

AT-HOME TOOLS FOR THE GLAUCOMA PATIENT



Current and future solutions may facilitate disease monitoring and management.

BY YVONNE OU, MD

Although essential, clinic-based touchpoints with patients provide only a snapshot of their glaucoma and its treatment. Several solutions that patients can use at home offer myriad potential benefits, whether by helping to capture a more complete picture of their disease, facilitating its management, or involving them more in their care. This article discusses some key efforts outside the clinic.

EYE DROP AIDS

The Nanodropper (Nanodropper) is a volume-reducing bottle adaptor that is compatible with most eye drop bottles. In a study by St. Peter et al,¹ the adaptor increased the number of drops dispensed from a standard 2.5-mL bottle for a range of medications. The drops delivered with the device were 62.1% smaller than those delivered with the standard bottles. Smaller drop size has the potential to reduce side effects and early bottle exhaustion, two obstacles patients face with medical glaucoma therapy.

A randomized trial evaluated the noninferiority of 10.4 μ L of eye drops eluted with the Nanodropper for

pupillary dilation and cycloplegia in children compared with the standard of care, 50 μ L of dilating eye drops.² One hundred eyes of 50 patients were included. The main outcome measures were spherical equivalent, maximum pupil diameter, and pupil constriction percentage. The investigators found that strict noninferiority was met for pupillary dilation but not for cycloplegia or pupil constriction percentage; however, the differences in the effect of the Nanodropper versus the standard of care on all primary outcome measures were not clinically significant.

Studies are now underway to evaluate the Nanodropper's efficacy for IOP reduction.

The GentleDrop is a nose-pivoted drop delivery device (NPDD) that stabilizes the eye drop bottle tip ergonomically over the ocular surface without obstructing the eye. A repeated-measures case series evaluated this device for eye drop delivery success and found that the NPDD improved eye drop delivery, reduced bottle tip contact with the eye, and decreased the number of wasted eye drops.³ Study participants also preferred the NPDD over standard eye drop delivery.

HOME VISUAL ACUITY TESTING

Remote self-administered visual acuity tests have the potential to enhance disease monitoring in patients with glaucoma. To assess the effectiveness of some available solutions, a systematic review of pragmatic trials evaluated home visual acuity tests.⁴ More than 1,000 studies were screened, and 10 were included in the review. The following three remote visual acuity tests were deemed comparable to in-clinic assessment: DigiVis (Cambridge Medical Innovation), iSight Test Professional (Kay Pictures), and Peek Acuity (Peek Vision). These tests all require access to digital devices, but PDF printouts such as the modified ETDRS Letter Distance Chart designed by the University of Arizona can also perform well.⁵

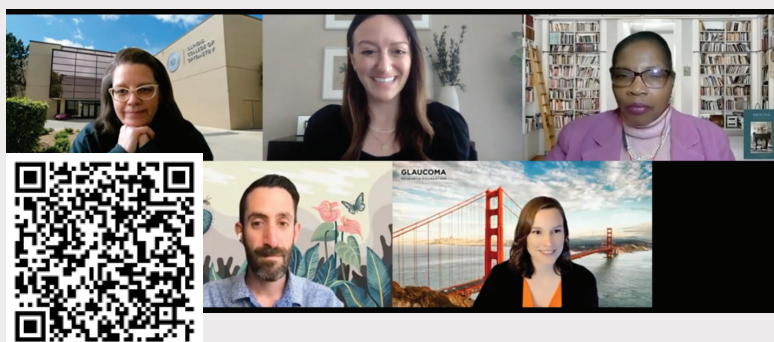
HOME VISUAL FIELD TESTING

Portable perimeters allow at-home and frequent visual field testing, and both web- and tablet-based methods are in development. A cross-sectional study compared perimetric outcomes from two portable perimeters—the tablet-based Melbourne Rapid Fields test and the virtual reality (VR)–based

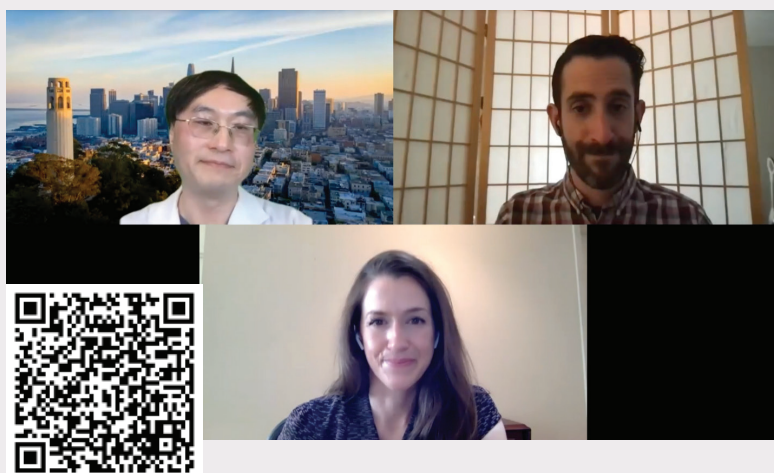
LIFESTYLE SUPPORT

Webinars from the Glaucoma Research Foundation offer guidance on lifestyle modifications and resources.

Working With Glaucoma



Lifestyle Tips for Glaucoma Patients



Smart Visual Function Analyzer (IMOVifa)—with outputs from the Humphrey Field Analyzer (HFA; Carl Zeiss Meditec).⁶ The main outcome measures were mean deviation, pattern standard deviation, reliability parameters, and point sensitivity. Overall, 133 eyes of 79 patients with mild glaucoma were included. They performed the tablet-based test at home, and the VR-based test was used in the clinic.

The HFA mean deviation was

-2.7 ± 3.9 dB. The global indices of mean deviation and pattern standard deviation did not vary significantly between the HFA and the two portable perimeters, but differences in specific point sensitivity values were significant. The tablet-based perimeter sensitivities differed from those of the HFA in 36 of 52 locations. Relative to the HFA, the tablet overestimated and underestimated light sensitivity in the nasal and temporal fields, respectively. The VR-based perimeter

sensitivities differed from those of the HFA in 39 of 52 locations. The VR-based test generally underestimated light sensitivity, but its results were more similar to those of the HFA than the tablet-based test.

My colleagues and I conducted a cross-sectional study to assess the feasibility of remotely training patients with glaucoma to take a 10-session clustered VR-based visual field test (VVP-10, Vivid Vision Perimetry) at home, analyzed the results for test-retest variability, and assessed correspondence with conventional perimetry.⁷ A total of 21 patients with glaucoma were included, and 36 eyes were used for test-retest analysis and determination of concordance with the HFA. Patients received a mobile VR headset containing the VVP-10 software and were trained remotely via video conferencing. They were then instructed to complete 10 sessions over a 2-week period.

Twenty patients (95%) successfully completed the VVP-10 test series after one training session. At-home VVP-10 results demonstrated low test-retest variability, and the VR-based test performed well in eyes with moderate to severe visual field loss. Ongoing research is needed to determine whether VR-based testing can provide results that are equivalent or complementary to standard in-clinic assessments of visual function in glaucoma and potentially be used for the monitoring of glaucoma stability and/or progression.

HOME OPTIC NERVE IMAGING

Optic nerve imaging is another potential area for at-home disease monitoring. Smartphone adapters can allow remote fundus photography, and some dedicated systems for self-imaging are in development or use, such as the Notal Home OCT (Notal Vision).

In one study of the Notal Home OCT,⁸ 15 patients with neovascular age-related macular degeneration

performed daily self-imaging at home with the device for 3 months. The mean weekly scan frequency was 5.7 ± 0.9 per week, and 93% of the scans were eligible for analysis. The median scan time was 42 seconds. The home OCT algorithm and human experts agreed on the fluid status in 83% of the scans. The Notal Home OCT scans analyzed with the home OCT algorithm and the in-office OCT scans graded by human experts agreed on the fluid status in 96% of cases. Whether home OCT can be used to accurately evaluate retinal nerve fiber layer thickness is to be determined.

HOME TONOMETRY

Many use cases for home tonometry exist. Peak IOP may occur outside of clinic hours, and IOP fluctuation is an independent risk factor for glaucomatous progression. Home tonometry can help ophthalmologists evaluate the efficacy of a new medication or laser treatment without requiring the patient to return to the office. Home tonometry can also be used to confirm that a patient with ocular hypertension does not need to come in for treatment and to remotely monitor postoperative patients who do not live near the office.

A retrospective cross-sectional study compared IOP characteristics measured over the course of 1 week with the iCare Home (Icare USA) versus in-clinic tonometry in 107 eyes of 61 patients with glaucoma.⁹ The maximum daily IOP occurred outside clinic hours on 50% of the days assessed and between 4:30 AM and 8:00 AM on 24% of the days assessed. Mean daily maximum IOP exceeded maximum clinic IOP in 44% of patients.

A prospective clinical trial assessed the utility of the iCare Home tonometer for detecting therapy-related IOP changes in 43 eyes of 27 patients

with open-angle glaucoma or ocular hypertension.¹⁰ Patients were grouped into control eyes managed on stable therapy ($n = 18$ eyes) or therapy change eyes undergoing selective laser trabeculoplasty ($n = 8$ eyes), initiating topical therapy ($n = 8$ eyes), or adding a second medication to existing monotherapy ($n = 9$ eyes).

Patients recorded their IOP four times per day for 1 week. The main outcome measure was the detection of a response to therapy, defined as an IOP reduction of at least 20%. For eyes in which Goldmann applanation tonometry demonstrated a response to therapy ($n = 11$), home tonometry detected a response in 90.9% of eyes in at least one time period and 45.5% of eyes in all four time periods evaluated. In eyes without a Goldmann-measured response to therapy ($n = 14$), home tonometry detected a response in 71.4% of eyes ($n = 10$) in at least one time period and 7.1% of eyes ($n = 1$) in all four time periods.

WEARABLE DEVICES

One potential variable with home tonometry is that it relies on patients taking their IOP measurements. Wearable devices may address this challenge through continuous monitoring.

The Triggerfish (Sensimed) is a continuous-wear contact lens with an embedded microsensor that measures spontaneous circumferential corneoscleral deformations as an indirect measure of IOP. An adhesive antenna placed around the eye wirelessly receives information from the contact lens and transmits it to a portable recorder worn by the patient. Acquired data are transferred via Bluetooth to the practitioner.

On the horizon is the Eyemate (Implandata; not available in the United States), an implantable IOP microsensor that transmits readings

through an external handheld device to a secure Internet database. The system received the CE Mark in 2021.

Some progress has been made to improve the size and use of wearable devices for IOP monitoring. Ongoing studies should provide a clearer picture of the technology's efficacy.

CONCLUSION

Various tools have been developed or are in development to facilitate glaucoma monitoring and management. Continued technological innovation and investigations will guide their development and incorporation into providers' practices and patients' homes. ■

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