

QuickSee in mobile eye clinics and global health vision care

Enabling accurate autorefracton anywhere



Bijan Azami (TwoBillionEyes Foundation) performing autorefracton in Gambia

Takeaways in Focus

- **Limited availability of trained professionals and clinical equipment contribute to the estimated 1.3 billion cases worldwide of uncorrected refractive errors**
- **QuickSee, a portable wavefront aberrometry-powered autorefractor, helps perform clinically accurate refraction in mobile care and low-resource settings**
- **Optometrists and vision care professionals demonstrate QuickSee's value for fast, high quality in demanding conditions**

SUMMARY

Over one billion people in the world suffer from poor vision that could be improved with a pair of prescription eyeglasses. While the problem is prevalent in developing nations, underserved populations in rich countries also suffer from uncorrected vision. Fortunately, the cost of appropriate eyeglasses isn't a major problem—prescription eyeglasses can cost as little as US\$2.00 per pair and “readers” for near vision correction are made for as little as US\$0.50.

The real barriers to getting vision correction in low income countries and communities are less obvious and more difficult to overcome. They include complex screening and delivery logistics, lack of infrastructure to get patients to eyecare facilities, the availability of adequately trained vision care professionals, and lack of affordable, accurate, and robust equipment to conduct vision exams.

PlenOptika designed the QuickSee handheld wavefront autorefractor to address two key limiting factors: the time it takes optometrists to make measurements for eyeglasses prescription, and the availability of clinical-quality equipment to conduct vision exams in low-resource environments.

QuickSee is an affordable, durable, handheld device that can be used both in and outside clinical settings to perform accurate objective refraction comparable to the gold standard of refractive error measurement—the desktop autorefractor—in a fraction of the time. By providing vision care professionals clinically valid starting points for subjective refraction in a few seconds outside a fully equipped clinic, QuickSee makes eyeglass prescription a dramatically more efficient process and amplifies vision care professional's potential for impact in mobile care and global health initiatives.

The global burden of low vision

According to the World Health Organization (WHO), there are currently 217 million people with moderate or severe distant vision impairment worldwide, and approximately 1.3 billion people suffer some degree of distance or near vision impairment¹. 89% of vision impaired people live in low and middle-income countries². Uncorrected visual impairment leads increased DALYs (Disability Adjusted Life Years), lower overall quality of life, learning difficulties for children, and lost employment opportunities for adults. The potential lost productivity attributed to low vision has been estimated to reach \$268.8 billion per year³.

Uncorrected Refractive Error (URE) is a top cause for visual impairment worldwide, with more than 650 million people suffering from lack of adequate refractive error correction⁴. It can be easily diagnosed and corrected with a pair of prescription lenses—such eyeglasses can cost as little as US\$2.00 per pair—but in many parts of the world people have limited or no access to eye care facilities where a trained professional can conduct sight measurement and write eyeglass prescriptions.

The availability of personnel trained to perform eye exams is especially severe in developing nations. In high-income countries there is an average of about one ophthalmologist for every 13,000 people⁵. In India, in contrast, this ratio ranges from 1:250,000 to 1:500,000 in some regions, and in sub-Saharan Africa a typical optometrist might serve a population of a million people⁶. Many skilled specialists also leave the developing world to work in countries where they have better financial prospects.

The accessibility of eye care services is also uneven in developed countries like the United States. People living in rural areas and low-income communities are at higher risk for vision problems compared to urban and wealthier Americans. Geographic isolation and life in medically underserved areas also add to the issues of financial barriers and lack of insurance coverage⁷.

With so many patients to serve in communities with limited access to vision care services, time becomes an especially valuable resource for vision care professionals. A regular optometrist visit might take up to 90 minutes, limiting the number of patients an optometrist can see. In a traditional eye care facility, objective refraction is conducted with the use of a stationary autorefractor, which is the standard practice. Optometrists working outside fully-equipped clinical settings are limited yet further; since autorefractors are expensive and not portable, optometrists often work with rudimentary or inadequate equipment to determine refractive error.

In such situations, where there are many patients to see with limited clinical resources, QuickSee can be a critical instrument. A portable, clinically accurate autorefractor, QuickSee enables trained technicians working under optometrists' supervision perform binocular measurements on as many as 40 patients per hour, under any lighting condition, indoors or outdoors, without electricity. The optometrists are given pre-screened patients with good starting points for subjective refraction and prescriptions, vastly accelerating and scaling their potential for patient impact.

PlenOptika: Vision driven innovation

PlenOptika is an innovative medical device company started at the Massachusetts Institute of Technology, in the Madrid–MIT M+Visión Consortium, by research fellows who felt driven to solve the problem of low vision worldwide. The mission of the company is to make high quality vision care available to everyone, and to improve optometrists' potential to deliver the very best patient care.

PlenOptika collaborated with research and healthcare centers in the United States, Spain, and India to design QuickSee. The company has been recognized by international social innovation foundations for its solution to eliminate the global burden of impaired vision and has received innovation grants from the American and Indian governments to develop the technology.

QuickSee: Accurate autorefractor anywhere

QuickSee is a handheld, open-view autorefractor that uses wavefront aberrometry to precisely determine refractive errors. It enables optometrists and their supervised technicians to conduct the objective refraction measurements faster than with a traditional desktop autorefractor (binocular measurements are made in 10 seconds) and it provides an easy transition to subjective refraction. It is an FDA Class 1 510(k) exempt (low risk) medical device commercially available in the United States.

It objectively measures the refractive errors by shining a light into the patient's eyes at their retinas, then measuring the wavefront pattern reflected back through the eyes' lens and cornea. Distortions in the light waves represent specific vision errors of patients' eyes, such as nearsightedness, farsightedness, and astigmatisms.

QuickSee has been tested by teams at Johns Hopkins University, New England College of Optometry, Aravind Eye Care System (India), Harvard School of Public Health, TwoBillionEyes (non-governmental organizations), and others. Over 3,000 patients participated in the studies with the use of the device. Studies published in peer-reviewed journals demonstrate its high specificity and sensitivity, showing QuickSee measurements comparable to traditional autorefractors and optometric exams⁸.

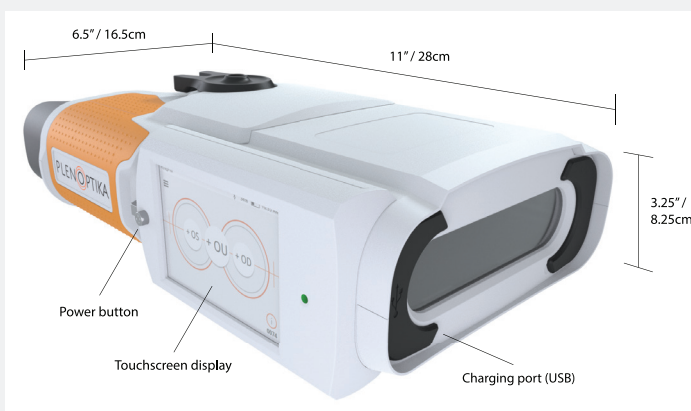
For complete technical specifications, visit <https://plenoptika.com/technology/> and for research findings, visit <https://plenoptika.com/media-library/>

QuickSee clinical advantages

- **Fast.** Alignment and measurement can be performed in seconds. Users can be trained in 15 minutes, and they can measure as many as 40 patients in an hour.
- **Accurate.** Provides consistent measurements comparable with the results from the gold standard of objective refraction tests.
- **Portable.** Handheld, lightweight, durable, and calibration-free for use demanding conditions outside the clinic. Battery powered and works for up to 8 hours on a charge; can operate while charging.
- **Affordable.** Costs about ½ as much as traditional desktop autorefractors.

QuickSee at a Glance

Device Dimensions	11x6.5x3.25 in (28x16.5x8.25 cm) / 2.3lb (1kg)
Accommodation Control	Open View
Spherical Range	-10D to +10D, increments of 0.01D, 0.125D, 0.25D
Cylindrical Range	-6D to +6D, increments of 0.01D, 0.125D, 0.25D
Axial Range	0-180°, increments of 1, 5, 10 degree
Interpupillary Distance Range	47–78 mm continuous
FDA Status	Class I
Dilation / Cycloplegic Requirements	None
Ambient Illumination Requirements	None



RESEARCH

Clinical and technical validation studies

QuickSee's accuracy has been tested and validated against traditional autorefractors, other portable autorefractors, and subjective refraction findings in several clinical studies internationally, and results from clinical research have been published in peer-reviewed journals.

QuickSee vs traditional autorefractor and subjective refraction in rural India⁹

Aravind Eye Hospital in Madurai and a rural satellite vision centre in Thiruppuvanam

In communities with limited access to eye care services, optometrists' time is a rare resource. The goal of this study was to assess the comparative quality of eyeglass prescriptions made with the use of QuickSee by a minimally trained technician and by subjective refraction conducted by an experienced refractionist with over 4 years of refraction experience.

708 adult patients were recruited from patients scheduled for a general refraction at the locations. Visual acuity (VA) and patients' preferences for glasses were used for quality assessment. 25% of participants had no preference, 33% preferred eyeglasses from autorefractor prescriptions, and 42% preferred eyeglasses from subjective refraction prescriptions. Average VAs from autorefractor-prescribed eyeglasses were one letter worse than those from subjective refraction.

The results show a minimal advantage of traditional eye examination procedure over use of QuickSee but still suggest the efficiency of use of portable autorefractor due to its cost, accuracy, short training needed for the device user, and less time spent on VA measurement.

Pediatric accuracy

Hospital Fundación Jiménez Díaz (Madrid, Spain)

Measuring refractive error in children can be challenging due to the patients' accommodation during the testing and occasional lack of cooperation. To deal with accommodation, cycloplegic drugs are commonly used, but they significantly lengthen the vision exam and causes discomfort for the patients.

A pilot study with 112 participants age 7–13 years old was conducted to compare the measuring results from QuickSee and standard clinical pediatric refraction. Participants' vision was first measured with a desktop autorefractor (Topcon KR 8800) followed by subjective refinement with trial lenses and visual acuity measurement. Later, a different optometrist determined the patient's visual acuity with three recordings using QuickSee autorefractor.

Differences between Spherical Equivalent power obtained by each refraction method were within 0.5 D for 83.3% of the eyes. The average visual acuity from QuickSee refractions was equal to or better than that achieved with the standard clinical procedure in 81.3% of eyes.

As it was a pilot study with a small number of participants, the statistical data is only moderate. To continue research on QuickSee pediatric use, the sample size is being increased to 100 children and will also include patients under the effects of cycloplegia, which will serve as an additional validation of this study.

CASES STUDIES

QuickSee in mobile care and global health missions

QuickSee is a clinically-valid tool for administering eye exams outside traditional clinical environment, such as in vision care missions by non-governmental organizations (NGOs) in developing countries, where technicians and community health workers can be trained to use the device in rural areas and urban slums, and in mobile clinics run by optometrists in underserved communities in the United States (such as rural or poor urban neighborhoods, pediatric and elderly exams, and health care for the homeless).



Vision care mission in the Caribbean

On September 6, 2017, Hurricane Irma swept westward across the Caribbean, causing catastrophic damage along its path. On the islands of Anguilla and St Maarten, homes were wiped away, roads submerged, and estimated losses between the two communities exceed \$4 billion.

A team of eight ODs and 16 support staff, backed by Essilor, traveled to the islands on March 27-29, 2019 and screened

more than 1,000 patients. Most patients were students, and after the screening about 60% of them received free new eyeglasses.

The teams set up their clinics in school rooms and nursing homes. They had five stations for each patient to visit: first to sign in and get a record; a station where they got objective refraction with QuickSee and tonometry measurements; a health station where their eye anteriors were examined; an OD station where they received a retinal examination with a direct ophthalmoscope, and if necessary, a prescription; and finally a table where they would select eyeglasses with their prescription. The frames were sent to Essilor to be fitted with lenses and then sent back to the patients.

"With so many patients to see in a short time, we had to go very fast," said Dr Alan Glazier, a Rockville, Maryland optometrist who led the trip. "QuickSee was a tremendous asset. Last year when we made the same trip, we had only retinoscopes for objective refraction, so we were able to see about twice as many patients efficiently and with more accurate data than before. It was especially good at getting cylinder measurements."

Mobile vision clinic in Cincinnati, Ohio

After performing exam visits to nursing homes, Todd Winkler, an optometrist practicing in Cincinnati since 1995, realized there is an unseen, underserved population and took action. In January 2019, Dr Winkler started Eye on Convenience, a mobile service to provide high quality vision care who can't get to his clinic.

"I have patients who are not only homebound, but bed-bound," he said. Moreover, they often have conditions like diabetic retinopathy worsening their vision, as well as age-related conditions like macular degeneration, glaucoma, and cataracts.

Using a sedan filled with equipment and samples, Dr Winkler visits patients at home to perform measurements and, if they are found to be in need of eyeglasses, he writes the prescription and they can choose their frames. Their new eyeglasses are delivered directly to them from a lab in a few days. A big part of the visit, says Dr Winkler, is the management of the equipment. "From a physical standpoint, it can be hard. Some of it is quite heavy," said Dr Winkler. "And I've got to set it up and take it down...it takes time. For example, I carry an actual phoropter, which I mount to a custom-made tripod."

Among his instruments, Dr Winkler has a QuickSee binocular wavefront autorefractor. He knew he would need a tool for objective refraction so QuickSee was included from the beginning. QuickSee's portability and ease of use make it the best choice for autorefraction, given his mobility needs and the patient conditions he finds.

"The better the technology you have and the less time you have to spend using it, the more patient-facing time you get to make accurate diagnoses...if you have something like [QuickSee] that reduces bottlenecks, increases efficiency, and doesn't break the bank, that's a real big winner for today's practices."

**—Alan Glazier, OD
Shady Grove Eye and Vision Care
(Rockville, Maryland) and
ODs on Facebook community leader**

"QuickSee gives me a computerized prescription estimate," said Dr Winker, "so I can more quickly and accurately determine their final prescription. Without it, I would have to perform a retinoscopy which is time consuming and less accurate...just much more difficult. With QuickSee, once I align it, I press the button and it takes 10 seconds to measure."

New tools like QuickSee, combined with his personalized service, make a big impact on Dr Winkler's patients. "The equipment gives them confidence that they're benefitting from cutting edge technology, that they're getting a very high-quality exam even without the office visit."



Community vision center in Lubbock, Texas

Moved by a volunteer experience performing vision exams for homeless people during the holiday season, Dr Garrett Wentz established Highflyer Optics in the Lubbock Impact community center in early 2019. The modest clinic serves the area's working poor and homeless by providing eye exams and free customized eyeglasses.

QuickSee has been a part of Highflyer Optics' process from its beginning. The clinic autorefracts everyone who comes for an exam, which also includes an extensive history interview, retinoscopy, and pressure testing. QuickSee helps the clinicians quickly determine who will need glasses and direct them toward subjective refraction with accurate starting points.

"The fact that we have this tool to make our prescription more precise gives our patients a lot more confidence and the feeling that they're well cared for."

**—Garrett Wentz, OD
Highflyer Optics (Lubbock, Texas)**

Because of QuickSee's portability and speed, technicians screen patients who are queued outside the clinic. Those identified with a need for glasses are flagged for further treatment. Without QuickSee in his workflow, Dr Wentz says, "patients who don't need eyeglasses would take time in the exam chair away from those who do."

QuickSee has a secondary impact on patients: the innovative device helps them feel they are getting high quality care despite not being in a traditional clinical setting. "The fact that we have this tool to make our prescription more precise gives our patients a lot more confidence and the feeling that they're well cared for," said Dr Wentz.

Road safety in Kenya

On average there are 3,000 reported road accident deaths in Kenya annually. Kenya is among the top 15 countries with highest death or injuries globally. Clear vision is an important factor contributing to road safety worldwide. Usually the drivers have their sight measured only during the process of receiving driving licenses, and for many that might have been decades ago. Some of the drivers have complaints about their vision but have no financial resources or no time to travel to eye care facility to get their vision tested, and many do not realize they have vision impairment due to the subjectivity of vision perception.

TwoBillionEyes Foundation is a non-profit organization working towards providing clear vision in low resource settings by building a low-cost, sustainable, scalable infrastructure for measuring vision and providing low cost eyeglasses. This cross-sectional study was conducted by TwoBillionEyes in Kenya to show the effectiveness of eye testing and issuing corrective eyeglasses, as well as how Kenyan youth are given an opportunity for employment when hired to perform vision testing with QuickSee as the first step during the eye exams. QuickSee has become an ideal tool to allow quick accurate objective refraction testing conducted by trained youth under the supervision of eyecare professionals.

Data from 550 drivers aged from 20 to 73 years were analyzed. Using the Kenyan requirement for driving (visual acuity with two eyes minimum 0.66) as a limit, 10.5% of participating drivers would not pass the test. For 6% of drivers the eyeglasses that were provided on the spot helped them pass the test and preserve their jobs. For another 8% of drivers, the corrective eyeglasses improved their visual acuity substantially and/or restored their depth vision with two eyes (important for judging distances and speed).

QuickSee saved working optometrists time by delegating a part of eye examination to assistants and still receive accurate and robust results for each patient. Given the limited resources in technology and expertise, the cost and efficiency of QuickSee contributed to getting a better understanding of what can be improved in drivers' vision screening in Kenya.

Conclusion

The limited availability of trained personnel and adequate equipment to perform vision measurements, a pre-requisite for corrective eyeglass prescriptions, are major contributors to the global burden of low vision. QuickSee is an affordable, durable, handheld autorefractor that can be used both in and outside clinical settings to perform accurate objective refraction comparable to the gold standard of refractive error measurement—the desktop autorefractor—in a fraction of the time. NGOs have used QuickSee to examine patients at high volume and efficiently facilitate accurate prescriptions for corrective eyeglasses. In the US and other developed nations, QuickSee helps vision care professionals bring accurate vision exams to the communities in need such as schools, nursing homes, community health centers, and rural/homebound patients.

For more information about QuickSee, peer-reviewed literature about its accuracy, and case studies of QuickSee in use, visit <https://plenoptika.com>

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