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Communication technologies such as smartphone apps help to connect people to the eye care they need. KENYA

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## Communication technology for eye care



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Communication technology has great potential to improve access to eye health care, provided equity of access is a priority.

Digital technologies are part of our life, and they have tremendous potential to improve people's health if applied in the health sector. The Global Strategy on Digital Health (see [bit.ly/digi-WHO](https://bit.ly/digi-WHO)), adopted in 2020 by the World Health Assembly, supports the strengthening of digital health services to improve health outcomes. There is also growing consensus that using cutting-edge digital innovations and technologies will enable more people to benefit from universal health coverage.

Digital health is an umbrella term that includes communication technology, health information

technology, big data, artificial intelligence, genomics, and wearable technology. In this issue, our focus is specifically on communication technologies such as mobile health (mHealth), telehealth, telemedicine, and teleconsultations. These have become vital tools for delivering health care services, in part due to the pressures brought by the COVID-19 pandemic.

Communication technology has great potential to help deliver good quality and affordable health care. However, there are challenges. New technology can be expensive and must therefore

*Continues overleaf* ➤



## About this issue

Communication technology has great potential to help deliver good quality and affordable health care, so long as equity of access is prioritised. The articles in this issue provide guidelines for developing inclusive and accessible mobile health (mHealth), teleophthalmology, and artificial intelligence (AI) services for everyone – including people with disabilities, those with low digital literacy, and those who lack internet access – while protecting patients' data and privacy.

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be well suited to the needs of the community where it will be used, and of sufficient quality to justify the financial investment made, as our article on refractive error innovations demonstrates. Another major challenge is pre-existing inequalities in communities' access to education, infrastructure, and technology. Appropriate, equitable, and ethical use of technology is a must if we are to avoid deepening already existing health inequities. Factors such as poor internet connectivity, low digital literacy, and lack of access to broadband internet and smartphones – known as the 'digital determinants of health' – should be central in our thinking when incorporating communication technology into existing services.

In this issue, you will therefore find articles that provide guidelines for developing inclusive and accessible teleophthalmology services for people with disabilities, those with low digital literacy, and those who lack internet access, while protecting patients' data and privacy. We also discuss artificial intelligence (AI) in eye care and the need for equitable development of AI services.

We hope that you will find useful ideas and inspiration in articles from different regions that show the potential of AI, mHealth and teleconsultations to bring patients closer to the eye care they need.



Woman holding a smartphone showing the letter 'E' and swiping the screen. **KENYA**

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# Teleconsultation for eye health delivery

Teleconsultation has emerged as a significant component of eye health service delivery, especially given the challenges of accessing in-person health care services in the wake of the COVID-19 health care crisis.



A slit lamp picture is captured at a vision centre in the primary eye care network and shared with the hospital, where an ophthalmologist views it and responds. **INDIA**

Teleconsultations – the use of communications technology to connect health professionals to each other and to patients – are important for providing health care to people in remote areas or to those unable to come to a secondary or teaching hospital, whether due to distance or the COVID-19 pandemic. Teleconsultation is not a new concept, but recent advances in technology solutions, the expansion of internet and cell phone connectivity, and the widespread use of smart devices have all contributed to its immense growth and popularity.

## What is teleconsultation?

Teleconsultation is a virtual medical consultation for diagnosis and/or treatment using information and communications technology (ICT) to bring health providers and patients together.

Teleconsultations can take place between the patient and physician, between physicians, between the physician and the primary care provider, between the patient and the primary care provider, or as three-way communication connecting the patient, the primary care provider, and the physician.

## Challenges and limitations of teleconsultations

The following are some of the challenges and limitations associated with teleconsultations.

**Absence of physical examination.** If patients consult from home, e.g., via videoconferencing or telephone/cellphone, the primary eye care provider or ophthalmologist is unable to directly examine their eyes. Therefore, their advice will depend on the patient's description of their condition, or the quality of the video or photographs the patient can send. Likewise, when patients are seen at the primary level, the ophthalmologist has to depend on the available technology and the examination skills of the primary eye care provider, e.g., their ability to accurately measure intraocular pressure.

**Lack of adequate technology and infrastructure.** Internet connectivity in remote rural areas can be erratic, and the lack of hardware devices such as mobile phones or computers might hinder the patient's ability to perform a teleconsultation directly with the clinic. Staff members in primary care also need access to technology such as slit lamps

with cameras or video cameras, and good quality internet connection so the images or videos can be transmitted electronically.

**Data security and regulatory barriers.** The exponential expansion of teleconsultation systems worldwide has created increased risks with respect to liability and legality. Data protection and data privacy are key issues that health care providers must be aware of, and comply with, to ensure patients' privacy. It is recommended that digital health information systems are put in place to ensure patient data safety and continuity of care while using electronic medical records during teleconsultations and other interactions.<sup>1</sup> Other regulatory matters to be aware of include country-specific licence and insurance requirements.

**Data accuracy and the potential for misdiagnosis.** Another key reason for setting up and maintaining digital health information systems is to ensure that patient data is accurate. This will help to avoid serious errors in the delivery of care.

Teleconsultations can be performed synchronously (i.e., in real-time, via video, audio, or text message interaction) or asynchronously (i.e., by transmitting or exchanging clinical information such as medical history, laboratory results, prescriptions, and so on).

## Benefits of teleconsultation

A well-designed teleconsultation service can:

- support diagnosis by providing timely access to the patient's medical information
- build consensus between different providers about the patient's care plan, thereby increasing the patient's trust in the health system
- contribute to the quality of the patient's overall experience of health care delivery.

## Teleconsultations in eye health care

Teleconsultations in eye health care (also known as teleophthalmology) can change the delivery of eye care from a centralised service to one which is patient-oriented and where decisions are made as close to the patient as possible. This reduces the need for an ophthalmologist to be present at every site.

In some countries, patients can attend consultations remotely via videoconferencing technology, which can be challenging due to connectivity issues or lack of access to technology. Another option is to connect a primary health care or eye care centre to a secondary or tertiary hospital staffed by ophthalmologists or specialist ophthalmologists, respectively.

Teleconsultation allows non-specialist eye care providers working in remote areas – who are trained to use diagnostic equipment such as slit lamps or fundus cameras – to consult with expert colleagues so that anterior and posterior segment causes of avoidable blindness can be identified. Patients can then be referred to specialist centres to receive medical or surgical care.<sup>2,3</sup> Teleophthalmology has been shown to be beneficial at the primary eye care level in screening for diabetic retinopathy,<sup>4</sup> and it is a viable and cost-effective alternative to conventional eye care services in rural and remote areas.<sup>5</sup>

The philosophy of moving information instead of patients (for example, a technician screens for retinopathy of prematurity and sends images to be graded, instead of sending the parents and baby to a hospital) has benefits for the patient (by addressing socioeconomic and demographic barriers to accessing care) and for care providers (by optimising health care costs).

In summary, this '**recognise, resolve, refer**' approach to teleophthalmology involves the following.

- **Recognise.** Timely **identification** of the common ocular conditions that cause visual impairment, such as pterygium, corneal ulcer, cataract, squint, and diabetic retinopathy, by the primary eyecare provider/ ophthalmologist stationed at the base hospital.
- **Resolve.** Treatment advice provided by the ophthalmologist to the patient and primary eye care provider.
- **Refer.** Referral for more specialist medical or surgical care if needed.



The command centre at the hospital receives the teleconsultation request from the primary eye care network and the ophthalmologists on duty respond. **INDIA**

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## Teleconsultations in India during COVID-19

In India, as the world over, the COVID-19 pandemic created many challenges in the area of health care, forcing health care providers to innovate and adapt quickly.

Forced to stay at home due to travel restrictions, patients and health providers turned to technology to communicate with one another, using apps or chat platforms such as Skype, Facetime, Zoom, Google Hangouts, Microsoft Teams, WhatsApp, Signal and Telegraph.

India's ministry of health and family welfare released telemedicine practice guidelines at the onset of the COVID-19 pandemic in 2020. The guidelines cover, among other points, definitions and applications of telemedicine, definitions of the registered medical professionals (RMPs) permitted to practice telemedicine, the technology used, patient consent, exchange of information for evaluating patients, and prescribing of medicines.<sup>6</sup> Every RMP must complete a mandatory online course on telemedicine within three years of the notification of the course; in the interim, RMPs must follow the principles of the telemedicine practice guidelines.

Although there are still challenges to be overcome in health service delivery through telemedicine and teleconsultation, there is no doubt that there has been a significant increase in the use of teleconsultation services in India. The goal should be to harness the full potential of teleconsultations to benefit patients, enabling them to access care at locations closer to home and subsequently reduce the number of patients who need to be referred (for physical examination).

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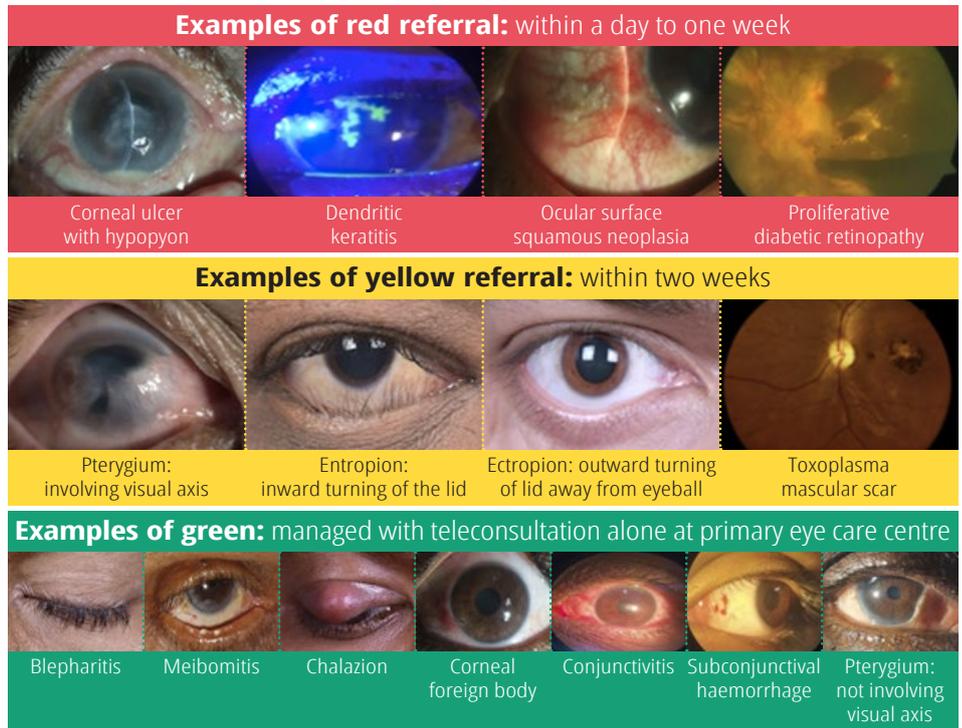
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# Setting up a primary eye care teleconsultation service

Advances in information and communication technology have made it possible to set up teleconsultation services that can improve primary eye care.



**Figure 1** The referral and tracking system used in LV Prasad primary eye care vision centres.

## Cloud computing

is an umbrella term that includes storing data on a distributed network of servers that are connected via the internet, and using applications or apps that are hosted on this distributed network, which is also known as 'the cloud'.

## Synchronising data

(or syncing data) involves the background upload and download of data across a cloud service so that the most up-to-date data are available to everyone who is authorised to have access.

Advances in information and communications technology (ICT) have enabled us to scale up digital health solutions around the world. Medical teleconsultation has come a long way from the early explorations with television and telephone<sup>1</sup> to the present use of smartphones and smart devices.

Today, primary eye care delivery can be greatly improved through ICT, enabling eye care staff at community or primary eye centres to be in direct contact with clinicians at tertiary centres and teaching hospitals. It is even possible for patients to speak directly with clinicians via online videoconferencing solutions.

Here are the key considerations when setting up a comprehensive primary eye care teleconsultation service.

## Location

The location of the primary eye care centre or eye clinic (either a standalone facility or as part of a primary health centre) is crucial: it should ideally be near enough so that patients can afford to travel to the base hospital that provides higher medical and surgical care to patients.

## Infrastructure

The primary eye care centre must have the space needed to carry out distance visual acuity tests (at a distance of 6m) and near vision tests. The room should be well lit to allow staff members to carry out eye examinations.

The amount of space needed for the teleophthalmology command centre at the base hospital will depend on

the number of teleconsultations per day and how many staff members have to work at the same time. The command centre would be staffed by ophthalmologists who could either work full time or allocate time for teleconsultations as a part of their weekly schedule.

## Connectivity

Reliable internet connectivity is crucial for seamless and smooth teleconsultation. If possible, a dedicated internet line with a Wi-Fi router should be installed in the primary eye care centre. Alternatively, a smart tablet with a 2G/3G/4G SIM card can be used to synchronise (sync) clinical information and teleconsultation requests through **cloud computing**.<sup>2</sup> Where internet is erratic, digital apps can be used to store clinical information and data, which can be synced to the cloud when the internet connection is working. Another way to sync information to the cloud is to create an internet hotspot using a smartphone. In challenging environments, all options must be explored, and a hybrid model can be used to sync data from remote eye care centres to the cloud.

When patients are unable to come to the primary health centre, as for example during a pandemic, free video platforms such as Skype, WhatsApp, Google Meet, Microsoft Teams, and Zoom offer patients an easy way to communicate with the primary care provider.

## Equipment

Visual acuity can be tested using a Snellen chart, digital screens, or through apps such as Peek Acuity and Smart Optometry.<sup>3</sup>

A basic set of equipment (trial lens set, slit lamp, and intraocular pressure measurement device) is necessary so that refractive errors and anterior segment disorders can be detected. A non-mydiatic fundus camera, if available, can be used to capture posterior segment pictures. Digital applications (apps) for teleconsultation can be installed on computers or smart tablets that run on Android or iOS.<sup>4</sup> Alternatively, a Google Form (or similar) can be designed for use by primary eye care personnel to enter clinical data, which can then be accessed by the ophthalmologist.<sup>5</sup>

Clinical data and media captured by digital devices (cameras/scanners) must be shared in standard formats such as JPEG and MP4. The system must ensure secure transmission of data, ensuring patient confidentiality through encryption and password protection, and there must be defined levels of access for the care providers. Cloud service providers such as Amazon Web Service (AWS), Google Cloud, and Microsoft Azure can be used to integrate the teleconsultation system.

Ophthalmologists at the command centre can access teleconsultation requests on computer monitors and provide expert opinion within a time frame that is acceptable to the patient. A 3D-printed attachment holding a smart device to the slit lamp eyepiece<sup>6</sup> can be used to live stream information during eye examination. A universal smartphone attachment can also be used to obtain better quality anterior segment pictures/videos for transmission to the command centre.<sup>7</sup>

## Human resources

The primary eye care centre should ideally have a primary eye care provider trained in the basics of ocular anatomy, physiology, and pharmacology, who is able to identify common anterior and posterior segment eye conditions in patients presenting to the primary eye care centres.<sup>8</sup>

## Training

There should be regular training for primary eye care providers to update them with the latest clinical information, image capturing skills, and referral guidelines. There should also be regular certification programmes in teleconsulting, and anterior and posterior segment image capture. In India, the Ministry of Health and Family Welfare mandates that registered medical practitioners undergo an online course before practising teleconsultation.<sup>9</sup>

## Audit and monitoring

An easy way to monitor and support primary eye care providers across centres is through chat groups on free messaging and video calling apps, such as Telegram, Signal, Skype, Slack, and WhatsApp. Such a group can be used to quickly resolve technical issues and user queries.

Image quality is an essential factor in efficient teleconsultation. Primary eye care providers can be encouraged to post a 'picture of the day' in their chat groups to improve their imaging skills. Regular assessments can be instituted through weekly or monthly audit meetings, virtually or in person.

## Legal considerations

Government guidelines, as applicable, should be followed on the handling of patient-related health care data. Secure data transmission through encrypted channels and robust access protocols will protect data privacy and minimise the risk of data breaches. Legally acceptable patient consent must be obtained prior to teleconsultation and saved for future reference.

## Learning and improvement

Teleophthalmology referral guidelines can help to optimise the time of the treating ophthalmologist.<sup>10</sup> Structured flow charts listing ocular conditions that can be referred for teleconsultation can be used in primary eye care centres. The teleophthalmology record system tracks referrals from primary to secondary/tertiary levels of care through a colour-coded system (Figure 1).

## Analytics

Analytics can give us better insight into the progress of the teleconsultation service. Data on patient demographics, clinical condition, triage categorisation, turnaround time, advice requested, and advice given must be analysed periodically. The graphical representation can be done on Microsoft Excel or visualised interactively using a platform such as Tableau or Power BI.

Finally, it is important to have the will to set up a teleconsultation service, especially considering the challenges that rural geography brings. However, the availability today of simple, free digital tools can minimise the cost of setting up such a service. Teleconsultation services offer a ray of hope to patients who may not otherwise have a chance to access quality eye care services.

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# Running an inclusive and accessible teleophthalmology service for people with disabilities

People with disabilities face various barriers when making use of teleophthalmology, and these must be addressed with care when planning and implementing services.

The ongoing pandemic has seen an increased push to improve remote access to health care, including eye care. However, despite the advances in telehealth and teleophthalmology, people with disabilities continue to face varied and complex challenges when accessing health services. The level of challenge people face depends on the type and severity of impairment and their age, gender, and socioeconomic status. In addition, there are the 'digital determinants of health': the degree of access people have to the internet and to assistive and communication devices, and their level of digital literacy.

The 184 countries that ratified Article 25 of the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) are legally bound to ensure that persons with disabilities enjoy the highest attainable standard of health without facing discrimination based on disability.<sup>2</sup> This also implies that health care providers have the responsibility to ensure that services such as teleophthalmology are inclusive for people with disabilities.

## Adapting teleophthalmology for people with disabilities

Teleophthalmology can allow people with disabilities to receive high quality and affordable eye care from the comfort of their home or at an easy distance from it. This can help them avoid the barriers of travel costs, travel and waiting time, and the need for support from a caregiver. Importantly, however, teleophthalmology services must themselves also be accessible and disability-friendly and not create new barriers.

Equally, it is important that people with disabilities have adequate representation in the design of telehealth services at the regional, national, and policy levels. It would also be good practice to seek their help to give feedback to ensure services are user friendly.

**People with visual impairment or blindness** use screen readers (such as NVDA, JAWS, or VoiceOver) to read what is on their screen. The teleophthalmology platform should therefore be compatible with assistive



Eye care centres that offer teleophthalmology services must be physically accessible and user friendly. CANADA

technology and Braille keyboards. Screen readers cannot read scanned documents, images, or infographics if no alternative text is provided. It is, therefore, recommended that optical character recognition (OCR) technology is used to scan physical documents (records, lab notes, reports, and prescriptions) before uploading them to a digital or telemedicine platform. The OCR software converts scanned documents to readable text documents. In addition, colour contrast and text magnification options are crucial for allowing people with low vision to access the platform.

Patients need clear instruction, in accessible formats, about how to upload photos of the eye. Tools such as VoiceOver in iOS devices make the camera app accessible to people with blindness. If such technology is unavailable, a friend or caregiver's help may be needed to take the picture.

**People with mobility impairments** may find it difficult to do tasks requiring fine motor skills, such as controlling the mouse to move the cursor or clicking multiple times to navigate a site. They may also find it challenging to set up appointments if they have to complete long or complicated forms. Well-organised information and forms with fewer fields can enhance access.

Depending on their level of impairment, **people with speech and hearing impairments** might use alternative communication devices or sign language interpretation to communicate with the eye care provider. Therefore, the teleconsultation platform should ideally make it possible to include an online interpreter on the same video call with the patient and eye care provider.

A possible solution in a low-resource setting would be to recruit and train several freelance interpreters so that one of them will be able to join in the audio or video call. Allied ophthalmic personnel can provide

two to three days of training to interpreters to explain the medical terminology commonly used in eye care; this will avoid misunderstandings or losing crucial information while interpreting. In India, the Indian Sign Language Research and Training Centre (ISLRTC) maintains a directory of sign language interpreters.<sup>3</sup> Such directories serve as a good resource for interpretation services as and when required.

Although masks are indispensable in pandemic times, an ophthalmologist undertaking an online consultation with a **patient with hearing impairment** could use a transparent face shield instead. This small change would help those using cochlear implants or hearing aids to lip read and see expressions, which helps them to follow the conversation. The chat option may also be helpful when communicating in a low-resource setting.

It is also vital to provide adequate captioning in regional languages for video content or educational/awareness materials that health providers put online so that these are accessible to everyone.

**People with intellectual or developmental disabilities** may not be comfortable explaining their eye health problems over the phone or video chat. Caregivers can be included in the conversation after taking consent from the patient with a disability.

Many people with disabilities, and older people in low-, and middle-income countries, are likely to have lower socioeconomic status, low levels of digital literacy, and limited or no access to the internet or smartphones; thus, they are unable to benefit from teleconsultations. To reach out to such a population, an eye hospital may have to arrange transport – with the help of non-governmental organisations (NGOs) or disabled people’s organisations (DPOs) – that would allow people to visit the nearest clinic or vision centre where teleophthalmology services have been established.

In the absence of such a centre, or when travel restrictions are imposed during a pandemic, a vision guardian or health worker – who may have a mobile internet device – can identify patients who require an eye care consultation and visit them at home. Providing a toll-free helpline number (which people can call to speak to a clinician) can also be an option.

If teleophthalmology services are planned at an eye care centre, the facility must be physically accessible and user friendly, equipped with universal design elements such as accessible parking, signage, step-free entrances, ramps, lifts, accessible toilets, tactile tiles, grab bars, and accessible examination spaces and diagnostic equipment.

Eye care service providers should work closely with the manufacturers of telehealth platforms to ensure that the needs of people with disabilities are anticipated and planned for from the start. Standardisation can address most of these barriers. For the latest guidelines on ICT accessibility, please see Web Content Accessibility Guidelines (WCAG)<sup>4</sup> at <https://bit.ly/3Lfx8dN>.

The most important thing to remember when providing services for people with disabilities is to make contact with them in advance to understand their preferred mode of communication. Table 1 lists the barriers typically faced by people with disabilities in accessing remote eye health services and some ways to overcome them.

Disability sensitisation workshops for eye care workers can also be planned in liaison with DPOs to improve staff members’ understanding of the barriers faced by people with disabilities in accessing eye care services. Developing a protocol for teleconsultations, and training staff members who provide teleconsultation services, will make this more comfortable for staff members and the patients who seek eye care.

**Table 1** How to make teleophthalmology services accessible for people with disabilities

Barriers faced	Action suggested
<b>Inaccessible teleconsultation platform</b>	<ul style="list-style-type: none"> <li>Ensure that your teleconsultation platform complies with accessibility standards and guidelines. In case your government has not yet adopted such guidelines, refer to the Web Content Accessibility Guidelines online (WCAG)<sup>4</sup></li> <li>Involve disabled people’s organisations (DPOs) in the planning stages and get your platform audited for accessibility</li> </ul>
<b>Communication barriers</b>	<ul style="list-style-type: none"> <li>Capture patients’ accessibility needs and support requirements when appointments are made</li> <li>Give disabled patients flexible and longer appointment times to avoid rushing</li> <li>Check what type of disability a patient has and make arrangements accordingly (e.g., arrange a sign language interpreter, or use audio messages)</li> <li>When speaking to a person with a visual disability, identify yourself and explain your role (e.g., “Hello, I am ..., and I am here to help you with ...”)</li> <li>Listen attentively to the person with speech impairment; let them complete the sentence at their pace and allow adequate time for them to ask questions</li> <li>Provide prescriptions in a preferred format such as Braille, large print, or audio messages</li> <li>Use optical character recognition (OCR) technology to scan documents before uploading them to a website and make the text-based version available too</li> <li>Provide adequate captioning in regional language for the website’s audio visual content</li> </ul>
<b>Low digital literacy or lack of access to digital devices and the internet</b>	<ul style="list-style-type: none"> <li>Provide home visits by eye care workers for patients who do not have active internet or devices</li> <li>Provide a toll-free helpline number for patients to contact the service they need</li> <li>Arrange transport with the help of NGOs or DPOs to the nearest primary eye care centre</li> </ul>

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# The use of teleconsultation and technology by the Aravind Eye Care System, India

Teleconsultation in vision centres, as a part of teleophthalmology services, is a critical component of primary patient care at the Aravind Eye Care System in India.

Teleconsultation services are a key element of teleophthalmology. Teleophthalmology is a coordinated eye health care approach that connects patients and health care providers via information and communications technology (ICT) to enable health care to reach remote and underserved areas.

In India, the Aravind Eye Care System (AECS) has been deploying teleophthalmology at the primary and secondary levels of eye care. The Aravind Teleophthalmology Network (ATN) provides accessible and affordable eye care service to people in remote areas using advanced communications technology, saving time and money that would otherwise be spent on travel.<sup>1</sup>

## Teleconsultation in vision centres: primary level eye care

Vision centres are primary eye care facilities based in rural and semi-rural communities. The centres, which were started in India in 2004, have grown in number and become an important part of eye care services in both the government and private sectors.

Each vision centre is managed by a trained ophthalmic technician and a coordinator. It has basic ophthalmic equipment, such as a slit lamp, an applanation tonometer, a trial lens set for refraction, and two computers with broadband internet connectivity.



The vision technician examines a patient at the vision centre before beginning a teleconsultation with the ophthalmologist at Aravind eye hospital. INDIA

During a teleconsultation, the ophthalmic technician examines the patient, records the refractive error and the anterior segment and fundus findings (on 90D examination), and documents the findings in a secure electronic medical record (EMR) which can be accessed securely by ophthalmologists working at the base hospital. Next, during a video call with the patient and the ophthalmic technician, an ophthalmologist at the base hospital views the EMR along with the images and any additional information provided by the technician. The ophthalmologist then enters her or his advice in the EMR and discusses the next steps with the patient.

Aravind vision centres together carry out more than 2,800 teleconsultations a day, and this model has been replicated by others in many states in India as well as across Bangladesh. Data from the AECS vision centre registry indicate that 15–17% of patients seen at AECS vision centres had to be referred to a tertiary centre.

## Technology in secondary level eye care

At the secondary level, technology can be used to support screening for conditions that affect the back of the eye, such as diabetic retinopathy (DR) and retinopathy of prematurity (ROP). Early diagnosis and treatment of these conditions can prevent needless blindness; however, not all secondary or district hospitals have retinal specialists who are able to diagnose these conditions.

The availability of tools based on artificial intelligence (AI) that can analyse retinal images has made the diagnosis of DR quicker and simpler. For ROP, retinal scans taken in neonatal intensive care units can be sent to specialists at tertiary hospital level for analysis and identification of ROP.

## Barriers

When implementing teleophthalmology, the major barriers are the initial cost of investment, difficulties capturing high quality digital images, the shortage of trained and dedicated health care and teleophthalmology personnel, and concerns about the privacy and security of patient data.

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Telescreening for retinopathy of prematurity at secondary level. The images recorded during the scan are shared with specialist paediatric ophthalmologists at tertiary or specialist hospitals. INDIA



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# Teleophthalmology case study: Sankara Nethralaya, India

Sankara Nethralaya eye hospital offers free community-based teleophthalmology services as well as paid online services to existing and new patients – even those who do not have their own access to the internet.

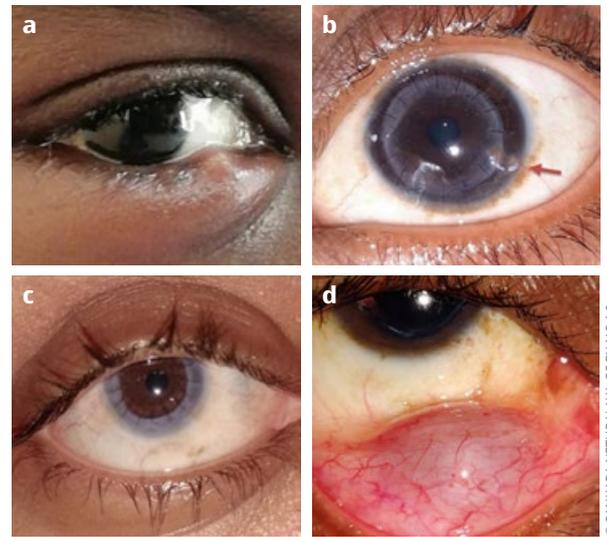
In 2003, Sankara Nethralaya eye hospital in Chennai became the first eye hospital in India to start using teleophthalmology to provide primary eye care to people in rural villages. This free service involves using a satellite link mounted on the roof of a mobile eye care van and includes comprehensive eye examinations and screening for cataract and diabetic retinopathy.

## New teleophthalmology models

With the arrival of the COVID-19 pandemic in 2020, it soon became clear that more people would need teleophthalmology services – not just those in rural areas.

The practice guidelines for telemedicine provided by the government of India at the beginning of the COVID-19 pandemic<sup>1</sup> provided a framework for the regulation and diversification of teleconsultation services in the country. In response, and in addition to its existing service in rural areas, Sankara Nethralaya set up three new teleophthalmology access points: for new patients, existing patients, and patients who are without internet access but can visit an optical shop.

- Existing patients.** These patients can set up an online teleconsultation appointment from home, by visiting the Sankara Nethralaya hospital website and completing an online form that is automatically linked to their patient records. Patients fill in their eye health history, check their vision using either of the two smartphone-based applications we recommend (Peek Acuity<sup>2</sup> or EyeChart), take photos of the affected eye on their smartphone, and upload the results through the online patient portal link provided. Patients are encouraged to watch a video that shows them how to take good quality photographs (see Figure 1).
- New patients.** The process is like the one for existing patients, but an optometrist connects with the patient online to help them with documentation, uploading of old reports, taking pictures, and the triage process.
- Patients with no internet access, but who can visit an optical shop that is connected to the base hospital,** can make use of the shop's comprehensive



**Figure 1** Photographs patients have taken of their own eyes after watching a video on how to take good quality photographs. **a** Hordeolum externum (stye). **b** Loose sutures following corneal graft. **c** Follow-up photo of deep anterior lamellar keratoplasty (DALK). **d** Conjunctival cyst. **INDIA**

eye examination facilities and connect to an ophthalmologist via audio/video call. This is currently a pilot project involving selected optical shops across India.

## Benefits of teleconsultation

The model of connecting a patient with an ophthalmologist directly from home requires relatively few resources. The hospital needs to have an electronic medical records system, teleconsultation facilities (audio/video calling) and a payment gateway. Free teleophthalmology services can be extended to those who cannot afford to pay after their eligibility is checked at the hospital.

With this model, patients need to have a smartphone and an internet connection (mobile internet or otherwise). Patients without access to a smartphone cannot share medical reports or pictures, but they can still get medical advice via short message service (SMS) and audio calls, or they can visit an optical shop linked to the hospital, if there is one nearby.

Teleconsultations are helpful for following up on surgical patients, for second opinions, for reviewing uploaded patient reports, and for counselling prior to surgery. Teleconsultations can also be used for orthoptic, contact lens, low vision, rehabilitation, and genetic counselling services. Collecting feedback from patients after every teleconsultation and taking quick action on grievances will help the quality management team to improve services.

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**Patients who have internet access can book online video appointments.** **INDIA**



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# Using technology to improve access to optometric services

Teleoptometry can reduce barriers and improve access to primary eye care services delivered by optometrists.

Measures to reduce the transmission of COVID-19 have severely limited the number of people who could make use of in-person optometry services over the last two years, leading many service providers to try and bridge the gap by using different forms of communication technology to improve access. For example:

- the deployment of technicians to facilitate remote optometry examinations in the community, e.g. by assessing vision and capturing patient details using mobile apps
- offering telephone or video consultations as a form of triage to streamline access to timely care for patients with urgent presentations
- offering such 'remote' or 'teleoptometry' consultations to existing patients who need follow-up care and advice, e.g., patients with low vision.

Teleoptometry can be a valuable companion to in-person services. Although peer-reviewed literature about this is limited, we know that in settings where optometrists are involved in online referrals that include video consultations, patients report being highly satisfied and accepting of these services.<sup>1</sup> Similarly, patients receiving low vision services via teleoptometry have reported a high level of satisfaction with the consultation.<sup>2</sup>

Some of the challenges that have arisen include uncertainty regarding professional indemnity insurance, and ensuring that teleoptometry services are delivered in accordance with local privacy and information security laws. The College of Optometrists in the United Kingdom have published temporary guidelines to guide optometrists conducting remote consultations during the COVID-19 pandemic; this is accompanied by a **clinical telephone review template**.<sup>3</sup>

## What remains a challenge?

More broadly, concerns have been raised about the delivery of teleophthalmology services increasing inequity in marginalised, vulnerable populations due to the 'digital divide' – the gap between those who have ready access to the internet and electronic devices, and those who do not.<sup>4</sup> It is therefore essential to design teleoptometry services that prevent the further marginalisation of vulnerable groups, for example by ensuring access to language interpretation or sign language services.

Teleoptometry services created during the pandemic present a unique opportunity to continue offering access to primary eye care services delivered by optometrists, which will help to reduce the barriers to access faced by marginalised and vulnerable



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populations. However, there is an urgent need for more evidence to support the safe, effective and equitable delivery of teleoptometry practice, including potential solutions to the digital divide.

## How to carry out a remote telephone/video optometry consultation

During the COVID-19 pandemic, the College of Optometrists, UK, published the following steps for optometrists to follow when carrying out remote telephone or video consultations. Adapted from: *Remote consultations during COVID-19 pandemic* (<https://bit.ly/RemoteOptom>).

- 1 Verify the patient's identity and contact details.
- 2 Ensure you and the patient are in a private space, as you would in an in-person consultation.
- 3 Confirm the patient is happy to continue with the virtual review.
- 4 Utilise the clinical telephone review template to document the conversation, including any observations you make during the video call.
- 5 Determine the management category for the patient: 1) refer to eye casualty for sight/life threatening condition, 2) book urgent optometry review, or refer to eye casualty for potentially sight/life threatening eye condition, 3) advise to self-manage minor eye condition, 4) book appointment for non-urgent eye condition.
- 6 Support self-care by emailing or posting advice to patients.
- 7 Securely store the clinical record of the telephone or video consultation.
- 8 Advise the patient to contact you again should their symptoms worsen.

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# Artificial intelligence in eye care: a cautious welcome

Artificial intelligence is being positioned as a technology that can transform health care. However, there are pitfalls.

Artificial Intelligence (AI) is a field that aims to develop computers with the same capabilities as humans, such as the ability to perceive, learn, problem solve, and manipulate.

One of the most well-known early applications of AI is the development of chess computers, culminating in the 'Deep Blue' computer which beat the world's leading chess player at that time, Gary Kasparov, in 1997. However, this was a very narrow and specific use for AI. It would take a rapid rise in computing power over the next two decades, plus the availability of vast sets of data in the areas of health, economics, and demographics (to name a few), before AI started to make a difference in health care – with ophthalmology as one of its first applications.

The key benefits of AI within health care are improved accuracy, decision making, and efficiency, which can relieve humans of mundane, repetitive tasks, thereby maximising their unique value within the workforce. The first AI-based medical device to get Food and Drug Administration (FDA) approval in the United States was a tool for automatically grading retinal images, known as IDx. Several retinal grading systems now exist, and they are much faster than human graders, thereby reducing the cost, burden, and delays associated with human grading.<sup>1</sup>

The use of AI for medical image analysis involves machine learning: 'training' the AI system using large data sets, such as sets of retinal images with features labelled by experts for the machine to 'learn' from. Provided that the machine has learnt from a large enough number of labelled images, it can then grade images it has never 'seen' before.

AI is being positioned as a technology that can bridge the health inequity gap. However, there are pitfalls, as stated in the *Lancet Global Health* Commission on Global Eye Health: "Technological developments such as ... artificial intelligence offer the potential to revolutionise eye health care in the next decade by delivering affordable, high-quality services to remote areas. However, caution is needed to ensure all populations benefit from these developments."<sup>2</sup>



A portable fundus camera equipped with AI software is used to screen for diabetic retinopathy. MOROCCO

The accuracy of an AI system depends on the quality and suitability of the data it is trained on. In DR screening, the need for large, well-managed databases of retinal images for the AI to learn from leads to a bias towards developing AI systems that are trained to identify diabetic retinopathy (DR) in populations for whom such datasets already exist, typically in well-resourced health systems. This further leaves behind those living in low-resourced health settings (an issue which has recently become known as 'health data poverty').<sup>3</sup>

It is not immediately obvious whether AI systems trained on high-income datasets will be able to achieve the same levels of accuracy in populations elsewhere, and they must therefore be tested locally – and evaluated against skilled human graders – before being implemented.

Eye health represents one of the most exciting areas in medicine where AI is likely to have a large impact. However, the hard and complex work of integration into health services has yet to be realised. Activities that enable task shifting and more affordable, local services, such as DR grading at primary health facilities, are needed to ensure better access and lower the pressure on the health service.

Even if the potential of AI for DR grading is fully realised, the 4.4 million people estimated to have any level of vision impairment from diabetic retinopathy equates to a small fraction of the 1.1 billion people living with vision impairment globally.<sup>2</sup> Leading causes of vision loss, such as untreated cataract and refractive error, have yet to receive the same level of interest and investment as DR.

If we are truly to realise the potential of AI in health care and eye care, a more equitable and purposeful design of technologies and incentive systems is required.

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# Innovative approaches to refractive error services: criteria and considerations for success

Innovative approaches and technology-based solutions have a significant role to play to ensure that equitable and accessible eye health services are available to all.

The success and sustainability of a new technology depends on how accurate and safe it is, and how well it meets the specific needs of the country or community it is meant to serve.

Technology-based solutions to enable access to refractive error care have been fast tracked during the pandemic, but evidence of their success and sustainability is mixed. To meet the need for guidance in this area, the IAPB Refractive Error Working Group recently published a paper (<https://bit.ly/RE-paper>) which defines minimum criteria and recommendations for the quality and operating environment of screening, self-refraction, and self-prescribing devices.

The minimum criteria in the paper can be used by the manufacturers and users of refractive error technologies to prepare for the successful introduction and sustained, ongoing use of these technologies to deliver equitable access to refractive error services.

## Efficacy, performance and quality

### Screening devices

The introduction of tablet and smartphone devices has increased access to vision screening, opening the potential for people to self-screen. Screening results can be digitally and automatically added to patients' digital health record and a positive test can also trigger a referral.

Ensuring the accuracy of these devices, and the competency of the personnel trained to use them, is critical. An excess of false positives can overload referral sites, lead to unnecessary expenditure by patients and reduce confidence in the system, whereas an excess of false negatives means patients will not get the refractive error correction they need.

### Criteria and considerations for introduction

- 1 Screening devices consistently achieve minimum screening thresholds for detection of vision impairment, validated against clinically trained screeners using traditional manual methods.



Getting a pair of spectacles can be life-changing. MALAWI

- 2 The devices have been tested and validated in the country of introduction or a similar country context, and the data and results are published in a peer-reviewed journal.
- 3 Devices are easy for screeners to understand and use.
- 4 Mechanisms are in place to monitor and assess the effectiveness of the device and its implementation.
- 5 The device is appropriate for children, to the required standard.

### Self-refraction and prescribing devices

Shortages of trained health workers to carry out refractions have led to innovations in self-refraction by means of various adjustable spectacle designs or smartphones, which can increase access for many communities. Caution should be used with self-refraction devices and adjustable spectacles for children aged 10 years and under, as these have not yet been sufficiently studied to determine their accuracy and efficacy.

### Criteria and considerations for introduction

- 1 The device has undergone testing that establishes a significant correlation between conventional refraction and the refraction received by the self-refraction testing device, defined as 95% of patients achieving visual acuity of 6/12 and/or N6 or better when using the device.
- 2 The device has been tested and validated in the country of introduction or in a similar country context, and the data and results are published in a peer-reviewed journal.
- 3 The organisation implementing the use of the device is competent and active in conveying basic eye

health information to the patients and is aware of existing referral pathways.

- 4 Device maintenance, repair, and replacement options are available locally or regionally.

### Context and operating environment

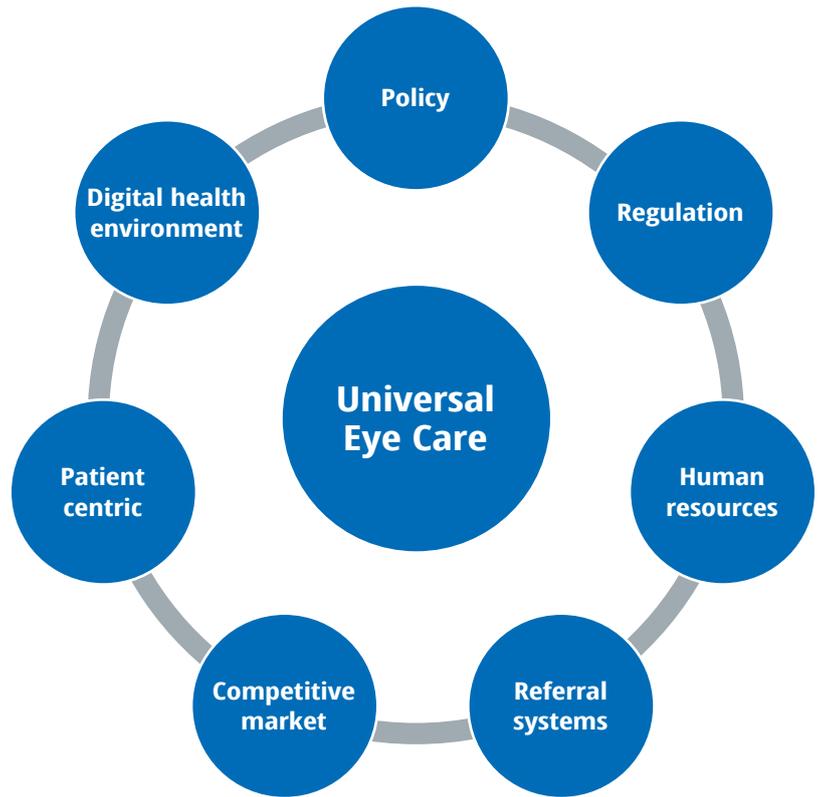
To set up for success, tailor any new refractive error innovation to the local or national context. Differences related to the digital health environment, policy, regulation, human resources, referral systems, and the competitive market environment (Figure 1) will determine the uptake and use of new technology and therefore its potential for facilitating equitable and permanent access to refractive error services in the community.

Invite local, national, and global stakeholders to help assess the relevance of the new technology and its potential for meeting the needs in that setting, compared to other models. The same stakeholders should also be involved in validating interoperability and integration with existing systems and establishing processes that will ensure that the technology can achieve positive eye health outcomes and benefit the health system in the short and long term.

### Ensuring equity

When introducing new technology, consider from the outset how you will reach the most difficult-to-reach groups; that is, how you will ensure equitable access. It's just as important to continue to measure equity of access by gathering information about groups of concern (e.g., people with disabilities, women, and minority ethnic groups) so that you can monitor the level and type of coverage and put protocols in place to address inequity. Any service involving children must be appropriate for children and have safeguarding protocols in place and activated.

**Figure 1** When introducing new technology for refractive error care, carefully consider the broader ecosystem in which it will be deployed.



To read more, the IAPB position paper on refractive error technologies (<https://bit.ly/RE-paper>) further outlines minimum criteria and recommendations for each of these elements of the operating environment and the quality of refractive error technologies.

*This is a summary of a position paper from the Refractive Error Working Group of the International Agency for the Prevention of Blindness (IAPB).*

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# mHealth for eye care: what is possible?

As people’s access to cellphones and mobile internet grows, how can mobile health (mHealth) interventions be used to improve patient outcomes in eye health care?

Mobile health (mHealth) interventions have become increasingly popular in health care. mHealth refers to the use of any mobile device, but particularly cellphones (also known as mobile phones), to support the achievement of health objectives.

Many mHealth interventions have been implemented in eye care, with the aim to:

- promote attendance at appointments
- promote adherence to medication
- provide eye health education
- increase access to eye care.

## Attendance at appointments

Mobile health (mHealth) interventions can be used to remind patients affected by chronic or long-term eye conditions, such as glaucoma or diabetic retinopathy, to attend their appointments. There are many different ways of sending patients reminders via their cellphones:

- short message service (SMS) or text messages
- voice messages
- automated voice calls (the person answering the phone hears a pre-recorded message)
- interactive automated phone calls (the person answering hears a message and can press numbers on the keypad to interact with the system)
- telephone hotlines (volunteers call patients to remind them of their appointments).

In one example, automated telephone calls were used in the USA to remind patients about their diabetic retinopathy screening appointments; patients were also able to reschedule their appointment if needed. This had positive results, including significant improvement in appointment adherence.<sup>1</sup> Patients who received the phone call were more likely to schedule their appointment and complete their appointment, compared with usual care.

## Adherence to medication

In patients with glaucoma, adherence to medication is vital for controlling intraocular pressure and slowing down disease progression. However, studies have indicated that adherence is not sufficient. To address this, a smartphone application was developed in Nigeria that patients could use to set up reminders to instil their glaucoma eye drops. Patients had better adherence to medication when using the application. One challenge that patients faced was unreliable electricity supply, which made it difficult to keep their phones charged and working.<sup>2</sup>



Cellphones can help to empower people to look after their eyes. ZAMBIA

## Patient education

The World Report on Vision emphasises the need to improve communication between patients and practitioners in order to facilitate decision-making and counselling. This is especially important in the context of the move towards integrated people-centred eye care.<sup>3</sup>

A web-based service called DiasNet has been implemented in Denmark and the UK. It is used by doctors and patients to improve education and communication in diabetes care.<sup>4</sup> This tool allows patients to see for themselves the changes in retinal lesions from one appointment to next, because of changes in their lifestyle and glycaemic control. Patients can then experiment with their own data and retrospectively adjust insulin doses, meal sizes, etc., allowing them to learn how to better manage their diabetes.

A study carried out in China used the WeChat communications app to decrease the anxiety experienced by parents of children with congenital cataract. This involved sharing health information with parents by sending links to online videos. As a result, parents’ satisfaction and understanding increased and their levels of anxiety decreased.<sup>5</sup>

## Improving access to eye care

In India and Kenya, Peek software was used to screen and identify children who needed to visit an eye specialist or wear spectacles. SMS and voice messages were used to inform parents about the need for their children to visit an eye specialist or receive spectacles, and why this was important. In Kenya, the adherence

*Continues overleaf* ➤

to referral was twice as high in the group where parents received an SMS reminder compared to the group where parents did not receive such a reminder. The proportion of pupils identified as having visual impairment who attended their hospital referral was also significantly higher in the group that received the SMS reminders.<sup>6</sup> In India, where voice messages were sent to parents to provide health education, the compliance with spectacle wear in children was higher than in any previous study: an average of 53%.<sup>7</sup>

### Implementing mHealth solutions

With increasing access to cellphones and smartphones, and with mobile internet connectivity growing in sub-Saharan Africa and Asia,<sup>8,9</sup> the potential for mHealth to be implemented within eye health care is growing. However, there is a need for more evidence from low- and middle-income countries on the impact of mHealth interventions in eye care. It is also important to acknowledge that women and people in rural areas still tend to be left behind in terms of cellphone use and mobile internet access.<sup>10</sup>

Eye health practitioners are encouraged to explore the use of mHealth within their setting. However, before implementing a new mHealth intervention, it is important to:

- understand the evidence which supports the use of this intervention
- ensure that the intervention is locally acceptable and/or can be adapted
- make provision for people with disabilities to ensure they can also benefit from the intervention
- check that the intervention complies with local legislation and regulations, including the protection of personal data.

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# Overcoming the challenges of access to eye care through mHealth in Kenya



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An mHealth project in Kenya has improved eye health care in schools and in the community.

While cellphone access and mobile health (mHealth) technology continues to improve, there is a need for research to fully understand the potential of any mHealth solution before it can be more widely adopted and scaled up. Peek mHealth solutions were tested in two contexts in Kenya: a school eye health programme and a community eye health programme. The aims were to:

- create awareness and identify individuals with eye problems through eye screening
- improve access to eye care services
- increase the efficiency of existing eye care workers through guided task sharing.

The Peek mHealth solution uses Peek Acuity™ which is a validated smartphone app that accurately and reliably identifies people with vision impairment.<sup>1</sup>

### The school eye health programme

In the trial group, school teachers were trained to detect visual impairment in their students using the Peek Acuity smartphone app. Children who failed the vision test were sent home with specially designed referral cards that showed parents what their vision looked like and stated why they needed to get spectacles (or be seen by an eye specialist); the cards also stated where and when their appointments would take place. We also sent parents short message service (SMS) reminders about their children's appointments. The Peek system allowed us to track, in real time, who did and did not attend, so that we could send reminders again and make new appointments where needed. Compared to the control group, where children were tested with a card-based test

**A teacher uses the Peek acuity app to screen children in her class for refractive error. KENYA**



and parents did not get SMS reminders (just standard referral letters) we found that the children in the trial group were more than twice as likely to attend the appointments (54% compared to 22%).<sup>2</sup>

## The community eye health programme

We ran a similar trial in the community, with the addition of a validated decision support algorithm<sup>3</sup> that enabled community volunteers to decide whether to refer people to primary health facilities. If someone screened positive at the household level, they were automatically referred and sent SMS reminders about appointments. A cluster randomised trial showed that the combination of the algorithm and reminder messages nearly tripled primary care attendance by people with eye problems compared to standard approaches (1,429 per 10,000 residents in the Peek arm of the study, compared to 522 in the control arm), indicating the potential of this mobile health package to increase service uptake.<sup>4</sup>

A follow-up study of the participants identified and referred using this system in the community setting showed that, despite the SMS reminders, some participants did not attend further referrals from primary facilities to secondary facilities as they were not aware of the reason for referral. We learnt from this that we must include counselling and provide more patient information during the referral process.<sup>5</sup> In other words, the team delivering primary eye care needed to further support the participants to understand their diagnosis and treatment options in order to improve their uptake of referrals.

## Adopting and scaling up

Adoption and scale-up of mHealth solutions involve identifying the strengths of various stakeholders and assigning responsibilities that maximise those strengths. In the scale-up of our school programme, for example, the stakeholders included local government, school leaders, the ministry of health, and the ministry of education. The ministry of health designed a policy guide, the local (county) government provided leadership and administrative support for the project, and the ministry of education offered insights into how policy and regulation were changing in the country and how our work needed to adapt. Open communication among stakeholders and constant review of the programme were also critical. Altogether, the scaled-up project resulted in a total of 168,820 children in Kenya being screened, of whom 6,200 were treated for eye problems.<sup>6</sup>

Evidence from the trials and the scale-up process was used to establish similar programmes in other countries; this also informed the inclusion of mHealth in Kenya's national eye care strategic plan as a means of supporting the provision of eye care services to the whole population.

## Challenges and considerations

We have identified some key emerging issues that must be considered when deploying mHealth solutions:

- the requirements of data protection laws in different jurisdictions



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- how to manage the constant improvements in technology, requiring regular software or equipment updates and training of staff members
- the ability to be agile – i.e., to adapt and evolve how the programme or project is carried out, based on real-time data about what is, and is not, working
- how to remain in alignment with government priorities
- the availability of personnel to offer services.

**A child undergoes an eye examination at Kitale Eye Hospital after school screening using Peek technology identified potential vision problems. KENYA**

Although mHealth solutions require eye care programme providers to continuously adapt programmes to meet the needs of the population, mHealth also supports and informs this process by allowing prompt analysis and sharing of programme data. This enables managers to monitor progress and make evidence-based decisions during programme implementation. mHealth solutions, therefore, allow for continuous improvement of programmes using locally generated data and make it possible for multiple stakeholders to be involved.

### Declaration of interests

*HR is a consultant at Peek Vision Ltd. UK. LK declares no competing interests.*

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# Technology-enabled primary eye health care in Pakistan

Mobile technology helped to optimise primary eye health care in Chakwal district, Pakistan, thereby increasing access to specialist eye health for those who need it.



A lady health visitor tests visual acuity through Peek Acuity on an Android smartphone at a basic health unit in Chakwal district, Punjab. PAKISTAN

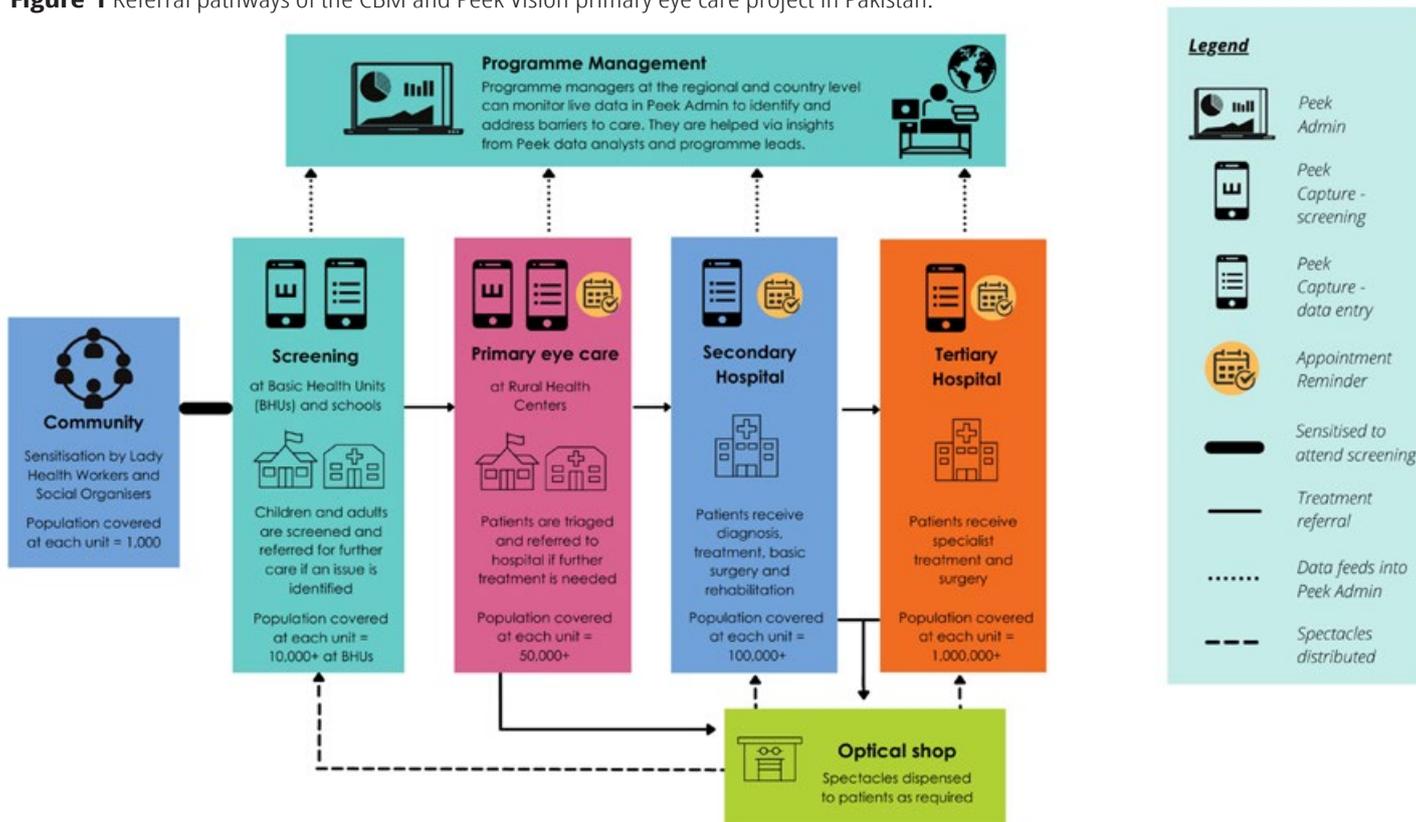
In 2018, the Pakistan National Committee for Eye Health, together with CBM and Peek Vision, launched a technology-enabled primary eye care project to assess, monitor, and improve eye care services in Chakwal district.

As previous studies in Pakistan have shown,<sup>1</sup> referral pathways must be optimised in order to increase access to specialist eye health for patients. The CBM-Peek project aims to increase screening at primary health care level by including eye health promotion and awareness raising about available eye services in the

community, thereby reducing pressure on secondary and tertiary eye care services.

The project ensures that patients are connected to care using referral systems that link all levels of the eye health system (Figure 1). Real-time information about the whole programme is visible to the programme managers via the Peek Admin app, and the Peek Capture app is used at various stages to support visual acuity measurement, decision making, and to capture patient information.

**Figure 1** Referral pathways of the CBM and Peek Vision primary eye care project in Pakistan.



## Programme structure

### Community level

The project involves training Pakistan's lady health workers (community-based health care workers) in Chakwal district to do the following:

- 1 Create awareness in their catchment communities about the availability of eye care services at nearby facilities (known as 'sensitisation').
- 2 Identify and refer patients with eye conditions.
- 3 Follow patients up after referral or treatment.

Lady health workers are employed by the ministry of health, and each one is responsible for providing primary health care to approximately 1,000 people in their local or catchment community.

### Primary level health care: basic health units

Basic health units each serve a population of around 10,000 people. Around 110 of Pakistan's lady health visitors (health centre-based workers) in Chakwal District were trained to carry out vision testing using the Peek Capture app. The app incorporates Peek's clinically validated visual acuity test to identify individuals with vision impairment, and it also includes specially adapted questionnaires that support the lady health visitors to identify people with other eye conditions and refer them. School health and nutrition supervisors who are trained to use the Peek Capture app were also deployed in schools throughout the Chakwal district to screen and refer children identified with eye conditions or visual impairment to primary health care facilities.

### Primary level health care: rural health centres

Peek Capture is also used at rural health centres to screen walk-in patients. Optometrists see patients referred from the basic health units and any walk-in patients identified as needing eye care. The optometrists validate the visual acuity measured during screening (as a means of quality control), perform refraction, and prescribe spectacles to those who need them. They also conduct anterior and posterior chamber examinations and can refer patients to secondary or tertiary eye care services. Their actions, decisions, and referrals are recorded in the Peek Capture app.

### Secondary and tertiary health care

At the secondary and tertiary health care units, teams of ophthalmologists and ophthalmic allied personnel perform triage, treat referred cases, and provide training if required.

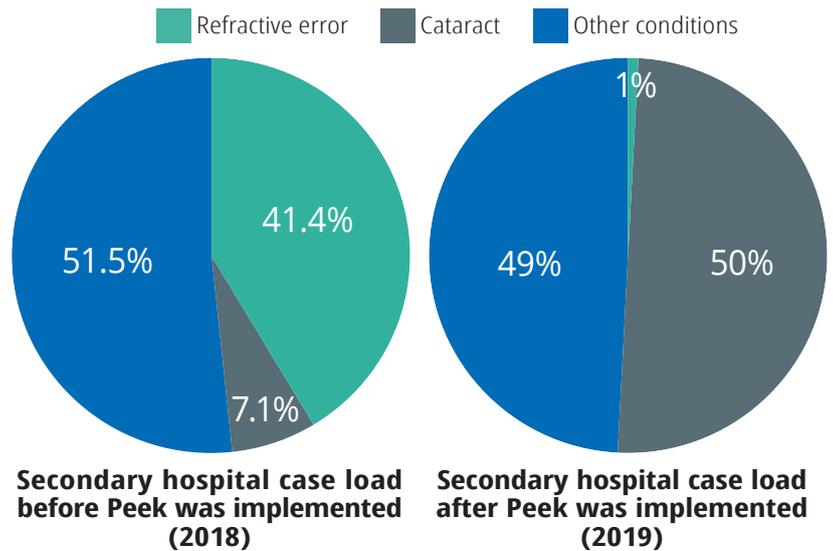
### Programme impact

Before the programme was introduced, more than 41% of eye health consultations in hospitals were related to refractive errors, which can usually be treated outside the hospital by an optometrist. Since the start of the project, this proportion has been reduced to less than 1%. As a result, hospital eye health services are in a better position to treat patients with more complex eye conditions, such as cataract (Figure 2).

From November 2018 to the end of December, 2021:

- 79% of patients had their needs met at the primary level, 21% required referral to secondary care, and

**Figure 2** Secondary hospital case load before (2018) and after (2019) the project was implemented.



- 1% required tertiary care.
- The number of people screened improved from 774 per month to almost 18,000 per month
- The percentage of false positive referrals from screening was reduced from 16.5% to 5.9%.

In addition, more people attended hospital within 30 days of their referral (12% in 2019, increasing to 66% in 2020). There was a greater increase in attendance of hospital appointments for women: from 45% in 2019 to 78% in 2020; for men this figure increased from 48% in 2019 to 70% in 2020.

### Next steps

Almost all the eye health facilities in Chakwal have now been connected using Peek Vision technology. The remaining facilities are due to be added to the system in 2022. We are also planning to expand this further, by equipping 1,500 lady health workers to conduct household-level screening and referral.

The data captured by the programme has also been used to advocate for eye health at the government level. As a result, the government of Pakistan has approved draft plans to strengthen eye care through digital solutions, and it has made a commitment to provide relevant human resources and help to expand

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### Data collection and monitoring

Thanks to the integrated system and dashboard, 'live' data is always available and accessible by the project's administrative and management team. Aspects covered include community screening, school screening, triage, referral, specialist referral, adherence to referrals, and spectacle prescription.

The data available on the Peek dashboard can be categorised and analysed by gender, age, location, project segment, and diagnostic conditions. It also enables the project staff members and field team to know the status of each step in the patient's journey, whether it is planned, pending, or completed.

As a result, gaps were highlighted so that services could be improved where needed and the quality of referrals could be improved.



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# Data protection and privacy: an introduction

Patients' right to privacy is an important consideration in the design of telemedicine and mobile health initiatives.

Protecting patients' personal and medical information is an important part of caring for them. Patients have the right to privacy and the dignity this provides, and will feel more comfortable sharing sensitive, but important, health information if they are confident that their privacy will be protected.

## Principles of data protection

The World Health Organization Regional Office for Europe has developed a useful set of principles for data protection and privacy in health systems<sup>1</sup> which applies to all forms of telemedicine and mobile health (mHealth). These principles can form a useful starting point for developing your own organisation's policy, while giving due consideration to the laws governing data security in your country and/or region.

According to these principles, patients' personal data should be:

- processed fairly, in a transparent manner, and with the patient's informed consent (i.e., the patient understands why and how their data will be used and what their rights are)

## Reference

<sup>1</sup> The protection of personal data in health information systems – principles and processes for public health. Copenhagen: WHO Regional Office for Europe; 2020. Available from: [bit.ly/WHO-eu-data](https://bit.ly/WHO-eu-data)



Medical personnel have a responsibility to keep patients' data confidential and secure. SWAZILAND

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- obtained and processed only for the purpose of providing health care, as understood by the patient, and not further processed for any other reason
- kept accurate and up to date
- adequate, relevant, and limited to only what is necessary for the purposes of providing health care to the patient
- kept for only as long as is necessary to provide health care to the patient
- kept confidential and not shared with anyone who is not authorised to access it or who doesn't need to access or process it for the purposes of providing health care
- kept safe and secure, protected from accidental loss or alteration.

Patient data should only be transferred to another country if that country can ensure that the patient's data will be adequately protected, as described above.

## Keeping patients' data safe

Many countries have strict data protection laws. It is important to ensure that health providers know what is expected of them, particularly when storing and transmitting patient information. Putting appropriate measures in place to prevent the loss or theft of personal data is essential for maintaining the trust of patients and the public. This can include:

- encrypting data when it is being stored and/or transmitted
- classifying data, e.g., as strictly confidential, confidential, or public
- managing who has access to which classification of data
- physical security, e.g., keeping files locked and secure and controlling who has access
- setting up a 'data breach plan' and communication strategy, with clear allocation of tasks and responsibilities, in the event that there is an accidental or deliberate breach of data security
- assessing and monitoring data security regularly, e.g., by inviting 'ethical hackers' to test weaknesses in the system.

## From the field

### Seeing data security from my patients' perspective

**Victor Hu**  
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The technical details of data governance can often be difficult to remember. What I try to keep in mind is that the important and necessary information we collect about our patients should be kept confidential so that it is only accessed by those who need to and have a good reason to – those who see the patient or are involved with their management. Anyone who isn't involved, or who doesn't have a good reason, shouldn't see any of that patient's information or data.

It is important that we keep patient records and information secure. We don't take patients' records home as they could easily be lost or stolen. If someone requests information about a patient, we must make sure that the request is genuine, that there is a good reason, that the patient has given consent (if appropriate), and that the information is transferred securely.

If in doubt, I ask myself: "If I were the patient, would I be happy with how my data were being used and stored?" As a health care professional, I should make sure that I can always justify or defend how I am using patients' information and data and how their information and data are being treated.





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# Technology in education

During the pandemic, many eye care educators have turned to technology to deliver eye care education.

The COVID-19 pandemic has triggered an unprecedented change in the delivery of eye care education. Before the pandemic, most education – ranging from continuing education and training (CET) to postgraduate training – was delivered as a combination of in-person lectures or tutorials and practical, clinical sessions. In March 2020, however, universities and colleges had to close their doors, and educators were forced to use online communication platforms to reach their students.

## What is online learning?

Online learning is a way of delivering educational material and classes over the internet, instead of in a face-to-face classroom setting, using an online, virtual environment to host and support education. Educational content is constructed using principles of teaching and learning (pedagogy) and supports student progression and success. Tools and technology are used to support delivery of the content, but its success is built on creating an inclusive, accessible, and interactive environment.

Online learning can improve access to education and flexibility for people who would otherwise have to travel long distances or struggle to balance studying with their work commitments. There are two main approaches to content delivery: **synchronous** and **asynchronous**.

**Synchronous** ('live') online learning experiences such as presenting live lectures or demonstrations, or leading small group discussions via video platforms such as Zoom or MS Teams, make it possible for people to take part in courses offered far away from where they live. Students share the same virtual space as their tutors and fellow students and can ask questions and interact in a range of different ways. However, a stable and reliable connection to the internet is essential and everyone has to be available to join sessions at the same time – which can be a challenge if students are based in different time zones, work different shift patterns, or have personal challenges (as was the case during the pandemic). Therefore, shorter presentations, recordings, and transcripts, which are typical of asynchronous learning, may better support engagement and learning amongst eye care professionals.

**Asynchronous** ('at your own pace') online learning takes place when students engage with study materials that are delivered online, such as lecture videos and notes, quizzes, question papers, and worked examples. Students work through content at their own pace.



Programme manager and outreach coordinator **Mathew Mbwogge** uses ICEH's Global Blindness online course to update his knowledge.  
**CAMEROON**

They can also post questions and comments on discussion boards, allowing them to interact with educators, subject experts, and fellow students. This approach facilitates flexible learning: participants can study while continuing to work as eye care professionals because they don't have to be online at the same time as their lecturers or fellow students. The main challenge with asynchronous learning is that students may feel disconnected from their teachers and from each other, but this can be addressed using the approaches described in this article (see panel).

## Learning platforms

The learning management systems or virtual learning environments used to organise and deliver content are also referred to as 'learning platforms.'

Learning platforms are virtual 'classrooms' where you, as the educator, can post asynchronous material such as articles, videos, quizzes, and activities to structure student learning. Students can access these via a computer or their smartphone, even while travelling.

Learning platforms are most useful when there is a clear course structure that allows students to navigate through learning activities. All activities within the platform must be designed to be inclusive and accessible. This means that graphics, colours, and how content can be downloaded when there is poor access to the internet (so someone can work offline) are key considerations. Videos need to have transcripts and captioning (subtitles) so that people can read and follow. Text descriptions of visual material and transcripts of audio/video content are required so that people who have hearing and/or visual impairment can understand the content. Ideally, a platform should include discussion forums where students can share ideas and experiences and ask advice. This increases opportunities for interaction

with educational content and fellow students, through ongoing discussions and reflection. A good learning platform should also enable educators to send emails to all students as one cohort.

The benefit of using an online learning platform is that educators can host all of the materials in one place, along with links to synchronous (live) learning activities such as lectures or workshop sessions, via Zoom or Microsoft Teams. The different tools that you can put onto a platform (such as quizzes, etc.) will vary, depending on the platform.

Educational institutions are beginning to invest in platforms such as Moodle, Blackboard, etc. but there are others which have been used such as Google. When selecting the platform and tools for interaction with students, it's always a good idea to speak with a learning technologist. Many universities now employ these specialists.

## Learner engagement

Interaction between educators and students (and among students) is very important, and often taken for granted in a classroom. In the online environment, interaction has to be planned and supported to create contact amongst

students (peer-to-peer contact), and between students and educators (peer to educator contact).

It is essential for these interactions to be **timely** and **responsive**, so that the student knows the educator is present, and cares about them. Be mindful that every student learning online is working in a unique environment with its own stresses and challenges. By interacting with students, educators can bridge some gaps, motivate students, show understanding, and provide support – all of which reduces some of the inequities that students face. Educator facilitation as part of content delivery is a key factor in determining student engagement and performance.<sup>1</sup> Alongside the content, it is always important that the digital skills of the students are developed. This is also known as 'digital literacy'.

Online education is developing at a very fast pace and is likely to become a permanent part of the higher education experience. Therefore, the emphasis on developing online education is not driven by the technology; rather, online educators are harnessing technology to provide equitable and accessible opportunities for students and life-long learning.

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## Examples of technologies for synchronous and asynchronous education

### Synchronous technology

#### Online interaction tools

**Poll Everywhere**, **Mentimeter** and **Padlet** are accessible via computer and smartphone and offer online polling, surveys, questions and answers, quizzes, and word clouds. They enable a variety of activity types that let educators visualise student responses in real time.

**How to use them, and why:** Use them for formative feedback during teaching to assess whether students understand key concepts and are attaining learning outcomes. Elements such as word clouds build visual consensus and encourage interaction and engagement. In Padlet, educators can create an online bulletin board where students can post their ideas and comment on each other's posts, in real time.

#### Videoconferencing tools

**Zoom** and **Microsoft Teams** are examples of online meeting or videoconferencing platforms. Both have automatic captioning, which transcribes and displays speech as people speak, and allow educators to create virtual 'breakout rooms' where students can have small group discussions.

**How to use them, and why:** Both Zoom and MS Teams allow remote attendance at lectures and tutorials and are fully inclusive for students with hearing impairment, thanks to the live captioning. Use breakout rooms to help

students collaborate in smaller groups, which builds interpersonal relationship and helps to keep students engaged. Educators can 'visit' different groups during a breakout session, to see how students are doing. For more one-to-one support, one option is to open live sessions 30 minutes before a lecture is due to start so that students can arrive early and ask questions. Another option is to set up regular or weekly drop-in sessions. This will improve students' sense of support from educators and help students who might be reluctant to speak up in larger groups.

#### Other tools

**Discord** and **Slack** offer topic-based channels for broadcasting live video or audiovisual materials and create an informal environment where students can collaborate with one another.

**OneDrive** and **Google Docs** enable educators and students to work on documents at the same time, either live or at their own pace, so they can be used for both synchronous and asynchronous learning.

### Asynchronous technology

#### Virtual Learning Environments

**Moodle**, **BlackBoard** and **Google Classroom** are examples of virtual learning environments that allow educators to create a structured learning journey for their students. It provides access to resources such as reading

materials, recordings (with transcripts), discussion forums, and interactive quizzes.

**How to use them, and why:** Use virtual learning environments to guide the students through the material in a structured way that allows them to build on existing knowledge and check their understanding as they progress from one section to the next. Students can interact with each other and with their educators on the discussion forum, which helps them to feel supported.

#### Other tools

**WhatsApp** groups allow students to create networks to support one another as they work through the content on the virtual learning environment. This helps to build a sense of community and aids peer-to-peer learning.

**Padlet**, **WordPress** and other blog websites can be used by students to publish group projects or to write individual reflections on their learning. Padlet, in particular, allows students to contribute their ideas asynchronously and comment on each other's contributions.

**Quizlet** is a useful online application that allows educators to create flash cards or study sets based on different topics supported by an artificial intelligence 'learning assistant'. Educators can also encourage students to document their own learning by making their own sets of flash cards or study sets; this helps students with self-directed study.



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# Harnessing photography and image recognition technology to aid in the elimination of trachoma

Technology can help to overcome human resource challenges in active trachoma grading and case finding for trachomatous trichiasis.

Significant progress has been made to reduce the global burden of trachoma in recent years. Since 2002, the number of people at risk has reduced by 92%, from 1.5 billion to 124 million. The number of people estimated to require surgery to treat trachomatous trichiasis (TT), the late blinding stage of trachoma, has reduced by 76% in the same period: from 7.6 million to 1.8 million.

When it comes to training people to grade active trachoma, or find people who need TT surgery (known as TT case finding), however, the global trachoma programme is becoming a victim of its own success. As the prevalence of trachoma declines, it is increasingly difficult to find individuals with active trachoma or TT who can serve as examples during the training of new field graders, or when re-certifying existing graders. This makes training more difficult, expensive and time consuming, and represents a significant challenge when integrating trachoma interventions into routine health services. Additionally, there are situations where the use of human case-finders or trained graders may not be ideal or sustainable, such as in conflict zones (where graders may not be allowed) or in remote or hard-to-reach areas.

A recent report<sup>1</sup> presents results of a series of workshops summarising existing studies and exploring the opportunities, challenges, and future operational research priorities related to the use of photography and image grading for trachoma. The report includes data from a systematic review on the utility of photography for trachoma surveys, and the development and testing of metrics for assessing the quality of images. It also highlights the inclusion of 3D images that provide greater specificity for TT diagnosis. These have been routinely included in trachoma training systems supported by Tropical Data<sup>2</sup> – a consortium of partners supporting health ministries to conduct globally standardised, high quality trachoma prevalence surveys that conform with World Health Organization recommendations. Results from studies seeking to replace field grading included the use of a head-mounted 'Image Capture and Processing System' (ICAPS) piloted in Tanzania and the development of a photography grading centre to increase local capacity for assessing images in Ethiopia.

Many opportunities and challenges were identified related to the use of photography to support training,



Classroom learning for TT-only surveys using 3D images. BENIN

supervision, and field grading in the future. These include the development of a library of appropriate images for training purposes, and establishing a consensus grading method for photographic images. Diverse options for photograph grading to replace field grading were explored, as was ensuring the feasibility of these new approaches. Different working groups organised by members of the trachoma community are now working to address these issues through the pursuit of various operational research projects.

Researchers at the University of North Carolina at Chapel Hill and RTI International are carrying research into an image recognition algorithm and an associated smartphone app that identifies TT in eyelids using machine learning techniques. The user-friendly app allows users to enter participant information and take a photograph. After the photograph is taken, the algorithm determines whether the eye has TT. At present, this technology is showing positive results and is being pilot tested with Tropical Data support. In the coming months, the algorithm and app will be tested more broadly with a large group of TT case-finders in Senegal.

To achieve the global elimination of trachoma as a public health problem, it will be critical to overcome human resource challenges, including grading for active trachoma and case-finding for TT. Technology offers a real opportunity to address the challenges of TT case finding and trachoma grading in a cost-effective way. However, there is currently a lack of standardisation and validated protocols outside of research projects for the use of photographs to train graders, for supervision purposes, and to serve as an adjunct to, or substitute for, field grading. Resolving these challenges will be critical if we are to scale up these new technologies and achieve vision for all.

## References

- 1 Use of photography for support of trachoma grading: Progress report. 2022. International Coalition for Trachoma Control <https://bit.ly/3IPz1Rj>
- 2 Tropical Data. <https://bit.ly/3Gpj8RS>



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# Electrical safety in the clinical environment – good habits to maintain

There are many habits that clinical personnel can practise to help ensure an electrically safe environment. Here are twenty of these habits.

## Cords and plugs

- 1 Only use electrical devices with 3-conductor power cords and 3-prong plugs (Figure 1 shows a plug with a broken ground prong – do not use).
- 2 Do not use cheater plugs (3-prong to 2-prong adapters, Figure 2). They eliminate the ground connection and increase the possibility of serious shock hazards.
- 3 Always unplug equipment by grasping the plug, not the cord.
- 4 Routinely check equipment power cords for frayed, cracked, or exposed wiring (Figure 3 shows a plug with the ground wire pulled out, which is very dangerous).
- 5 Do not rest cords over hot or sharp objects.
- 6 Do not run cords where they may cause a tripping hazard (Figure 4).
- 7 Avoid rolling equipment over equipment cords.

## Wall receptacles

- 8 Do not plug equipment into defective receptacles.
- 9 Plug equipment into wall receptacles with power switches in the OFF position.
- 10 Avoid using extension cords and power bars.
- 11 Do not overload electrical outlets by plugging in devices exceeding the current limit for the circuit (Figure 5).

## Fuses

- 12 Replace fuses only with the same exact type (voltage, amperes, slow-blow vs. fast blow, physical size). If the fuse of the correct rating is not readily available, and if the instrument has to be used in an emergency situation, a fuse of a lower rating can be used while waiting for the fuse of the correct rating. For instance, if a 250 mA fuse is required and is not available, the instrument will work with a 200 mA fuse if it is available.
- 13 Do not continue to replace fuses if they keep burning out. Whatever is causing this must be found and corrected.

## General

- 14 Make sure your hospital engineering department performs regular safety and performance inspections on all equipment and electrical outlets.
- 15 Do not attempt to perform repairs yourself. A little knowledge can be a dangerous thing. Call your qualified biomedical equipment technician, the manufacturer or someone with technical troubleshooting and repair skills.
- 16 Make contingency plans for power failures.
- 17 If you suspect a fault, report it immediately to your engineering department. Never assume that someone else will take care of it.
- 18 Report any electrical tingling sensations promptly.
- 19 Keep equipment dry unless it is purposely designed to be wet.
- 20 Wear appropriately insulated shoes in wet areas.

**Figure 1** A plug with a broken ground prong. Do not use.



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**Figure 2** A 3-prong to 2-prong adapter. Do not use.



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**Figure 3** A plug with the ground wire pulled out, which is very dangerous. Do not use.



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**Figure 4** Do not run cords along the floor, as they may cause a tripping hazard.



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**Figure 5** Do not overload electrical outlets by plugging in devices that, together, will exceed the circuit's current limit.



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# Conjunctival pyogenic granuloma following insect bite



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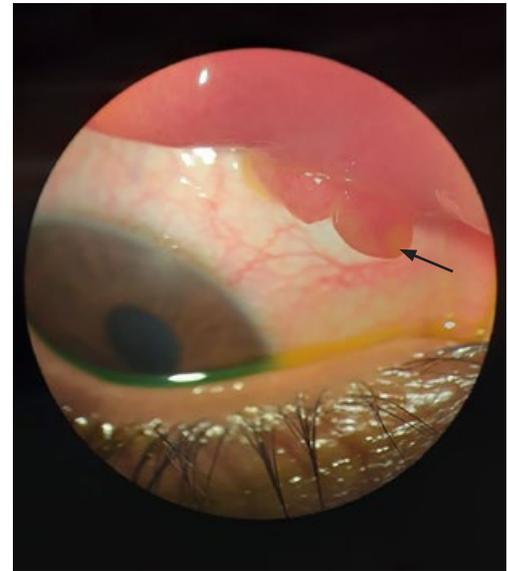


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A woman in her thirties came to our primary eye care centre (vision centre) complaining of foreign body sensation and discharge in her right eye which she had been experiencing for three weeks. She had been bitten in the eye by an ant and an insect particle had been removed from the eye one week before the onset of symptoms. She had applied topical antibiotics that were prescribed locally but there was no improvement.

On examination at the vision centre, the vision in the right eye was 20/20. All the anterior segment findings were normal. However, upon eversion of the eyelid, a reddish-pink vascular pedunculated lesion was visible on the palpebral conjunctiva of the upper eyelid of the right eye (Figure 1).

The vision technician took a photograph (Figure 1) using the camera on a smart tablet and uploaded the photograph to the patient's cloud-based electronic medical record. The medical record could be seen by the ophthalmologists based at the central hospital's teleophthalmology centre. Teleconsultation with the ophthalmologist was requested and a provisional diagnosis of pyogenic granuloma was made. The patient was promptly referred to the central hospital (a tertiary centre) for further management.



**Figure 1** Pedunculated vascular fleshy growth (arrow) on palpebral conjunctiva of upper eyelid (right eye).

### Question 1

**What is pyogenic granuloma?**

- a. A vascular lesion of infectious aetiology
- b. A benign, non-tender, exuberant proliferation of granulomatous tissue in response to trauma or surgery
- c. A malignant vascular proliferative lesion
- d. A tender granulomatous lesion of inflammatory aetiology

### Question 2

**What is the key differential diagnosis for conjunctival pyogenic granuloma?**

- a. Dermolipoma
- b. Dermoid cyst
- c. Conjunctival concretions
- d. Squamous cell carcinoma

### Question 3

**What are the management options for conjunctival pyogenic granuloma?**

- a. Topical antibiotics, hot fomentation, lid hygiene
- b. Topical corticosteroids, removal of inciting agent, excision biopsy, pulsed dye laser
- c. Topical lubricants and lid scrubs with baby shampoo
- d. Topical anti-inflammatory agents and oral analgesics

## ANSWERS

**1. b.** Pyogenic granuloma is a benign, exuberant proliferation of granulomatous lesions due to angiogenic imbalance as a result of minor trauma, foreign body, or surgery. Eversion of the eyelid is important in order to correctly diagnose these lesions.  
**2. d.** The term pyogenic granuloma is a misnomer, as the lesion is neither infectious nor inflammatory in nature. It is a benign, non-tender lesion. Differentiating from malignant lesions is important in order to avoid unnecessary treatment. The main difference is the slow growth of malignant lesions in contrast to the rapid growth of pyogenic granulomas.  
**3. b.** Conjunctival pyogenic granulomas of smaller size usually respond to topical corticosteroids or pulsed dye lasers. Pulsed dye lasers are effective and safe for the treatment of small and solitary pyogenic granulomas, treated with a vascular-specific (585 nm), pulsed (450 microseconds) dye laser using a 5 mm spot size with a laser energy of 6 to 7 J/cm<sup>2</sup>. Many patients will eventually require surgical excision of the granuloma along with the removal of the inciting agent or irritant. Excision biopsy allows histological confirmation, and is helpful if there is any doubt about the diagnosis.

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A doctor is carrying out an intraocular pressure test on an elderly woman. Photo by Gideon Okorie for IAPB WSD Photo Competition.

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