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Two patients awaiting surgery, Mohammadi Hospital. INDIA

Improving the refractive outcomes of cataract surgery

Poor refractive outcomes form one of the main reasons for cataract surgery failing to provide patients with the vision they need to function well.

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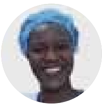

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Cataract is the leading cause of blindness worldwide, despite an effective cure having been available for several decades, in the form of cataract surgery.

A focus on biometry and IOLs

One of the main reasons for cataract surgery failing to provide patients with the vision they need is poor refractive outcomes. In this issue, we will explore how refractive outcomes can be monitored and improved through good biometry, intraocular lens (IOL) selection, and auditing to improve biometry – all of which helps to minimise the number of people who remain limited in their visual function after undergoing cataract surgery.

Our next issue will focus on surgical quality and safety, which is equally vital, and we will be covering patient-centred cataract services, including postoperative refraction, in early 2026.

Peter Drucker, a celebrated management guru, said, "If you can't measure it, you can't improve it." This applies to cataract surgery outcomes as well. If we don't know what vision our cataract patients are left with after surgery, there is little scope for improving it. For individual surgeons and hospitals, this means seeing your patients postoperatively and collecting data on complication rates and visual outcomes. Historically, national level monitoring just involved asking, "What proportion of those who need cataract surgery

About this issue

One of the main reasons for cataract surgery failing to provide patients with the vision they need is poor refractive outcomes. In this issue, we will explore how refractive outcomes can be monitored and improved through good biometry, intraocular lens (IOL) selection, and auditing to improve biometry – all of which helps to minimise the number of people who remain limited in their visual function after undergoing cataract surgery.

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have had surgery?" This was the **cataract surgical coverage** (CSC). Although helpful it did not provide any information about the quality and effectiveness of that operation from the patient's perspective.

Effective cataract surgical coverage

The cataract outcome indicator now promoted by the World Health Organization (WHO) is **effective cataract surgical coverage (eCSC)**. This is the proportion of all those who had developed cataract (both those operated for cataract and those still in need of surgery) who have been operated on and who have a presenting visual acuity of 6/12 or better. (Note: presenting visual acuity is measured with whatever correction a person is currently using.) This effectively raises the standard from the previous threshold for "good" outcomes of 6/18 or better.[1]

The WHO have recommended a target for countries to increase eCSC by 30 percentage points by 2030. Population-based surveys conducted in 55 countries showed substantial variation in eCSC, ranging from 3.8% to 70.3%. The median eCSC was 24.8%, while the median CSC stood at 40.0%. The relative quality gap (the difference between 40.0% and 24.8%, expressed as a percentage of 40.0%) is 38%; this means that over one-third of operated patients did **not** achieve a good outcome of ≥ 6/12 presenting visual acuity. In settings where the relative quality gap exceeds 25%, it is recommended to prioritise quality improvement initiatives before scaling up surgical access or volume.[2] The IAPB Vision Atlas provides estimates of CSC and eCSC for several ountries (see **visionatlas.iapb.org**).

In India, data from population-based surveys conducted in 31 districts reported an overall eCSC of 36.7% and a CSC of 57.3%, giving a relative quality gap of 35.9%. This indicates that, in more than one-third of operated patients, the presenting vision was below the threshold of 6/12.[3] This gap was more pronounced among patients who underwent manual small incision cataract surgery (MSICS), at 39%, compared to 8% in those who had phacoemulsification.[4] Nonetheless, MSICS is likely to continue to be the preferred technique as it doesn't need expensive equipment, with its accompanying maintenance challenges.

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In one Liberian hospital-based study, at 4–11 weeks, good outcomes of 6/12 or better were reported in 38.6% of patients (uncorrected visual acuity) and 82.5% (best-corrected visual acuity).[5] In an Indian hospital-based study with a much larger sample size of about 84,000 patients, it was found that 54.4% of operated eyes (71.2% of MSICS eyes and 21.0% of phacoemulsification eyes) showed a potential improvement of 2 lines or more of Snellen acuity with refraction.[6] This evidence suggests that a lack of postoperative follow-up and refraction is a significant cause of the quality gap between CSC and eCSC. Attention should be paid to optimising the direct refractive outcomes of surgery, particularly in settings where the uptake of postoperative spectacles – including near vision spectacles for presbyopia – is low. However, even where biometry and lens choices have been optimised, effective postoperative refractive management will improve patients' visual function and quality of life after cataract surgery.[7]

Refractive aims: does one size fit all?

Targeting good distance vision is appropriate for most patients, and there is the expectation that those who need good near vision postoperatively will access reading glasses. However, there are settings in which long-term use of near vision spectacles is very limited following cataract surgery, despite affordable spectacles being made more accessible; this may be for cultural reasons, or where literacy levels amongst the elderly are low. For such patients, emmetropia may not be the best option and a low myopic aim would provide acceptable distance vision with more near functionality. There may be other patients who spend the majority of their time on near tasks, and who would prefer to prioritise getting good unaided near vision with a myopic postoperative refractive target.

There is no evidence currently available to tell us what refractive outcome provides patients with the best function, quality of life, or satisfaction with their surgery. The best refractive aim for maximised quality of life scores is likely to vary according to gender, age, and socioeconomic status as well as between and within countries, as patient preferences and visual demands vary according to circumstances. It is also possible that the best visual function in patients who are less likely to sustain spectacle use postoperatively would be to have one eye focused near emmetropia, with the other eye being left with a low myopic correction. For this reason, it is important that clinicians listen to patients in order to understand each individual's needs.

There is no point discussing targets, unless a service is achieving sufficient accuracy with biometry: the process of measuring the power of the cornea (keratometry) and length of the eyeball (axial length) and using this data to determine the ideal IOL power. Biometry for all patients undergoing cataract surgery is no longer considered optional by the majority of eye care professionals. Equally, if various powers of IOL are unavailable, efforts with biometry are wasted. We have therefore included articles on practical approaches to biometry in lower-resource settings, auditing to improve the outcomes of biometry, and IOL choice and management to improve availability. We also have an excellent case study demonstrating how biometry can improve outcomes in hospital and in outreach settings.

Good refractive outcomes and patient satisfaction with surgery is dependent upon the collective efforts of everyone involved in the patient journey, including the ophthalmologist, counsellor, biometry technician, supply-chain person, operating room team, and refractionist/optometrist. We aim to provide evidence-based recommendations and case studies for service improvement at each step in the process in this issue and our next three issues.

Look out for our next three issues, covering the surgical quality and safety of cataract services; presbyopia; and patient-centred cataract care. Subscribe at **cehjournal.org/subscribeonline** *to make sure you don't miss any!*

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Delivering high-quality biometry in low-resource settings: a practical guide

Accurate biometry is possible in any setting when a small, well-trained team follows a standardised protocol, audits its results, and keeps its equipment calibrated and well maintained.

An optical biometer. INDIA

Biometry is the cornerstone of modern cataract surgery because it helps surgeons to select the correct intraocular lens (IOL) power for their needs. Modern biometry measures variables such as axial length, anterior chamber depth, lens thickness, white-to-white corneal diameter, corneal power (keratometry, or K), and effective lens position. A study on parameters influencing refractive outcomes in a high-income setting (the Netherlands) showed that effective lens position contributed 27% to refractive predictive error, axial length 17%, and K measurements 10%.[1] This may be due to inaccuracies and limitations in measurement and calculation techniques.

In low-resource environments, the risk of such errors rises because staff members often have higher patient numbers and have to work with older machines in a more challenging environment, leading to greater stress. This practical guide explains, step by step, how eye care teams can deliver accurate, repeatable biometry despite these constraints. Accurate biometry supports the wider goal of effective cataract surgical coverage, by optimising postoperative vision for as many patients as possible.

Choosing equipment

Axial length

When funds are scarce, the first decision concerns axial length measurement. A handheld A-scan ultrasound unit that costs between USD 1,000–3,000 is widely available and robust enough for field work. Adding an inexpensive immersion shell (approximately USD 200) immediately improves accuracy by avoiding corneal compression.

Portable/mobile modular equipment: A-scan, B-scan, pachymetry, ultrasound biomicroscopy.

Optical biometers, such as the IOLMaster, Lenstar, and Eyestar, deliver good precision and speed, but their prices can exceed USD 16,000. One shared optical unit, transported with the surgical team, often represents the best compromise for a cluster of district hospitals. Since there is often limited clinical space in such settings, it is necessary to prioritise portability of the equipment, in addition to the safety of the equipment and the operating environment.

Keratometry

A base hospital that can rely on mains electricity may invest in a tabletop autokeratometer, or autorefractor keratometer, for faster keratometry, while outreach teams can use manual keratometers (approximately USD 800) or even some newer smartphone attachments. Some may choose to transport an autokeratometer as was the case with the team in Uganda (see article in this issue).

Human resources: small team, big impact

Equipment alone does not guarantee accuracy. A dedicated biometry team made up of two to four motivated technicians can produce results that match those of large advanced centres.

Clear role separation allows surgeons to focus on the operating theatre while maintaining confidence that every IOL calculation is sound. For example, one team member positions the patient, captures the measurements, and checks quality, while a second member records the data, keeps batteries charged, and disinfects probes so that the flow of patients never slows down.

Trained Optometrist performing immersion ultrasonic A scan, measuring axial length of eye. Immersion USG A scans are considered gold standard for ocular axial length measurement. INDIA

Train team members to adequately perform various aspects of biometry. This will prevent interruptions to biometry services when a team member is unwell or on leave. Use checklists and protocol sheets (see panel) to ensure each team member records information appropriately.

Provide regular refresher training for team members so that they are up to date with of advancements in biometry protocols.

Standard workflow at the base hospital

Consistency begins with the operating environment and set-up. A small darkened cubicle fitted with a chair with a firm headrest stabilises the patient's gaze and eliminates glare.

Ideally, a technician would calibrate the A-scan with a test block and perform a zero check on the keratometer. Immersion ultrasound is preferred because it removes the risk of pressing the probe against the cornea, but contact ultrasound is acceptable provided at least five traces are recorded for each eye and the standard deviation is kept below 0.1 mm.

Contact ultrasound should ideally not be performed on the day of the operation. If this cannot be avoided, then try to ensure that it is performed more than four hours before the operation, as disruption to the corneal epithelium can impair the view during surgery.

Keratometry should be taken three times and the average used for the calculation. Enter results immediately into the electronic record or a bound logbook to avoid transcription errors. Any axial length difference greater than 0.3 mm, or any unexplained asymmetry in corneal power, should trigger a repeat measurement or a review by a senior team member. By adhering to this sequence, the team soon finds that accuracy does not slow them down; it simply becomes the routine.

Outreach workflow: portability and reliability

Cataract outreach brings care to people who might never reach a hospital, yet it exposes the team and equipment to dust, heat, and erratic electricity supply. Essential kit should include a battery or electric-powered A -scan (whichever is available and suitable), a manual or handheld autokeratometer, a small tablet or printer (optional), spare batteries, and alcohol wipes. When water baths for immersion are impractical, the team can rely on contact ultrasound with plans for a slightly myopic offset of 0.25 dioptre (D) to compensate for possible corneal compression. With practice, two operators can measure twenty patients an hour without losing quality. At the end of each session, clean the probes, back up the data to an encrypted memory stick, and charge every battery from a solar power bank, ready for the next village or outreach visit.

Ensuring repeatability and accuracy

Keratometry. The accuracy of keratometry depends on an undisturbed tear film and so it is important that readings are taken before instilling anaesthetic eye drops or touching the cornea with a tonometer; patients must also not wear contact lenses for 2 weeks or more beforehand. This prevents changes in the tear film that will affect the readings. In addition, correct focusing and proper centring of the mires are essential. Three measurements are taken and averaged, but the eyes are rechecked if the corneal powers differ by more than 1.5 D or if either eye falls outside the 40.0 D to 48.0 D range. When scars distort the mires, the team may use the fellow eye (second eye prediction refinement) or, where available, a topographer, always remembering that accuracy in one parameter cannot compensate for inaccuracy in the other.

Axial length. The key to reliable examinations is alignment of the probe with the eye being measured. The probe or optical beam must point directly at the fovea, otherwise the reading will be falsely long or short. The patient should fixate on the probe light with the eye being examined. If the patient finds this difficult, it is helpful to have them fix on a distant target with the other eye. The operator should select the lowest gain that still shows clear echoes from the cornea, anterior lens, posterior lens, and retina. A missing scleral spike indicates that the beam has wandered into the optic nerve and the trace must be discarded. Only the five most consistent traces are averaged, and the operator repeats both eyes if the results differ by more than 0.3 mm or if either eye measures shorter than 22 mm or longer than 25 mm. Immersion is strongly advised for such extremes, because even a 0.1 mm error can shift the chosen IOL by 0.5D in a short eye or by 0.25D in a highly myopic eye.

IOL power prediction formulae

More modern formulae have replaced the old SRK II conversion charts, and many of these new formulae are available free of charge online. For eyes shorter than 22 mm, most surgeons favour Hoffer Q, Holladay II, or the Barrett Universal II. For eye lengths between 22 mm and 26 mm SRK/T, Hill-RBF, and Barrett remain reliable; Haigis, Barrett True-Axial, and Hill-RBF are considered to perform better for eyes longer than 26 mm. Whichever formula is chosen, the surgical team should audit its outcomes every quarter and adjust the A-constant for their preferred IOL model until the mean absolute error sits comfortably below 0.5D.

Data capture and the audit cycle

A prospectively collated spreadsheet can support auditing (see article on auditing in this issue). Discussing these figures with the entire team turns numbers into learning. If the mean error creeps above 1.0D, the technicians retrain; if a consistent bias appears, the A-constant is adjusted accordingly. Publishing local results keeps the focus of the team on maintaining high-quality care, and that builds trust with patients. It may also help persuade administrators that an optical biometer or a second keratometer is money well spent.

Cost-saving and sustainability tips

High-income hospitals often replace equipment long before it fails, so partnerships with high-income hospitals can yield refurbished ultrasound units and keratometers at a fraction of their original cost. Sharing an optical biometer between district centres, couriered with the surgical packs, spreads both the expenses and the benefits. Solar chargers with batteries can guard against power cuts. The guiding principle is that technology must serve the patient, not the other way round. For consumables, consider bulk purchasing or shared services.

Maintenance

Poor maintenance due to lack of technical support is an important contributor to biometry services not being sustained. It is important that any devices chosen can be serviced locally, calibrated daily, and backed up by low-tech alternatives when power fails or if the cataract is too dense for optical methods.

Key take-home messages

Accurate biometry is possible in any setting when a small, well-trained team follows a standardised protocol, audits its results, and keeps its equipment calibrated and well maintained. Contact ultrasound remains reliable provided the operator avoids corneal compression and respects the standard-deviation limits. Immersion or optical methods improve outcomes for very short or very long eyes but are only worthwhile if the data are recorded correctly and reviewed regularly. Low-cost innovation and shared resources can help ensure that all communities can access optimum results from modern cataract surgery.

Practical tips

How to reduce errors while using a keratometer

1 Calibrate and check the accuracy of the keratometer.
2 Use a dedicated single instrument that is known to be accurate.
3 Don't touch the cornea beforehand, and ensure a good tear film.
4 Adjust the eyepiece to bring the central cross-hairs into focus.
5 Make sure that the patient's other eye is occluded and that the cornea is centred.
6 Take an average of three readings, including the axes.
7 If high or low results are encountered (< 40.0D or > 48.0D), it is advisable to have a second person check the measurements.
8 Repeat if the difference in total keratometric power between the eyes exceeds 1.5D.
9 In a scarred cornea, use the fellow eye or average the results.

How to reduce errors while using A-scan

1 Check machine calibration and set for the correct velocity setting (e.g., cataract, aphakia, pseudophakia).
2 The gain should be set at the lowest level at which a good reading is obtained.
3 Apply topical anaesthesia.
4 The four echoes from cornea, anterior lens, posterior lens, and retina should be present and of good amplitude. Misalignment along the optic nerve is recognised by an absent scleral spike.
5 Maintain eye alignment by asking the patient to fixate on the light from the probe to avoid underestimation.
6 Avoid any cornea compression – don't push too hard.
7 Take the average of the five to ten most consistent results giving the lowest standard deviation (SD) – ideally, < 0.06 mm. Reject any axial-length SD > 0.1 mm.
8 Always measure both eyes and repeat if the difference between eyes is greater than 0.3 mm, or if consecutive measurements differ by more than 0.2 mm.
9 Look out for extreme readings and unexpected values – very short (less than 22 mm) or very long (more than 25 mm).
10 There must be a weekly comparison of inter-observer differences.
11 The immersion method increases accuracy in long/short eyes, where a scleral (Prager) shell is used with the patient in a supine position. It is better to opt for immersion or contact-plus-myopia when precision tools are lacking.

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How to conduct a refractive outcome audit to improve biometry: a step-by-step guide

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Regular audits help surgical teams to avoid systematic errors and improve IOL selection, thereby ensuring better refractive outcomes for patients.

Applying the manufacturer's A constant without calibration can result in a refractive shift, often towards unintended hyperopic outcomes.

Postoperative refractive error is one of the most common causes of poor visual outcomes after cataract surgery, underscoring the need for more accurate biometry. Residual refractive errors after cataract surgery can significantly impair near, intermediate, and distance vision, with larger errors leading to worse visual outcomes and, ultimately, reducing quality of life.[1]

According to the United Kingdom's National Health Service benchmark guideline, 85% of eyes should be within 1.0 D and 55% within 0.5 D of the desired spherical equivalent (SE) refraction after cataract surgery.[2] In countries where access to postoperative spectacles is limited, even small errors in biometry can limit patients' ability to perform daily tasks.

Precise intraocular lens (IOL) power selection depends on various key elements, including:

- Accurate biometry measurements (axial length or keratometry readings)
- Accurate prediction of effective lens position
- Appropriate formula selection
- An optimised A constant that reflects local surgical techniques.

This article introduces the ABC refractive outcome audit framework to systematically address the above factors:

- **A (A-constant).** Optimising or calibrating the A-constant to take into account the effective lens position and other formula variables in order to ensure that it reflects local practice conditions
- **B (biometry).** Ensuring measurement accuracy across technicians and devices
- **C (customisation).** Aligning refractive outcome targets with patient needs and surgical realities.

A. Optimising the A-constant

Accurate IOL power calculation relies on the precise calibration of the A-constant. The value of the A-constant depends on three factors: the IOL model, the biometry instruments used, and the desired position of the IOL implantation (either in the bag or in the sulcus).

Real-world surgical variations – including differences in surgical technique and variations in postoperative wound healing – can introduce systematic errors. Regular audits of refractive outcomes allow surgical teams to identify and correct these discrepancies, ensuring that the A-constant reflects local practice conditions.

An unoptimised A constant systematically skews outcomes towards hyperopia or myopia. Manufacturer-published constants are typically based on contact ultrasound biometry and may not account for the longer axial length measurements obtained with immersion or optical biometry. Consequently, applying these constants, without calibration, to modern optical biometry models can result in a refractive shift, often towards unintended hyperopic outcomes.[3]

The labelled constant on IOL packaging usually does not consider local surgical conditions. For new IOL introductions, it is advisable to adopt published constants from peer-reviewed sources until enough institutional data is gathered for optimisation. Constant optimisation recalibrates the formula's mean prediction error to zero, ensuring that the intended refractive target matches postoperative results. It has minimal effect on the dispersion of outcomes around the mean (i.e., the standard deviation); however, it increases the proportion of eyes falling within a particular target range.[4] A study done at an eye department in the United Kingdom demonstrated that repeated optimisation of the A-constant increased the proportion of eyes achieving postoperative refraction within ±1.0 D of the target from 65% to 95%.[5]

How to optimise the A-constant

1 **Collect postoperative refraction data**. For reliable results, record a minimum of 30 eyes consecutively, implanted with the same biometry device, IOL model, and surgical technique. (For the IOLMaster optical biometer, the recommendation is to use data from more than 50 eyes).[6] Refraction should ideally be performed at 4 weeks postoperatively for phacoemulsification, at 4–6 weeks for manual small-incision cataract surgery, or after suture removal for extracapsular cataract extraction. Autorefractors may be a pragmatic alternative in outreach settings where manual refraction is unavailable, although you might want to verify the accuracy of the autorefraction by cross-checking through subjective refraction on selected patients.

2 **Calculate each patient's spherical equivalent (SE) prediction error.** This is the difference between the target SE and the actual postoperative SE. For example, if the target SE was −0.5 D and the achieved SE was +0.1 D, the error is +0.6 D (indicating hyperopic surprise).

$$\text{SE prediction error} = \text{Postoperative SE} - \text{Predicted (target) SE}$$

3 **Calculate the mean error.** This is defined as the arithmetic average of the prediction errors from a patient cohort:

$$\text{Mean error} = \frac{\text{Sum of prediction errors}}{\text{Number of patients}}$$

It shows how close the actual outcome aligns with the intended target in a group of patients and indicates the direction and magnitude of bias in your prediction.

4 **Adjust the A-constant.** A negative mean error suggests that the outcomes are generally more myopic than desired, while a positive mean error indicates a hyperopic tendency. If the mean error exceeds +0.3 D or −0.3 D, an adjustment to the A-constant is needed. If the mean error is positive (hyperopic outcomes), the A-constant should be increased by the magnitude of the error; if negative (myopic outcomes), it should be decreased by the magnitude of the error. The mean error should be as close to zero as possible after A-constant optimisation.

5 **After recalibration, repeat the audit annually to verify sustained accuracy.** Conduct audits sooner if there are changes to the IOL model or manufacturer, the biometry equipment or staff members, and the surgical technique.

B. Ensuring accuracy in biometry measurements

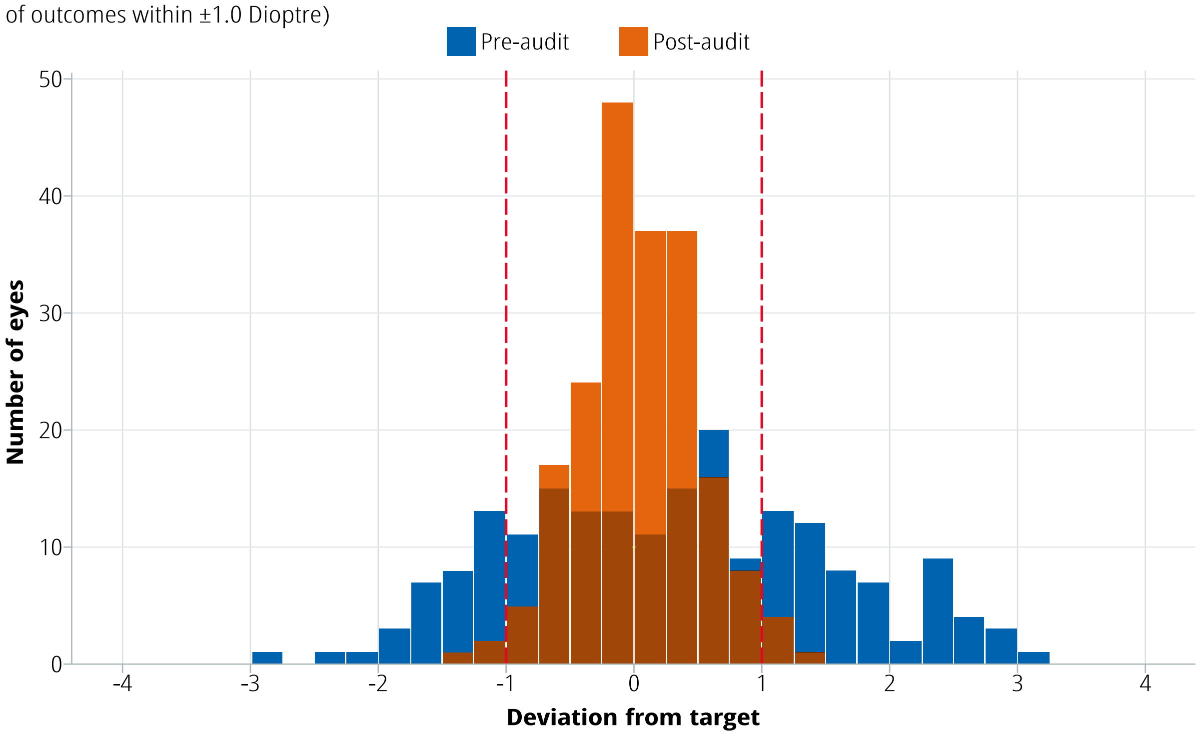
Biometric measurements of the eye are necessary for accurate IOL power calculations, with axial length and corneal power being the minimum required parameters. Errors in axial length or corneal power readings – whether due to technician technique, equipment calibration, or patient factors – directly impact IOL power calculations. An error of 1 mm in axial length measurement can alter the IOL power by 2.5–3.0 D, while an error in corneal power of 1.0 D brings about an equivalent change in power of 1.0 D.[10]

Contact ultrasound methods introduce systematic errors in measuring axial length due to unintended corneal compression, with the magnitude of error influenced by the operator's experience. In contrast, immersion ultrasound techniques avoid corneal compression and can provide refractive results comparable to optical methods.[5]

Steps to evaluate biometry measurement consistency

1 **Plot the distribution of refractive errors.** Generate a histogram of postoperative prediction errors (actual SE minus target SE) in 0.5 D increments. A well-calibrated and precise measurement should give a normal distribution

Figure 1 Distribution of refractive outcomes compared to the target before and after audit (with benchmark set of 85% of outcomes within ±1.0 Dioptre)



Tabletop autokeratometer (or autorefractor keratometer). The value of the A-constant depends on the equipment used. NIGERIA

centred on zero (Figure 1).

2 **Quantify outliers.** If the histogram is skewed to one side, consider adjusting the A-constant (Section A); if the spread of outcomes is wide with 15% or more outcomes >1.0 D from target, consider investigating inconsistencies in biometry measurement.[3]

3 **Compare measurements across technicians.** If the spread exceeds the set benchmarks, compare measurements across technicians. Ensure that at least three technicians measure the same subset of 10–15 patients (same eye, same session), recording axial length and keratometry values. Discrepancies exceeding 0.2 mm for axial length suggest technique-related errors, such as corneal compression during A-scan (resulting in artificially short axial lengths) or fluid bridge artefacts (causing overestimated axial lengths).[11]

4 **Standardise protocols.** Next, standardise biometry protocols to minimise variability. Repeat measurements to ensure consistency in the protocol. For A-scan users, prioritise immersion techniques or enforce consistent probe pressure in contact methods. Keratometry requires monthly calibration.

5 **Operator-specific A-constants (if needed).** If inter-technician variability persists, consider calculating operator-specific A-constants to account for individual measurement biases.

C. Customise refractive targets to local needs: patient-centred outcomes

A one-size-fits-all target of emmetropia (0 D error) may leave patients struggling with daily tasks. Tailoring refractive outcomes to individual lifestyles and local realities improves quality of life and enhances patient satisfaction. While emmetropia provides sharp distance vision, presbyopia and the lack of a truly accommodative IOL require many patients to wear spectacles for near tasks. In low-resource settings, where postoperative access to spectacles is limited, and for patients accustomed to lifelong myopia, strict adherence to plano targets may diminish quality of life.

"Tailoring refractive outcomes to individual lifestyles and local realities improves quality of life and enhances patient satisfaction."

For example, a farmer in rural India may benefit from a deliberate myopic target of −1.0 D, which reduces dependence on spectacles for reading and improves the ability to perform critical daily tasks, like sorting seeds.

When planning monovision – such as targeting −0.25 D in the dominant eye and −1.25 D in the non-dominant eye – anisometropia should not exceed 2.0 D; this will avoid intolerable imbalance.[11]

Preoperative counselling is essential. Simple questions like 'How many hours a day do you spend cooking or reading?', may reveal vision requirements and daily priorities. Hyperopia should be rigorously avoided, as even mild hyperopic refractive surprises are often poorly tolerated, particularly in regions with limited access to corrective spectacles. Patients must also be educated about the inevitability of spectacles for near vision if emmetropia is targeted, and they should be offered alternatives like affordable near vision spectacles.

Conclusion

The ABC framework – A-constant refinement, biometry audits, and customised targets – provides a roadmap for conducting refractive outcome audits and improving cataract surgery outcomes in low- and middle-income countries. By integrating regular audits, standardised protocols, and patient-centred targets, surgical teams can reduce postoperative refractive errors and enhance patients' quality of life.

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IOLs for cataract surgery

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Achieving quality refractive outcomes after cataract surgery depends not only on surgical skill, but also on thoughtful IOL selection and strong logistical planning.

Patient counselling on types of IOLs. INDIA

In low- and/or middle-income countries, manual small-incision cataract surgery (MSICS) using rigid polymethylmethacrylate (PMMA) monofocal intraocular lenses (IOLs) has remained the default option for decades, as MSICS can be performed in basic clinical settings, and because these are the most affordable type of lens, costing around USD 17 in Africa and as little as USD 3–4 for a locally manufactured IOL in India. However, in recent years, an increasing number of IOL types have become available worldwide (see panel). In low-resource settings, the challenge is to balance good clinical practice with patient needs, costs, and infrastructure.

In resource-limited settings, a pragmatic approach, focusing on monofocal and advanced monofocal lenses, selective use of toric lenses, and efficient inventory management, can help to ensure cost effective personalised care with the best possible refractive outcomes.

Tailoring IOL selection

Clinical factors such as astigmatism, ocular surface health, macular status, and surgical history help guide the selection of an IOL. In patients who have undergone refractive procedures, advanced biometry techniques or the Barrett True-K formula are needed to accurately calculate the lens power needed.[1]

The patient's capacity to pay also significantly influences the IOL choice among self-paying individuals. However, even when they can pay, it is essential to consider the patient's expectations, lifestyle, and personality. Using a questionnaire to assess patient's visual needs and preferences makes the choice of IOL and counselling easier for the provider and patients. For example, extended depth of focus (EDOF) or advanced monofocal lenses (see panel) may be well suited to active, working-age individuals. In contrast, standard monofocal lenses typically meet the needs of older adults or patients with lower visual expectations. Multifocal IOLs offer spectacle independence, but may cause glare, making them less suitable for patients with retinal disease or those who are particular about clarity.[2,3]

The availability of operating infrastructure also affects IOL options. In basic surgical settings, MSICS with rigid PMMA monofocal IOLs remains the default option. In centres with phacoemulsification and advanced diagnostic tools, premium options such as toric and multifocal lenses can be offered. However, in low-resource settings, routine use of multifocal or toric IOLs is often not practical due to the high cost of these IOLs and the lack of infrastructure needed to ensure precision in assessment and surgery.[1,2]

Inventory management strategies

Inventory management requires good local logistics and communication between the medical and procurement teams. A yearly audit of lenses used can help to predict the numbers needed so they can be ordered in advance (see the KCMC case study in this article), ensuring that you have a baseline stock of both standard and less frequently used dioptres.

Here are some additional strategies:[4]

- Categorise inventory by IOL type, then IOL power
- Use a first-in, first-out (FIFO) system to prevent wastage due to expiry
- Track monthly usage to ensure there is enough stock. Use spreadsheets or tracking software to monitor expiry dates, usage rates, and reorder points
- Order rare IOL powers or advanced IOLs after the patient confirms they would like to go ahead, and schedule the operation once you know when the IOLs will arrive. This avoids the cost associated with holding a costly inventory of different powers and reduces the risk of expiry
- Maintain regular communication with suppliers to enable timely restocking.

As per National Institute for Health and Care Excellence (NICE) guidelines, one matching IOL should be in the operating room, with an identical backup available. For routine cataract surgery, two sets are usually enough. In patients at risk of complications such as posterior capsular rupture, [A1] a backup multipiece IOL of the same power must be available, regardless of the technique used.[4]

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Main types of IOL, by visual outcome

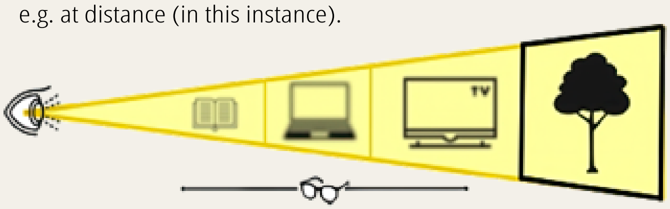
1. Monofocal IOLs

Monofocal IOLs offer clear vision at a single focal point, e.g. at distance (Figure 1). These are used in most cataract operations.

The most affordable type of monofocal IOL are **polymethylmethacrylate (PMMA)** lenses. They are rigid, not foldable, and are inserted using the manual small-incision cataract surgery (MSICS) technique.

Hydrophilic and **hydrophobic acrylic** IOLs also have a single focal point. They are foldable and can therefore be used in phacoemulsification cataract surgery, which creates a much smaller incision compared to MSICS. Hydrophobic lenses are more expensive (USD 40–90), but they are popular for use in children as they give optimal results with the least amount of inflammation.[5]

Figure 1 Monofocal IOLs offer clear vision at a single focal point, e.g. at distance (in this instance).

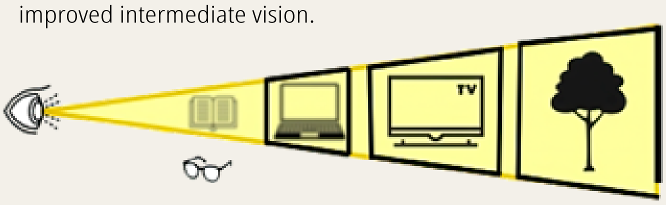


Visual outcome. Monofocal IOLs provide clear vision at a single distance only. The choice of distance depends on the patient and their needs, as described **in another article in this issue**. Many patients choose to be corrected for distance vision, and then typically require spectacles for near and intermediate tasks. Patients with a history of myopia may choose to have clear intermediate vision instead; this helps them to retain some near vision without relying on spectacles. They would need spectacles for distance vision. Patients can also be offered **monovision**, which means the IOL for one eye provides clear distance vision, and the IOL in the other eye provides clear near vision.

2. Advanced monofocals

These lenses have a broader depth of focus and enhanced contrast, thereby improving functional intermediate sight and distance vision. They are ideal for drivers, children, and people who work in low light.[5] These lenses offer high optical quality, but patients will still need spectacles for near vision.

Figure 2 Advanced monofocals offer distance vision with improved intermediate vision.



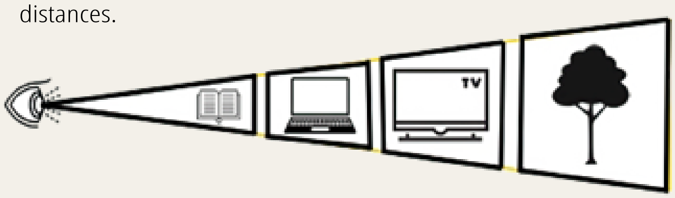
Visual outcome. Advanced monofocal IOLs offers improved intermediate vision along with distance, reducing dependence on spectacles for mid-range tasks like computer use.

Limitations. Advanced monofocals are 4–8 times as expensive as PMMA lenses.

Multifocal IOLs

These usually have bifocal or trifocal designs that split light into two or three focal areas (foci) respectively. Trifocal lenses typically distribute light as follows: 50% for distance, 20% for intermediate, and 30% for near.[2] These lenses offer independence from spectacles at all distances, but they are expensive and not suitable for all patients; their use requires careful patient selection and counselling.[3]

Figure 3 Multifocal offer independence from spectacles at all distances.



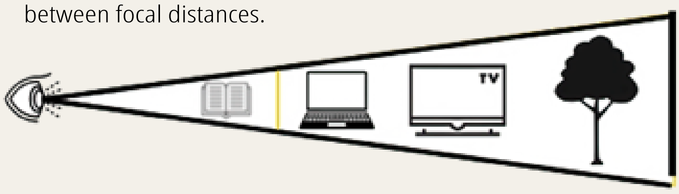
Visual outcome: Multifocal/trifocal lenses are designed to offer spectacle-independent vision at different distances (near, intermediate and distant). Up to 90% of patients using these lenses can be spectacle-free.

Limitations. Risk of glare, halos, reduced contrast. They are not ideal for patients with retinal disease, ocular pathologies, or glaucoma, as they make it difficult to examine the retina. They are significantly more expensive than PMMA lenses.

Extended depth-of-focus (EDOF) IOLs

These extend one focal point across a continuous range rather than splitting light into multiple foci. This helps patients move smoothly between distances, especially for intermediate vision and functional near sight. They cause fewer halos and glare and offer better contrast and night vision compared to multifocal lenses. However, there may still be more glare than with monofocal IOLs. Moreover, some patients may still require spectacles for near work.[6]

Figure 4 Extended depth-of-focus lenses offer smooth transition between focal distances.



Visual outcome. Extended depth of focus (EDOF) lenses provide a continuous range of vision from intermediate to distance with minimal visual disturbances, and some near vision support.

Limitations. Significantly higher cost. May still need near vision spectacles. Some glare still present.

Toric IOLs

These are foldable acrylic IOLs that correct regular corneal astigmatism. They give excellent quality of vision when correctly aligned. However, this requires precise preoperative biometry, calculation, planning, and intraoperative placement, as postoperative rotation can compromise their effectiveness.[1] Toric lenses are available in both monofocal and multifocal types. Monofocal toric IOLs are most commonly used, and more than 90% of these patients achieve Snellen visual acuity of 6/9 or better.

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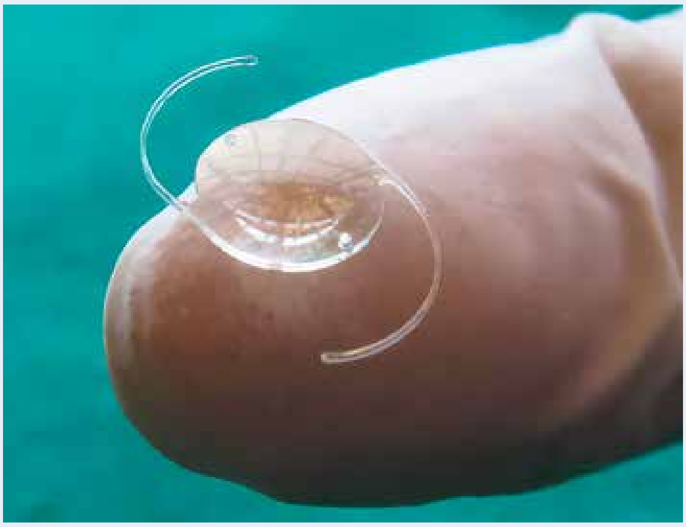
IOL use at Kilimanjaro Christian Medical Centre, Tanzania

Internal audits of IOL consumption improved the availability of correct lens powers in a teaching hospital.



It is vital to have the correct IOL available.

The use of intraocular lenses (IOLs) at KCMC in Tanzania dates back to 1990, when we started using anterior chamber intraocular lenses. Posterior chamber intraocular lenses were introduced in 1992. By the year 2000, phacoemulsification services were available and foldable intraocular lenses were in common use.

Between 2011 and 2017, our department had been purchasing intraocular lenses based on overall numbers used and an estimate of the powers needed: a high volume of the most common powers (which we estimated to be 22D), and smaller quantities of higher and lower powers. We did not record or analyse the type or power of intraocular lenses used, which resulted in some higher-powered lenses expiring before they were used.

In 2017, we carried out our first internal audit of intraocular lens consumption based on lens type and dioptre. We found that the most common IOL used was 20D, not 22D as initially thought. We also found that the most common lens power we used in children was 25D.

This process continued to be improved annually until 2022, by which time a comprehensive picture had emerged of our average annual consumption of the three types of IOL we use most often – polymethylmethacrylate (PMMA), foldable hydrophilic, and hydrophobic acrylic – along their full dioptric ranges (from 1D to 30D).

> “A comprehensive picture emerged of our average annual consumption of the three types of IOL we use most often.”

We found that the proportion of powers stayed the same, year on year, which makes it possible to estimate how many IOLs of each type and power we will need per year. We buy IOLs annually and – provided our finances allow it – we usually order 50% extra of each lens type and power, to ensure we don’t run out.

When we do run out of a particular dioptric power, it is almost always as a result of neglecting to monitor the available stock. Stock monitoring is ideally done monthly, but it is challenging for us as our team has to manually tally the operating theatre stock with the main store stock; this makes it difficult to get real-time information of overall stock levels. However, as our store keeper and procurement officer gain more experience, this is less often a problem.

When a particular dioptric power intraocular lens is not available, and this is found out on short notice, the nearest dioptric power may be used, at the discretion of the surgeon; this is usually different by half a dioptre.

The IOLs we use

The IOLs we use most commonly in our setting are polymethylmethacrylate (PMMA) for small-incision cataract surgery (USD 10 per lens), followed by foldable hydrophilic acrylic IOLs (USD 25–35) and hydrophobic acrylic intraocular lenses (USD 40–90), for phacoemulsification. We also stock a few anterior chamber PMMA intraocular lenses, as well as scleral-fixated PMMA intraocular lenses and foldable hydrophilic three-piece intraocular lenses. Some of the foldable intraocular lenses come pre-loaded into a cartridge, making them easy to use, even for trainee surgeons. The foldable hydrophobic acrylic intraocular lenses are popular with our paediatric ophthalmology team and it’s a great consolation that they give optimal results in children, considering the severe inflammation that can result from eye surgery in children.

We do not use toric or multifocal intraocular lenses. These decisions were made internally, by our ophthalmologists, after evaluating all aspects of using these products in our environment.

IOLs in India: How and where they are used

A wide variety of IOL types are now available in India.

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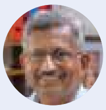

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In India, implanting an intraocular lens (IOL) became standard practice for cataract surgery in the late 1990s. The government supported this by providing grants for patients operated on during outreach eye camps.

According to the recent Indian National Blindness & Visual Impairment Survey 2015-2019, the majority (94.3%) of cataract operations were performed using intraocular lenses (IOLs). The ease of access to IOLs seem to have improved the cataract surgical coverage (CSC): at best-corrected visual acuity (BCVA) levels of <3/60, <6/60, and <6/18, the CSC was 93.2%, 89.0%, and 74.0%, respectively.[1]

In the 1990s, monofocal three piece or single piece polymethylmethacrylate (PMMA) IOL or foldable silicone/acrylic IOLs were the standard IOLs available. Since then, advances in IOL technology and rising patient expectations have led to a wide variety of IOL models, with varying visual outcomes and costs.

A wide range of cost-effective, locally manufactured IOLs are available in India, alongside more expensive imported IOLs from other countries. Based on the current data, nearly 30% of patients are operated as a result of outreach camps conducted by government or non-governmental organisations.[2] These patients typically receive MSICS with implantation of single or three-piece PMMA IOLs. These IOLs are locally manufactured, widely available, and and cost around USD 3–4 each.

Walk-in patients at government hospitals usually receive MSICS with a PMMA IOL at no cost. At eye hospitals owned by non-governmental organisations (NGOs), the same procedure costs USD 12–50. In some Indian states, for patients living below the poverty line, operations in government, NGO, or private eye hospitals are reimbursed through the government insurance scheme (Ayushman Bharat). The scheme pays around USD 100 per phacoemulsification operation with a monofocal foldable hydrophobic IOL, or USD 50 for MSICS with a PMMA IOL.

In private hospitals, where patients pay for their own operation, phacoemulsification with a foldable IOL costs around USD 150–250 for locally manufactured monofocal foldable IOLs and more than USD 500 for imported aspheric hydrophobic foldable IOLs. The locally manufactured foldables cost around USD 25–30 while the imported foldables cost USD 80–90.

In our experience, about 85% of patients who have MSICS with rigid PMMA IOL achieve uncorrected Snellen visual acuity (UCVA) of 6/18 or better. Many of them also have reasonable near sight due to some myopic astigmatic error postoperatively. Nearly 25% of these patients have near vision of N8 or better. After phacoemulsification with a foldable IOL, more than 80% of the patients achieve 6/12 or better UCVA for distance, but require spectacle correction for near sight.[3]

Operations using **advanced monofocals** are usually performed for private patients, particularly those with personal health insurance. These IOLs cost around USD 500–600.

While the locally manufactured **toric IOL** cost around USD 70–80, imported ones cost around USD 200–225. About 1–2% of patients end up requiring re-rotation of the IOL postoperatively to achieve optimal results.[3] Toric IOLs are implanted in about 12–20% of paying patients at Aravind.[4]

Multifocal and extended depth-of-focus (EDOF) IOLs cost around USD 500–600. At Aravind, the uptake of multifocal or EDOF IOL surgery is around 5% of paying patients.

Table 1 Intraocular lens (IOL) types commonly used at Aravind Eye Care System

IOL GROUPS	IOL OPTIONS
MONOFOCAL	PMMA
	I- VISION
	AUROFLEX
	AUROVUE
	AUROVUE EV GOLD
	ACRYLIC (Alcon, JNJ, Hoya)
	ASPHERIC (Alcon, JNJ, Hoya)
MONOFOCAL TORIC	AUROVUE TORIC
	ACRYSOF TORIC
	TECNIS TORIC
	HOYA TORIC
Advanced MONOFOCAL	EYHANCE
	CLAREON
	ESSENCE
Advanced MONOFOCAL TORIC	EYHANCE TORIC
	CLAREON TORIC
EDOF	VIVID
	VIVITY
EDOF TORIC	VIVITY TORIC
MULTI FOCAL	AUROVUE DFINE
	SYNERGY
	PANOPTIX
MULTIFOCAL TORIC	EYECRYL TORIC
	SYNERGY TORIC
	PANOPTIX TORIC

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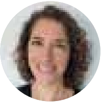

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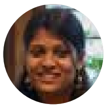

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Systems leadership for sustainable change

To lead change in eye health, we must first understand the system we're trying to change.

In our previous article "Leadership for 2030 In Sight" we outlined the need for a new kind of leadership in eye health, and introduced a core set of skills needed to drive transformative change. This article explores the first of those skills: systems thinking.

What is systems thinking? What do we mean by "the system", and how does it relate to leadership?

Eye health services are being integrated into garment factories – the largest sector employing women in Bangladesh – as the result of a systems approach to eye care. BANGLADESH

Eye health as a complex system

Eye health does not exist in isolation. It is part of a complex system made up of interconnected people, organisations, and institutions, each with their own goals, challenges, and ways of working. These elements interact in unpredictable ways, shaped by policies, financing, service delivery, workforce dynamics, social beliefs, and individual behaviours. No single perspective can capture the full picture. Imagine viewing a large painting with only a small torch: you can only see part of it, making it hard to understand the whole.

> "Eye health does not exist in isolation. It is part of a complex system made up of interconnected people, organisations, and institutions, each with their own goals, challenges, and ways of working."

Most of us engage with just one part of this system, as clinicians, programme managers, advocates, or policymakers. While the WHO Health Systems Framework identifies components like service delivery or governance, it's the interconnections between these components – and with broader social and economic forces – that shape patient outcomes.

For example, a policy shift in insurance or government funding can ripple through the system, affecting service availability, medication costs, and even public awareness. A patient's decision to seek care might hinge on family support, workplace incentives, or social beliefs. These interdependencies mean that outcomes in eye health are rarely linear, requiring adaptable approaches.

Understanding how all these factors interact gives us more choices and ideas about how to make improvements. To strengthen access and quality, we need a mindset that works with – not against – this complexity.

Shifting mindsets: leading as a systems activist

Eye health leaders face challenges like unequal access to care, resource constraints, and rising need. In such environments, isolated interventions won't work. Instead, we must understand the wider system and collaborate across boundaries to co-create solutions.

Systems leadership offers a framework for doing this. It's not about authority or position; it's about perspective, influence, and the ability to mobilise others around shared goals. Useful resources include Donella Meadows' work on systems change[1], Systems Leadership for Sustainable Development from The Harvard Kennedy School,[2] and the seminal article *The Dawn of Systems Leadership* in Standford Social Innovation Review.[3]

IAPB has identified four mindset shifts that support systems leadership in eye health:

- **From health to the whole of society.** Addressing not just clinical issues, but the social, economic, and environmental factors that shape eye health.
- **From programmes to policy.** Influencing policy for long-term impact rather than focusing solely on programme delivery.
- **From competition to collective impact.** Collaborating rather than working in silos.
- **From management to mobilisation.** Enabling action through shared ownership, rather than relying on top-down control.

These shifts offer a powerful lens through which eye health professionals – at all levels – can see their work differently and lead more effectively.

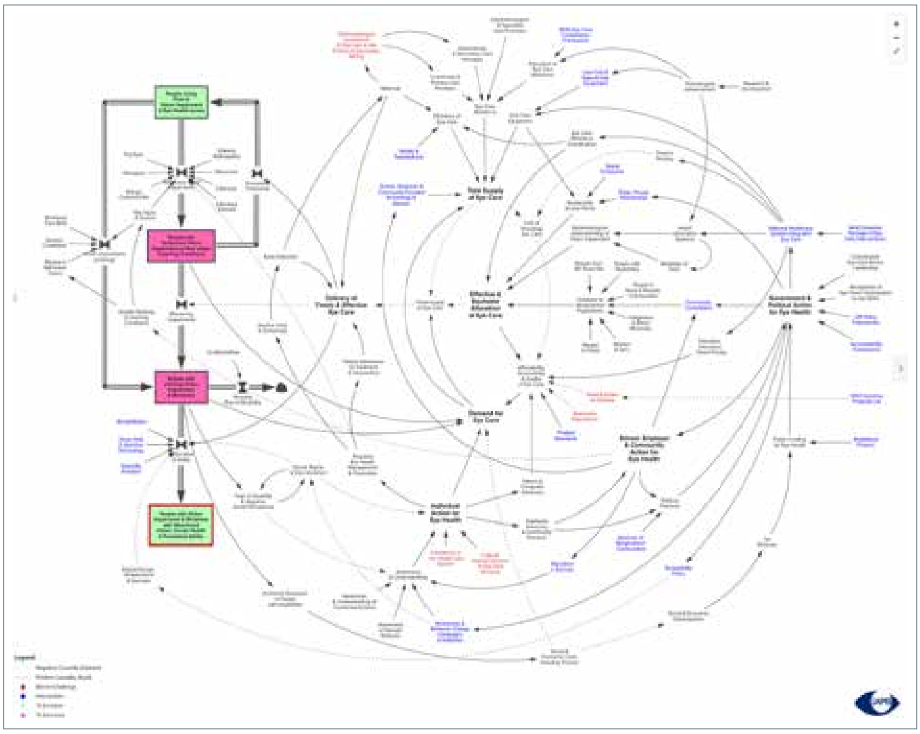
Case study: systems leadership in action in Bangladesh

A recent initiative in Bangladesh illustrates these mindset shifts in practice. The Fred Hollows Foundation, an IAPB member, applied systems leadership to drive national level change aligned with 2030 In Sight.

The initiative began with a system mapping workshop to identify the many interdependencies affecting access to eye care, as well as opportunities for collaboration (see Figure 1). This brought together diverse stakeholders and laid the foundation for joint action: moving from competition to collective impact.

One key insight from the mapping process was that of seeing eye health as a workforce issue. In a follow-up workshop, participants agreed to engage with the garment industry – Bangladesh's largest export sector, employing over 4 million workers – 80% of whom are women.[4] **This represents a shift from a narrow health perspective to a whole of society approach,** which recognised the economic and gender dimensions of access to health care.

Figure 1 A systems map of the many interdependent factors affecting access to eye care in Bangladesh.



The initiative aligned with the interests of industry stakeholders and created momentum for change. International NGOs are now collaborating with the Bangladesh Garment Manufacturers and Exporters Association (BGMEA) to integrate eye care into workplace health services across 4,500 factories. The next step will be agreeing on a model of care, followed by the development of a sustainable financing plan and an initial pilot in 200 factories. **This represents a shift from isolated services to sector-wide policy change—moving from programmes to policy**.

Beyond these immediate outcomes, the initiative fostered new relationships and a sense of shared ownership. It catalysed the emergence of a community of practice committed to systemic change.

To sustain this momentum, the United Nations Development Programme (UNDP) in Bangladesh – supported by The Fred Hollows Foundation – is creating a dedicated role for someone who will nurture cross-sector collaboration. This exemplifies the shift from management to mobilisation: moving from project-based control to enabling networks of changemakers.

What does this mean for eye health professionals?

The Bangladesh case study shows how systems leadership can lead to sustainable improvements in eye health. But systems leadership is not only for those leading national programmes. It's a mindset that *anyone* in eye health can adopt.

It means looking beyond day-to-day responsibilities to understand how your work fits into the bigger picture. It might involve building relationships with other sectors, engaging your community, or rethinking how to address everyday challenges.

We know time and resource constraints can make this challenging. But with vision loss still affecting so many, we urgently need new approaches to leading change.

Eye health professionals bring deep expertise and community trust. By adopting a systems leadership approach, you can use your unique strengths to influence change beyond the clinic. This means working collaboratively, thinking long-term, and embracing continuous learning and adaptation.

Wherever you are working, and whatever your role, you can help shift the system, and be part of the global movement to achieve eye health for all.

ACTION STEP

To start preparing for the next article in this series on creating a shared vision for change, re-connect with your organisation's vision. If it doesn't have one, perhaps invite people you work with – clinicians, managers, community leaders, advocates – to reflect on their shared purpose. Try the question: *"What future are we working towards, and what matters most to get us there?"*

You can also:

- Reconnect with the vision, mission, and priorities of the sector strategy 2030 In Sight in the summary document: **bit.ly/3G4qoa4**
- Explore this article about creating a shared vision for change from The Systems Thinker: **bit.ly/4kpw3TP**

References

1 **https://donellameadows.org/archives/dancing-with-systems/**

2 Dreier, Nabarro, Nelson, 2019, Systems Leadership for Sustainable Development, Strategies for Achieving Systemic Change **https://www.hks.harvard.edu/sites/default/files/centers/mrcbg/files/Systems%20Leadership.pdf**

3 Senge, Hamilton, & Karia, 2015, The Dawn of Systems Leadership **https://ssir.org/articles/entry/the_dawn_of_system_leadership**

4 **Understanding the Gender Composition and Experience of Ready-Made Garment (RMG) Workers in Bangladesh**, International Labour Organisation and UN Women Issue brief, 2020

KEY MESSAGES

Key community eye health messages

Accurate biometry is essential for good sight outcomes after cataract operations

- Measure both eyes and cross-check readings to identify errors before selecting the intraocular lens (IOL) power
- Use optical biometry wherever possible for greater precision; if ultrasound is used, ensure the probe is properly aligned and corneal compression is avoided
- Confirm that the IOL power calculation formula (for example, SRK/T, Holladay 1, or Barrett Universal II) is appropriate for the eye's axial length
- Regularly calibrate and maintain the biometer to prevent drift and inaccurate measurements
- Recheck calculations or repeat measurements when results differ greatly between eyes or seem inconsistent with refraction

Choosing and maintaining good-quality intraocular lenses (IOLs) matters

- Always perform accurate axial length and keratometry measurements to calculate IOL power precisely
- Use a biometry formula that matches your patient population and available technology (e.g. SRK/T, Barrett Universal II)
- Inspect IOL packaging and labelling carefully before use to confirm power, sterility, and expiry date
- Record the IOL model and power in the patient's record for postoperative audits and quality monitoring

Monitoring refractive outcomes helps improve cataract services

- Record the unaided and best-corrected sight of each patient at follow-up to assess surgical outcomes
- Compare the achieved postoperative refraction with the target refraction to identify sources of error
- Keep a register of refractive outcomes by surgeon or service site to monitor trends and guide quality improvement
- Review outcome data regularly and discuss findings during team meetings to plan corrective actions
- Use simple tools or software to calculate the mean prediction error and maintain records for audits

Training and teamwork ensure safe and consistent biometry and IOL practices

- Provide regular hands-on training for staff performing axial length and keratometry measurements
- Develop and follow standard operating procedures (SOPs) for biometry, IOL storage, and recording outcomes
- Encourage communication between the operating team, optometrists, nurses, and counsellors to avoid avoidable errors
- Assign clear roles and checklists for each stage of cataract service delivery to maintain efficiency and accountability