulations are transforming training for retinopathy of prematurity

By Richard Vincent

Every year, thousands of premature infants are at risk of losing their sight to retinopathy of prematurity (ROP). The good news: ROP is treatable. The persistent challenge is that the specialists needed to diagnose and treat it are in short supply, and training takes time, access, and repetition that traditional models of surgical training and education currently struggle to provide.

XR (extended reality) simulation and AI (artificial intelligence) are now beginning to change that equation.

Small eyes, high stakes

Retina surgery is already among the most technically demanding disciplines in medicine. Surgeons operate at a microscopic scale within the posterior segment, navigating instruments through tissue so fragile that the margin for error can be measured in microns. Ophthalmic surgical learning curves are steep, with performance only stabilizing after roughly 200 cases (1), and the skill required is as much instinct as it is technique.

ROP raises the stakes further as clinicians must adapt every technique to a much smaller anatomy, the eye of a premature infant – especially when these patients cannot communicate distress and can move unpredictably. Diagnosis requires indirect ophthalmoscopy, where the physician wears a head-mounted ophthalmoscope and manually aligns a condensing lens with the infant's eye, maintaining that alignment across a systemic examination of multiple retinal quadrants. Treatment, when indicated, involves laser photocoagulation of the peripheral retina, relying on precise, sustained, targeting that can last 20 to 40 minutes, depending on disease severity.

These are not skills that are built quickly, and the case volume to build them organically simply isn't available to most trainees.

Practice without consequence

This is where immersive simulation makes its strongest argument. The core promise of XR in surgical training is simple: repetition without any of the risk. Trainees can practice indirect ophthalmoscopy, lens positioning, optical alignment, and systemic retinal visualization as many times as they need, without placing an infant patient at risk.

Beyond procedural rehearsal, virtual patient libraries give trainees something clinical training rarely can: a reliable spectrum of pathology. From early vascular abnormalities to advanced retinal detachment, learners can encounter every stage of ROP disease progression on demand, without having to wait for the right case to come through the door.

Procedural simulation enhances this even further. Trainees can rehearse laser photocoagulation techniques, targeting accuracy, energy control, and treatment coverage without time pressure and without consequence. Early evidence suggests immersive training can accelerate surgical learning (2), reducing operating room training time and supporting faster progression towards procedural independence.

Moving beyond "keep practicing"

Simulation alone is valuable, yet when paired with intelligent assessment it can be transformative. AI-driven platforms are able to capture performance metrics that would be impossible to track in a clinical setting – metrics such as examination coverage, procedural timing, targeting accuracy, training frequency, and consistency across sessions. This data provides something traditional apprenticeship cannot – an objective, longitudinal record of how a trainee is developing at any given time.

The record supports structured competency assessment for program directors to reference, and enables targeted, specific feedback for trainees. There is a significant gap between generic feedback such as "keep practicing" versus more targeted feedback like "your peripheral coverage is inconsistent in the inferior quadrant." Now, AI has made the latter possible at scale.

Training at scale, anywhere

The urgency is not confined to training programs in wealthy academic medical centers. Advances in neonatal care across low- and middle-income countries have improved survival rates for premature infants. The number of ophthalmologists trained to screen and treat ROP has not kept up with demand, leading to a growing burden of preventable childhood blindness in regions least equipped to handle it (3).

Simulations offer scalable responses, and XR platforms can deliver standardized, high-quality training without requiring proximity to a specialist teaching center. Web-based immersive simulation training extends the reach even further, enabling training in settings even without access to virtual reality (VR) hardware. In 2024, the American Academy of Ophthalmology recognized this potential, launching a VR education program with Fundamental XR that expanded access to ophthalmologic training globally.

More reps, better surgeons

It is worth noting that there are limitations with these technologies. XR simulation does not replace the clinical experience that defines ophthalmologic training, and no virtual environment can fully replace the judgement, tactile feedback, and situational complexity that you get from working with a real patient in a real setting. But it can simulate that scenario in significant ways.

Credit: Fundamental XR

Credit: Fundamental XR

Retinopathy of prematurity (ROP) is a major cause of preventable childhood blindness, and while effective treatment tools exist, training physicians has historically been a significant challenge. Recent advancements in technology – particularly virtual reality – are transforming this landscape by enabling ever more realistic simulations of a premature infant's eye using a condensing lens. This innovation makes it possible to train specialists more efficiently in diagnosing and treating ROP. The current focus is on bridging the gap between this emerging technology and broader treatment access, with each simulation bringing the field closer to reducing avoidable childhood blindness and making a lasting impact.

This type of technology offers an extended and structured real-time simulated experience for the trainee. It fills gaps between observation and independent performance, as well as giving trainees the repetition they cannot get from the volume of cases alone, in an environment where mistakes made become learning opportunities rather than poor patient outcomes.

In this subspecialty alone, where the patients are vulnerable and unpredictable, safer training matters most. Technological advancements such as the use of extended reality, AI, and robotics are all crucial to enabling those coming into the world early to have a future where their sight is not limited by access to proper care.

Richard Vincent is Founder and CEO, Fundamental XR

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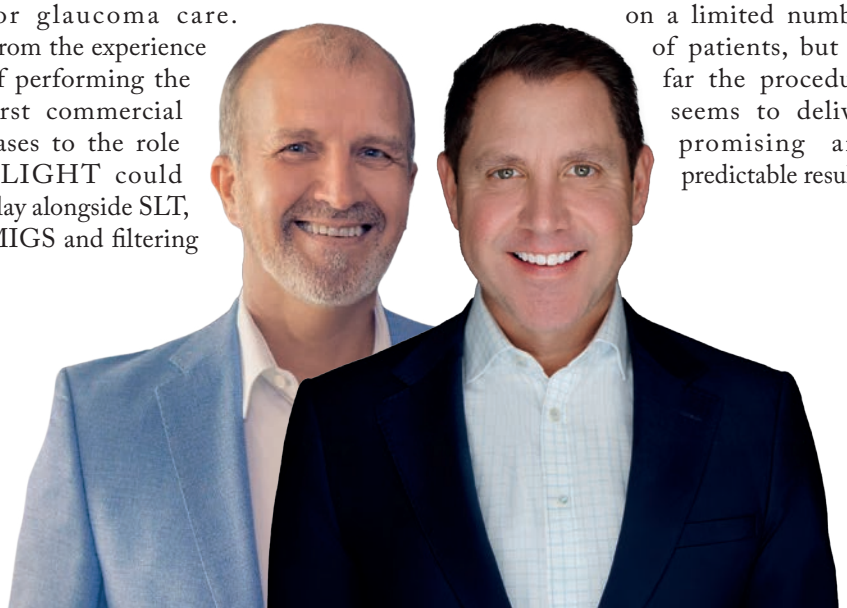
GLAUCOMA

Mapping the FLIGHT Path

How incision-free intervention could expand glaucoma treatment options

ViaLase recently announced the completion of the first commercial femtosecond laser image-guided, high precision trabeculotomy (FLIGHT) procedures anywhere in the world, with treatments performed at Centre for Sight in London and at Breyer, Kaymak & Klabe Augenchirurgie in Düsseldorf. The procedures mark the commercial introduction of the company's incision-free, image-guided femtosecond laser treatment for open-angle glaucoma, which is designed to create precise channels through the trabecular meshwork to restore aqueous outflow and reduce intraocular pressure.

At this year's EGS meeting in Brussels (May 31-June 2), The Ophthalmologist sat down with Karsten Klabe, glaucoma specialist and head surgeon at Breyer, Kaymak & Klabe Augenchirurgie, and Pete England, Chief Commercial Officer at ViaLase, to discuss what this means for glaucoma care. From the experience of performing the first commercial cases to the role FLIGHT could play alongside SLT, MIGS and filtering surgery, the pair shared their views on where the technology fits today and what success might look like over the next few years.



With the completion of the first commercial FLIGHT procedures anywhere in the world, how did it feel like to move from clinical studies to real-world practice?

Karsten Klabe (KK): For me, it's a huge honor to be involved. I felt a little nervous because it was a completely new procedure. Any time you're among the first surgeons performing a new technology, there's a sense of responsibility to do it well. It's a new procedure, and I'm not a very "new" surgeon. But we've done two days of surgery, treating 15 patients overall, and it felt easy to repeat by the third or fourth procedure.

The technology is amazing. You do a precise cutting of the trabecular meshwork without cutting into the eye, which is like a miracle. We used topical anesthesia only; after the first few cases, the procedure itself took about 2–3 minutes per eye. Afterwards, we asked patients how they felt and they said they felt no pain, nothing at all. It works so smoothly, and the docking step seems much more gentle to the patient compared to what we know from femtosecond laser in cataract surgery.

These are early days, of course. We do have two years of published results on a limited number of patients, but so far the procedure seems to deliver promising and predictable results.

Pete England (PE): What makes this milestone particularly meaningful for us is that our president and chief technology officer, Tibor Juhasz, who pioneered femtosecond laser technology in refractive and cataract surgery, originally envisioned applying femtosecond laser technology to glaucoma before the imaging capabilities existed to make it possible. Seeing that vision finally reach commercial patients is incredibly rewarding.

The current glaucoma treatment pathway is quite crowded. Where do you see FLIGHT fitting in – in place of drops after SLT, before MIGS, or somewhere else entirely?

KK: With a non-incisional procedure, the first thing that comes to mind is SLT. SLT is safe and is proven by long-term results. But we know that after repeated SLT, some patients have little or no meaningful pressure reduction, and the pressure-lowering effect often diminishes over time. So, the next step could be a FLIGHT procedure.

Another group of patients who might benefit are pseudophakic patients. Many glaucoma patients get a modest pressure-lowering effect from cataract surgery alone, but that effect often lasts only 1–3 years. After that, we frequently have to restart glaucoma drops. If we can offer FLIGHT, there is a good opportunity to keep patients off drops for as long as possible, because in real life drops often don't work as well as they should due to side effects and poor adherence.

PE: This technology is designed to serve a broad spectrum of patients suffering from glaucoma. There's a tendency to try and slot every new technology into a neat, linear treatment algorithm. But that's just not the way glaucoma is practiced.

The fact that this procedure is repeatable is important because that aligns with the longitudinal nature of this chronic, lifelong disease. Every surgical intervention is episodic, meaning it happens once. The primary determinant today for a MIGS procedure in Europe and the US is the presence of a cataract. That's great, but many

glaucoma patients are either too young for cataract surgery, already pseudophakic, or simply need another option.

What excites me most is the possibility of intervening earlier in the disease process, rather than waiting until patients have accumulated years of medication burden.

What is the challenge of rolling out this technology to the global market?

PE: The challenge is like anything else that we've seen in bringing to market novel technologies in ophthalmology. This isn't really a technology question. It's a behavior change opportunity. The opportunity is to move interventional glaucoma from conference presentations and thought leadership discussions into everyday clinical practice.

Ophthalmologists, like all of us, are creatures of habit and there is the tendency to put a patient on drops and start that trial-and-error cycle. Karsten and the small percentage of ophthalmologists talking about interventional glaucoma already have a different mindset, but most do not. So, again, this is not a technology question; it's a behavior change question.

KK: Yes, it's about behavior. When we give medication to patients, we put the adherence burden on their shoulders. If we do a surgery, if we do a laser treatment, as ophthalmologists we put the responsibility on our shoulders.

One thing we have to look at is how long SLT has been talked about. Dr. Mark Latina published his paper on SLT back in 1996, and it was more than 20 years before the results of the LiGHT trial were announced as a breakthrough at EGS in 2019. We now have a new technology, and there is still a way to go. It takes time to bring it to market.

The next EGS is only two years away, but if we were to talk then, what would success look like for FLIGHT?

KK: Success for FLIGHT in two years' time would not necessarily mean replacing incisional surgery like trabeculectomy. Trabeculectomy remains the gold standard for patients who need very low pressures – around 10 mmHg or lower – and it can provide long-term pressure control. However, it is invasive and carries significant risks.

The real question in glaucoma management is whether every patient needs such an invasive procedure from the outset, or whether we can adopt a stepwise approach.

Many glaucoma patients have mild or moderate disease. In my practice, only about 25 percent requires the very low pressures that typically necessitate filtering surgery. For the majority, a safer, less invasive procedure that provides meaningful pressure reduction and delays disease progression may be more appropriate.

If FLIGHT can safely lower intraocular pressure, reduce dependence on drops, and provide durable control for five to ten years, that would be a major success. In younger phakic patients, it could buy time until cataract surgery becomes necessary, at which point further pressure-lowering procedures could be combined with cataract surgery if needed.

In other words, success would be a treatment that fits between SLT and incisional surgery: safer than filtering surgery, capable of keeping many patients drop-free, and effective enough to prevent progression in patients with mild to moderate glaucoma.

PE: Speaking about Europe, ideally we would want maximum access to both surgeons and patients in every market that we enter. But as a startup company, that's just not viable. Our commercial strategy is very focused and intentional.

We want to be responsible in how we roll out this technology, so we're focusing on the right surgeons in a few select markets. We want to walk before we run and apply the learnings we're getting from a handful of sites in Europe to other markets, including the US. The most important thing right now is making sure every surgeon and every patient has a great experience with the technology.

Karsten Klabe, glaucoma specialist and head surgeon at Breyer, Kaymak & Klabe Augenchirurgie, Düsseldorf, Germany.
Pete England, Chief Commercial Officer at ViaLase, Inc.

PROFESSION

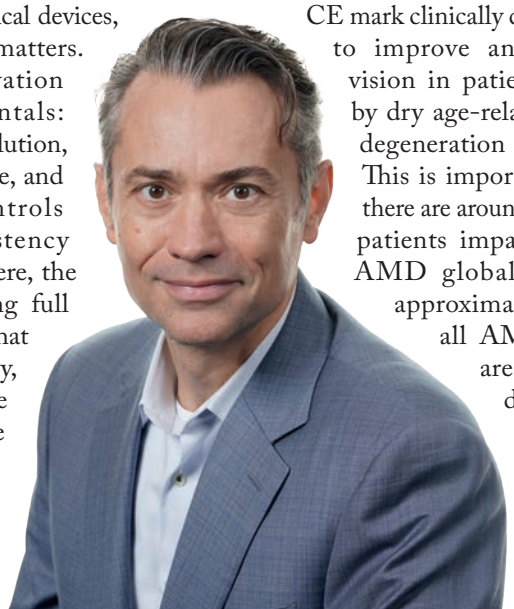
Inside Alcon's Innovation Strategy

Seba Leoni, President of International Surgical at Alcon, discusses the company's approach to innovation and "ecosystem thinking"

From your perspective, what are the most important drivers of innovation in eye care?
Demand is rising, driven by aging populations and higher patient expectations. Against that backdrop, innovation must do two things: make it easier for surgeons to deliver great outcomes, and make the end-to-end process as efficient as possible.

How does Alcon approach innovation?
We see patients' needs through the eyes of eye care professionals. They are at the center of how we invest in R&D, and our job is to earn their trust by turning feedback into reproducible clinical performance.

For example, in cataract, we keep pushing our limits to give more to surgeons and patients. Because it is the most performed surgery worldwide (1), and Alcon lenses are among the most widely implanted medical devices, innovation at scale matters. We approach innovation with the fundamentals: material platform evolution, optic design excellence, and manufacturing controls that support consistency lens to lens. From there, the focus is on advancing full range vision in ways that improve predictability, visual quality, and make true EDOF more meaningful in practice.



More broadly, we apply the same ecosystem thinking across the pathway – from diagnostics and planning to OR execution and follow-up – because innovation is not just about a product, but about a process designed for consistency, always within approved indications.

How do advances such as Alcon's UNITY VCS (Vitreoretinal Cataract System) and UNITY CS (Cataract System) contribute to the evolution of the ophthalmic operating room?
UNITY VCS and UNITY CS reflect a shift toward integrated OR platforms – built for surgeon control, standardization, and smoother team execution (2). When the OR is designed as a coherent workflow rather than a collection of separate tools, you can reduce handoffs, simplify set-up, and protect consistency case-to-case (3). And these technologies introduce a portfolio of innovative features designed to support predictable performance (4), stability, and procedural efficiency (1).

With innovations such as the Valeda™ PBM (photobiomodulation) highlighting new therapeutic approaches beyond traditional surgery, how do you see the scope of ophthalmic innovation expanding?
In the case of Valeda™ PBM, innovation is expanding into intervention earlier in disease progression. Valeda is the first and only FDA-authorized treatment with CE mark clinically demonstrated to improve and maintain vision in patients affected by dry age-related macular degeneration (AMD) (5). This is important because there are around 200 million patients impacted by dry AMD globally (6), and approximately 90% of all AMD patients are living with dry AMD (7). Having a proven technology like Valeda provides a new level of confidence to clinicians, in terms of their ability to effectively improve and maintain vision in patients affected by dry AMD at approximately two years (8).

"We approach innovation with the fundamentals: material platform evolution, optic design excellence, and manufacturing controls that support consistency lens to lens."

Looking to the future, what role do you believe Alcon will play in shaping the next generation of ophthalmic care?
Our role is to help surgeons deliver more consistent outcomes at scale – by pairing an R&D engine with an operating model that makes innovation usable in the real world, so as to make advanced eye care more consistent, more connected, and to help more people see brilliantly.

Availability and indications may vary by country. Please refer to relevant product Instructions for Use for complete indications, contraindications and warnings.

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See References online.

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We are excited to announce that The Ophthalmologist is now officially part of Conexiant Vision!

Home to a number of titles including Ophthalmology Management, Contact Lens Spectrum, and Glaucoma Physician, this strategic integration brings together The Ophthalmologist's trusted expertise in ophthalmology with Conexiant Vision's cutting-edge technology and innovative vision solutions.

This partnership allows us to expand our commitment to providing comprehensive, patient-centered eye care. By combining advanced diagnostic tools, treatments, and resources, we are positioned to deliver enhanced vision care that sets new standards in the field of ophthalmology.

We look forward to the exciting opportunities ahead as we continue to lead the way in vision care innovation. Stay tuned for more updates as we embark on this new chapter together!

The Power of Adjustability

Sitting Down With… Ron Kurtz, President and Chief Executive Officer, RxSight

Your career spans clinical practice to serial entrepreneurship – what drew you from practicing ophthalmology to building companies?

I had been involved in a biotech start-up before I went to medical school, so I've always done both. In fact, I was partly drawn to medicine because it allowed me to pursue entrepreneurial things that directly helped people.

I loved taking care of patients and it is only in the past ten years or so that I haven't had direct clinical care as part of my activities. There's nothing more gratifying, but there is an analogous gratification when you bring a product to market. That positive feedback loop is what keeps us all going.

What were the toughest hurdles in bringing RxSight's technology to market?
Medical device projects tend to follow a similar pattern. The first hurdle is usually the technology itself, where you have to ensure the product accomplishes its intended purpose. The second hurdle is usually regulatory approval. Often the two processes are iterative, with the product evolving over time.

The Light Adjustable Lens system involves both an implant and an optical device that delivers ultraviolet light into the eye. Because it was a novel device, navigating the regulatory pathway was more challenging.

Then comes commercialization – getting people to want to use the product and discovering how best to use it. This is probably the most difficult phase and historically it can take ten years or more for ophthalmologists to fully adopt a new technology.

What convinced you that the Light Adjustable Lens could transform cataract surgery?
People often initially think about the Light Adjustable Lens in terms of enhanced refractive precision, which is, of course, true. However, refractive customization might be an even more important feature of the technology, which of course requires the enhanced precision delivered by post-operative adjustability.

The LAL technology had been in development for more than ten years before I became involved, and the initial clinical studies had already been completed, with the Phase 3 clinical trial underway.

As I got involved with the project, I spoke with many doctors who had worked with the technology, including many in Europe. While cataract surgeons often talked about whether they "hit the target," the initial users understood that the real question was what should be the refractive target?

It isn't always emmetropia. Since we have two eyes, the ability to fine tune binocular vision allows individuals to optimize both the range and quality of vision, with the unique ability to test the result before making a final decision.

How do you see the surgeon–patient relationship changing?
There was a time when the doctor simply told the patient what would happen. Now every patient carries in their pocket a device that gives them access to enormous amounts of information. Patients arrive having already looked things up and often with formed expectations. That means the relationship must be much more collaborative.

Patients still need a skilled doctor – for both the technical aspects of surgery and the judgment that comes with experience. But many also want a sense of control over what happens in their own bodies.

In traditional cataract surgery, the surgeon chooses the lens and says, "We'll see how it turns out." With an adjustable lens the conversation becomes: "We'll implant the lens, and then after surgery we'll customize it to your needs." For patients, that can be very reassuring. The outcome isn't fixed.

"Patients still need a skilled doctor, but many also want a sense of control."

What excites you most about the current direction of innovation?
One of the biggest developments right now is the rise of machine learning models. I'm not particularly fond of calling it artificial intelligence, but it's a powerful tool we're only beginning to tap into.

Medicine does have an important difference compared with other industries: the regulatory framework. That means adoption of this new tool may not be as fast as in areas like advertising or social media, but on the development side the impact is already significant.

How do you stay motivated to continue innovating?
I don't think anyone can really claim true innovation. Most of us build on what others have done. We learn from each other and add pieces along the way. That process itself is what excites me.

These days, much of my role is encouraging others and helping create the environment where ideas can develop. Often, it's younger people who drive those advances. One of the things I enjoy most is being around colleagues earlier in their careers. It's energizing.

My wife, who is also an ophthalmologist, often tells our children something very simple: "Just be useful. If you're useful, a lot of good things will happen." That's a philosophy I like.

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