

# Remote Monitoring Comes Into Focus

Early adopting glaucoma specialists share observations on home-monitoring technology and its implementation.

By Annie Stuart, Contributing Writer

**W**ITH A TSUNAMI OF GLAUCOMA cases on the way—more than doubling from 2010 to 2050<sup>1</sup>—how will all these patients be monitored? asked L. Jay Katz, MD, at Wills Eye Hospital in Philadelphia. “We’ll need to be creative to manage this, and many patients will likely be followed using remote patient monitoring.”

During COVID, monitoring of glaucoma patients has not only occurred in medical office parking lots but also at home. In fact, telehealth services have mushroomed overall, and 40% of patients expect to continue using these services following the pandemic.<sup>2</sup>

What does this new age of remote patient-monitoring have to offer glaucoma patients? “To begin with, it may limit the number of doctor visits needed,” said Dr. Katz, “but more importantly, it gives us the ability to more rapidly detect changes that may trigger more prompt, timely therapies to benefit our patients in the long run.”

Although the utility of this technology is promising, it is only now starting to be used in some practices, bringing with it a mixed bag of benefits, challenges, and questions.

## Why Home-Based Tonometry?

One big challenge with office-based tonometry alone is that IOP spikes can often occur at night or during early waking hours, said Barbara M. Wirostko, MD, at the University of Utah in Salt Lake City. In fact, 24-hour monitoring has shown

that nearly two-thirds of patients experience peak IOP outside regular clinic hours, most often occurring at night.<sup>3</sup> Although unconfirmed, this may be due to blood pressure changes, sleep apnea, catecholamine release, or positioning, she said.

**Hard to capture.** “In the past, we couldn’t easily gather this information,” she said. “For example, we’d have to admit patients with normal tension glaucoma to the hospital, waking them several times to get their eye pressures.” Other options, said Dr. Katz, have involved sleep laboratories or diurnal variation testing, with measurements taken in the office at two- to three-hour intervals throughout the day, looking for the highest readings to gauge the risk of progression. “All these options are impractical for most people,” he said.

**Easier at home.** “With home monitoring, we now have additional data points, so we can more easily pick up pressure spikes that would otherwise be missed,” said Kateki Vinod, MD, at New York Eye and Ear Infirmary of Mount Sinai in New York City. Dr. Wirostko strongly recommends that her patients get up during the night at various times to check pressures. “The benefit is incredible,” said Ranya Habash, MD, at Bascom Palmer in Miami. “We instruct patients to measure their pressures anywhere from one to three times a day at home, depending on how concerned we are, but we still bring them into the office every three to four months as we normally would.”

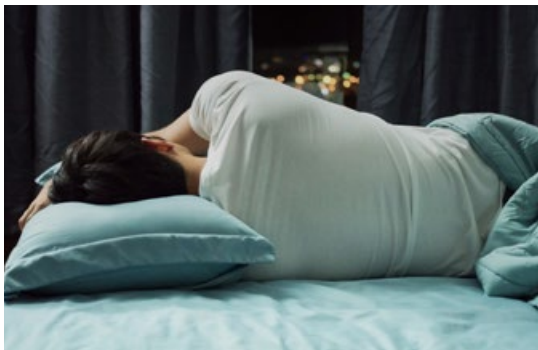
## Common Questions

The benefits of remote patient monitoring may be clear, but the reality of implementing the technology presents challenges and raises questions.

**Who are the best candidates?** If motivated, most patients could use home monitoring, but not every patient with glaucoma will choose to, said Dr. Katz. “For example, in a typical practice, patients who are doing reasonably well don’t want to be bothered with it.”

Then, there are patients who have severe visual compromises, neurocognitive challenges, or limited use of their hands or arms—such as those with Parkinson disease or rheumatoid arthritis. They may not be good candidates for home monitoring that requires a handheld device, said Dr. Wirostko.

The best candidates are those whose disease may be progressing, especially if they can’t or won’t come into the office due to age or an immune-compromised status, said Shan Lin, MD, at the Glaucoma Center of San Francisco.



**24-HOUR MONITORING.** Because IOP spikes often occur at night, 24-hour monitoring can provide glaucoma specialists with valuable data.

**What is the effect on treatment?** With home monitoring, we can make more informed treatment decisions based on extra data points, said Dr. Habash. “We currently make decisions based on the single IOP measurement that we get every six months. With home monitoring, we can get daily pressure measurements, so if a patient’s pressure is brittle or is spiking overnight, we can intervene before permanent damage is done.”

Dr. Katz cited a study of patients with normal tension glaucoma who used the iCare Home tonometer outside of office hours, which provided pressure readings that were higher than those seen in the office visits for many of the subjects.<sup>4</sup> “In the trial, these findings led to a change in treatment for 56% of patients,” he said.

**Do the devices improve access to care?** “Everyone talks about better access to care, but telehealth and remote patient monitoring actually offer a real solution to the problem,” said Dr.

Habash. “With tools like these, patients can get care no matter where they are. Our patients can give us a much better picture of what’s going on with their eyes, while taking greater ownership of their own health.”

However, not everyone has access to the platforms on which some remote patient monitoring programs run, such as smartphones, tablets, or computers, said Dr. Vinod. “While trying to improve access to care, we have to be cautious not to exacerbate inequities that already exist.”

**What about insurance and reimbursement?** During COVID, insurance companies started covering more remote types of services, such as video and Zoom visits, said Dr. Wirostko.

Because CMS has seen the benefit of keeping patients healthier and health care costs down, clinicians are also reimbursed for the remote patient monitoring services they provide, said Dr. Habash. “The CMS guideline is for 20 minutes of cumulative time per month in monitoring and live, interactive communication with each patient, much of which can be done by a technician or other clinical staff,” she said. (See “Remote Patient Monitoring: Billing and Coding,” next page.)

Dr. Wirostko also pointed to the potential of ForeseeHome (Notal Vision). Currently, it uses home-based OCT and artificial intelligence-enabled data analysis to help manage age-related macular degeneration (AMD) by revealing if there is a change that requires a doctor’s visit. This is reimbursed by Medicare, she said. The technology might provide a future model for home monitoring of visual fields to help signal a change prior to an office visit, she said.

**What is involved in training?** Setting up remote patient monitoring clinics and training patients does initially take some time and organization, said Dr. Habash, and there can be a learning curve for patients. “You don’t want a bunch of incorrect measurements because the patient doesn’t know how to use the device correctly.” However, this is unlikely, she added, because “most remote patient monitoring software has reliability metrics. If we see that there’s too much variability in data points, it’s our responsibility to call our patients and instruct them better. In addition, we can set parameters that trigger an alert if a measurement falls outside the values we want.”

**Are there liability issues?** Liability is a very active area of discussion, said Dr. Lin. “For example, many patients have not come into the office during COVID,” he said. “What is the doctors’ liability, then, if they rely solely on data collected remotely by the patient?” Normally, this is less of an issue, because home tests are adjunctive and supplementary, he said. “They don’t replace the



standard tonometry or visual fields. In fact, by catching IOP spikes or progression earlier on, they might actually reduce liability.”

**How to manage the data?** There are many questions—and few answers—about data management, said Dr. Katz. “Where does the data go? How do you package it? How do you interpret it?”

And, Dr. Vinod asked, how much data is too much? “What is the ideal frequency of data collection at home to obtain useful information without overwhelming the ophthalmologist who’s interpreting it?”

### The iCare Home Tonometer

iCare Home is the technology that’s currently most widely used for remote monitoring, said Dr. Katz. (See “Other Tonometry Innovations,” page 43.) Cleared by the FDA in 2017, the iCare Home rebound tonometer is commercially available for office and home. “Used by staff, the professional version is helpful when you can’t get a reading with the Goldmann applanation tonometer [GAT],” he said.

The readings may also be more reliable and reproducible when captured by a trained professional than by a patient, added Dr. Lin.

**How it works.** “Because the patient feels virtually nothing, no anesthetic is needed to capture pressures with the iCare Home,” said Dr. Katz. “All the patient has to do is aim and pull the trigger and the device shoots out a tiny, plastic, blunt-tipped probe, which hits the cornea and bounces back into the housing.” The deceleration velocity at which the projectile comes back correlates with the IOP of the eye, he said.



**A CLOSER LOOK.** The patient feels almost nothing as the iCare Home’s blunt-tipped, plastic probe hits the cornea. Deceleration velocity as the probe returns to its housing correlates with IOP.

Rebound tonometry may give slightly lower or higher readings than the gold standard GAT, said Dr. Lin. However, several studies, required for FDA clearance to demonstrate reliability and reproducibility, show the values are quite close, often within 1 mm Hg or 2 mm Hg. It is important to know, however, that iCare Home gives less reliable readings at extremes of central corneal thickness, such as over 600  $\mu\text{m}$  or under 500  $\mu\text{m}$ ,<sup>5</sup> said Dr. Vinod.

To ensure accuracy, Dr. Lin has his patients bring in their device, and he watches them check their own pressures. He then compares the readings to those he obtains with the iCare device in his clinic as well as with GAT.

**Training.** “There are nuances with regard to technique, such as placing the tonometer probe properly, holding the instrument correctly without tilting it, and making sure the device makes

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## Remote Patient Monitoring: Billing and Coding

Below are some of the current codes for remote patient monitoring. The first three codes (99453, 99454, and 99457) are specific to the iCare Home tonometer. Note that payment for CPT codes can vary depending on where your practice is located, and many insurance companies do not reimburse for the iCare Home tonometer. The fees listed below were for Dallas, in 2021.

**Initial setup.** (CPT code 99453: \$19.52) This is a one-time claim and reimbursement for instructing the patient on performing home monitoring and transmitting data with the iCare Home tonometer.

**Device.** (99454: \$64.63/month) This is a monthly claim for the equipment and software used to perform the remote patient monitoring

test with the iCare Home tonometer.

**Monitoring.** (99457: \$51.53/month) This is a monthly claim for communicating with the patient and managing and/or coordinating services for a cumulative total of 20 minutes/month about the iCare Home tonometer.

**In-person or telehealth visit.** (99212-99215/92012-92014) When an office visit or telehealth visit is needed, submit extra visit code(s) as usual. Note: Eye visit codes 92012-92014 were temporarily added by CMS for telehealth use during the public health emergency (PHE).

**Evaluation and Management (E/M).** (99213: <\$93 or 99214: <\$132) This is reimbursement for a follow-up visit, whether virtual or in person, meeting 2021 E/M documentation guidelines.

contact with the central cornea,” said Dr. Vinod. “That’s why training ideally occurs in person with a technician certified in its use.” Dr. Wirostko pointed out that whether purchasing or renting the equipment, patients also have access to instructional information from the company.

**Advantages.** Patients, especially if they have advanced glaucoma, benefit from home monitoring not only medically but also psychologically, said Dr. Lin. “Home monitoring gives patients reassurance that their pressures haven’t gone up too fast between visits.” It also can confirm whether therapy is working, offering encouragement and reinforcing the need to continue with medications, said Dr. Katz.

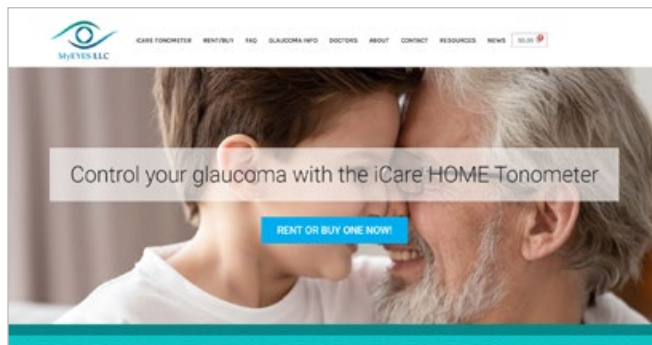
The iCare Home has also served a vital role in the pediatric glaucoma patient population, said Dr. Vinod. “It’s been used in children who’ve undergone placement of a nonvalved glaucoma drainage device, tied off at the time of surgery. Parents are trained to use the iCare Home to help identify when the ligature spontaneously releases, the tube opens, and the pressure drops.” Home tonometry identified 12 of 13 spontaneous tube openings in a study of 19 children who underwent placement of a Baerveldt glaucoma implant.<sup>6</sup> Whether in children or adults, spotting pressure-related problems following glaucoma surgery could hasten in-person evaluations and help avoid catastrophic complications, she said.

**Cost constraints.** “This is not inexpensive technology,” said Dr. Katz. iCare Home can be purchased for about \$2,500 (down from around \$4,000 about two years ago) and rented for \$100 to \$200 a week, said Dr. Lin. Dr. Katz said that he expects the cost will come down even more over time.

Dr. Lin has about a dozen patients who have purchased the device. Dr. Habash and colleagues at Bascom Palmer have implemented a leasing or renting system for their patients. And Dr. Wirostko has developed a program called MyEyes.

**MyEyes.** Because iCare Home is a prescribed device, direct sales to glaucoma patients is a challenge. That’s why Dr. Wirostko founded MyEyes ([myeyes.net](http://myeyes.net)), along with one of her patients and her ophthalmic medical technicians. All of them were motivated to help those who need easier access to iCare Home.

“The doctor writes a prescription, and then the patient can easily rent or buy it through the MyEyes website,” said Dr. Wirostko. “Although most insurance doesn’t cover iCare Home, some patients can save by using flexible spending



**ACCESS TO ICARE HOME.** Dr. Wirostko and colleagues founded [myeyes.net](http://myeyes.net) to help patients rent or buy an iCare Home tonometer.

accounts. We’ve tried to make it more affordable for patients, and we look forward to next year as we start working with glaucoma nonprofits to help patients who can’t afford it.”

### Home-Based Perimetry: Best for Screening?

Two main types of home perimeters have been developed: web-based software and virtual reality (VR) headsets.

**Web-based perimetry.** At this point, web-based visual fields may be better used as a screening tool than for tracking progression, said Dr. Vinod. “While many of these programs are able to identify normal versus abnormal, they are not refined enough to pick up subtle progression.” In addition, they are better at identifying moderate-to-severe glaucoma than detecting earlier stages of disease, she said. However, establishing a new baseline with each patient using online perimeters might be helpful, said Dr. Lin.

Given that web-based perimeters are 2D, Dr. Katz questioned whether they could provide a true peripheral visual field test. “With more refinement and validation,” said Dr. Vinod, “I think these will ultimately be useful as a supplement to the Humphrey Field Analyzer [HFA], but the correlation between this gold standard and web-based perimeters is currently inconsistent.”

One benefit for patients, said Dr. Lin, is that “aside from the cost of the tablet or computer, web-based software is typically free for the patient.”

**Peristat.** The Peristat online perimeter was developed in 2002 by Sean Ianchulev, MD, MPH, and Peter Pham, MD, then residents at the Doheny Eye Institute. Peristat shows significant correlation with Humphrey visual field testing.<sup>7</sup> The company reports that the technology allows 24 degrees of visual field to be interrogated in less than three minutes. It can qualify for reimbursement under CPT code 92499 *unlisted procedure*. Peristat is available at KeepYourSight ([kysvision.com](http://kysvision.com)), which

has also developed platforms to monitor AMD and diabetic retinopathy.

**Other perimeters** include the following:

- George Kong's VisualFields Easy, now known as Melbourne Rapid Fields Test. But its sensitivity and specificity has been inadequate for screening.<sup>8,9</sup>
- Eyecatcher ([eyecatchervision.com](http://eyecatchervision.com)) is an open-source tablet perimeter that uses eye- and head-tracking technologies. Originally used for rapid triage in glaucoma clinic waiting rooms, it is being evaluated for use by patients at home.<sup>10,11</sup>

**VR headsets.** VR perimetry devices use a smartphone or tablet to run the headset, which is typically associated with a Bluetooth-enabled response button and Cloud-based data storage, said Dr. Vinod. "These headsets can be beneficial for patients who can't position easily at the HFA," she said. "However, the headset's weight may pose a problem for some."

Ophthalmologists are primarily using VR headsets in the office, especially since the devices allow for guidance from a professional, said Dr. Katz. During COVID, they have helped avoid close patient proximity. (Of note, the devices cost about \$1,000.)

Studies are evaluating the headsets' usefulness in the home setting, he said. The VisuALL (Oll-eyes) is a VR visual field perimeter that has been shown to have close correlation with Humphrey perimetry in glaucoma patients and those without glaucoma.<sup>12</sup>

### Home-Based Photography: Potential for Future Use

The quality of smartphone photography has come a long way, raising the prospect of its utility for remote optic disc imaging. In addition to needing someone else to take the photograph, a big obsta-

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## Other Tonometry Innovations

Some of the other tonometry innovations have been less accurate, more expensive, or more difficult to use, said Dr. Katz. This includes noncontact tonometers and those that involve pushing an instrument against the eyelid to capture a pressure reading (Proview and Diaton).

There are two other novel types of technology used for remotely measuring IOP.

**Sensimed Triggerfish.** Cleared by the FDA in 2016, this single-use, silicone "smart" contact lens is inserted and worn by the patient for up to 24 hours a day.<sup>1</sup> "Although patients have reported mild irritation and redness, the device is well tolerated overall," said Dr. Vinod, explaining that it measures changes in corneoscleral circumference, which is thought to be a surrogate for IOP. "The Triggerfish contact lens wirelessly transmits data to an antenna near the eye and then to a portable recorder, which is worn by the patient. Once the lens is removed, data are transferred to a computer via Bluetooth."

"Because it doesn't measure millimeters of mercury, though, we've had a difficult time interpreting its results—unlike the iCare, which does measure in millimeters of mercury," said Dr. Wirostko. For these reasons, it's been mainly used in research settings, added Dr. Katz.



**TRIGGERFISH.** A "smart" contact lens.

### IOP-monitoring implants.

Now in development, IOP-sensing devices can be implanted in various parts of the eye to provide readings 24 hours a day that are recorded and sent remotely.

Many of these implants are linked to IOLs during cataract surgery, said Dr. Lin. There have been reports of compassionate use in the United States for patients who have had a keratopro-

sthesis, which increases the risk of glaucoma but prevents accurate tonometry readings, said Dr. Katz.

A variety of companies are developing devices. For example, Implants has a CE-approved product called eyemate, and Injectsense received breakthrough device program designation from the FDA in 2020 for its continuous IOP monitoring system.<sup>2</sup> Because these devices offer accurate measurements, they might one day obviate the need for in-office readings or other remote patient monitoring, especially for those unable to monitor pressure themselves, said Dr. Katz.

1 Mansouri K et al. *PLoS One*. 2015;10(5): e0125530.

2 [Injectsense.com](http://Injectsense.com): "Injectsense Receives Breakthrough Device Program Designation from FDA, Highlights Eye Sensor Performance and Path to Human Studies."

cle is the need for dilation, said Dr. Vinod.

**Good but suboptimal.** “As expected, studies have found that the quality of dilated images obtained at the office are superior to those obtained using a smartphone,” said Dr. Vinod. “We’re not quite there, but this field is really promising.”

Dr. Wirostko said that she looks forward to cameras with widefield capability that don’t require dilation. She also said that she’s excited by AI and computer analysis programs with the potential to show changes in optic nerves.

**More reliance on OCT.** Portable home-based OCT machines by Notal Vision are being used to follow AMD patients, said Dr. Vinod. “It would be helpful if we could harness that technology to remotely image the retinal nerve fiber layer and ganglion cell complex.”

Dr. Lin said that he relies more on OCT than photographs to diagnose and follow progression of glaucoma. “But, along with remote tomography,” he said, “photography might be helpful for community screening in underserved areas when an ophthalmologist is unable to see everybody.”

### Improving Outcomes?

Is remote patient monitoring improving patient outcomes? We don’t really know yet, said Dr. Lin. “But even without prospective randomized trials, a great starting point would be to collect large amounts of retrospective data to compare those who’ve been monitored at home versus those who have not. Already there is a significant number of patients who have done home monitoring with the iCare Home, and it will be interesting to see if they

have better glaucoma outcomes over the years.”

Home-based tonometry, perimetry, and optic disc imaging have the potential to produce a paradigm shift in glaucoma care delivery, said Dr. Vinod.

“Patients who are fast progressors and those losing field despite seemingly acceptable in-office IOPs are among those whose care could be meaningfully impacted by additional data points acquired outside the office,” she said. She added, “Further refinement and validation of remote monitoring tools and availability of higher quality and longer-term data will enable us to expand the scope of glaucoma care and optimize outcomes for our most vulnerable patients, including those at greatest risk of disease progression and blindness.”

1 [www.nei.nih.gov/learn-about-eye-health/outreach-campaigns-and-resources/eye-health-data-and-statistics/glaucoma-data-and-statistics](http://www.nei.nih.gov/learn-about-eye-health/outreach-campaigns-and-resources/eye-health-data-and-statistics/glaucoma-data-and-statistics). Accessed Dec. 6, 2021.

2 McKinsey & Company. [www.mckinsey.com/industries/healthcare-systems-and-services/our-insights/telehealth-a-quarter-trillion-dollar-post-covid-19-reality](http://www.mckinsey.com/industries/healthcare-systems-and-services/our-insights/telehealth-a-quarter-trillion-dollar-post-covid-19-reality). Accessed Dec. 6, 2021.

3 Sood V, Ramanathan U. *J Glaucoma*. 2016;25(10):807-811.

4 Mansouri K et al. *Surv Ophthalmol*. 2020;65(2):171-186.

5 Dabasia PL et al. *Br J Ophthalmol*. 2016;100(8):1139-1143.

6 Go MS et al. *J Glaucoma*. 2019;28(9):818-822.

7 Lowry EA et al. *Transl Vis Sci Technol*. 2016;5(4):4.

8 Quigley HA, Broman AT. *Br J Ophthalmol*. 2006;90(3):262-267.

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11 Jones PR et al. *BMJ Open*. 2021;11:e043130.

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## MEET THE EXPERTS



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**See disclosure key, page 8. For full disclosures, see this article online.**