Comprehensive eye examination: what does it mean?

A routine comprehensive eye examination helps to screen for and diagnose common eye diseases.

As an eye health professional, it is important to talk to patients and public about:

- consulting an ophthalmologist early when experiencing eye or vision-related problems and
- regular, periodic eye examination for early detection and treatment of eye diseases

In addition, it is a good practice to talk about basic measures for prevention of common eye diseases.1-3

A routine CEE presents a good opportunity to fulfil the above objectives. It helps to screen and diagnose common eye diseases, thus helping to reduce morbidity and the costs associated with eye diseases. A CEE is done when a patient with ocular symptoms seeks medical advice and also when a simple routine eye check-up is sought. This article explains what a CEE includes.

A CEE consists of a series of tests that assess the different aspects of eye health. Ideally, a CEE should be done not just for patients seeking medical advice but also for individuals above the age of 40 as a yearly check-up.
Eye diseases are common and can go unnoticed for a long time. A comprehensive eye examination helps to screen and diagnose common eye diseases, thus helping to reduce vision loss. What does a comprehensive eye examination include? In this issue, we will discuss what it should include, how you can perform one and current best practices in diagnosis and treatment of eye conditions prevalent in south Asia.

About this issue

Eye diseases are common and can go unnoticed for a long time. A comprehensive eye examination helps to screen and diagnose common eye diseases, thus helping to reduce vision loss. What does a comprehensive eye examination include? In this issue, we will discuss what it should include, how you can perform one and current best practices in diagnosis and treatment of eye conditions prevalent in south Asia.

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Figure 1 Snellen’s visual acuity chart

In case, a routine annual review is not possible for the entire population, it should be recommended for those with:

- a known chronic eye disease
- a family history of glaucoma or
- a systemic disease known to affect the eyes such as diabetes mellitus

Do note, that these tests may vary depending upon the population examined and the infrastructure available at a clinic. (Table 1 lists various tests in a CEE.)
Table 1 Components of a comprehensive eye examination

<table>
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<td>• Bagolini’s striated glasses</td>
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<td>• Red filter test</td>
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<td>Stereopsis*</td>
<td>• Self-illuminated/mirror retinoscope</td>
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<td>• Trial frame</td>
<td>• Slit lamp biomicroscope</td>
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<td>• Cycloplegic drugs</td>
<td>• Automated refractometers</td>
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<td>• Jackson cross cylinder</td>
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<tr>
<td>Refraction</td>
<td>• Slit lamp biomicroscope</td>
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<tr>
<td>Anterior segment and pupillary examination</td>
<td>• Torch light</td>
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<tr>
<td>• Tonometer (Goldmann, Tono-pen, Perkins,</td>
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<tr>
<td>• Shiotz)</td>
<td>• Goniolens (Goldmann two, three and four mirror)</td>
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<tr>
<td>Gonioscopy*</td>
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<td>Intraocular pressure</td>
<td>• Tonometer (Goldmann, Tono-pen, Perkins, Shiotz)</td>
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<td>Fundus evaluation</td>
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<td>• +90D/+78D lens</td>
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</table>

History

A detailed medical and treatment history is essential before beginning a CEE. Make a note of:

- family history of illnesses and working and living conditions to get an idea of the symptoms
- systemic illnesses like diabetes, hypertension, thyroid or inherited disorders. Such illnesses may affect the eyes and need appropriate investigations

Visual acuity (VA) is a measure of the eye’s ability to distinguish shapes and the details of objects at a given distance. To measure VA, ask your patient to read letters on Snellen (Figure 1) or an E chart. Note the type of correction (spectacles/contact lenses) used by the patient. Any reduction in VA can show an underlying pathology. Write the results of the VA test as a fraction (20/40). The top number in the fraction is the standard distance at which a patient stands/ sits (20 feet). The bottom number is the smallest line of letter-size that the patient can read. Normal distance VA is 20/20. A pinhole test can distinguish if the reduced vision is due to refractive errors or other causes. Record the best corrected VA after you identify full correction of refractive error.

In young children, use Tellers and Cardiff acuity cards or optokinetic nystagmus. Measure the presenting and corrected near visual acuity with hand-held test cards by placing them at a distance of 40 cm.

Perimetry tests are used for a more detailed and systematic evaluation of VF. Amsler grid is a useful tool for macular disorders with central field defect (age-related macular degeneration). Testing the visual field is useful in the management of patients with glaucoma, neuro-ophthalmic and retinal disorders. Of colour blindness.

Contrast sensitivity is the measure of the eye’s ability to...
detect an object against its background. A Pelli Robson chart is used to test for contrast sensitivity. The Pelli Robson chart consists of horizontal lines of capital letters in contrast of one colour. Glaucoma, diabetic eye disease, and cataracts have shown to reduce contrast sensitivity in patients.

**Colour vision** deficiency is the inability to distinguish between certain shades of colour. It is a genetic disorder more common in men. Red-green deficiency is most common. Conditions like diabetes, glaucoma, optic neuritis and use of certain drugs (chlorpromazine, thiidiazine, ethambutol) may lead to colour vision deficiencies. Many patients are unaware of their deficiency unless tested. We recommend use of colour vision charts for screening and detecting specific types of colour blindness.

**Binocular vision** is the vision achieved by the coordinated use of both eyes together. Simultaneous perception, fusion, and stereopsis are the three grades of binocular vision. Binocular vision can be tested using Bagolini’s striated glasses, Worth four dot test and red filter test.

**Refraction** is a test that determines the type (myopia, hypermetropia, and astigmatism) and the amount of refractive error (RE). It also tells us the required lens power needed to compensate for it. For a correct estimate of RE, the patient’s accommodation should be minimal. Accommodation is the ability of the eye to change focus from distant to near images. Dry retinoscopy is the technique of refraction done without using cycloplegics. Here you can control the accommodation by asking the patient to fixate at a distant target. In wet retinoscopy, cycloplegic drugs are used to paralyse the ciliary body and remove the influence of accommodation during the test. Use a self-illuminated or mirror retinoscope to measure refractive error by placing a series of lenses in trial frames (Figure 2) in front of the eyes. You can also use automated refractometers for an initial estimate of RE. You can fine-tune your estimates using Jackson cross-refractive error by placing a series of lenses in trial frames in wet retinoscopy. For correction of presbyopia, we prescribe adding a plus lens over the patient’s distance refractive correction.

We recommend cycloplegic refraction followed by a post- mydriatic test for adequate assessment of RE in infants and young children. For correction of presbyopia, we prescribe adding a plus lens over the patient’s distance refractive correction.

**Torchlight external eye exam**

An external torchlight examination helps to inspect:
- alignment and position of the eyes, eyelids, adnexa, conjunctiva, sclera, cornea, iris, pupils and extraocular movements
- palpebral symmetry, lid abnormalities, redness or growths on the conjunctiva and presence of any discharge (see Table 2)

**Intraocular pressure**

Tonometry is used to measure intraocular pressures (IOP) and to evaluate patients with or at risk of glaucoma. Different types of tonometers include:
- applanation tonometry (Goldmann and Perkins applanation tonometry, non-contact tonometry, ocular response analyser)
- indentation tonometry (Schiotz tonometer, pneumotonometer, tono-pen)
- rebound tonometry
- Pascal dynamic contour tonometer

**Preliminary assessment of the posterior segment with distant direct ophthalmoscopy**

Distant direct ophthalmoscopy (DDO) is performed routinely before a dilated fundus examination. DDO helps in diagnosing media opacities. Use a self-illuminating retinoscope or ophthalmoscope in a semi-dark room at a distance of 20-25 cm from the patient’s eye. Note the features of red glow in the pupillary area. You may see abnormal greyish pupillary reflexes in cases of cataract or some retinal detachments.

**Detailed fundus exam with a direct, and indirect ophthalmoscope and slit lamp biomicroscopy**

Direct ophthalmoscopy provides an upright and monocular image of the retina. It is very useful for examining optic disc changes and foveal pathologies at higher magnification. A dilated fundus evaluation using a binocular indirect ophthalmoscope or slit lamp biomicroscope with a +90Dioptres (D)/+78D lens is essential to record pathologies affecting the peripheral...
retina. Limited field of view is one limitation of direct ophthalmoscopy.

A dilated fundus examination helps to rule out diseases like diabetic retinopathy (DR) which have a high prevalence. Non-mydriatic fundus cameras are also available for peripheral centre-based screening of DR.

After a CEE, consider the results of the examination to determine a diagnosis. Sometimes more investigation may be needed to confirm or rule out the suspected diagnosis and to develop a treatment plan. Make appropriate referrals if your patient needs specialist consultations.

### Table 2 Ocular structures and related disorders to look for during a comprehensive eye examination

<table>
<thead>
<tr>
<th>Ocular structures</th>
<th>Disorders</th>
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<tbody>
<tr>
<td>Eye brows</td>
<td>• Madarosis (Leprosy, Myxedema)</td>
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<tr>
<td></td>
<td>• Ptosis</td>
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<td>• Lid retraction</td>
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<td>Eye lids</td>
<td>• Lagophthalmos</td>
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<td></td>
<td>• Entropion</td>
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<td>• Ectropion</td>
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<td>• Distichiasis</td>
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<td>• Blepharitis</td>
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<td></td>
<td>• Chalazion</td>
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<td>• Stye</td>
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<tr>
<td>Palpebral aperture</td>
<td>• Blepharophimosis</td>
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<td></td>
<td>• Ankyloblepharon</td>
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<tr>
<td>Lacrimal apparatus</td>
<td>• Fistula</td>
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<td></td>
<td>• Punctual stenosis</td>
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<td></td>
<td>• Regurgitation</td>
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<tr>
<td>Eye balls</td>
<td>• Proptosis</td>
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<td></td>
<td>• Anophthalmos</td>
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<td></td>
<td>• Enophthalmos</td>
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<td>• Heterotropias</td>
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<tr>
<td>Conjunctiva</td>
<td>• Discolouration</td>
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<td></td>
<td>• Conjunctivitis</td>
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<td></td>
<td>• Chemosis</td>
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<td></td>
<td>• Circumcorneal congestion</td>
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<td></td>
<td>• Pterygium</td>
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<td></td>
<td>• Pinguecula</td>
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<td>• Follicles</td>
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<td>• Papillae</td>
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<td></td>
<td>• Symblepharon</td>
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<td>• Foreign body</td>
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<tr>
<td>Sclera</td>
<td>• Discolouration</td>
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<td>• Episcleritis</td>
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<td></td>
<td>• Scleritis</td>
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<td>• Staphyloma</td>
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<td></td>
<td>• Perforations</td>
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<tr>
<td>Ocular structures</td>
<td>Disorders</td>
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<td>---------------------------</td>
<td>---------------------------------------------------------------------------</td>
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<tr>
<td>Cornea</td>
<td>• Microcornea&lt;br&gt;• Megalocornea&lt;br&gt;• Keratoconus&lt;br&gt;• Keratoglobus&lt;br&gt;• Cornea plana&lt;br&gt;• Dry Eyes&lt;br&gt;• Edema&lt;br&gt;• Scarring&lt;br&gt;• Degenerations&lt;br&gt;• Ulceration&lt;br&gt;• Vascularisation&lt;br&gt;• Guttae&lt;br&gt;• Keratic precipitates&lt;br&gt;• Keratitis</td>
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<tr>
<td>Anterior chamber</td>
<td>• Shallow/irregular depth&lt;br&gt;• Aqueous cells/flare&lt;br&gt;• Hypopyon</td>
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<td>Iris</td>
<td>• Heterochromia&lt;br&gt;• Synechiae&lt;br&gt;• Iridodonesis&lt;br&gt;• Rubeosis iridis&lt;br&gt;• Transillumination defects</td>
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<tr>
<td>Pupil</td>
<td>• Shape (festooned pupil) size (anisocoria, traumatic mydriasis),&lt;br&gt;• Colour (leucocoria, greyish reflex)&lt;br&gt;• RAPD (swinging torch light test)&lt;br&gt;• Correctopia</td>
</tr>
<tr>
<td>Lens</td>
<td>• Dislocation&lt;br&gt;• Subluxation&lt;br&gt;• Cataract</td>
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<tr>
<td>Optic disc</td>
<td>• Glaucoma&lt;br&gt;• Papilledema&lt;br&gt;• Papillitis&lt;br&gt;• Optic atrophy</td>
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<tr>
<td>Macula</td>
<td>• Macular hole&lt;br&gt;• Haemorrhage&lt;br&gt;• Cherry red spot&lt;br&gt;• Oedema&lt;br&gt;• Hard and soft exudates&lt;br&gt;• ARMD</td>
</tr>
<tr>
<td>Retinal vasculature</td>
<td>• Diabetic and hypertensive retinopathy&lt;br&gt;• CRVO&lt;br&gt;• CRAO&lt;br&gt;• Vasculitis</td>
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How to measure distance visual acuity

Visual acuity is a measure of the ability of the eye to distinguish the details of objects.

Visual acuity testing is part of every eye examination. It is important that it is done well, and accurately, as an incorrect measurement can lead to inappropriate decisions and management.

It is important to assess visual acuity in a consistent way in order to detect any changes in vision. One eye is tested at a time.

**Equipment**
- Multi-letter Snellen chart or tumbling E (or C) chart
- Plain occluder, card or tissue
- Pinhole occluder
- Patient’s documentation

**Preparation**
- Ensure good natural light or illumination on the chart.
- Explain the test to the patient.
- Tell the patient it is not a test that they have to pass. Tell them not to guess if they cannot see.
- Position the patient, sitting or standing, six metres away from the chart.
- Ask the patient to cover one eye with the occluder.
- Position the pin hole over the eye to be tested so they can see the letters, use a tumbling E or C chart and ask them to point in the direction that the ‘legs’ of the E (or the opening in the C) are facing. There is a one in four chance that the patient can guess the direction; the patient should therefore correctly indicate the orientation of most letters of the same size, e.g., three out of four.
- Record the visual acuity for the examined eye. Visual acuity is expressed as a fraction e.g. 6/18. The top number is the distance the patient is from the chart in metres (6). The bottom number is the **smallest** line on the chart the person can read accurately.

**Testing and recording visual acuity**
- Test the eyes one at a time, usually starting with the right eye, without any spectacles.
- Ask the patient to cover the left eye with the plain occluder, card or tissue.
- Ask the patient to read from the top of the chart and from left to right. For children or adults who cannot read the letters, use a tumbling E or C chart and ask them to point in the direction that the ‘legs’ of the E (or the opening in the C) are facing. There is a one in four chance that the patient can guess the direction; the patient should therefore correctly indicate the orientation of most letters of the same size, e.g., three out of four.
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**The pinhole test**

Using a pinhole reduces the need to focus the light that enters the eye, and people with a refractive error, such as myopia, can usually see better with the pinhole than without it.

**Steps**
- Position the patient 6 metres from the chart.
- Ask the patient to cover one eye with the occluder.
- Position the pin hole over the eye to be tested so they can see the chart through the pinhole.
- Test one eye at a time by following the same procedure used to test visual acuity.

If the person can read more letters with the pinhole than without, they are likely to have a refractive error, such as myopia. All patients (adults and children) whose acuity improves with a pinhole should undergo a full refraction to see whether they require spectacles, and of what power.
 Advances in anterior segment examination

Corneal imaging techniques are used to assess the structure and function of the cornea and anterior segment. They are crucial for diagnosing and treating a wide variety of ocular diseases.

Corneal and ocular surface imaging is an ever-advancing field in ophthalmology. There have been several innovations in imaging technologies, such as rotating Scheimpflug, anterior segment optical coherence tomography (ASOCT) and confocal microscopy. Investigative technologies like ocular surface analysers have helped to understand and manage anterior segment diseases in newer ways. In this article, we discuss various techniques, their advantages, and their limitations.

Corneal topography and tomography

The growing popularity of refractive surgeries has prompted rapid advancements in corneal imaging. Corneal topography helps to map the shape and features of the corneal surface. Placido's disc-based and slit-scanning system are two common technologies in use today. Tomographers, generate 3D images of the anterior segment of a cornea which gives information about its thickness. Scheimpflug imaging and optical coherence tomography (OCT), are two examples of tomography.

Placido disc-based keratoscopy

Placido's disc-based videokeratoscopy (Figure 1) is a common and easy-to-perform topography technique to study the anterior corneal surface. It provides information on cornea’s shape (central power, simulated keratometry, corneal asphericity.) and aberrometry. It is useful in the diagnosis of corneal ectatic disorders like keratoconus and while fitting contact lenses. It also helps in intraocular lens power calculation for cataract surgery in patients with irregular corneas, follow-up, and management of post-keratoplasty (corneal transplantation) astigmatism and dry eye assessment (with non-invasive tear break up time).

A limitation with this technique is that it covers a limited corneal surface area (about 60 per cent). It does not provide information about the posterior corneal surface, which is important in the early diagnosis of ectasia.

Slit-scanning

Slit-scanning elevation topography combines projection of a slit of light with Placido's disc keratoscopy to get anterior and posterior corneal curvature measurements. The final image represents a 3D topography that includes various colour-coded maps (curvature, elevation, pachymetry) of the entire surface and anterior segment in a non-invasive manner.

Optical coherence tomography (OCT)

Anterior segment OCT (ASOCT) captures dynamic high-resolution cross-sectional images of the ocular surface and anterior segment in a non-invasive manner. OCT captures images with ease and precision.

Figure 1 Placido disk with alternate light and dark concentric rings

Pentacam is a device that uses a rotating Scheimpflug camera to generate a 3D model of the anterior segment. It provides information, such as corneal and lens densitometry for opacification, keratometry, colour-coded maps for corneal thickness, elevation, curvature, or refractive power (or four maps refractive), pupil diameter and anterior chamber analysis. A popular feature, known as Belin-Ambrósio enhanced ectasia display (BAD) helps in detecting early cases of ectasia and is useful in screening candidates for refractive surgery.

Pentacam also helps in patients with previous refractive surgery and cataract, and in determining corneal aberrations. Galilei is a newer device that uses a dual Scheimpflug camera and incorporates Placido disc technology to improve curvature information on the central cornea.

The advantages of these devices are their accuracy, ease of use, repeatability, speed, quality and holistic anterior segment analysis.

The initial steep learning curve for data and image interpretation is a limitation for using Scheimpflug imaging. Image resolution, visualisation of iris and anterior chamber details may be better with ultra-high-resolution OCT. Pentacam’s accuracy in the case of corneal scars is limited, in which case ultrasound bio-microscopy (UBM) may be a better option to visualise the anterior segment structures.

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Optical coherence tomography (OCT)

Anterior segment OCT (ASOCT) captures dynamic high-resolution cross-sectional images of the ocular surface and anterior segment in a non-invasive manner. OCT captures images with ease and precision.
interpretation of the images is not difficult. OCT is used for several investigations such as:
- Ocular surface disorder and dry eye disease: tear meniscus height and meibomian gland assessment
- Assessment of corneal opacities: endothelial gutta, depth of scarring, corneal thickness
- Keratoplasty workup and follow-up: assessment of corneal thickness and opacity, especially for lamellar/partial thickness surgeries
- Keratoconus: evaluation of focal corneal thinning and asymmetry; epithelial thickness measurement; visualisation of depth of demarcation line after collagen cross-linking; diagnosis and management of hydrops in keratoconus
- Corneal infections: assessment of depth of infiltrates, areas of necrosis, endothelial plaque
- Refractive surgery: assessment of flap thickness, interface details; workup for phakic intraocular lens for myopia
- Anterior segment tumours: ocular surface squamous neoplasia, stromal iris cysts and conjunctival nevi
- Others: corneal deposits (Kayser–Fleischer ring, drug deposits) and intracameral foreign body
- Intra-operative OCT: integration with operating microscope helps in lamellar keratoplasty and ocular surface reconstruction (Figure 2A and B)

**Ultrasound biomicroscopy (UBM)**

**Confocal microscopy**

In vivo confocal microscopy (IVCM) is a minimally-invasive bio-imaging technique that allows high-resolution analysis of corneal microstructure and function. IVCM is useful in:
- diagnosing and managing acanthamoeba and fungal keratitis
- detecting deep-seated infections thereby preventing corneal scraping for microbiological diagnosis diagnosing corneal dystrophies and deposits
- gaining a better understanding of dry eye disease
- studying long-term changes in corneal backscatter, corneal nerves, and cellularity

Confocal microscopy has provided more insights into visual quality after lamellar keratoplasty, excimer kerato-refractive surgery and corneal alterations after contact lens wear.

**Ultrasound biomicroscopy (UBM)**

UBM is a high-frequency ultrasound used to capture images of the anterior segment. The procedure involves placing a fluid-filled eyecup over the eye and immersing the probe into the fluid to visualise the anterior segment. It allows deeper penetration and imaging through corneal opacities, dynamic view of the anterior segment structures and visualisation of the ciliary body, which, may not be possible with an OCT examination.

UBM is a contact procedure, it requires patient cooperation, and a highly-skilled operator to get good quality images which might sometimes be a challenge.

**Ocular surface analyser**

Ocular surface analyser (OSA) is a new addition to the plethora of imaging devices. It helps in non-invasive analysis of tear film, enables quick and detailed structural research of the tear composition and tear film layers. It also helps to identify the type of dry eye disease and determine targeted treatment for individual layers. OSA is helpful in several investigations such as:
- interferometry- measurement of tear film stability, thickness, and pattern of the lipid layer
- tear meniscus- helps to check its height, regularity, and shape
- non-invasive break up time (NIBUT)- using grids projected onto the cornea, it measures, the stability of the mucin layer and the entire tear film
- meibography- images the shape of the meibomian gland through transillumination of the eyelid with infrared light, helps in picking up drop-out areas, and diagnosis of the meibomian gland dysfunction
- others- ocular redness classification, blink rate, pupillometry (scotopic, mesopic, and photopic)

While we have come a long way with the available investigative modalities, a thorough clinical examination is crucial for correlation and appropriate management.

**References**

Diagnosing glaucoma

Glaucoma is a disease that damages the eye's optic nerve. It is often a chronic, progressive and degenerative disease that can lead to visual defects. There may also be an acute presentation with redness, pain, tearing and photophobia due to acute raised intraocular pressure (IOP) in cases with angle closure. The damage caused by glaucoma is irreversible. This is why it is important to diagnose the disease early to prevent further vision loss.

You can suspect glaucoma in a patient if the patient has:
- family history of the condition
- high refractive errors
- diabetes
- symptoms like coloured halos and/or pain,
- frequent change of glasses
- raised intraocular pressure
- occludable angles
- signs of optic nerve head damage

India is a country of nearly 1.380 million people of which about 345 million people (25 per cent) are aged 40 years and above. This age group is eligible for opportunistic screening for glaucoma.

Opportunistic screening for glaucoma

Opportunistic screening involves checking those at risk for glaucoma when they present themselves for any eye examination. It can be done in outreach camps, vision centres and ophthalmology clinics. Opportunistic screening for glaucoma includes:
- checking for family history of glaucoma
- measuring IOP
- examining the anterior segment with torchlight, including relative afferent pupil defect (RAPD)
- evaluating the optic disc with direct ophthalmoscope

If available it can also include obtaining an image of the optic disc with smart phone photography.

Eye trained staff at outreach camps, vision centres and eye clinics can examine those at risk of glaucoma (anyone aged 40 years and over); this includes patients who may present with presbyopia, refractive errors or cataract. Proper family history, measurement of intraocular pressure, torchlight examination and optic nerve head assessment is recommended for all patients for opportunistic screening of glaucoma.

Comprehensive ocular examination for glaucoma

Slit-lamp evaluation for glaucoma

Van Herick technique is used to evaluate anterior chamber depth with a slit-lamp to look for:
- pseudo exfoliation
- neovascularisation of iris
- iris atrophy
- presence of peripheral iridotomy
- blebs
- pigments of corneal endothelium (Kruckenbergh spindle)
- pigments on the anterior surface of the lens

Tonometry

Do remember to measure IOP of all patients above 40 years at every visit. Applanation tonometer is ideal but rebound or non-contact tonometer can also be used. Corrected IOP according to corneal thickness is useful in suspected cases of ocular hypertension and normal-tension glaucoma.

Gonioscopy

Gonioscopy is essential for all patients suspected of glaucoma. It examines the angle of the anterior chamber. It is best performed using four-mirror indentation gonioscope. The ophthalmologist should assess the angle as occludable or open as the treatment will depend on the assessment. An angle is occludable when posterior trabecular meshwork is not seen in 180 degrees of angle and more.

Dynamic or manipulative gonioscopy assesses if angle closure is only appositional or if peripheral anterior synechiae are formed. Evidence of blotchy pigments, neovascularisation, excessive pigments on trabecular mesh with wide open angle and concave iris are signs of pigmentary glaucoma.

Disc evaluation

The best way to evaluate a disc is with a 78 or 90 Dioptre non-contact fundus lens on a slit lamp. It gives a stereoscopic view of the disc to assess optic disc...
size, cup and rim delineation. In patients suspected of glaucoma important signs to note are: cup size and depth, loss of rim, notches, slopes, and disc haemorrhage. A point to remember is that the margin of cup is where vessels bend and not the area of pallor.

The disc suspected for glaucoma may include:
- a vertical cup to disc ratio of more than 0.5
- asymmetric cups (that is a cup disc ratio between both the eyes of more than 0.2)
- notching of the neuro retinal rim and
- splinter haemorrhages at the disc

Disc damage likelihood score (DDLS) is a tool that can help to classify optic discs of different sizes as normal, disc at risk, glaucoma damage and glaucoma disability.

Visual field analysis
All the patients who are glaucoma suspects need perimetry to check for glaucomatous field loss.

Imaging in glaucoma
Visual field defects begin to be obvious after a loss of about 40 per cent of retinal ganglion cells. Hence structure imaging tools that can pick up abnormalities earlier have become popular. These tools include optic disc and retinal nerve fibre layer (RNFL) imaging for disc documentation and RNFL loss. The most popular technique is optical coherence tomography (OCT). OCT is a non-invasive test that provides images of disc, RNFL and ganglion cell count of macula. These are useful for early detection and to track progression.

Progression of glaucoma
Family history, refractive errors, and age are risk factors for progression of glaucoma. Progression is tracked using IOP, visual fields, disc photos and/or OCT. Optic disc progression can be seen as neuro-retinal rim thinning, enlargement of the cup/ disc ratio and increased area of parapapillary atrophy. Visual field progression is assessed by increasing mean deviation and pattern standard deviation, enlargement of scotoma or increased depth of scotoma. OCT gives numeric values of disc parameters and RNFL thickness; a reduction of ten per cent or more from a previous visit is considered progression. Visual fields and OCT both have built-in progression analysis package called GPA that is capable of giving trend and event analysis.

When something goes wrong
Thank you so much for your courageous coverage of medical error in the most recent issue of the Community Eye Health Journal. Inadvertent harm in health care settings can be devastating for patients and caregivers alike. Not too long ago, when I was trained in medicine, disclosure of medical error and apology were discouraged because of the potential for lawsuits. Such an approach disrespected patients and morally harmed caregivers. It was therefore tremendously encouraging to learn that, at least in clinical eye care, disclosure of error and apology are being practiced in hospitals and clinics around the world. A recent account in the Huffington Post by a gynaecologist (http://bit.ly/Huff-apology) complements your reporting and highlights the positive impact of disclosing medical error.

When something goes wrong in public health, or global health, offering an apology can be even more difficult. Responsibility is diffuse and causal pathways are more difficult to discern. There may be fear that acknowledging inadvertent harm could threaten public health programmes that deliver substantial benefits. Consequently, as described in a recent article (http://bit.ly/glob-apoli), apology in public health is less often the norm. We in public health can be inspired and challenged by the progress made by eye health in acknowledging unintended harm.

Your remarkable coverage of this topic in the Community Eye Health Journal has done us all a great service. Indeed, this issue can serve as a model for other fields within health care and across global health. Thank you for so positively advancing the conversation, with extraordinary clarity and forthrightness.

David Addiss
Director: Focus Area for Compassion and Ethics (FACE), Task Force for Global Health, Decatur, USA.
Web: www.taskforce.org Email: daddiss@taskforce.org
Recent advances in retinal imaging and diagnostics

New imaging technologies like artificial intelligence and deep learning systems show a potential to screen populations at risk of retinal diseases at a large scale in a resource constrained setting.

Retinal disorders are emerging as important causes of blindness in middle-income countries. In a recent rapid assessment of avoidable blindness plus diabetic retinopathy (RAAB plus DR) survey in western India, posterior segment disorders (PSD) were responsible for nearly 39 per cent of blindness next only to cataract (45 per cent).1 Diabetic retinopathy (DR), retinopathy of prematurity (ROP) and age-related macular degeneration (ARMD) are the important retinal diseases of public health significance.

Challenges in screening for retinal diseases
Challenges to provision of screening in resource poor regions such as Asia include lack of specialists and lack of equipment. Of the limited specialists, most practise in urban areas, whereas a large population resides in remote rural areas. Retinal imaging devices and telemedicine can help address the ‘rural-urban gap’,2 as non-ophthalmologists can screen for retinal diseases to save the precious time of specialists.

Types of retinal imaging
Several types of cameras can image the retina or optic nerve. Imaging a retina allows one to:
• screen various diseases
• photo document pathological lesions
• track disease process
• see response to therapy overtime

Fundus photography has transformed from electronic flashes to smart phone-based cameras to more recent portable eye examination kit (PEEK). PEEK is a smart phone-based application for comprehensive eye examination (www.peekvision.org). The advantage of these cameras is that a non-ophthalmologist can take pictures and, with some training, grade them as well.

We discuss various types of imaging systems below:

Mydriatic camera
This is the most used and sophisticated imaging system available in the market. By asking patients to move their eyes in different directions, one can take images of posterior pole as well as the periphery of retina. Pupillary dilatation and bright flash lights make this system less patient friendly. The bulky size of a mydriatic camera makes it unsuitable for use in outreach/high volume screening.

Non-mydriatic camera
Low cost and less weight makes a non-mydriatic camera ideal for screening. It also appeals to patients as you can image without pupillary dilatation and use low intensity flash light.

Hand-held cameras
The big advantage of a hand-held camera system is its small size. This system does not need to be mounted on a table top unlike the mydriatic and non-mydriatic cameras. It’s portable size and low cost make this a good option for high volume screening programmes. One important disadvantage with this camera is that, it is difficult to get good quality images if cataract or other media haze are present. Hand-held cameras cannot be used for special investigations such as FFA.

Smart phone-based camera systems
Special adaptors make it possible to use smart phones as fundus cameras. This is the cheapest way to image a retina. In several studies, a smart phone-based retinal camera has shown similar results to a desktop fundus camera.3

Most cameras we mention above provide a field of view between 30 and 45 degrees. This is suitable to identify diseases that affect posterior pole like diabetic retinopathy (DR) or age-related macular degeneration (ARMD). However, there is a possibility of missing lesions in the retinal periphery.

Ultra-wide field (UWF) camera
UWF camera helps to take images of peripheral retinal lesions like vein occlusions, vasculitis, posterior uveitis, breaks and detachments. UWF cameras provide a field of view of 200 degrees which is approximately 82 per cent of retina surface. Fundus fluorescein
even through dense cataracts. Recent addition of OCT angiography allows dyeless visualisation of retinal vessels in macula.

**Artificial intelligence in diagnosis of retinal conditions**

Artificial intelligence (AI) and deep learning system (DLS) have the potential to improve screening coverage in resource constrained settings. In DLS, neural networks read labels of images with normal and abnormal findings. It then starts to recognise patterns and groups similar images of a particular diagnosis. More the number of image sets, higher the precision and accuracy.

In a study done in Singapore, researchers used AI and DLS to screen and identify DR and other eye diseases. The results of the study showed a very high sensitivity to vision threatening DR but a low sensitivity for diabetic macular oedema. Which makes it, one of the major limitations in a DR screening programme. However the study showed a high sensitivity and specificity for detection of glaucoma and ARMD. Further research may establish the validity of DLS in making a difference at a large scale. AI and DLS show the potential in screening programmes. They can reduce the burden on trained human resources and enable specialists to focus on treatment of these conditions.

**Conclusion**

Advances in retinal imaging have led to a paradigm change in diagnosis and management of retinal diseases. In future, use of new technologies like AI and DLS in screening programmes is likely to help identify severe blinding retinal conditions and treat them at an early stage.
Managing demand generation with evidence

Generating and managing demand for eye care services must be based on evidence. We discuss what this evidence includes and how it can be effectively used to start eye care programmes to reach underserved populations.

An estimated 1.3 billion people worldwide live with some form of distance or near vision impairment. Uncorrected refractive errors and cataracts are the leading causes of vision impairment. They are also avoidable. The WHO estimates that globally only about a quarter of people with eye problems use eye care services.

Studies conducted in rural India and Nepal show the levels of uptake of eye services and cataract surgery range from seven per cent to 35 per cent. In another study in 52 countries only 18 per cent of people over 60 years got their eyes examined within the last one year; 38 per cent reported never having an eye exam.

Appropriate demand generation strategies can address this unmet need in the community. With large eye care providers based in urban areas, there is a need to reach the rural population. Community outreach programmes are a viable strategy to generate demand in rural populations. These programmes have an indirect or snowball effect on the patients who come to a base hospital. Another strategy is setting up primary eye care centres in rural areas. Primary eye care centres can enable access and refer those who need further interventions to a base hospital.

Estimating the demand potential
While evidence exists for prevalence or backlog, it is a challenge to estimate the demand for, let’s say, cataract surgeries or spectacles, from a particular area at a certain period. Yet, one can make reasonable estimates based on existing trends, comparing with other similar regions, and the need in the community. Such estimates can also be made for a country or state.

Setting targets for an eye hospital
Besides, estimating the demand potential, eye hospitals needs to set targets which requires us to understand the current level of eye care in the service area to arrive at the unmet demand potential. Targets combined with the hospital’s own capacity can help derive the annual goals for the hospital.

Setting targets for an outreach event
An outreach event covers a circle of eight to ten kilometres radius around the camp and is influenced by the access time to reach the eye camp site. The population covered and the intensity of promotion are the main drivers of the event. Past experiences help to refine the estimates for expected outpatients, surgery or spectacles.

Why are such targets important?
At the national level such targets are critical for advocacy and to build capacity of human resources and facilities. This applies to the hospital level as well. For outreach events such targets guide adequate staffing. Technology like geographic information system (GIS) can help to set realistic targets for served or underserved areas.

Ensuring effectiveness of the programme
Several factors influence the effectiveness of our efforts or deployment of resources. Having evidence helps to develop the right interventions to enhance the effectiveness. Such factors are:

References
Variation in Access:
New patients per lakh population

Compliance refers to whether or not patients follow their physicians instructions. It is important to understand how many patients comply with the prescribed surgery, spectacles or treatment. All the diagnostic or outreach efforts on those who don’t comply, is essentially wasted. Plus without the treatment, there is no impact on the problem. So it is important to track the prescriptions and their compliance. Understanding the barriers to non-compliance helps to plan appropriate strategies to improve compliance.

Cataract surgery acceptance rate is the number of cataract patients accepting a surgery among the total number of patients prescribed. Setting a target for the surgery acceptance rate helps to measure the gap and plan for increased productivity and cost effectiveness. You may find that transport, counselling and costs are also facilitators for improving effectiveness.

Cataract conversion rate is the number of cataract surgeries done per hundred outpatients served. We use this when calculating cataract surgery acceptance rate is not possible due to lack of data. The rate varies across the regions as per the prevalence of cataract and the type of services available. Comparing the rate with similar organisations ensures that we do not miss the patients needing cataract surgery. The rate can suggest refinements to clinical protocol and counselling process.

Diagnostic profile of outpatients gives an insight into the patients’ condition. We must take appropriate action if patients are not visiting the hospital for certain conditions. For instance, if very few patients with diabetes are getting their eyes examined, focused awareness campaigns at the community level can address this and reduce the risk of diabetic retinopathy.

A geographic analysis of where patients come from can help to identify areas of low coverage. This, in turn, helps to frame appropriate strategies to reach patients from all locations.

It is a common phenomenon in many regions to see seasonal variations in patient load. This can be due to several reasons, including changes in the weather. Such variations lead to underutilising resources during lean periods and stretching in peak periods. Both scenarios are undesirable. So, knowing the variations would help managers to smooth the seasonality.

Sustaining the demand
Sustaining and growing the demand is largely driven by word of mouth and trust in the hospital. Therefore the evidence for quality of services, patient satisfaction and retention requires constant improvement.

Post-operative visual outcome:
Satisfied patients usually become the ambassadors of the hospital. It is important to minimise operative complications and ensure that the patient gets the best possible vision. The WHO recommends that over 90 per cent of the cataract surgical patients should gain a best corrected vision of 6/18 or better. It is heartening that very good outcome of better or equal to 6/12 is a step in the right direction for quality vision.

Patient experience:
This is another major influence on demand. It includes both clinical and non-clinical services. Apart from clinical outcomes, patients should be happy with other services you offer like short waiting time, support services, food and quality of communication. A simple way to know what patients want is by placing a suggestion box or through feedback surveys.

Tracking patients with chronic conditions:
Patients with conditions like glaucoma or diabetes need to be monitored regularly to preserve their vision. A patient register to track such patients and sending reminders via SMS or WhatsApp may be useful. You can track the effectiveness of such interventions through compliance to periodic follow-up.

Benchmarking:
Any evidence by itself in isolation does not give much insights. Looking at historical data or a comparison with other providers can give rich insight. For example, an indicator of quality of surgery is when a hospital reports that 80 per cent of cataract patients gained best corrected visual acuity (BCVA) 6/18 or better. When you compare this with WHO standards of 90 per cent you can find the gap and opportunities for improvement.

Monitoring system:
For excelling in operations, monitoring should be an integral part of a hospital teams work. Periodic systematic review of what went well or what didn't, can pave the way for continuous improvement of existing systems and processes.

Conclusion
Managing demand has two facets and each has a different orientation. Looking at the current demand for services that is, those who come and have their need met by your services. All providers, regardless of whether you are programme manager or running a hospital, should also be concerned with those in the catchment area you are not reaching, the unmet need. Coverage is the percentage of those who have their need met out of all those who have a need. This needs to be based on good evidence generated through ongoing monitoring and population based studies.
Beyond VISION 2020: universal eye health coverage and the elimination of trachoma

On 18 February 1999, the World Health Organization (WHO) and the International Agency for the Prevention of Blindness (IAPB) launched VISION 2020: The Right to Sight. This global initiative was created to eliminate causes of avoidable blindness by the year 2020. VISION 2020 aims to build comprehensive and sustainable eye health systems by integrating existing health services and ensuring high quality universal eye care. VISION 2020 has three key objectives: 1) the control of diseases that affect eye health; 2) the development of human resources; and 3) the provision of appropriate technology and infrastructure.

Trachoma, the world’s leading infectious cause of blindness, is one of the priority diseases targeted by VISION 2020. There has been significant advancement towards elimination since the launch of VISION 2020. In June 2019, WHO announced a 91% global reduction in the number of people at risk of trachoma, from 1.5 billion in 2002 to 142.2 million today. During the same period, the number of people requiring surgery for trachomatous trichiasis (TT), the late blinding stage of trachoma, reduced from 7.6 million to 2.5 million – a 68% reduction. Nine countries across all endemic WHO regions have reduced from 7.6 million to 2.5 million – a 68% reduction. Nine countries across all endemic WHO regions have

References

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The Community Eye Health Journal has come a long way in the last three decades: our paper editions reach over twenty thousand people worldwide, our online readership has grown to 120,000 and our articles have been viewed or downloaded on PubMed 1.2 million times.

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You can also view the app in any browser, on any device, by visiting https://m.cehjournal.org

Thank you to Tijssen Foundation and the Peek Vision Foundation (www.peekvision.org) for funding the development of the Community Eye Health Journal app.

Elmien Wolvaardt
Editor: Community Eye Health Journal, International Centre for Eye Health, London School of Hygiene & Tropical Medicine, UK.

Thank you to Tijssen Foundation and the Peek Vision Foundation (www.peekvision.org) for funding the development of the Community Eye Health Journal app.
Test your knowledge and understanding

This page is designed to help you to test your own understanding of the concepts covered in this issue, and to reflect on what you have learnt.

You can detect many eye conditions using a simple torch. NEPAL

We hope that you will also discuss the questions with your colleagues and other members of the eye care team, perhaps in a journal club. To complete the activities online – and get instant feedback – please visit www.cehjournal.org

Answer TRUE or FALSE for every part of all questions.

Question 1
The following eye examinations can be performed by a trained eye health worker (who is not a doctor) who has suitable equipment:

- a. Measurement of visual acuity
- b. Indirect ophthalmoscopy
- c. Refraction for presbyopia
- d. Measurement of intraocular pressure using a Schiötz tonometer
- e. Examination of the visual fields

Question 2
The following can be performed using a torch:

- a. Examination of the pupil light reflex
- b. Examination of the conjunctiva
- c. Diagnosis of trichiasis
- d. Examination of the optic disc
- e. Examination of the cornea for a foreign body

Question 3
The Arclight:

- a. Requires batteries
- b. Costs about £30
- c. Can be used to examine the optic disc
- d. Can only be used by doctors
- e. Can be used to examine the ears

Question 4
Which of the following statements are TRUE?

- a. A baby with a white pupil should be referred immediately
- b. Reading glasses can be given to a 50-year-old patient with 6/60 vision in both eyes
- c. A 50-year-old patient who has an in-turned eye on cover test and complains of double vision probably has a squint from childhood
- d. A patient who complains of sudden unilateral painless loss of vision should have their pupil reactions tested and fundus examined following dilation of the pupils
- e. Community health workers must refer all eye patients to a specialist

ANSWERS

c = d = a and b are TRUE. a c d e are TRUE. b and e are TRUE. It is also possible and costs around £10 (US $13). It can be used by any trained health worker.

2 c d and e are TRUE. Indirect ophthalmoscopy is helpful done by anophthalmoscopists.

1. a, c, d and e are TRUE. Indirect ophthalmoscopy is helpful done by ophthalmologists.

2. d, is FALSE. a, b, c and e are TRUE.

3. c and e are TRUE. a and d are TRUE. It is also possible and costs around £10 (US $13). It can be used by any trained health worker.

4. a. TRUE. It may be cataract or retinoblastoma, both of which require urgent specialist attention. b. FALSE. The cause of poor distance vision needs to be found before considering giving reading glasses. c. FALSE. Double vision implies a recent muscle or nerve problem, e.g., sixth nerve palsy. d. TRUE. Sudden vision loss in a non-painful eye may be due to diseases of the retina or optic nerve. e. FALSE. A community health worker can be trained to carry out a basic eye examination and detectable and treatable blinding conditions. The worker can be trained to refer patients to ophthalmologists or optometrists for further diagnosis and treatment.

NIRANJAN GAIRE, CHHANDA (KALE-BABU) NARAYANI EYE HOSPITAL
**Picture quiz**

**Question 1**
What do you notice about each of the following?
- Eyelids
- Conjunctiva
- Cornea
- Pupil

*Note: the dense white oval mark at 12 o'clock on the pupil margin is a reflex from the flash of the camera.*

**Question 2**
What is the diagnosis?

**Question 3**
What disease is likely to cause this?

**Question 4**
What is the name of the public health strategy to eliminate blindness from this disease?

---

**ANSWERS**

1. **What can you see?**
   - a) Eyelids: turning in of the upper eyelashes
   - b) Conjunctiva: it is red
   - c) Cornea: there is a small grey-white opacity at 4 o'clock near the pupil edge; the rest of the visible cornea is clear
   - d) Pupil: it looks normal.

2. **What is the diagnosis?**
   - Trichiasis.

3. **What disease is likely to cause this?**
   - Trachoma.

4. **What is the name of the public health strategy to eliminate blindness from this disease?**
   - The SAFE strategy (S for surgery to treat trichiasis, A for antibiotics to clear infection, F for facial cleanliness and hand hygiene to help reduce transmission and E for environmental improvement (for access to water and sanitation).

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**Inaugural World Ophthalmic Nursing Forum**

The World Ophthalmic Nursing Forum will offer nurses the opportunity to meet and network with a wide range of colleagues from across globe. It is free for nurses who register to attend the IAPB Global Assembly in Singapore from 12-14 October 2020. Find out more: email communications@iapb.org or visit IAPB.org/GA2020

**Egypt carries out first trachoma intervention since 2001**

Egypt distributes antibiotics to over 300,000 people to prevent and treat trachoma. Egypt has conducted its first mass drug administration (MDA) since 2001, giving it to over 300,000 people to prevent and treat trachoma. Read more at www.cehjournal.org/NAME-OF-ARTICLE

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Are you a practicing ophthalmologist cataract surgeon interested in improving cataract surgical outcomes? The BOOST app will help you to capture key cataract outcome data and produce simple, engaging reports that can help you improve outcomes. To help us test the app, email BOOST@hollows.org or read more at www.cehjournal.org/NAME-OF-ARTICLE. The deadline is **30 December**.

**Paediatric cataract surgery video now online**

Highly respected paediatric ophthalmologist Albrecht Hennig has made a valuable teaching video about cataract surgery in children, based on techniques he perfected while working in Nepal and performing cataract surgery on thousands of children. Watch it on YouTube: https://youtu.be/exYk409KgL8

**Courses**

- **MSc Public Health for Eye Care, London School of Hygiene & Tropical Medicine, London, UK**
  - Fully funded scholarships are available for Commonwealth country nationals. For more information visit www.lshtm.ac.uk/study/masters/mscphec.html or email romulo.fabunan@lshtm.ac.uk

- **Small Incision Cataract Surgery Training at Lions Medical Training Centre in Nairobi, Kenya**
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**Next issue**

The next issue is on the theme **Viral infections and the eye** and it will be available on our app and online only.
The visual acuity should be measured in each eye for all patients complaining of eye problems

How to examine the eyelids, conjunctiva, cornea and pupils with a torch should be taught to all health workers

Smart phone-based cameras for retinal examinations are inexpensive, easy to use and show similar results as a fundus cameras