Title: European Society of Cataract and Refractive Surgeons Guideline for Cataract Surgery 2024: Executive Summary

Running head: ESCRS Guideline for Cataract Surgery 2024

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The complete declarations of interest for all authors of the ESCRS Cataract Surgery Working Group are provided in the appendix.

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ABSTRACT

Cataract is a leading cause of visual impairment globally, with surgery as the only effective treatment. Management involves a care pathway, including screening, patient selection, preoperative assessment, surgery, and postoperative care. The European Society of Cataract and Refractive Surgeons (ESCRS) developed evidence-based guidelines to aid decision-making for patients, clinicians, and stakeholders. A multidisciplinary panel, supported by methodologists using the GRADE-approach, addressed 32 key clinical questions. Recommendations include intracameral antibiotics to prevent endophthalmitis, topical anesthesia as the preferred technique, and toric intraocular lenses for corneal astigmatism ≥1.0D. Conventional and femtosecond laser-assisted surgeries are comparably safe and effective. NSAID eye drops, alone or with corticosteroids, are recommended to reduce inflammation and prevent cystoid macular edema. Additional guidance includes shared decision-making for lens selection, safe use of immediate sequential bilateral cataract surgery, and potential of remote postoperative care to enhance healthcare efficiency. These guidelines aim to improve outcomes, patient experience, and care delivery.

1. Definitions

1.1 Definitions of target refraction

Prior to cataract surgery, patients should be consulted regarding the desired target refraction. This guideline covers the following target refraction goals:

- Emmetropia: Emmetropia refers to the condition in which there are no refractive errors present. When the eyes are in an emmetropic state, objects located at infinity are sharply focused on the retina without any need for accommodation. In practice, a refraction ranging between +0.25 diopters (D) and -0.25D is defined as emmetropia. [1]
- Mini-monovision: Mini-monovision refers to the condition where one eye (usually the dominant eye) is targeted for emmetropia while the other eye (usually the non-dominant eye) is targeted for slight myopia ranging between -0.25D and -0.75D in order to increase spectacle independence. [2]
- Monovision: Monovision refers to the condition when one eye is targeted for distance vision while the other eye is targeted for near vision. The range of diopters for monovision correction may vary according to the specific needs of the patient and discretion of the surgeon. In practice, monovision ranges from -1.00D to -2.00D. [3]

1.2 Definitions of different types of astigmatism

- Grading
    - Low astigmatism (0.25 to 1.5D)
    - Moderate astigmatism (1.5 to 3.0D)
    - High astigmatism (above 3.0)
    - Myopic / hyperopic / mixed astigmatism [4]

- Regular astigmatism

- With-the-rule astigmatism: Steep axis of the cylinder is vertical or within 30 degrees of the 90 degrees of vertical meridian (60-120 degrees)
- Against-the-rule astigmatism: Steep axis of the cylinder is horizontal or within 30 degrees of the horizontal meridian (0-30 or 150-180 degrees)
- Oblique astigmatism: Steep axis of the cylinder is not within 30 degrees of the horizontal or vertical meridians (31-59 degrees and 121-149 degrees)

- Irregular astigmatism
  - Where the two main axes of astigmatism are not symmetric and/ or do not lie 90 degrees apart (orthogonal)
  - Irregular or pathological astigmatism treatment is beyond the scope of these guidelines (e.g., those caused by corneal dystrophies, trauma, degeneration, ocular surface disease, corneal ectatic diseases such as keratoconus, and prior corneal surgery)

1.3 Definitions of different IOLs

Classifying intraocular lens (IOL) technologies is not an easy task, primarily due to the various categories that can be integrated into a classification. Some of these categories represent different characteristics that may be inappropriately combined in an attempt to create a simplified taxonomy, which is not always feasible. Therefore, when defining an IOL, it is crucial to differentiate between various categories and avoid mixing them, to prevent confusion for the user.

1.3.1 Optical Technologies

Two main types of optical technologies, diffractive and refractive, have historically been used to classify IOLs, depending on the optical principles utilized for focusing light.[5] Diffraction and refraction can be achieved through distinct optical structures or optical features.[6,7] Diffraction can be accomplished with small optical apertures and diffractive gratings, while refraction can be achieved by varying the asphericity and radius of an optical surface or through zones and sectors.[5,7] However, some designs may combine some of the previously described optical features or mechanisms, thus controversies are likely to occur forcing to assign an IOL to one optical classification.[5,8,9]

According to the shape and number of foci, a taxonomy with five categories has been described in the literature: multifocal intraocular lenses (including bifocal, and trifocal), with the first trifocal lens commercially introduced in 2010,[10] extended depth of focus lenses (EDF), which emerged in 2014,[8,11] monofocal IOLs with enhanced depth of focus (Mono-EDF) for which the first Conformité Européenne (CE) mark was granted in 2019,[5,12,13] and conventional monofocal aspherical and finally spherical IOLs.

1.3.2 Standard Terms and Definitions

According to the International Organization for Standardization (ISO 11979-7, 2024), there are four main categories of IOLs that are determined by optical design and/or clinical characteristics or performance.[14] Monofocal, Toric, Simultaneous Vision Lens (SVL) and Accommodating IOLs. From these, SVL are those non-accommodative lenses that provide simultaneous vision at multiple distances and can be subclassified in three types:

- Multifocal (MIOL): lens implants that emphasize optical and functionally useful acuity levels at far, but when compared to the monofocal control lens, also have improved optical and clinical performances at near focal distances;
- Extended Depth of Focus (EDF): lens implants that emphasize optical and functionally useful acuity levels at far but also from far through intermediate focal distances;
- Full Visual Range (FVR): lens implants that emphasize optical and functionally useful acuity levels at far but also from far through intermediate and up to near focal distances.

It is important to note, that ISO agrees with the ANSI standard for EDF IOLs in all the end-points described in Table 1, but ISO adds the achievement of a depth of field (DOFi) absolute value at a visual acuity level of 0.2 logMAR of 1.5 D.[15] Conversely, ANSI describes that EDF IOLs should have a monotonous decrease of visual acuity which means that the visual acuity from far to near should have a continuous decrease, and in the case of having an inflexion point, this one should be $\leq$ 0.04 logMAR.[15]

1.3.3 Evidence-Based Functional Classification

A functional classification has been developed considering the end-points described in the standards,[16] especially those referring to the DOFi measured through monofocal visual acuity defocus curves with the best distance correction. This classification has been qualified as evidence-based because the scientific method (cluster analysis) has been the pillar during the development.

184 The cluster analysis found that two metrics were enough to classify IOLs:

185 1. The increase in VA (ΔVA) from intermediate to near in the event of a non-monotonic
186 decrease in visual acuity from far to near and
187 2. The DOFi from CDVA to 0.20 logMAR or 0.30 logMAR cut-offs of visual acuity.

188 Figure 1 and Table 1 show that two main categories can be identified depending on the
189 defocus curve DOFi at the visual acuity level of 0.20 logMAR and the shape: 1. PARTIAL-
190 DOFi, 2. FULL-DOFi. In 1. PARTIAL-DOFi three subcategories can be described according
191 to the achieved DOFi: 1.1. PARTIAL- DOFi Narrowed, 1.2. PARTIAL-DOFi Enhanced, and
192 1.3. PARTIAL- DOFi Extended. On the other hand, 2. FULL-DOFi IOLs subcategories
193 depend on how steep is the increase in visual acuity from intermediate to near: 2.1. FULL-
194 DOFi Steep for an increase of 0.14 logMAR or higher, 2.2. FULL-DOFi Smooth for an
195 increase between 0.05 and below 0.14, and 2.3. FULL-DOFi Continuous for an increase
196 below 0.05 logMAR.

197

198 **1.3.4 Conclusion**

199 This IOL classification has been proposed by members of this ESCRS guideline development
200 group. Historical terminologies used for classifying IOLs have been reviewed, and a
201 functional classification has been introduced to enhance understanding, focusing on the visual
202 acuity that patients achieve across the visual range. The importance of separating
203 classification categories is emphasized, as different optical technologies could produce
204 similar functional outcomes. However, there is a recognized relationship between optical
205 terms and functional classification. Therefore, Table 2 summarizes the usual correspondences
206 between optical, standard, and functional classifications, which may help surgeons
207 understand the new concept.

2. Introduction

Cataract is a significant cause of blindness, which is currently only reversible by surgery. As age advances, the prevalence of cataracts increases significantly. The prevalence of cataracts ranges from 3.9% among individuals aged 55-64 years to as high as 92.6% among those aged 80 years and older. It is projected that by 2025, the worldwide population of individuals affected by cataract blindness will increase to 40 million.[17] Cataract surgery is the most commonly performed surgical procedure worldwide, with 7 million cases each year in Europe, 3.7 million cases in the USA, and 20 million worldwide.[18]

The purpose of the ESCRS Cataract Surgery Guidelines is to address the value of diagnostic and therapeutic steps for various stakeholders in the patient cataract care pathway. The guideline aims to apply to all healthcare workers (e.g., ophthalmologists, residents, general practitioners, nurses, optometrists, opticians, health care decision takers, patient societies, and health care insurance companies) and patients interested in cataract management. It provides explicit, evidence-based recommendations and insights that healthcare providers should follow to deliver high-quality care. The clinical recommendations are crucial for supporting clinical decision-making and promoting better care, transparency, and reduced unwanted practice variation. While they are not prescriptive regulations, healthcare providers may deviate from these recommendations in complex cases where the patient's circumstances differ significantly from the 'average patient.' The physician must exercise his/her judgment on the suitability of the care provided to a particular patient, considering all the circumstances presented by the patient. However, any deviation should be documented in the patient's record and be supported by clear reasoning.

3. Methodology

This guideline was developed according to the comprehensive quality criteria as described in the Appraisal of Guidelines for Research and Evaluation II (AGREE II) instrument.[19] The guideline development group (GDG) consisted of 18 ophthalmologists, and the constituting guideline development group (CDG) of two PhD candidates and a supervising methodologist. All clinical members possessed expertise in diagnosing and treating cataracts, and they were geographically distributed to cater to diverse regions. Review questions were formulated according to the PICO framework. Outcome parameters were selected based on importance for decision-making in the clinical setting. Literature searches were performed, using KSR evidence, CDSR, Medline, Embase, and Central as resources to identify relevant systematic reviews and randomized controlled trials for each review question, in total 5744 articles were found. The two PhD candidates performed selection of the articles supervised by the methodologist. Critical appraisal of available systematic reviews was performed based on the Risk of Bias assessment Tool ROBIS by reviewers at KSR Ltd.[20] The quality of the relevant evidence was summarized using the GRADE approach.[21] According to the GRADE approach, the evidence is classified as high (++++), moderate (+++), low (++) or very low (+). These classifications are accompanied by a specific formulation of the recommendations, using the wording “must”, “should”, “could”, “may”, “may not”, and “can be considered”. Considering high-level evidence, the term “must” was used in the recommendations of this guideline. In the case of moderate evidence, “should” or “could” were used. For low-graded evidence, “could” or “may” are applicable, and lastly, when there was very low evidence implemented in the recommendations, “can be considered” was used.[20-22]

4. Summary of Recommendations

The structure of this guideline is according to the patient cataract care pathway, and includes following sections: screening and patient selection, preoperative assessment, perioperative procedure, postoperative care, and complications.

4.1 Screening and patient selection

4.1.1 What are the indications for cataract surgery? (Question 4.1)

A cataract is clinically diagnosed at the slit lamp examination by an ophthalmologist. The patient and ophthalmologist should take the shared decision for cataract surgery, and this should be well documented in the patient's medical records. (GRADE +)

Important aspects to be considered for the indication for cataract surgery are the presence and appearance of cataract, a patient’s visual acuity and function (visual acuity and quality of vision), the subjective disability of the patient and the expected benefits of the cataract surgery. (GRADE +).

Co-morbidities and the surgical risk profile should be considered and discussed with the patient prior to the surgery. Documentation of this process in the patient file is mandatory. It is recommended to use validated patient satisfaction questionnaires and Patient Reported Outcome Measures (PROMs) to evaluate the outcome of cataract surgery. (GRADE +)

4.1.2 Will the presence versus absence of (characteristic A) impact efficacy and safety outcomes in patients for whom cataract surgery is considered? (Question 4.2)

The presence of patient characteristics and comorbidities can have an impact not only on the outcome in vision but also on the risks of surgery and postoperative complications. These should be discussed with the patient so that they are fully informed, and expectations are realistic. (GRADE +)

Significant ocular comorbidities, such as diabetic retinopathy, glaucoma, maculopathies, and uveitis should be identified during the preoperative evaluation since its presence can affect the postoperative visual acuity and function. (GRADE +)

Additionally, certain risk factors can lead to a higher complication rate during cataract surgery including: pseudoexfoliation syndrome, Fuchs endothelial dystrophy, shallow anterior chambers, white and brunescent cataracts, small pupils, and eyes with an extreme axial length (<22mm or >26mm). In patients who previously underwent refractive surgery, specific precautions should be taken to prevent a refractive surprise.

Regarding eyes with 'active disease' (such as uveitis, proliferative diabetic retinopathy, neovascular AMD, herpetic keratitis), these may be more susceptible to complications when performing cataract surgery.

It is recommended to perform the surgery when the disease is in a quiet phase. Customizing the postoperative follow-up based on the presence of ocular comorbidities is essential for ensuring comprehensive and effective care. Furthermore, it is crucial to provide patients with thorough information about potential risks to ensure realistic expectations. (GRADE +)

Table 3 presents recommendations for patient characteristics and comorbidities associated with increased risk of surgical complications or suboptimal visual outcomes.

300

301 *4.1.3 What mental health factors must be considered when preparing for cataract surgery?*
302 *(Question 4.3)*

303

304 Cataract surgery has a beneficial effect on cognitive and mental health. Cataract extraction
305 can be considered in patients at higher risk for cognitive decline and impaired vision due to
306 cataracts. (GRADE +/++)

307 The timing of the surgery with regard to the course of the mental illness and the potential
308 application of Immediate Sequential Bilateral Cataract Surgery (ISBCS) may be of benefit for
309 these patients. (GRADE +/++)

310

311 *4.1.4 What information about surgery, target refraction and complications should be given to*
312 *the patient before cataract surgery? (Question 4.4)*

313

314 The ophthalmic surgeon should ensure that the following information is verbally provided to
315 the patient before obtaining informed consent and performing cataract surgery:

316 - The option of not undergoing surgery
317 - Purpose and nature of the cataract surgery
318 - Surgery process overview
319 - Risk for (serious) complications during and after the surgery
320 - Patient-specific additional risks
321 - Surgery on one or both eyes
322 - Target refraction and expected vision improvement after surgery
323 - Treatment options: IOL types

- The financial implications of the surgical and IOL choices
- In cases of bilateral cataract surgery: delayed sequential or immediate bilateral surgery
- Type of anesthesia
- What to do in emergencies

Targeted interventions improve patients' satisfaction with cataract surgery and the accompanying postoperative care. (GRADE +)

In addition to verbal information, patients undergoing cataract surgery should be provided with written information and, if possible, audio-visual material. It is important to consider national informed consent guidelines and adapt the information provided to local best practices and legal frameworks. (GRADE +)

4.1.5 In patients needing cataract surgery, what are the effects of immediate bilateral surgery compared with delayed sequential surgery and what is the minimum time between cataract surgery on the first and second eye? (Question 4.5)

ISBCS (Immediate Sequential Bilateral Cataract Surgery) is effective and safe, has a high degree of patient satisfaction and can be considered in patients without complication-inducing ocular comorbidities. (GRADE +)

There are comparable clinical outcomes of DSBCS (Delayed Sequential Bilateral Cataract Surgery) and ISBCS. Therefore, either technique can be considered. (GRADE +/+++ (for endophthalmitis))

Bilateral cataract surgery on the same day allows rapid patient rehabilitation and helps avoid suboptimal visual function while waiting for second-eye surgery. However, there was no

extra long-term benefit of self-assessed visual function compared with cataract surgery in one eye at a time. (GRADE +)

Specific relative contraindications must be considered if bilateral simultaneous cataract surgery is planned:

- The ISBCS should be reconsidered if there is an increased risk of peri- or postoperative complications.
- If complications occur during surgery of the first eye, these adverse events have to be resolved before proceeding to the second eye and delaying the second eye should be considered.

If bilateral simultaneous cataract surgery is planned, it should be considered and treated as two entirely separate procedures, according to the principal practice guideline for bilateral surgery. These guidelines can be found at: https://www.rcophth.ac.uk/wp-content/uploads/2020/09/Immediate-Sequential-Bilateral-Cataract-Surgery-Guidance.pdf [23]

4.1.6 Do pseudophakic presbyopia correcting IOLs have a better postoperative outcome than monofocal IOLs with a monovision target? (Question 4.6)

Detailed patient information must be given to choose the correct IOL type for patients undergoing cataract surgery with pseudophakic correcting presbyopia IOLs. (GRADE +)

A comparison of visual outcomes, spectacle dependence, dysphotopsia risk, and associated costs for multifocal IOLs, EDF IOLs, and monovision is provided in Table 4.

Multifocal IOLs should be considered in patients who desire a high chance of spectacle independence for far, near and intermediate vision, as multifocal IOLs show better results

than standard monofocal IOLs in uncorrected near and intermediate vision. (Low certainty evidence for bifocal vs. trifocal)

Thoughtful use of multifocal IOLs is recommended, as unwanted visual phenomena such as halos, glare, and starbursts are more common with multifocal IOLs than with monofocal IOLs. (GRADE +)

EDF IOLs or pseudophakic monovision can be recommended for patients who desire a good intermediate visual acuity, with significantly less dysphotopsia compared to patients who received multifocal IOLs. (GRADE +)

The implantation of EDF IOLs can be considered an effective method to treat some presbyopia with high rates of spectacle independence and minimal dysphotopsia side-effects and limited reading or near vision spectacle independent performance. (GRADE +)

4.1.7 Do toric IOLs give a better postoperative outcome than non-toric IOLs in cataract surgery? From which magnitude of corneal astigmatism is a toric IOL indicated? (Question 4.7)

Current recommendations are based on studies performed using anterior keratometry:

In the case of regular corneal astigmatism, toric IOLs may be considered for implementation. (GRADE ++)

Toric IOLs should be considered in eyes with a degree of corneal astigmatism of 1.0D or more. The greatest clinical effectiveness is observed in eyes with corneal astigmatism >2.0 D, with meaningful visual benefits also observed from 1.5 D and above. While toric IOLs may

offer benefits in eyes with astigmatism ≥1.0 D, the supporting evidence is more limited. (GRADE ++)

New insights rely on predictions of postoperative astigmatism, making it imperative to use these predictions as a basis for decision-making in cases with corneal astigmatism.

4.1.8 What type of anesthesia is indicated for the patient? (Question 4.8)

There are several accepted and safe anesthesia techniques available for patients who undergo cataract surgery. Topical anesthesia appears to be the most used anesthesia technique during cataract surgery, if suitable for the patient. (GRADE ++/+++)

For further reducing pain during the cataract surgery, an additional intracameral lidocaine injection can be considered. (GRADE ++/+++)

The choice for a specific type of anesthesia during cataract surgery should be made together with the surgeon and patient. (GRADE +)

Nevertheless, other techniques have also gained acceptance and have demonstrated safety during cataract surgery. The decision-making process regarding the choice of anesthesia should be a collaborative effort involving the ophthalmic surgeon and the patient. The anesthesia technique may vary from surgeon to surgeon, influenced by their experience and individual preferences. Additionally, patient-specific considerations, such as medical history, anxiety levels, and comfort, are vital in determining the most suitable anesthesia approach.

Under certain conditions, preoperative fasting and intravenous sedation can be considered. When general anesthesia is needed, preoperative health tests and blood samples might be necessary.

4.2 Preoperative assessment

4.2.1 What kind of diagnostics and preoperative assessment of the patient should be done? In patients who will undergo cataract surgery, what are the effects of diagnostic A versus no diagnostic A or versus diagnostic B on efficacy and safety outcomes? (Question 5.1)

Prior to cataract surgery, a series of essential preoperative examinations must be conducted to ensure a comprehensive understanding of the patient's ocular health and overall medical condition.

In general, for preoperative assessment prior to cataract surgery the following diagnostic measures are recommended: refraction, visual acuity, slit lamp assessment, optical biometry and tonometry. (GRADE ++)

In the presence of refractive astigmatism additional measurements with tomography/topography are recommended. (GRADE +)

It is recommended to provide patient with detailed information (see chapter 4.1.4) and use cataract-specific checklists adapted to the clinic of practice, since checklist use is associated with improvement of patient safety by reducing surgical morbidity and mortality. (GRADE +)

In addition to diagnostic measurements, providing detailed patient information is crucial. This includes discussing target refraction, potential visual outcomes, and postoperative instructions with the patient. Equally essential is providing a detailed explanation of the surgical process and potential complications.

4.2.2 What kind of diagnostics and preoperative assessments of patients who previously underwent refractive surgery should be done? (Question 5.2)

It is recommended to perform corneal tomography or topography in patients who previously underwent corneal refractive surgery. (GRADE +)

In post-radial keratotomy (RK) eyes, a corneal tomography/ topography should be performed for assessment of corneal astigmatism and corneal irregularities. (GRADE +)

A slightly myopic target refraction should be considered. (GRADE +) Patients should be informed about the possibility of a refractive surprise. (GRADE +)

It is recommended to choose a slightly myopic target refraction in eyes with anterior and posterior phakic IOLs. (GRADE +) An anterior segment OCT may be used for anterior chamber depth measurements in anterior phakic IOLs. (GRADE +) Endothelial cell count should be done in patients with anterior phakic IOLs prior to cataract surgery. (GRADE +)

4.2.3 In which patients with an indication for cataract surgery is posterior segment OCT indicated? (Question 5.3)

In general, posterior segment OCT in cataract surgery should be used when there is a clinical indication, such as age-related macular degeneration, diabetic retinopathy, glaucoma, or when the visual acuity is worse than expected. (GRADE +)

OCT is more effective in detecting optic nerve or macular pathologies than a regular fundus examination. (GRADE +)

Posterior segment OCT may be used in routine cataract cases and can be considered at least in the following situations: (GRADE +)

- In case of increased risk or medical history of macular abnormalities that could adversely affect the postoperative visual outcome, such as AMD, diabetic retinopathy
- Where the visual acuity is worse than expected and cannot be fully explained by the degree of cataract
- In case of considering presbyopia correction IOLs.

4.2.4 In which patients with an indication for cataract surgery is ultrasonography (A- or B-scan) indicated? (Question 5.4)

Ultrasound biometry (A- and/or B-scan) should be used when there is low visibility of the posterior segment, such as in mature and dense cataracts when optical biometry is not applicable or feasible. (GRADE +) An A-scan provides valuable information about the axial length, while B-scan offers detailed imaging of the posterior segment, enabling the detection of any underlying ocular conditions that may impact surgical planning and outcomes.

4.2.5 What are the indications for specific assessment examinations for patients with corneal comorbidities? (Question 5.5)

Pre-existing corneal comorbidities, including dry eye disease, Fuchs' endothelial dystrophy and corneal scars and opacities are crucial to identify before performing cataract surgery since this may influence the outcomes.

Consider treatment of the dry eye disease before performing cataract surgery. Patients with pre-existing dry eye disease should be recognized and diagnosed before cataract surgery by using questionnaires, testing the tear breakup time, corneal fluorescein staining or Schirmer test. (GRADE +)

The severity of Fuchs' endothelial dystrophy should be evaluated for cataract surgery decision-making, based on the clinical presentation and the visual symptoms. (GRADE +)

Identifying corneal scars or opacities before cataract surgery is important for estimating potential vision gain. If a patient is not a good candidate for corneal transplantation, phacoemulsification can still be safely performed. In addition, cataract surgery can serve as an interim measure while the patient waits for penetrating keratoplasty. (GRADE +)

4.2.6 What are the indications for specific assessment examinations for patients with keratoconus? (Question 5.6)

In keratoconus patients, stabilizing procedures before cataract surgery should be considered if the patient is at risk of progression. (GRADE +)

When evaluating astigmatism in this patient population, the anterior, posterior and total corneal astigmatism should be assessed to perform the most accurate IOL power calculations. (GRADE +)

4.2.7 What preoperative assessment is necessary for presbyopia correcting IOLs? (Question 5.7)

Patient selection for pseudophakic presbyopia correcting IOLs should be based on the presence of ocular comorbidities, the desire for spectacle independence, and realistic patient expectations. (GRADE +) For the preoperative assessment before implantation of a presbyopia correcting IOL additional assessments can be considered including evaluation of dry eye symptoms, stereopsis assessment, corneal topography/tomography, posterior segment OCT, and pupillometry. (GRADE +)

4.2.8 What preoperative assessment is necessary for toric IOLs? (Question 5.8)

In the case of implantation of a toric IOL the preoperative assessment should encompass not only general mandatory evaluations but also corneal topography and/or tomography. (GRADE +) Methods which include measurements of factors such as the additional posterior corneal astigmatism and effective lens position are preferred for toric IOL calculation. (GRADE +)

4.3 IOL power calculation

4.3.1 Which formula(e) for calculating lens power should be considered? (Question 6.1)

There is a tendency towards improved outcomes with newer-generation formulae as they show less trend error, meaning that they appear more consistent along the range of axial

lengths. Traditional formulae can still be considered an acceptable option where newer formulae are not available. (GRADE +)

4.3.2 Which formula(e) for calculating lens power in specific conditions should be considered? (Question 6.2)

Specific IOL formulae are recommended for eyes with certain conditions to ensure accurate outcomes. In extreme long and short eyes new-generation formulae are recommended. (GRADE +)

In eyes with keratoconus all formulae tend to result in a hyperopic surprise. It is recommended to avoid traditional formulae other than SRK/T and to use keratoconus-specific formulae for more accurate outcomes. It is suggested that the Barrett True-K and Kane formulae for keratoconus have more accurate results, especially in more advanced stages of keratoconus. (GRADE +)

In patients with steep (>46D) or flat corneas (<42D), the Barrett Universal II (Total Keratometry (TK)) and EVO (TK) formulae may be considered. (GRADE +)

The Haigis formula should be considered for patients with an ACD >3.5mm, while the Hoffer Q formula is suggested for a shallow anterior chamber (ACD <2.5mm). (GRADE +)

4.3.3 Which formula(e) for calculating the intraocular lens in patients who have undergone refractive surgery is/are preferred? (Question 6.3)

When performing IOL calculations in patients who have undergone refractive surgery, designated formulas and methods should be used such as those in the American Society of Cataract and Refractive Surgery (ASCRS) post-refractive surgery calculator.

The ESCRS calculator is available at: https://iolcalculator.escrs.org/

4.3.4 Which target refraction is preferred in patients who will undergo cataract surgery? (Question 6.4)

The selection of a specific target refraction highly depends on the selected IOL, expectations and preferences of the patient. The patient and ophthalmologist should take the shared decision for IOL target selection. (GRADE ++)

4.4 Perioperative procedure

4.4.1 What are the differences between femtosecond assisted laser cataract surgery (FLACS) and conventional phacoemulsification cataract surgery? (Question 7.1)

Both conventional cataract surgery (CCS) and femtosecond laser assisted cataract surgery (FLACS) can be used as:

- They are both safe and effective procedures. (GRADE +/++)
- Visual acuity and refractive outcomes are comparable. (GRADE +/++)

- Overall intraoperative and postoperative complication rates are low and appear similar for both conventional phacoemulsification and femtosecond laser assisted cataract surgery (GRADE +/++)

FLACS may be considered in patients with dense cataract or low endothelial cell count as it is a more effective method for reducing endothelial cell loss and postoperative central corneal thickening. Nonetheless, at 6 months postoperatively no significant differences were found between conventional cataract surgery and FLACS regarding endothelial cell loss. (GRADE +/++)

4.4.2 What is the role of femtosecond laser in astigmatism control during cataract surgery? (Question 7.2)

Femtosecond-laser assisted (FLACS) as well as manual corneal incisions (e.g. opposite clear corneal incisions, limbal relaxing incisions and astigmatic keratotomies) are safe and effective options for astigmatism control during cataract surgery. (GRADE +)

FLACS incisions for the main surgical incision are less effective than relaxing incisions in terms of effectivity and variability and should therefore only be considered in selected patients. (GRADE +)

Femtosecond lasers can be used to perform corneal incisions specifically designed to correct corneal astigmatism (e.g. intrastromal and penetrating femtosecond laser astigmatism keratotomies). These are more precisely performed than when done by hand. (GRADE +)

4.4.3 What are the differences between different marking techniques for patients receiving toric IOLs? (Question 7.3)

Digital marking may result in less axis misalignment, a smaller difference vector and less postoperative astigmatism than manual marking, but there are no clinically significant differences in visual and refractive outcomes between the two techniques. (GRADE +)

4.4.4 What prophylaxis should be administered during cataract surgery to minimize the risk of postoperative endophthalmitis? (Question 7.4)

Intracameral antibiotic therapy should be used because it is effective and safe for preventing endophthalmitis after cataract surgery. The use of intracameral antibiotics significantly reduces the risk of endophthalmitis. (GRADE +)

An intracameral injection should be used (cefuroxime 1 mg in 0.1 ml.) at the end of the cataract surgery to lower the risk for postoperative endophthalmitis. (GRADE +++)

Adequate antisepsis can be achieved by applying povidone-iodine 5-10% drops 3 minutes before commencing cataract surgery. In cases of povidone-iodine allergy, chlorhexidine (0.02%) can be used as an alternative. (GRADE +)

4.4.5 What prophylaxis should be used in cataract surgery to minimize the risk of post-operative inflammation? (Question 7.5)

- *What is the most effective treatment to reduce post-operative inflammation after cataract surgery and reduce the risk of cystoid macular edema?*
- *Is perioperative inflammatory prophylaxis (dropless cataract surgery) equally effective as a postoperative anti-inflammatory eye drop regimen?*

The use of NSAIDs eye drops, either in combination with corticosteroid eye drops or as monotherapy is effective to use after routine cataract surgery to prevent inflammation and CME. (GRADE +/++)

It is currently unclear whether dropless inflammatory prophylaxis is as safe and effective as topical inflammatory prophylaxis to prevent CME and inflammation after cataract surgery. (GRADE +/++)

4.4.6 What are the optimal intra- and postoperative medication for patients with other ocular pathologies who undergo cataract surgery? (Question 7.6)

Specific postoperative treatments should be considered for patients with certain ocular comorbidities following cataract surgery.

In diabetic patients without diabetic retinopathy, it is recommended to use a combination of corticosteroid and non-steroidal anti-inflammatory drug (NSAID) eye drops to prevent cystoid macular edema. (GRADE +/++)

In patients with diabetic retinopathy, a supplementary depot of triamcinolone should be considered to reduce this risk. Intraocular pressure must be monitored postoperatively when using a triamcinolone depot. (GRADE +)

Literature reports discrepancies concerning the effect of anti-vascular endothelial growth factor (VEGF) intravitreal therapy in preventing CME after cataract surgery in patients with diabetes. (GRADE +/++)

In patients with retinal diseases, topical NSAIDs should be used, and only in selected cases intravitreal anti-VEGF injections could be considered. (GRADE +)

In patients with uveitis, an increased frequency and prolonged treatment with steroids is suggested. Oral steroids should be applied only in specific cases. (GRADE +)

Glaucoma patients should receive carbonic anhydrase inhibitors postoperatively to minimize the potential increase in intraocular pressure (IOP) after surgery. A follow-up visit within one day after surgery is essential to monitor and control IOP. (GRADE +)

Oral acetazolamide administration postoperatively can be considered to reduce IOP elevation after cataract surgery. (GRADE +)

Patients with dry eye disease should use artificial tears both before and after surgery to manage symptoms and optimize ocular surface health. (GRADE +/++)

4.5 Postoperative care

4.5.1 What precautions does the patient have to consider after the surgery? When should the next follow-up visit take place? (Question 8.1)

The following precautions have to be considered after surgery: the patient should take the eye

drops as instructed and seek help if vision decreased after prior vision increase, sudden appearance of black dots, flashing lights, increased pain or redness of the operated eye. Patients should not rub the eye, avoid getting water in the eye for at least one week, avoid activities that could strain the eyes for the first days after surgery, and cannot drive the car after surgery and have to wait until legal clearance. (GRADE +)

New glasses can be prescribed after 4-6 weeks. Uncomplicated cases can defer follow-up visits by up to two weeks without safety reduction. (GRADE +)

4.5.2 What is the preferred postoperative medication that should be administered to treat inflammation and CME after cataract surgery? (Question 8.2)

The incidence of clinically significant cystoid macular edema (CME) following cataract surgery has been reported to be as high as 2%. In many cases, the CME is a self-limiting condition that resolves spontaneously without any visual impairment.[24] Nevertheless, there are instances where CME might persist or may lead to deterioration of the visual function which necessitates treatment. The primary treatment options for CME after cataract surgery are topical NSAIDs or steroids. However, there is a lack of sufficient evidence to establish the optimal treatment approach for this condition. This highlights the importance of conducting future research to further explore and clarify the most effective strategies for managing CME following cataract surgery. (GRADE ++)

No definitive conclusions can be drawn regarding the clinical effectiveness of injectable medications (including intravitreal injection of anti-VEGF, sub-Tenon steroid injections and intravitreal steroid implants) for the treatment of CME. (GRADE +)

683 *4.5.3 When is remote care after cataract surgery indicated for patients? (Question 8.3)*

684

685 Postoperative remote care following cataract surgery may serve as an alternative to short-
686 term clinical examinations, potentially improving resource allocation and enhancing time and
687 cost efficiency in surgical centers. However, the accuracy and validity of remote care and
688 telemonitoring still require evaluation. (GRADE +)

689 Screening has to be performed prior to allocating patients to a certain group that will receive
690 remote care. Patients at an increased risk of complications or patients with comorbidities
691 which may adversely affect their postoperative outcome should be prioritized for traditional
692 postoperative hospital care. (GRADE +)

693

694 **4.6 Complications**

695 *4.6.1 What kind of (serious) complications can occur during cataract surgery? (Question 9.1*
696 *and 9.2)*

697

698 Cataract surgery is generally regarded as a safe procedure with a low incidence of
699 complications. However, intraoperative complications can occur and may vary in severity.
700 Serious adverse events include posterior capsule rupture, dropped nucleus, zonular dialysis,
701 iris or intraocular lens (IOL) damage, and suprachoroidal hemorrhage. Other intraoperative
702 complications may include anterior capsule tear, iris trauma, and zonular dialysis without
703 vitreous loss.

704

4.6.2 What kind of (serious) adverse events can occur after cataract surgery? (Question 9.3 and 9.4)

Postoperative complications may also vary in severity and timing. Serious adverse events include intraocular inflammation (such as cystoid macular edema), endophthalmitis, toxic anterior segment syndrome (TASS), retinal detachment, pseudophakic bullous keratopathy, and IOL-related issues such as dislocation, luxation, malposition, damage, opacification, calcification, residual refractive error, and photic phenomena. Other postoperative complications may involve posterior capsular opacification (PCO), capsular contraction syndrome, elevated intraocular pressure, persistent inflammation, corneal edema, binocular imbalance, diplopia, dry eye symptoms, and refractive surprise.

4.7 Cost-effectiveness

4.7.1 What is the cost-effectiveness of specific cataract surgery-related decisions? (Question 10)

A cost-effectiveness overview is provided in chapter 10 (Appendix 1), including the following topics: endophthalmitis prevention, prevention of inflammation/CME after cataract surgery, toric IOLs, Immediate sequential bilateral cataract surgery (ISBCS), and femtosecond laser assisted surgery. The main findings are summarized below:

Endophthalmitis prevention: Prophylactic intracameral cefuroxime significantly reduces the risk of endophthalmitis and is cost-effective compared with no antibiotic use. The incremental cost-effectiveness ratio (ICER) was €2427 per Quality Adjusted Life-Year (QALY).[25]

Inflammation and CME prevention: In non-diabetic patients, combination therapy with bromfenac and dexamethasone is cost-effective compared to monotherapy, with an ICER of €6 544 per QALY.[26] In diabetic patients, subconjunctival triamcinolone alone is more cost-effective than combination therapy with triamcinolone and intravitreal bevacizumab, with an ICER of €321 984 per QALY for the combination therapy.[27]

Toric intraocular lenses: Bilateral toric IOL implantation in patients with corneal astigmatism was associated with slightly lower QALYs and was not considered cost-effective compared to monofocal IOLs, with reported ICERs ranging from €2500 to €20 000 per QALY.[28]

Femtosecond laser-assisted cataract surgery (FLACS): FLACS does not offer clinical or economic advantage over conventional phacoemulsification, with reported ICERs showing higher costs and no added benefit (ICER: £167 120/QALY).[29]

Immediate sequential bilateral cataract surgery (ISBCS): ISBCS demonstrates superior cost-effectiveness compared to Delayed Sequential Bilateral Cataract Surgery (DSBCS), with ICERs ranging from €2 500 to €80 000/QALY.[30]

5. Limitations and implementation considerations

The aim of this guideline is to provide comprehensive and evidence-based recommendations for managing cataract surgery. However, it is important to acknowledge certain limitations. Primarily, there are persistent evidence gaps in specific areas, which may necessitate careful interpretation of certain recommendations. The ESCRS has supported various clinical studies, including the Endophthalmitis Study and PREMED Study, but further research projects are needed to address the knowledge gaps identified in this guideline. Moreover, it is crucial to recognize that the guideline primarily focuses on routine cataract patients. Cases involving severe comorbidities may require individualized decision-making regarding outcomes or the

surgery itself. Additionally, the implementation of these recommendations may face barriers due to the variability in clinical practices and workflows. It is important to acknowledge these potential barriers, as they may require tailored approaches in certain instances. Despite these limitations, this guideline serves as a valuable resource for all stakeholders involved in cataract care, providing evidence-informed guidance for cataract management.

6. Conclusion

This guideline presents valuable insights and practical recommendations for healthcare professionals engaged in cataract care, achieved through a rigorous review of evidence and expert consensus. By adhering to these evidence-based guidelines, clinicians can elevate the quality of care they deliver to patients, thereby enhancing outcomes and overall health. We urge stakeholders to integrate this guideline into their clinical decision-making processes, recognizing its capacity to instigate positive changes in healthcare practice and patient outcomes. It is important to note that this document is dynamic and can be adapted as new evidence emerges. The ESCRS has played a crucial role in optimizing future cataract care by providing a transparent, evidence-based guideline, and supporting clinical studies in the field.

The extended version of the guidelines and all critical appraisals, and the comments overview can be found in Appendix 1, 2, and 3.

7. Key recommendations

The principal recommendations of this guideline are summarized below, structured by the corresponding level of evidence:

1. An intracameral injection should be used (e.g. cefuroxime 1 mg in 0.1 ml.) at the end of the cataract surgery to lower the risk for postoperative endophthalmitis. (GRADE +++)
2. Topical anesthesia appears to be the most used anesthesia technique during cataract surgery, if suitable for the patient. (GRADE ++/+++) For further reducing pain during the cataract surgery, an additional intracameral lidocaine injection can be considered. (GRADE ++/+++)
3. Toric IOLs should be considered in eyes with a degree of corneal astigmatism of 1.0D or more. The greatest clinical effectiveness is observed in eyes with corneal astigmatism >2.0 D, with meaningful visual benefits also observed from 1.5 D and above. While toric IOLs may offer benefits in eyes with astigmatism ≥1.0 D, the supporting evidence is more limited. (GRADE ++)
4. The selection of a specific target refraction highly depends on the selected IOL, expectations and preferences of the patient. The patient and ophthalmologist should take the shared decision for IOL target selection. (GRADE ++)
5. The primary treatment options for CME after cataract surgery are topical NSAIDs or steroids. However, there is a lack of sufficient evidence to establish the optimal treatment approach for this condition. (GRADE ++)
6. Both conventional cataract surgery (CCS) and femtosecond laser assisted cataract surgery (FLACS) can be used as they are both safe and effective procedures. (GRADE +/++). They give comparable visual acuity and refractive outcomes and overall intraoperative and postoperative complication rates. (GRADE +/++)
7. The use of NSAIDs eye drops, either in combination with corticosteroid eye drops or as monotherapy is effective to use after routine cataract surgery to prevent inflammation and CME. (GRADE +/++)

8. In diabetic patients without diabetic retinopathy, it is recommended to use a combination of corticosteroid and non-steroidal anti-inflammatory drug (NSAID) eye drops to prevent cystoid macular edema. (GRADE +/++) In patients with diabetic retinopathy, a supplementary depot of triamcinolone should be considered to reduce this risk. Intraocular pressure must be monitored postoperatively when using a triamcinolone depot. (GRADE +)
9. ISBCS (Immediate Sequential Bilateral Cataract Surgery) is effective and safe, has a high degree of patient satisfaction and can be considered in patients without complication-inducing ocular comorbidities. (GRADE +)
10. EDF IOLs or pseudophakic monovision can be recommended for patients who desire a good intermediate visual acuity, with significantly less dysphotopsia compared to patients who received multifocal IOLs. (GRADE +)
11. In general, posterior segment OCT in cataract surgery should be used when there is a clinical indication, such as age-related macular degeneration, diabetic retinopathy, glaucoma, or when the visual acuity is worse than expected. (GRADE +)
12. Patient selection for pseudophakic presbyopia correcting IOLs should be based on the presence of ocular comorbidities, the desire for spectacle independence, and realistic patient expectations. (GRADE +)
13. In the case of implantation of a toric IOL the preoperative assessment should encompass not only general mandatory evaluations but also corneal topography and/or tomography. (GRADE +) Methods which include measurements of factors such as the additional posterior corneal astigmatism and effective lens position are preferred for toric IOL calculation. (GRADE +)

14. Specific IOL formulae are recommended for eyes with certain conditions to ensure accurate outcomes. In extreme long and short eyes new-generation formulae are recommended. (GRADE +)
15. Postoperative remote care following cataract surgery may serve as an alternative to short-term clinical examinations, potentially improving resource allocation and enhancing time and cost efficiency in surgical centers. However, the accuracy and validity of remote care and telemonitoring still require evaluation. (GRADE +)

8. Plans for updating these guidelines

The ESCRS aims to update its guidelines periodically, every 5 years. This process will involve conducting update searches and assessing any relevant research in relation to the current recommendations and considerations. The project team will evaluate whether modifications or revisions to the recommendations are warranted in light of emerging evidence or evolving best practices.

9. Conflicts of interest

Conflicts of interest can be found in Appendix 4.

10. References

1. Langenbucher A. Emmetropia, definition. In: Schmidt-Erfurth U, Kohnen T, eds. *Encyclopedia of Ophthalmology*. Springer; 2015.
2. Cochener B. Influence of the level of monovision on visual outcome with an extended range of vision intraocular lens. *Clin Ophthalmol*. 2018;12:2305-2312. doi:opth-12-2305 [pii]

10.2147/OPTH.S184712 [doi]

3. AAO PPP Cataract and Anterior Segment Panel, Hoskins Center for Quality Eye Care. *Cataract in the adult eye PPP 2021 [Internet]*. 2021 [accessed 2.5.23]. https://www.aao.org/education/preferred-practice-pattern/cataract-in-adult-eye-ppp-2021-in-press

4. Nunez MX, Henriquez MA, Escaf LJ, Ventura BV, Srur M, Newball L, Espaillat A, Centurion VA. Consensus on the management of astigmatism in cataract surgery. *Clin Ophthalmol*. 2019;13:311-324. doi:https://dx.doi.org/10.2147/OPTH.S178277

5. Rampat R, Gatinel D. Multifocal and Extended Depth-of-Focus Intraocular Lenses in 2020. *Ophthalmology*. Nov 2021;128(11):e164-e185. doi:10.1016/j.ophtha.2020.09.026

6. Davison JA, Simpson MJ. History and development of the apodized diffractive intraocular lens. *J Cataract Refract Surg*. May 2006;32(5):849-58. doi:10.1016/j.jcrs.2006.02.006

7. Teng S LG, Zhang C, Liu D. . The diffraction by a small aperture. *Opt - Int J Light Electron Opt*. 2013;124(16):2507-2510. doi:10.1016/j.ijleo.2012.08.028

8. Kanclerz P, Toto F, Grzybowski A, Alio JL. Extended Depth-of-Field Intraocular Lenses: An Update. *Asia Pac J Ophthalmol (Phila)*. May-Jun 2020;9(3):194-202. doi:10.1097/APO.0000000000000296

9. SM. D. A discussion on modern IOL terminology. Accessed February 23, 2023. https://crstodayeurope.com/articles/feb-2021/lets-speak-lenspeak/

10. Sudhir RR, Dey A, Bhattacharrya S, Bahulayan A. AcrySof IQ PanOptix Intraocular Lens Versus Extended Depth of Focus Intraocular Lens and Trifocal Intraocular Lens: A Clinical Overview. *Asia Pac J Ophthalmol (Phila)*. Jul-Aug 2019;8(4):335-349. doi:10.1097/APO.0000000000000253

11. Kohnen T, Suryakumar R. Extended depth-of-focus technology in intraocular lenses. *J Cataract Refract Surg*. Feb 2020;46(2):298-304. doi:10.1097/j.jcrs.0000000000000109

12. Fernández J, Rocha-de-Lossada C, Zamorano-Martín F, Rodríguez-Calvo-de-Mora M, Rodríguez-Vallejo M. Positioning of enhanced monofocal intraocular lenses between conventional monofocal and extended depth of focus lenses: a scoping review. *BMC Ophthalmol*. Mar 14 2023;23(1):101. doi:10.1186/s12886-023-02844-1

13. Mencucci R, Cennamo M, Venturi D, Vignapiano R, Favuzza E. Visual outcome, optical quality, and patient satisfaction with a new monofocal IOL, enhanced for intermediate vision: preliminary results. *J Cataract Refract Surg*. Mar 2020;46(3):378-387. doi:10.1097/j.jcrs.0000000000000061

14. Part 7: Clinical investigations of intraocular lenses for the correction of aphakia. . Accessed Februrary 27, 2024. https://www.iso.org/standard/79689.html.

15. Extended depth of focus intraocular lenses for presbyopia. . Accessed December 14, 2023. https://webstore.ansi.org/standards/vc%20(asc%20z80)/ansiz80352018.

16. Fernandez J, Ribeiro F, Rocha-de-Lossada C, Rodriguez-Vallejo M. Functional Classification of Intraocular Lenses Based on Defocus Curves: A Scoping Review and Cluster Analysis. *J Refract Surg*. Feb 2024;40(2):e108-e116. doi:10.3928/1081597X-20231212-01

17. Fang R, Yu YF, Li EJ, Lv NX, Liu ZC, Zhou HG, Song XD. Global, regional, national burden and gender disparity of cataract: findings from the global burden of disease study 2019. *BMC Public Health*. Nov 12 2022;22(1):2068. doi:10.1186/s12889-022-14491-0

18. Rossi T, Romano MR, Iannetta D, Romano V, Gualdi L, D'Agostino I, Ripandelli G. Cataract surgery practice patterns worldwide: a survey. *BMJ Open Ophthalmol*. 2021;6(1):e000464. doi:10.1136/bmjophth-2020-000464

19. Dans AL, Dans LF. Appraising a tool for guideline appraisal (the AGREE II instrument). *J Clin Epidemiol*. 12/2010 2010;63(12):1281-1282. doi:10.1016/j.jclinepi.2010.06.005

20. Whiting P, Savović J, Higgins JPT, Caldwell DM, Reeves BC, Shea B, Davies P, Kleijnen J, Churchill R. ROBIS: A new tool to assess risk of bias in systematic reviews was developed. *J Clin Epidemiol*. 01/2016 2016;69:225-234. doi:10.1016/j.jclinepi.2015.06.005

21. Neumann I, Pantoja T, Peñaloza B, Cifuentes L, Rada G. El sistema GRADE: un cambio en la forma de evaluar la calidad de la evidencia y la fuerza de recomendaciones. *Rev Med Chil*. 05/2014 2014;142(5):630-635. doi:10.4067/S0034-98872014000500012

22. Joanna Briggs Institute. *Checklist for randomized controlled trials: critical appraisal tools for use in JBI systematic reviews [Internet]*. 2020 [accessed 20.2.23]. https://jbi.global/critical-appraisal-tools

23. Immediate Sequential Bilateral Cataract Surgery (ISBCS) during COVID recovery: RCOphth/UKISCRS rapid advice document. https://www.rcophth.ac.uk/wp-content/uploads/2020/09/Immediate-Sequential-Bilateral-Cataract-Surgery-Guidance.pdf.

24. Kessel L, Tendal B, Jorgensen KJ, Erngaard D, Flesner P, Andresen JL, Hjortdal J. Post-cataract prevention of inflammation and macular edema by steroid and nonsteroidal anti-inflammatory eye drops: a systematic review. *Ophthalmology*. Oct 2014;121(10):1915-24. doi:10.1016/j.ophtha.2014.04.035

25. Rękas M, Młyńczak K, Dobrowolska I, Niewada M, Golicki D. Cefuroxime (Aprokam®) in the prophylaxis of postoperative endophthalmitis after cataract surgery versus absence of antibiotic prophylaxis: a cost-effectiveness analysis in Poland. *Value Health Reg Issues*. Sep 2020;22:115-121. doi:10.1016/j.vhri.2020.01.007

26. Simons RWP, Wielders LHP, Dirksen CD, Veldhuizen CA, van den Biggelaar F, Winkens B, Schouten J, Nuijts R, Group EPS. Economic evaluation of prevention of cystoid

macular edema after cataract surgery in patients without diabetes: ESCRS PREMED study report 4. *J Cataract Refract Surg*. 2021;47(3):331-339. doi:10.1097/j.jcrs.0000000000000449

27. Simons RWP, Wielders LHP, Nuijts R, Veldhuizen CA, van den Biggelaar F, Winkens B, Schouten J, Dirksen CD, Group EPS. Economic evaluation of prevention of cystoid macular edema after cataract surgery in diabetic patients: ESCRS PREMED study report 6. *J Cataract Refract Surg*. 2022;48(5):555-563. doi:10.1097/j.jcrs.0000000000000785

28. Simons RWP, Visser N, van den Biggelaar F, Nuijts R, Webers CAB, Bauer NJC, Beckers HJM, Dirksen CD. Trial-based cost-effectiveness analysis of toric versus monofocal intraocular lenses in cataract patients with bilateral corneal astigmatism in the Netherlands. *J Cataract Refract Surg*. 2019;45(2):146-152. doi:10.1016/j.jcrs.2018.09.019

29. Day AC, Burr JM, Bennett K, Hunter R, Bunce C, Dore CJ, Nanavaty MA, Balaggan KS, Wilkins MR. Femtosecond laser-assisted cataract surgery compared with phacoemulsification: the FACT non-inferiority RCT. *Health Technol Assess*. 2021;25(6):1-94. doi:10.3310/hta25060

30. Spekreijse L, Simons R, Winkens B, van den Biggelaar F, Dirksen C, Bartels M, de Crom R, Goslings O, Joosse M, Kasanardjo J, Lansink P, Ponsioen T, Reus N, Schouten J, Nuijts R. Safety, effectiveness, and cost-effectiveness of immediate versus delayed sequential bilateral cataract surgery in the Netherlands (BICAT-NL study): a multicentre, non-inferiority, randomised controlled trial. *Lancet*. 2023;doi:10.1016/S0140-6736(23)00525-1

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956 Appendix 1. Extended version of the European Society of Cataract and Refractive Surgeons
957 Guideline for Cataract Surgery 2024

958 Appendix 2. Critical appraisals of included evidence

959 Appendix 3. Comments of stakeholders and responses of cataract surgery working group

960 Appendix 4. Declarations of interest for all authors

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DISCLOSURES

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Conflict of interest: One is consultant for Roche. One is consultant for Alcon, BVI, Carl Zeiss Meditec AG, Croma, Johnson&Johnson and Merck. One is consultant for Theapharma, Horus, Hoya, Bausch & Lomb, Johnson&Johnson, Roche, Alcon, Novartis, BVI, and Cuttin edge. One is consultant for Alcon, Oculus, Schwind, Staar, Tarsus, Ziemer, Abbvie, Geuder, LensGen, Santen, Stadapharm, Thieme, and Zeiss Meditec AG, he has received lecture fees from Alcon, Oculus, Schwind, Staar, Tarsus, Ziemer, Teleon Surgical B.V., Allergan, Bausch & Lomb, Johnson&Johnson, MedUpdate, Streamedup, and has received research support from Alcon, Oculus, Schwind, Staar, Teleon Surgical B.V. One is a consultant for Alcon, Johnson&Johnson, TheaPharma and Carl Zeiss Meditec, has received lecture fees from Alcon and has received research support from Alcon, Teleon Surgical B.V. and Carl Zeiss Meditec AG.

The complete declarations of interest for all authors of the ESCRS Cataract Surgery Working Group are provided in appendix 4.

LIST OF ABBREVIATIONS

ACD: Anterior chamber depth

AGREE II: Appraisal of Guidelines for Research and Evaluation II

AMD: Age-related Macular Degeneration

ANSI: American National Standards Institute

ASCRS: American Society of Cataract and Refractive Surgery

AL: Axial length

CCS: Conventional Cataract Surgery

CDG: Constituting Guideline Development Group

CDVA: Corrected Distance Visual Acuity

CE: Conformité Européenne

CME: Cystoid Macular Edema

D: Diopter

DED: Dry eye disease

DOFi: Depth of Field

DSBCS: Delayed Sequential Bilateral Cataract Surgery

EDF: Extended Depth of Focus

ERM: Epiretinal Membrane

ESCRS: European Society of Cataract and Refractive Surgeons

FLACS: Femtosecond laser assisted cataract surgery

FVR: Full Visual Range

GDG: Guideline Development Group

GRADE: Grading of Recommendations Assessment, Development and Evaluation

ICER: Incremental Cost-Effectiveness Ratio

IFIS: Intraoperative Floppy Iris Syndrome

IOL: Intraocular lens

IOP: Intraocular pressure

ISBCS: Immediate Sequential Bilateral Cataract Surgery

ISO: International Organization for Standardization

KSR: Kleijnen Systematic Reviews

MIOL: Multifocal intraocular lens

Mono-EDF: Monofocal intraocular lens with Enhanced Depth of Focus

NSAID: Non-steroidal anti-inflammatory drug

OCT: Optical Coherence Tomography

PCO: Posterior Capsular Opacification

PEX: Pseudoexfoliation syndrome

PICO: Population Intervention Comparators Outcome

PROMS: Patient Reported Outcome Measures

QALY: Quality-Adjusted Life Year

RK: Radial Keratotomy

SVL: Simultaneous Vision Lens

TASS: Toxic Anterior Segment Syndrome

TK: Total Keratometry

UDVA: Uncorrected Distance Visual Acuity

VA: Visual Acuity

VEGF: Vascular Endothelial Growth Factor

Table 1. The criteria for classifying intraocular lenses are based on the best distance corrected monocular visual acuity defocus curves' range of field and shape. Adapted from Ribeiro et al., J Cataract Refract Surg. 2024;50(8):794–798.

Abbreviations: DOFi = Depth of field from CDVA with visual acuity ≤ 0.20 or 0.30 logMAR at some defocus data points; ΔVA = visual acuity increase from intermediate to near

	DOFi for 0.20 logMAR (Diopters, D)	DOFi for 0.30 logMAR (Diopters, D)	ΔVA (logMAR)
1. PARTIAL-DOFi	< 2.3	< 2.75	0
1.1. Narrowed	< 1.2	< 1.61	0
1.2. Enhanced	≥1.2 and <1.58	≥1.61 and <1.98	0
1.3. Extended	≥1.58 and <2.3	≥1.98 and <2.75	0
2. FULL-DOFi	≥ 2.3	≥ 2.75	≥ 0
2.1 Continuous	≥ 2.3	≥ 2.75	< 0.05
2.2 Smooth Transition	≥ 2.3	≥ 2.75	≥0.05 and <0.14
2.3 Steep Transition	≥ 2.3	≥ 2.75	≥ 0.14

Table 2. Summary of the usual correspondences between historical, standard, and functional terms. Adapted from Ribeiro et al., J Cataract Refract Surg. 2024;50(8):794–798.

Abbreviations: EDF=extended depth of focus; MIOL=multifocal intraocular lenses; SVL=simultaneous vision lenses; FVR=full visual range; DOFi=depth of field

Optical Technologies	Standard Terms	Functional Classification
Monofocal	Monofocal	PARTIAL-DOFi Narrowed
Enhanced Monofocal	-	PARTIAL-DOFi Enhanced
EDF	SVL: EDF	PARTIAL-DOFi Extended
MIOL: trifocal / bifocal of low addition	SVL: FVR	FULL-DOFi Steep
MIOL: trifocal of high addition	SVL: FVR	FULL-DOFi Smooth
MIOL: bifocal of high addition	SVL: MIOL	FULL-DOFi Continuous

Table 3. Patient characteristics and comorbidities with an increased risk for complications during or after cataract surgery, and a suboptimal visual outcome.

Abbreviations: AMD=age-related macular degeneration; DED=dry eye disease; ERM=epiretinal membrane, GRADE=Grading of Recommendations, Assessment, Development and Evaluations; IFIS=intraoperative floppy iris syndrome; PEX=pseudoexfoliation syndrome

Comorbidity	**Recommendation**
Macular degeneration	Cataract surgery in patients with macular degeneration improves visual function in all severity grades of AMD, at least in the short-term. (GRADE +) It is recommended to perform cataract surgery in a period of quiescence of neovascular AMD, but timing for cataract surgery must be individualized according to the patient's needs (GRADE +) Maculopathies should be identified before cataract surgery. The long-term effects of AMD after cataract surgery are still unclear. (GRADE +)
Glaucoma/ Ocular hypertension	Intraocular pressure should be monitored short-term after cataract surgery in glaucoma patients. (GRADE ++)
Diabetic Retinopathy	The presence of active diabetic retinopathy or diabetic macular edema increases the risks of intraoperative and postoperative complications, such as macular edema. (GRADE +) Cataract surgery can be considered when the underlying retinal disease is stabilized or when the presence of the cataract impedes with the evaluation and treatment of the retinal disease. (GRADE +)
Dry eye disease (DED)	Preoperative dry eye has an impact not only on preoperative examinations but also on postoperative outcomes. DED management should be optimized prior to surgery (see preoperative examinations) and the patients should be informed that DED symptoms often become worse after surgery (although often temporary). (GRADE +)
Fuchs Endothelial Corneal Dystrophy	The severity of Fuchs' endothelial dystrophy should be evaluated for cataract surgery decision-making, based on the clinical presentation and the visual symptoms. (GRADE +)

Amblyopia	Preoperative orthoptic examination may be necessary to assess binocular vision and detect possible amblyopia. (GRADE +)
Corneal opacities	Patients should be advised on the impact of the opacities on outcomes and the risk of additional medical or surgical management. (GRADE +)
Macular pucker/ epiretinal membrane (ERM)	Compared to eyes without ERM, higher rates of cystoid macular edema and a reduced postoperative gain in visual acuity can be noted. (GRADE +)
Previous refractive surgery	In cataract patients who previously underwent refractive surgery, special preoperative examinations such as corneal topography and tomography may be of added value. (GRADE +) The impact of previous surgery on refractive outcome prediction should be discussed as well as the need for further refractive correction. (GRADE +)
Shallow anterior chamber	Patients with a shallow anterior chamber should be informed about the increased risk of peri- and postoperative complications such as iris prolapse and corneal endothelial cell loss. (GRADE +)
Pseudoexfoliation syndrome (PEX)	PEX is an important risk factor in phacoemulsification because of complications such as poor pupillary dilatation, zonular weakness inducing intra- or postoperative lens dislocation, vitreous loss, postoperative IOP spikes, capsular phimosis, prolonged inflammation, and postoperative corneal decompensation. Patients should be counselled accordingly. (GRADE +)
White/ Brunescent cataract	Surgical adaptions such as using trypan blue for capsular bag staining and decompression/ aspiration, or “milking” of the cortical material should be performed to reduce the risk of capsular tear. (GRADE +) High cohesive viscoelastics and intravenous mannitol may be used to reduce the risk of tear out. (GRADE +) Anterior segment ocular tomography (OCT) may be performed to grade lens intumescence. (GRADE +)
Small Pupil/ Intraoperative floppy iris syndrome (IFIS)	The use of pupil expansion strategies should be considered in cases with small pupils that cannot be dilated pharmacologically. (GRADE +). A staged approach of viscodilation, pupil expansion devices, including rings and iris hooks, should be considered and these devices should be available in the operating room. (GRADE +) In cases of IFIS a combination of strategies including appropriate phacoemulsification fluidic parameters, pharmacological agents, longer corneal tunnels and dispersive viscoelastics should be considered. (GRADE +)
Eyes with extreme axial length	Long eyes can be defined as eyes with an axial length of over 26mm, while short eyes are generally defined as eyes with an axial length of

	under 22mm. Patients should be informed about the increased risk of refractive surprise and complications with postoperative refraction being non-coherent with target refraction. (GRADE +)
Uveitis	Patients with uveitis will have visual improvement after cataract surgery but are also at more risk for the development of macular edema and a recurrence of uveitis. (GRADE +) Active inflammation should be controlled prior to surgery, which means that the inflammation is sufficiently controlled, where possible. (GRADE +) Pre-existing corneal, anterior, and posterior segment pathological changes such as corneal scarring, band keratopathy, iris atrophy, vascular fragility, anterior and posterior synechiae, pupillary and cyclic membrane formation, macular scarring, optic nerve inflammation, ischemia, atrophy and retinal vascular disease should be considered. (GRADE +)
History of herpes keratitis	Antiviral prophylaxis with acyclovir or valacyclovir should be considered. (GRADE +)
Vascular occlusions	Patients with preoperative history of central retinal vein occlusions should be informed about the possible limitations on their visual outcomes after cataract surgery compared to other patients without retinal diseases. (GRADE +)

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Table 4. Overview of visual performance, spectacle dependence, dysphotopsia risk, and cost for multifocal IOLs, EDF IOLs, and monovision.

Abbreviations: EDF=extended depth of focus; IOL=intraocular lens

Multifocal IOLs	**EDF**	**Monovision**
Good near, intermediate and distance visual acuity	Good intermediate and distance visual acuity	Good intermediate and distance visual acuity
Spectacle independence	Spectacles for near vision needed in most cases	Spectacles for near vision needed in most cases
Higher probability of dysphotopsia, reduced contrast sensitivity	Reduced probability of dysphotopsia	Low probability of dysphotopsia
Increased costs (depending on IOL/clinic)	Increased costs (depending on IOL/clinic)	Mostly covered by insurance

Figure 1. Diagram of functional classification depending on: 1. the depth of field (DOFi) achieved in the monocular defocus curve with best correction at distance at 0.20 logMAR visual acuity level, and 2. the improvement of visual acuity from intermediate to near (ΔVA). Adapted from Ribeiro et al., J Cataract Refract Surg. 2024;50(8):794–798.

Abbreviations: DOFi=depth of field; ΔVA = visual acuity increase from intermediate to near