# AI FOR DIABETIC RETINOPATHY SCREENING: PAVING THE WAY FOR GLAUCOMA?

Advances in retinal care and what they may mean for AI's future use in glaucoma management.

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The FDA approval of AEYE Diagnostic Screening (AEYE-DS, AEYE Health), the first fully autonomous AI system for diabetic retinopathy (DR) screening, represents a groundbreaking milestone in ophthalmic AI.[1] By autonomously identifying retinal changes, AEYE-DS enables primary care providers to accurately detect DR early and provide timely referrals without the need for an on-site specialist, marking a new era in medical diagnostics.[1] Replicating this success for glaucoma detection, however, presents distinct challenges due to the disease's multifaceted nature, progressive course, and lack of standardized diagnostic criteria.[2,3]

## THE SIMPLICITY OF DR SCREENING WITH AEYE-DS

AEYE-DS exemplifies AI's effectiveness for detecting conditions with straightforward diagnostic pathways.[1] Using a single image per eye from a handheld fundus camera, it streamlines DR screening for primary care providers.[1] The system's portability and ease of use increase patient access to early DR detection, which is crucial for preventing vision loss, especially in underserved areas.[1,4]

DR's visible signs, such as retinal hemorrhages or exudates, enable AEYE-DS to leverage AI's pattern recognition strengths to provide reliable, autonomous decision-making.[1] The FDA approval demonstrates that autonomous AI can function effectively within certain diagnostic boundaries,[1] but the same approach cannot be directly applied to glaucoma diagnostics.[3]

## THE COMPLEXITIES OF GLAUCOMA DIAGNOSIS

Creating an autonomous AI diagnostic tool for glaucoma is more complex than for DR.[2] Glaucoma assessment involves multiple tests, including an optic nerve head examination, IOP measurement, OCT imaging of the retinal nerve fiber layer thickness, visual field testing for functional vision loss, and gonioscopy for anterior chamber angle evaluation.[2,5]

The absence of standardized diagnostic criteria further complicates the development of AI for glaucoma management.[2,3] Variations in disease presentation, such as normal-tension versus open-angle glaucoma, lead to inconsistencies in diagnosis and treatment.[2,6] An effective AI model must analyze and interpret diverse data types, each relevant to different aspects of glaucoma.[2]

Although researchers are making strides, significant challenges remain in developing AI for glaucoma diagnosis. Machine learning models require training on large, annotated datasets covering multiple diagnostic modalities, which are currently scarce.[2,3,5] Glaucoma's variable progression rates among patients pose additional obstacles, necessitating advanced

## AT A GLANCE

- The FDA approval of the first fully autonomous AI system for diabetic retinopathy screening, AEYE Diagnostic Screening (AEYE Health), shows AI's potential to improve early disease detection.
- Replicating the success of AEYE Diagnostic Screening for glaucoma detection presents distinct challenges because the disease is multifaceted and progressive and it lacks standardized diagnostic criteria.
- Despite challenges with diagnosis, AI holds promise for tracking glaucomatous progression. Deep learning models can detect subtle changes in OCT scans and visual field data over time, providing insight into the course of the disease.

predictive capabilities that adapt to each individual's unique profile.[2,4]

## AI AND GLAUCOMATOUS PROGRESSION

Despite challenges with initial diagnosis, AI holds great promise for tracking glaucomatous progression, which is vital for preventing vision loss.[2] Deep learning models can detect subtle changes in OCT scans and visual field data over time, providing precise insights into the course of the disease.[2,4,5]

Several studies have demonstrated AI's potential in this domain. Mariottoni et al used a convolutional neural network to detect progression in 14,034 OCT scans and achieved an area under the receiver operating characteristic curve (AUC) of 0.97.[7] Similarly, Christopher et al employed a transformer-based approach to predict the need for glaucoma surgical intervention from OCT images.[8] These findings underscore AI's capacity to identify progression biomarkers from structural data.

In addition, AI models are being developed to predict rapid disease progression by analyzing historical data, including OCT scans, visual fields, and IOP.[5] Some models can forecast progression years before clinical symptoms develop.[5] For instance, Li et al demonstrated AI's ability to predict the development of glaucoma with an AUC of 0.91 using retinal photographs.[9]

Recent research from my (J.Y.) group has further pushed the boundaries of AI-enabled progression monitoring. Using deep learning, we forecasted an eye's risk of rapid visual field worsening from early OCT and clinical data (AUC 0.87).[10] In another study, our model identified eyes at high risk for future glaucoma surgery using multimodal data from a single visit (AUCs >0.9).[11] The group also demonstrated that AI trained on visual fields and clinical parameters can predict glaucomatous progression with AUCs of 0.84 to 0.92.[12] These results showcase AI's ability to integrate diverse data types to enable more comprehensive progression forecasting.

Moreover, AI-driven predictive models open new avenues for personalized glaucoma management. By assessing an individual's unique progression risk, these tools could guide tailored treatment decisions, such as adjusting medication dosages or recommending surgical evaluation.[4,13] For example, a model predicting rapid progression might prompt a clinician to intensify treatment or shorten follow-up intervals. While published data on specific personalized applications remains limited, this area holds immense promise for optimizing patient outcomes.

## CONCLUSION

The FDA approval of AEYE-DS showcases AI's potential to enhance early disease detection and expand patients' access to care.[1] The complexity of glaucoma, however, make a singular autonomous AI model for diagnosis elusive.[2,3]

Nevertheless, this technology is poised to transform glaucoma management by enabling more precise tracking of disease progression, predicting future outcomes, and facilitating the creation of personalized treatment plans.[2,4,5] As research advances and more diverse datasets emerge, the integration of AI could augment clinicians' abilities to preserve vision and improve patient outcomes.[2,3,14]

Continued collaboration among clinicians, researchers, and technology experts is crucial to the development of robust, validated tools that navigate the complexities of this sight-threatening disease. With advances in dataset diversity, algorithmic transparency, and clinical validation, AI has the potential to revolutionize glaucoma care and thus offers hope for earlier detection, more effective management, and better outcomes for patients worldwide.[2,3] ■

1. Mott M. Enter AI. *EyeNet Magazine*. October 1, 2024. Accessed January 29, 2025. www.aao.org/eyenet/article/enter-ai-screening-diagnosis-DR-ROP-glaucoma
2. Zhu Y, Salowe R, Chow C, Li S, Bastani O, O'Brien JM. Advancing glaucoma care: integrating artificial intelligence in diagnosis, management, and progression detection. *Bioengineering (Basel)*. 2024;11(2):122.
3. Huang X, Islam MR, Akter S, et al. Artificial intelligence in glaucoma: opportunities, challenges, and future directions. *Biomed Eng Online*. 2023;22(1):126.
4. Yousefi S. Clinical applications of artificial intelligence in glaucoma. *J Ophthalmic Vis Res*. 2023;18(1):97-112.
5. Zhang L, Tang L, Xia M, Cao G. The application of artificial intelligence in glaucoma diagnosis and prediction. *Front Cell Dev Biol*. 2023;11:1173094.
6. AlShawabkeh M, AlRyalat SA, Al Bdour M, Alni'mat A, Al-Akhras M. The utilization of artificial intelligence in glaucoma: diagnosis versus screening. *Front Ophthalmol (Lausanne)*. 2024;4:1368081.
7. Mariottoni EB, Datta S, Shigueoka LS, et al. Deep learning-assisted detection of glaucoma progression in spectral-domain OCT. *Ophthalmol Glaucoma*. 2023;6(3):228-238.
8. Christopher M, Gonzalez R, Huynh J. Transformer-based deep learning approach predicts glaucoma surgical intervention from OCT. *Invest Ophthalmol Vis Sci*. 2023;64(8),371
9. Li F, Su Y, Lin F, et al. A deep-learning system predicts glaucoma incidence and progression using retinal photographs. *J Clin Invest*. 2022;132(11):e157968.
10. Herbert P, Hou K, Bradley C, et al. Forecasting risk of future rapid glaucoma worsening using early visual field, OCT, and clinical data. *Ophthalmol Glaucoma*. 2023;6(5):466-473.
11. Wang R, Bradley C, Herbert P, et al. Deep learning-based identification of eyes at risk for glaucoma surgery. *Sci Rep*. 2024;14(1):599.
12. Hou K, Bradley C, Herbert P, et al. Predicting visual field worsening with longitudinal OCT data using a gated transformer network. *Ophthalmology*. 2023;130(8):854-862.
13. Stuart A. Augmented intelligence: harnessing AI for glaucoma. *EyeNet Magazine*. May 1, 2023. Accessed January 29, 2025. www.aao.org/eyenet/article/augmented-intelligence
14. Jan C, He M, Vingrys A, Zhu Z, Stafford RS. Diagnosing glaucoma in primary eye care and the role of artificial intelligence applications for reducing the prevalence of undetected glaucoma in Australia. *Eye (Lond)*. 2024;38(11):2003-2013.

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