



This article was commissioned and funded by Santen.

AI could help the highest-risk patients get glaucoma care

While artificial intelligence has many possible uses in glaucoma, its greatest potential is in identifying those at highest risk, says **Michael Marshall**

EDITED BY LINA OSMAN & ANDREW TATHAM

Artificial intelligence (AI) has been having a moment. Since the launch of OpenAI’s ChatGPT in late 2022,¹ AI has provoked a mix of excitement and apprehension. The technology could vastly improve our lives, or obliterate many of our jobs, or both.

AI is already being used in healthcare. For example, several randomised controlled trials have shown that AI can help analyse colonoscopy results, enabling the detection of polyps that human clinicians sometimes miss.²

In the field of eyecare, a British company called Ufonia has developed a chatbot called Dora to support patients who have had cataract surgery.³ Dora phones patients and asks them questions, and based on their answers determines whether they need to see a clinician. A study published in July 2024 found that Dora generally made the same decisions as clinicians.³

What about glaucoma care? How could AI be used to improve clinical decisions and patient outcomes? Experts in glaucoma care believe there are several promising avenues, but the most dramatic benefits will probably

come from using AI for risk stratification. By screening out the lowest-risk patients and highlighting those who need clinical attention, AI could streamline services.⁴ This would reduce under-diagnosis of glaucoma – something patients are concerned about – and also reduce over-treatment of low-risk patients.⁵

Smart machines

AI is a group of loosely related technologies that can perceive aspects of their environment, learn from them, and behave intelligently. The boundaries of AI are fuzzy: it is

not always clear whether a software or algorithm counts as AI.⁶

A key element of many AI systems is machine learning. These systems can absorb large and complex datasets, understand the patterns within them, and use this information to respond to new situations. Machine learning systems can therefore perform tasks without explicit instructions, sometimes behaving in seemingly intuitive or creative ways.⁶

While text-based tools like ChatGPT have had the most public attention, AI has also had a huge impact on biological research. A prominent example is Google DeepMind’s AlphaFold, which

can predict the 3D structures of proteins better than expert humans and is accelerating research in structural biology.⁷ Similar technologies could be used for the rapid design of new pharmaceuticals.

Clearly, AI is a powerful set of tools with diverse applications. Naturally, AI has many potential uses in glaucoma care, ranging from designing new drugs to screening potential patients and providing them with information (see BOX: Chatbots for glaucoma patients).⁴ The challenge is to cut through the hype in order to identify those uses with the largest and most immediate potential.

Machine learning systems can perform tasks without explicit instructions, sometimes behaving in seemingly intuitive or creative ways

Clinicians and patient groups agree that one of the biggest problems for glaucoma care is the sheer number of patients.⁸ The UK’s ageing population is a major factor, as glaucoma is a disease of later life, says Nishani Amerasinghe at University Hospital Southampton. Furthermore, glaucoma is a chronic condition, so patients “don’t leave the service until they die,”⁹ and often acquire comorbidities as they get older.¹⁰

“The demand is very high,” says Imran Masood at the Birmingham and Midland Eye Centre. “We’re drowning.” As a result, he says, patients are “coming to harm because of the delays.” →

Screening and risk stratification

AI has considerable potential to improve the diagnostic process, in two related ways. First, it could be used to help identify people at high risk of glaucoma, who could then be prioritised for additional testing.⁴ Glaucoma patients could benefit from such screening programmes that target those with multiple risk factors. And second, it could aid elements of the diagnostic process, such as interpretation of imaging results, potentially improving diagnostic accuracy and freeing clinicians to spend more time with patients.⁴

Currently, the gateway to glaucoma care is the initial round of testing, including optic disc assessment and visual field tests. If patients cannot access these services, they do not get diagnosed. Furthermore, a national screening programme for glaucoma is not currently practicable (see *Sustainable Service Delivery*).¹¹

AI offers alternative ways to get people into the healthcare system

smoothly and rapidly. The early signs of glaucoma are difficult to detect, so humans often miss them, but there is growing evidence that AI can do better.⁴

A review published in May 2024 identified several promising systems. One AI system trained on visual field tests learned to distinguish patients with glaucoma from healthy individuals with an accuracy of 87.6%. The AI outperformed human glaucoma experts, who only achieved 62.6% accuracy. Other AIs achieved “remarkable success” in identifying subtle changes in images obtained by optical coherence tomography (OCT) and fundus photography. However, the most effective systems were able to synthesise several types of data – in some cases achieving accuracies above 85%.¹²

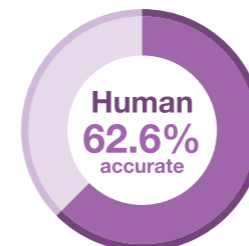
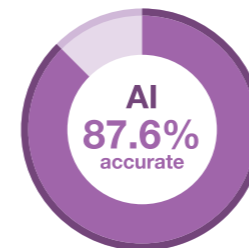
Aside from diagnosis, the most promising immediate use of these AIs is for screening: identifying people who are at high risk of glaucoma, who can be prioritised for in-depth testing.¹³ Data from retinal photography and other

simple tests could be analysed by the AI, to provide an estimate of the patient’s risk of glaucoma – perhaps in a simple red-amber-green traffic light system. Those at highest risk could be directed to an optometrist.¹⁴ Such testing systems could be installed in public places like at pharmacies, general practitioner (GP) practices or even supermarkets, increasing access to eye health assessments.

Alternatively, AI could be used to streamline the process of analysing test results. Many glaucoma clinics use a referral refinement system where newly referred patients are seen at their initial visit by a technician in a virtual clinic. The results of the visit are examined by a clinician at a later date and relayed to the patient. This has



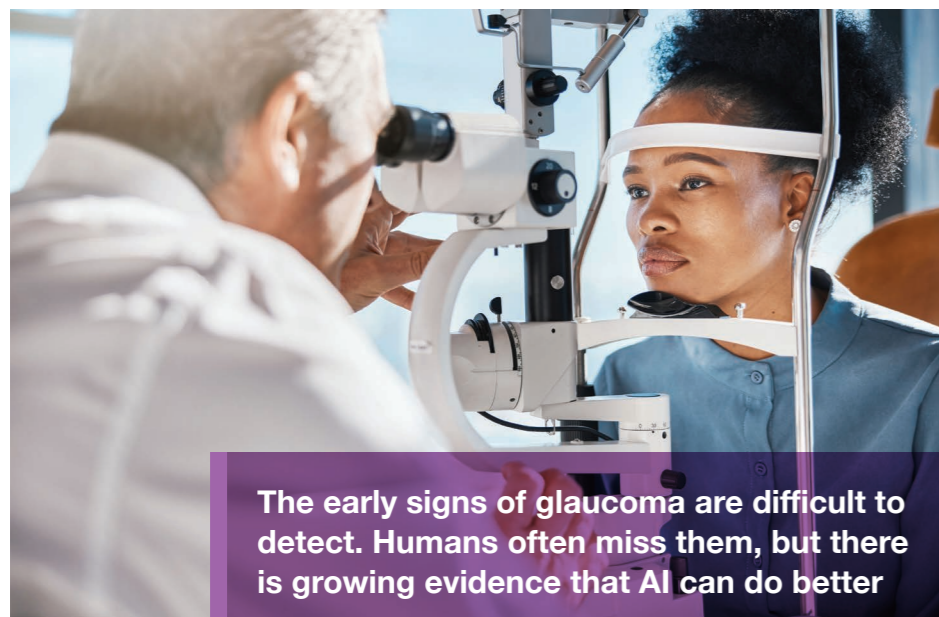
Distinguishing patients/people with glaucoma from healthy individuals



the advantage of speed, but it generates an enormous amount of data that must be analysed.¹⁵ AIs, which do not get tired, could go through this swathe of results and identify the highest-risk patients. Those people would then have their data reviewed by human clinicians and could be brought back for a consultation.

Already, the US government has approved AI systems for autonomous screening for diabetic retinopathy and macular oedema.¹⁶ Similar systems for glaucoma cannot be many years away.

Once patients are in the healthcare system, a further challenge is tracking the progression of glaucoma for those under long-term follow up (Holistic and Expert Care). This →



The early signs of glaucoma are difficult to detect. Humans often miss them, but there is growing evidence that AI can do better

Chatbots for glaucoma patients

AI-based chatbots could soon be used to answer patients’ most basic questions about glaucoma.

Such chatbots would fill an urgent need. Multiple studies have shown that online educational materials about glaucoma are highly variable in quality,²² unaccountable,²³ and often too difficult to read:²⁴ many are only suitable for people 15 years and up, when it is recommended they be aimed at 12-year-olds so that they are widely accessible.¹⁵

Chatbots offer a promising alternative. In the UK, the Dora chatbot offers advice and information to people who have had cataract surgery.³ No such chatbot exists for glaucoma as yet. However, a study published in July 2024 found that OpenAI’s ChatGPT successfully answered 24 questions about glaucoma, according to three expert reviewers.²⁶

In future, such tools could be personalised to the individual patient, becoming virtual assistants. This would boost patients’ Empowerment and Education.

At the same time, such chatbots could also streamline glaucoma services. People at the lowest risk of glaucoma could be directed to the chatbots, which would answer the most frequently-asked questions (see Sustainable Service Delivery). This would free up clinicians to spend more time with high-risk patients with complex needs (Personalised Care).

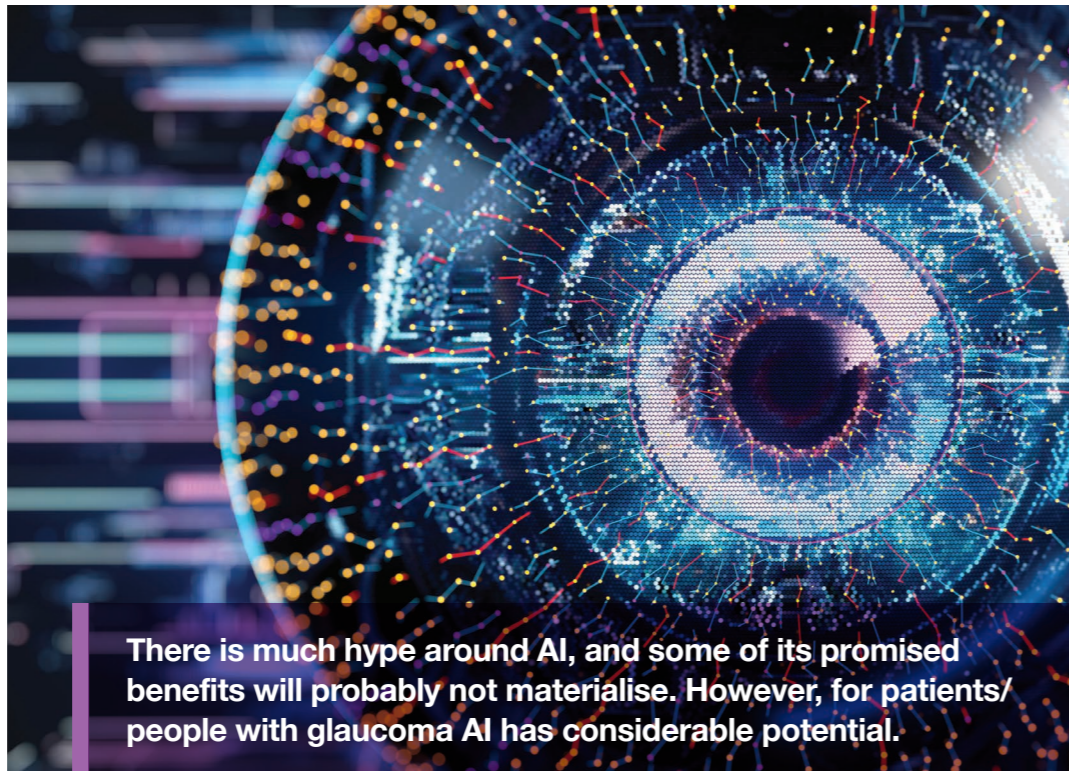


requires spotting subtle changes from one test to the next and determining rate of progression: exactly the sort of thing AI is good at, and which tired humans struggle with.¹⁷

In the longer term, AI may even be able to predict which people will experience the fastest progression in their glaucoma. As early as 2021, a machine learning algorithm predicted glaucoma progression with “modest accuracy” based solely on patients’ initial visual field test.¹⁸ Such predictive algorithms would probably fare better if they were supplied with multiple tests and different forms of data: for instance, genomic data as well as visual field tests (see Genomics and Biomarkers).¹⁹

Integrating AI into glaucoma care

Despite this potential, clinicians do not want to turn diagnosis of glaucoma solely over to AI.



There is much hype around AI, and some of its promised benefits will probably not materialise. However, for patients/people with glaucoma AI has considerable potential.

It is not yet reliable enough to autonomously diagnose glaucoma. “It’s more like a tool,” says Wai Siene Ng at University Hospital of

Wales in Cardiff. She co-authored a 2020 review arguing that outputs from such AIs “may serve as an adjunct to assist clinical decision making.”²⁰

Hence the focus on using AI for risk stratification, bringing the highest-risk patients to the attention of clinicians while reassuring everyone else that their sight is not at risk.⁴

Several barriers must be overcome before AI can be used in this way in the glaucoma healthcare system. The first barrier is technical: the AIs need better training data. Visual field tests and other key analyses need to be stored in a systematic way, so that the AIs can digest them. There is also an urgent need for more diverse data, with greater representation of racial and ethnic minorities (see *Health Equity and Access*).¹⁷

However, the biggest barriers to mainstream use of AI in glaucoma care are not technical, but regulatory and political. One such issue is data retention and privacy.

AIs need enormous amounts of data to become ‘expert’ and that patient data must be safely stored in accordance with regulations like the EU’s General Data Protection Regulation (GDPR). The obvious risk of privacy violations needs to be mitigated.²¹

Alongside that is the question of whether patients will accept the use of AI in their healthcare. Many people instinctively distrust the idea of a faceless, inscrutable computer system. However, clinicians argue that when AI is not all-powerful but is instead used as a tool, and clearly explained, these fears can be addressed.²¹ Furthermore, by reducing the amount of time clinicians spend analysing routine tests of low-risk patients, AI has the potential to increase the amount of time they can spend having humane and empathetic conversations with the patients who most need their help.⁴

Solving these problems will require concerted effort. As well as clinicians, politicians and other actors will need to take action to ensure AI can be rolled out in glaucoma healthcare in a way that is both effective and publicly acceptable. This will be a complicated business. But the potential benefits of AI for glaucoma patients are too great to pass up.

There is much hype around AI, and some of its promised benefits will probably not materialise. However, for patients/people with glaucoma AI has considerable potential. It could streamline glaucoma care by performing rapid and accurate risk stratification, funnelling the highest-risk patients to clinicians.⁴ Once the barriers – primarily regulatory and political – are overcome, AI will become a valuable tool enabling personalised care.

“I think AI will come in somewhere in the next 10 years,” says Siene Ng.

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Job code: NP-GLAU-UKIE-0154. Date of prep: October 2025.

What matters to patients

Patients who took part in the Future of Glaucoma research project did not directly raise or discuss artificial intelligence, but some of their “care abouts” link to some of the areas AI could be used in glaucoma care.

Patients feel that they may be picked up by chance, and want reassurance the system will catch them at the right time: both are areas where AI could help. Likewise, knowing that someone is keeping an eye on them, so they don’t fall through the cracks between routine appointments, is of great importance to patients. AI can play a role here in identifying patients who may have been missed. Furthermore, if home monitoring or point-of-care visual field tests in the community become mainstream, then AI will help to manage and triage the large volume of data created.

As the box on chatbots illustrates, tailored patient information, pitched at the right level and individual to the patient’s condition, is important: it drives engagement in their care and confidence in the treatment approach for them.

Finally, patients say that they have much more trust in individuals who have taken good care of them and their eyes, rather than the system. Clear communication on the role AI plays in the care of patients will be critical to build confidence in the system.