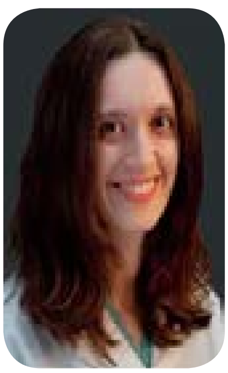
Article • Assistive Technology in Low Vision: Overview and Case Report

Leannza Tang, OD • New York Eye and Ear Infirmary of Mount Sinai • New York, New York
Rebecca Marinoff, OD • State University of New York State College of Optometry • New York, New York

Leannza Tang, OD
New York, New York
Director of Low Vision Services, New York Eye and Ear Infirmary of Mount Sinai
OD, Illinois College of Optometry, 2019
Residency in Low Vision Rehabilitation, SUNY Optometry, 2020
BS, University of Saskatchewan, 2015
Fellow, AAO



Rebecca Marinoff, OD
New York, New York
Associate Clinical Professor, SUNY College of Optometry
Residency in Low Vision Rehabilitation, Southern College of Optometry, 2009
OD, SUNY College of Optometry, 2008
BS, SUNY University at Buffalo, 2003
Fellow, AAO
Diplomate in Low Vision, AAO

ABSTRACT

Background: Vision impairment, whether sudden or gradual, can make it difficult for patients to perform activities of daily living (ADLs). Advances in technology have benefited patients with a range of disabilities. The use of assistive technology in low vision has provided additional devices, programs, and resources to help visually impaired patients perform ADLs, gain independence, and improve quality of life.

Case Report: A 75-year-old male with advanced glaucoma presented to the Low Vision Clinic with a chief complaint of difficulty reading his Bible. He also reported distance vision blur. Assistive technology low vision devices, which provided magnification and contrast enhancement, helped him to reach his visual goals.

Conclusion: Assistive technology low vision devices can help patients to achieve their visual needs and goals when traditional hand and stand magnifiers do not bring these patients to goal acuity. Eye care providers should consider referral for low vision rehabilitation services so that patients can benefit from the wide array of available technology options.

Keywords: activities of daily living, assistive technology, low vision rehabilitation

Introduction

Assistive technology is defined by the Assistive Technology Industry Association as "...products, equipment, and systems that enhance learning, working, and daily living for persons with disabilities."[1] Patients with vision, hearing, or physical impairment can benefit from using assistive technology because it allows them to continue to live active and productive lives using advances in technological devices. Regarding vision impairment, these devices can help patients remain independent and achieve their visual goals, which may include reading smaller print, using a computer more efficiently, using their smartphones to communicate with others, and traveling more independently. Certain devices and programs can improve a patient's ability to perform activities of daily living (ADLs) such as cooking, completing household chores, watching television, reading, shopping, and grooming themselves. Assistive technology may involve the use of electronic magnifiers, software and computer programs, built-in accessibility tools and applications on smartphones and computers, smart home devices, wearable and head-mounted devices, and mobility aids.[2]

Categories of Assistive Technology

Electronic Magnifiers

Electronic magnifiers, also called closed-circuit televisions (CCTVs), are devices used for reading. Their main features include different powers of magnification, an illumination source, and different color and contrast modes, including enhancement and inversion. Enhanced-contrast mode allows the patient to view material as dark bold print on a white background and would be most useful when reading material with poorer contrast such as newspaper print. Reverse (or inverted) contrast allows the user to view their reading material as white print on a black background. Different models may have other color combinations, including yellow print on a blue background or yellow print on a black background. Typically, patients who would benefit from using an electronic magnifier require high powers of magnification, have reduced contrast sensitivity, may be sensitive to glare, and may have limited dexterity such that they have difficulty holding either other types of devices or their reading material. There is also "frame-freeze" capability that allows the user to capture an image and further magnify that section of reading material.[2,3]

Electronic magnifiers are available in different models and are typically classified by their level of portability and screen size. Portable electronic magnifiers typically have smaller screen sizes, ranging from 3 inches to 13 inches, and therefore can easily be used in many different settings. Laptop-compatible electronic magnifiers make use of a camera attached to a stand that can be connected to a laptop computer and display the image on the screen. Desktop electronic magnifiers include a camera connected to an even larger monitor, ranging from 16 inches to 24 inches, making them less travel-friendly.[2,3] All of these devices allow for higher amounts of magnification while still maintaining a large field of view, with desktop magnifiers allowing the largest field of view. With a larger field of view, desktop electronic magnifiers allow a patient to achieve faster reading and writing rates.[4,5]

Software and Computer Programs

Using a computer can be difficult for low vision patients. They may not be able to see the text, images, or icons on the screen; the pointer or mouse cursor may be difficult to see because of its size or color; and the contrast between foreground and background material on the screen may not be sufficient for some users. There are different software programs available that can help low vision patients use a computer more effectively and efficiently. ZoomText (Vispero, Clearwater FL) is a magnification program that allows the patient to enlarge everything on a computer screen, including words, images, and icons. In addition, the program includes options to invert or change the color scheme on the screen and to enhance the size and color of the mouse or cursor to make it more easily visible. Certain computer programs can be used by blind individuals, including Job Access with Speech (JAWS) (Vispero, Clearwater FL), which is a screen-reader program that will read the text that is displayed on the screen and allows the user to rely more on audio cues rather than visual, especially for lengthy emails or documents. The patient can control the program using keyboard commands on a braille keyboard instead of having to navigate a screen with a pointer or cursor. Non-Visual Desktop Access (NVDA) is another screen-reader program that is free and can be easily accessed through their website.[6] Some of the computer programs include free trials, but once the trial expires, users must either purchase a yearly subscription or purchase the software program in full to use it indefinitely.[2,3]

Built-in Accessibility Tools

Smartphones, tablet computers, laptop computers, and desktop computers are widely used with ease in the general population for work and leisure, but it may be difficult for low vision patients to access the many different functions and use them to their fullest extent. Some low vision patients already own one or more of these devices but are unaware of the built-in accessibility tools that allow more efficient use. General categories of built-in accessibility tools for Microsoft Windows (Microsoft, Redmond WA), Apple (Cupertino CA), and Android (Google, Mountain View CA) devices include text-to-speech, enlargement of text, color filters and color inversion, zoom function, and magnifier.[2,3] Text-to-speech allows a user to convert text on their phone to an audio format using a voice synthesizer that will read out loud what is on the screen at any given time. Enlarging text allows the patient to magnify the text on the screen. Certain smartphones include color filters and color inversion options similar to those built into electronic magnifiers. Zoom functions allow the user to increase screen magnification when needed, while built-in magnifiers use the phone's camera to magnify printed materials or other objects.

Smartphone Applications

There are numerous smartphone applications (apps) available that can help increase a low vision patient's independence by helping them perform ADLs. Certain apps assist with everyday tasks, including color, money, and product identification, while others assist with navigation. There are also apps that convert text or print to speech. Before these apps were created, patients needed to purchase separate devices to complete these tasks. Some apps are free, while others must be purchased.

Color-identification apps allow users to hold up the camera lens of the smartphone in front of an object, and the app will recognize and say aloud the color of the object. Money-identifying apps work by holding a bill in front of the camera lens of the smartphone, and the app will say aloud the denomination of the money that the patient is holding. Product-identifier apps may use barcode readers or take a picture of the object to identify it aloud. Certain apps allow an entire scene to be captured and describe in detail the area of interest. Global Positioning System (GPS) apps are designed to assist visually impaired users in navigation by providing detailed directions to the destination while they travel. For example, the GPS apps may be customized to announce street names, intersections, and nearby points of interest. There are numerous text-to-speech apps available that typically include features to control the playback of speech and are available in multiple languages.[2,3]

Smart Home Devices

Smart home devices are hands-free devices that are solely voice controlled and can be connected to other household products. These devices may benefit low vision patients since they only require the patient to speak or to say a certain command in order to complete certain tasks. Common smart home devices are supported by Amazon Alexa (Amazon, Seattle WA) and Google Assistant (Google, Mountain View CA), which incorporate the use of Amazon Echo products (Amazon, Seattle WA) and Google Home (Google, Mountain View CA). Through voice activation, these devices allow patients to perform tasks such as setting reminders and timers, checking the weather, and playing music. These devices can also be connected to other smart home products, which can then be turned on or off and manipulated through voice control. Examples of smart home products available include lightbulbs, thermostats, certain kitchen appliances, televisions, and vacuums. Smart home devices typically require additional subscriptions and a Wi-Fi network, as well as additional set-up to connect and to sync the devices.

Wearable and Head-Mounted Devices

Certain wearable and head-mounted devices allow patients to complete everyday tasks more effectively by including a number of built-in functions all in one device, while providing additional magnification and different color and contrast modes. The base unit of the device can vary. The OrCam My Eye (OrCam, Jerusalem Israel) is a spectacle-mounted unit. The IrisVision (IrisVision Global, Pleasanton CA) and CyberEyez (Cyber Timez, Arlington VA) use a virtual reality headset. Aira (Aira Tech Corp, San Diego CA) includes smart glasses with a camera. The eSight (eSight Corp, Toronto Canada) is a head-mounted device referred to by the company as electronic eyewear. The devices listed are only a few examples of the wearable devices that are currently available on the market. The OrCam My Eye features include text-to-speech, color and money identification, a barcode reader, and face recognition. IrisVision, CyberEyez, and eSight use a camera mounted on the front of the device that displays the image to the user. The low vision patient is then able to magnify what they are viewing, whether it is reading material or streamed content on the device. With Aira, the user is connected to a highly trained agent through a live call so that the agent can view the user's environment through the camera mounted on the smart glasses. The agent can then provide guidance to the visually impaired patient as needed, such as navigating through an airport or assisting in reading product labels at a grocery store.[3]

Mobility Aids and Devices

Many of the mobility aids and devices for low vision patients involve the use of ultrasonic technology. In some cases, these aids are used in conjunction with a mobility cane, so that obstacles are detected not only below waist level and on the ground, but also at the level of the head and torso. Mobility aids and devices that incorporate this technology include the WeWalk Smart Cane (Young Guru Academy, London, United Kingdom), the iMerciv Buzz Clip (iMerciv, Inc., Toronto Canada), and the Sunu Band (Sunu, Inc., Boston MA). The WeWalk Smart Cane is a mobility cane with an adapted handle that will vibrate when an obstacle located above the waist is detected. The iMerciv Buzz Clip is typically worn clipped to the user's shirt. The Sunu Band is worn around the patient's wrist. Both of these devices will also vibrate to warn the patient of obstacles that could potentially cause serious head injuries.[2,3]

Case Report

History

A 75-year-old African American male presented to the Low Vision Clinic with reduced vision secondary to advanced primary open-angle glaucoma in both eyes, which was diagnosed by another eye care provider. He reported currently taking latanoprost once per day at bedtime in the left eye and dorzolamide-timolol twice per day in the left eye. He reported past ocular surgical history of cataract extraction in the left eye, followed by the right eye. The right eye cataract extraction was combined with glaucoma surgery to implant an Ahmed valve

(New World Medical, Inc., Rancho Cucamonga CA). The patient reported that he lost vision in the right eye following the glaucoma surgery, with possible etiologies of vision loss including hypotony versus another iatrogenic complication.

The patient's chief complaint was difficulty reading his Bible. He had additional complaints of distance vision blur, difficulty seeing and recognizing faces, and difficulty telling colors apart. The patient's adult daughter presented with him to the examination and expressed concerns related to the patient's vision, including difficulty cooking for himself, picking up food with utensils, and keeping his food on the plate during meals. She was concerned that it was no longer safe for him to continue to live alone in his home and had arranged for him to move into an assisted-living facility. The patient expressed that he could not read for extended periods of time without experiencing discomfort and frustration. The patient had a pair of bifocal glasses that were 10 years old, and he reported that he could not read mail, handwritten material, or price labels with these glasses. He reported that there was no significant improvement in distance vision while wearing his current glasses compared to viewing without correction, but he was aware that he needed to wear the glasses regularly for protection.

The patient and his daughter reported that he had already been registered as legally blind with the state agency for the blind, and they reported other agency connections, but he was not currently receiving services and denied prior use of low vision devices.

Examination Findings

Distance acuity was taken without correction due to the patient's report of no improvement with his current glasses. Uncorrected distance acuity, taken with the ETDRS chart, was hand motion in the right eye, 2/5M (20/50) in the left eye, and 2/5M (20/50) with both eyes. His uncorrected entering near acuity in the left eye was 20 point print at 27 cm using the Lighthouse "Game" near card. Confrontation visual field testing was attempted using the count fingers method, but due to the patient not being able to see the fingers and a lack of understanding of the test, kinetic red testing was used instead. The patient had constricted visual fields in all quadrants in his left eye. His extraocular muscle movements were grossly full, with limited patient understanding. Retinoscopy was attempted but could not be performed due to dim reflexes that were observed in both eyes. A trial frame refraction was performed. The patient's subjective refraction was +0.50 sphere in the right eye and plano in the left eye, with no improvement in acuity in either eye. His predicted near add using the Lighthouse predicted add card was +3 D. Using Mars contrast sensitivity testing (Precision Vision, Woodstock IL), the patient had severe contrast sensitivity loss. To further quantify his remaining visual field, kinetic Goldmann perimetry was performed on his left eye using a III4e stimulus and revealed that the patient had severe constriction in all quadrants, with his widest field measured to be approximately 7 degrees temporally.

A variety of near add powers were trialed to help the patient reach his goal of reading his Bible. Given this extended reading task, a goal of 5 point print or better was set for near, which would allow at least two lines of acuity reserve. The add trials began with +3 D, the predicted add. With a +3 D add over the left eye, near acuity was measured to be 8 point print at 33 cm using the Lighthouse single-line continuous-text card. The patient had a slow reading speed with this add power. With a +4 D add over the left eye, the patient could read 6.4 point print at 22 cm with a slight improvement in reading speed and reported that he was more comfortable with this power and working distance compared to the +3 D add. A +5 D add was trialed over the left eye to see if there was additional improvement in near acuity, but there was not. Next, a 2x dome magnifier was trialed in combination with the +4 D add, but this also did not result in an improvement in near acuity or reading speed. The patient reported no subjective improvement with this combination versus the +4 D add alone.

The Ruby portable electronic magnifier (Vispero, Clearwater FL) with a 4.3″ screen was trialed with a +3 D add over his left eye, using 6x magnification and yellow print on a black background. With this device, he achieved a near acuity of 3.2 point print at 40 cm using continuous text, which reached the goal set of 5 point print or better. The patient did not notice a significant difference in vision and visual comfort without the +3 D over his left eye. Another portable electronic magnifier, the SmartLux (Eschenbach Optik, Danbury CT), with a 5″ screen was trialed without an add power over his left eye, using 8x magnification and the same color contrast setting of yellow print on a black background, and the patient also achieved near acuity of 3.2 point print at 40 cm, which also reached goal acuity. The patient preferred the SmartLux due to the larger screen size. Table 1

Table 1. Low Vision Devices Trialed and Recommended, Purpose of Device, and Visual Acuity Achieved

Low Vision Device	Purpose of Device and Visual Acuity Achieved
+4 D reading glasses (trialed) 	Hands-free device for extended reading Near acuity achieved: 6.4 point print
2x dome magnifier (trialed) 	Stand magnifier for extended/ prolonged reading Near acuity achieved: 6.4 point print
Ruby Portable Electronic Magnifier with a 4.3″ screen (trialed) 	Provides a more comfortable working distance with a reverse-contrast setting for prolonged near work Near acuity achieved: 3.2 point print at a 40 cm working distance
SmartLux Portable Electronic Magnifier with a 5″ screen (recommended) 	Provides a more comfortable working distance with a reverse-contrast setting and larger field of view for prolonged near work Near acuity achieved: 3.2 point print at a 40 cm working distance The patient preferred the portable electronic magnifier with the larger screen size.

illustrates and summarizes the low vision devices trialed and recommended for this patient.

The patient reported difficulties seeing his smartphone, including seeing the number keypad to make phone calls and seeing his emails. The built-in accessibility tools on the patient's current Android smartphone were demonstrated to the patient, mainly focusing on the ability to enlarge the text on his screen. Unfortunately, a reverse-contrast setting was not available on his current model of smartphone.

An ocular health evaluation was performed. His pupils were equal, round, and minimally reactive to light, and a right afferent pupillary defect was observed. Anterior segment evaluation revealed mild Meibomian gland dysfunction in both eyes, mild to moderate superficial punctate keratitis in both eyes, and areas of iris atrophy in his right eye. His intraocular pressures were 12 mmHg in the right eye and 12 mmHg in the left eye at 11:53 AM using Goldmann Applanation Tonometry. An undilated view using a 90 D lens was attempted but was unobtainable secondary to miotic pupils. A dilated fundus examination was not performed as the patient deferred this examination to his glaucoma specialist. A copy of the record from his last dilated fundus exam was obtained from his glaucoma specialist, which reported a cup-to-disc ratio of 0.90 in the right eye and a cup-to-disc ratio of 0.95 in the left eye.

At the conclusion of the exam, the final recommendations were made and discussed with the patient. The SmartLux portable electronic magnifier was recommended to read small print, including the Bible. A plate bumper/guard was recommended to prevent food from spilling off his plate during meals. Occupational therapy to work on basic ADL skills related to eating was also recommended. As the patient was already in an assisted-living facility, a letter was given to facilitate this referral via his primary care doctor. Plano-powered glasses made of polycarbonate material were prescribed for protection since the patient was functionally monocular. Lastly, the patient was instructed to continue care with his glaucoma provider as directed.

Discussion

The use of assistive technology in low vision has led to a wider range of options for patients to help them achieve their visual needs and goals. When traditional low vision devices such as glasses or hand and stand magnifiers no longer allow patients to achieve the desired level of acuity or to complete ADLs, assistive technology devices can be recommended as an alternative management option.[7]

In this case report, the patient reported that he had difficulty reading small print, specifically his Bible. Assistive technology was used to help him achieve his reading goal with the use of a portable electronic magnifier. Prior to demonstrating the portable electronic magnifier, glasses and a dome magnifier, which are examples of traditional low vision devices, were trialed to determine whether magnification provided by spectacles and a stand magnifier would help him read smaller print. When a 2x dome magnifier was used together with +4 D reading glasses, there was no objective improvement in measured near visual acuity and no improvement in reading speed compared to the use of glasses alone. This demonstrated that magnification alone was not sufficient in helping the patient reach his goal, and there was another barrier, likely the patient's severe contrast sensitivity loss, that was preventing him from achieving an adequate level of acuity and reading speed.

When a portable electronic magnifier was trialed, he was able to fluently read 3.2 point print using continuous text, with the use of 6x magnification, a larger field of view, and yellow text on a black background. With traditional stand magnifiers, as the power of the device increases, the field of view decreases.[2] With this device, he was able to achieve 6x magnification with a larger field of view compared to 6x magnification with a traditional stand magnifier. In addition, he appreciated an even larger field of view using the SmartLux portable electronic magnifier with a 5" screen compared to the Ruby portable electronic magnifier, which has a smaller screen size of 4.3". The larger screen size allowed the patient to view more letters on the screen at a time and resulted in an increase in reading speed.[3]

In addition, choosing a portable electronic magnifier benefited the patient because he was able to change the color settings to yellow print on a black background. The reverse contrast setting allowed the patient to overcome the barrier of severe contrast sensitivity loss and improved the patient's acuity and reading rate. In addition, the patient's preferred contrast setting also reduced the amount of glare from the device and improved patient comfort because a white background causes more glare than a black background. These contrast and color settings cannot be changed on traditional magnifiers without changing the color and contrast of the reading material itself, but are quickly accessible on electronic magnifiers.

Although smartphone apps were not demonstrated to the patient in this case, studies have shown the advantages of smartphones and applications to increase independence and activities of daily living for low vision patients. With additional training, smart phones have allowed visually impaired patients to manage leisure and communication independently by allowing them to make phone calls, listen to songs, hear weather updates and search food recipes on their own.[8,9] Smartphone apps have also allowed patients to be independent in dressing and grooming themselves.[10]

Although the patient did not specifically report difficulty ambulating independently, it is likely the patient would also have mobility related complaints due to his severely constricted visual field in his only functionally seeing left eye. Activities including crossing the street and managing stairs and curbs may be troublesome, and the patient may complain of bumping into objects or other people. With patients who report difficulties traveling independently or are at risk of falling due to their vision loss, a referral to a local agency for orientation and mobility training with a certified specialist can be made. Because this patient was already in an assisted living facility, being able to travel independently was not necessarily a main goal of his.

The goals of orientation and mobility training for visually impaired people include compensating for reduced visual information, increasing patient safety, and improving their level of independence.[14] More-common mobility aids and devices include mobility canes to detect obstacles below the waist and other wearable mobility devices to detect obstacles above the waist. With advances in low vision assistive technology, smart mobility canes like the WeWalk Smart Cane (Young Guru Academy, London, United Kingdom) uses ultrasound technology to alert users to nearby obstacles. In addition, it allows users to connect their mobility cane to a smart phone app to provide additional navigational tools.

Other mobility devices like the iMerciv Buzz Clip (iMerciv Inc., Toronto Canada) and the Sunu Band (Sunu, Inc., Boston MA) use assistive technology to detect obstacles above the waist. These devices are either clipped onto the user's clothing or worn around their wrist and use similar ultrasound technology to detect nearby obstacles and alert the user. When these mobility aids and devices are used in combination, patient safety, independence, and quality of life can be enhanced.

When prescribing assistive technology to low vision patients, there are many factors that may influence and determine how successful a patient is with the recommended device or program and that should be considered. These include proper patient selection, patient expectations, training, and cost factors. To ensure proper patient selection, the patient's visual goals and needs should be carefully explored.[3] It is essential that patients prioritize their goals if they have many to discuss with their doctor, and the goals should be as specific as possible. For example, when a low vision patient reports a goal of reading small print, further questioning on what kind of print (digital versus non-digital) and the source of reading material (books, magazines, newspaper, price labels, etc.) should be asked to create a more specific goal. In this case report, the patient specifically mentioned he would like to be able to read his Bible. The patient's familiarity and experience with technology can be considered when recommending assistive technology. At least some experience may be beneficial in learning how to use such devices. Although it wasn't apparent that this patient had much experience with using technology, he had a family member who was also present at his evaluations, as well as other relatives who were more than willing to assist him with using the recommended portable electronic magnifier and built-in accessibility tools on his Android phone as needed. Motivation to use a certain device, even if there is a lack of experience with technology, is a very important factor to determine whether a patient will be successful, because a motivated patient is likely to put the effort into the learning and training aspects in order to achieve their visual goals.

Realistic patient expectations need to be set when recommending assistive technology devices during low vision evaluations.[3] A patient may hear and learn about different devices from websites, television shows, social media, and peers. Advertisements tend to show the product in a very positive manner, which may lead a patient to believe that a device may significantly improve their vision. It is essential that patients are educated as to whether a specific product is or is not appropriate to help them achieve their visual goal and why. For this case, realistic expectations were discussed by educating the patient that the portable electronic magnifier would be an appropriate device for him to read small print but that there might be a learning curve in learning how to use the device efficiently. The patient was educated that he should not expect to be able to read fluently for long periods of time when first introduced to the device. He would need to practice using his portable electronic magnifier frequently to become proficient while using it to read. He acknowledged what was said to him and was motivated to order the device.

Device training is an important component to ensure that a device is used effectively.[3] The provider should estimate and educate the patient regarding how many training sessions may be needed to become proficient with the use of the recommended device(s), although the number of sessions may depend on several different factors. Multiple sessions may be required if the recommended device is more complex or if a patient has trouble demonstrating independent use of the device. Other considerations with patient training include determining who will take on the role of training. The provider or a trained staff member/technician may conduct the training in-office, but the patient will also need to practice using the device at home. With certain products, company representatives may complete the training as part of purchasing the device. Proper training can help reduce the abandonment of devices, especially ones that are costly. This results in less patient frustration and improved quality of life from using the device when in-office and home training are completed versus a low vision device dispense without any additional training.[11]

Although many assistive technology products and programs are costly, the price of a device should not completely steer the direction of the exam.[3] Low vision patients benefit from trial of a range of options. For example, in this case, the patient was unable to reach his goal acuity with increasing powers of spectacles and a dome magnifier. To demonstrate a range of options, trial of a portable electronic with yellow print on a black background diagnostically revealed his severe contrast sensitivity loss as a barrier to him achieving his goal acuity. It was only after the successful trial of the portable electronic magnifier that the cost of the device was discussed. In certain instances, lower-cost options can be considered, including older models of a device or refurbished instruments. Some companies have introduced other financing options and payment plans to lessen the burden on the individual. Because some devices may fall into the price range of thousands of dollars, traditional low vision devices may end up being the recommended choice due to lower cost, as long as the patient is able to achieve goal acuity.[7,12] The patient in this case report was educated regarding a fee reduction program available through a non-profit organization.

There are obstacles that may prevent the use of assistive technology amongst the low vision population. One limitation is that many patients who may benefit from the devices and programs are unaware of their availability. In one study, clients of the Utah State Library for the Blind and Disabled were surveyed to determine who would be interested in using assistive technology in the library, the level of awareness of available services, and factors that would promote their use. The survey revealed that less than one quarter of their users were aware that this technology was available for them to use. Users who were aware of the benefits of assistive technology were more inclined to use it. Other factors that increased a client's willingness to use assistive technology at the library included current use of other services at the library; access to a computer at work, school, or other locations; proximity to the library; and the user's age. Specifically, a larger number of younger people compared to older people reported that they would use the technology if it were available.[13]

Conclusion

The use of assistive technology in low vision has created additional management options to help visually impaired patients achieve their personal visual goals and perform ADLs independently.

Proper patient selection, setting realistic expectations, and providing or facilitating training will all contribute to the successful use of recommended devices and programs. Cost factors should be considered when appropriate but should not preclude demonstration of assistive technology options.

Visually impaired patients are likely unaware of the many assistive technology devices, tools, and resources available to them. The eye care provider does not need to be a low vision provider in order to recommend certain devices and tools discussed, such as built-in accessibility functions and apps for smartphones. Eye care providers should consider referral to low vision rehabilitation services if they are not able to provide such services themselves. These services will help visually impaired patients be more independent and have improved quality of life.

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Correspondence regarding this article should be emailed to Leannza Tang, OD at leannza.tang@mountsinai.org.

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