LEARNING METHOD AND MEDIUM
This educational continuing medical education activity consists of a supplement and ten (10) study questions. The participant should, in order, read the learning objectives contained at the beginning of this supplement, review the supplement, answer all questions in the post test, and complete the Activity Evaluation/Credit Request form. To receive credit for this activity, please follow the instructions provided on the post test and Activity Evaluation/Credit Request form. This educational activity should take a maximum of 1.5 hours to complete.

CONTENT SOURCE
This continuing medical education (CME) activity captures content from a CME symposium held on November 16, 2013, in New Orleans, Louisiana.

ACTIVITY DESCRIPTION
Recent data indicate that nearly 4 million cataract and refractive surgeries are performed annually in the United States, and that number is growing. This continuing medical education program uses the ophthalmic chronological progression of a single patient as the background for an expert panel discussion of evaluation and management strategies to optimize outcomes for patients undergoing cataract and refractive surgery. Anti-inflammatory and anti-infective strategies will be explored.

TARGET AUDIENCE
This educational activity intends to educate cataract and refractive surgeons and comprehensive ophthalmologists.

LEARNING OBJECTIVES
Upon completion of this activity, participants will be better able to:
- Assess and treat ocular surface disorders prior to cataract and refractive surgery
- Select best practices for the use of anti-inflammatory and anti-infective regimens in patients undergoing cataract and refractive surgery to prevent postoperative complications
- Evaluate nonsteroidal anti-inflammatory drugs (NSAIDs), steroids, and anti-infective agents for efficacy, safety, and dosing
- Evaluate conventional and femtosecond cataract surgery techniques with respect to inflammation and patient outcomes

ACCREDITATION STATEMENT
This activity has been planned and implemented in accordance with the Essential Areas and Policies of the Accreditation Council for Continuing Medical Education through the joint sponsorship of New York Eye and Ear Infirmary of Mount Sinai and MedEdicus LLC. New York Eye and Ear Infirmary of Mount Sinai is accredited by the ACCME to provide continuing medical education for physicians.

In July 2013, the Accreditation Council for Continuing Medical Education (ACCME) awarded New York Eye and Ear Infirmary of Mount Sinai “Accreditation with Commendation,” for six years as a provider of continuing medical education for physicians, the highest accreditation status awarded by the ACCME.

AMA CREDIT DESIGNATION STATEMENT
New York Eye and Ear Infirmary of Mount Sinai designates this enduring material for a maximum of 1.5 AMA PRA Category 1 Credits™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

GRANTOR STATEMENT
This continuing medical education activity is supported through an unrestricted educational grant from Bausch + Lomb Incorporated.

DISCLOSURE POLICY STATEMENT
It is the policy of New York Eye and Ear Infirmary of Mount Sinai that the faculty and anyone in a position to control activity content disclose any real or apparent conflicts of interest relating to the topics of this educational activity, and also disclose discussions of unlabeled/unapproved uses of drugs or devices during their presentation(s). New York Eye and Ear Infirmary of Mount Sinai has established policies in place that have identified and resolved all conflicts of interest prior to this educational activity. Full disclosure of faculty/planners and their commercial relationships, if any, are noted below.

DISCLOSURES
Steven J. Dell, MD, had a financial agreement or affiliation during the past year with the following commercial interests in the form of Consultant/Advisory Board: Bausch + Lomb Incorporated; Contracted Research: Bausch + Lomb Incorporated; Honoraria from promotional, advertising or non-CME services received directly from commercial interests or their Agents (eg, Speakers Bureau): Bausch + Lomb Incorporated; Eric D. Donnenfeld, MD, had a financial agreement or affiliation during the past year with the following commercial interests in the form of Consultant/Advisory Board: Abbott Medical Optics, AcuFocus, Inc; Alcon, Inc; Allergan, Inc; AqueSys, Inc; Bausch + Lomb Incorporated; Cataract and Refractive Surgery Today; ELENZA, Inc; Glaukos Corporation; Kala Pharmaceuticals Inc; LarcPen/Lacrisciences LLP; Lenox Lasers/Alcon Inc; Mati Therapeutics Inc; Merck & Co, Inc; Mimetogen Pharmaceuticals; NovaBay Pharmaceuticals; Odyssey Medical, Inc; Pfizer Inc; QLT Inc; RPS/ReSearch Pharmaceutical Services, Inc; SARcode Bioscience, Inc; Strathspey Crown; TLC Laser Eye Centers; TearLab Corporation; TrueVision; and WaveTec Vision; Ownership Interest: AcuFocus, Inc; AqueSys, Inc; ELENZA, Inc; Glaukos Corporation; LarcPen/Lacrisciences LLP; Mati Therapeutics Inc; NovaBay Pharmaceuticals; RPS/ReSearch Pharmaceutical Services, Inc; SARcode Bioscience, Inc; Strathspey Crown; TearLab Corporation; TrueVision; and WaveTec Vision; Bonnie An Henderson, MD, had a financial agreement or affiliation during the past year with the following commercial interests in the form of Consultant/Advisory Board: Alcon, Inc; and Bausch + Lomb Incorporated; Contracted Research: Alcon, Inc; and Bausch + Lomb Incorporated.

This continuing medical education activity is supported through an unrestricted education grant from Bausch + Lomb Incorporated.
INTRODUCTION

New technologies and products— from vision correction with contact lenses in childhood to femtosecond laser cataract surgery and presbyopic intraocular lenses (IOLs) in adulthood— have increased the opportunities for visual rehabilitation and reduced spectacle dependence throughout life. Even with these advances, clinicians face multiple challenges that they must overcome to achieve ophthalmic goals for an ever-increasing number of patients. Recent data indicate that nearly 4 million cataract and refractive surgeries are performed annually in the United States,1,2 and that number is growing.

This continuing medical education program uses the ophthalmic chronological progression of a single patient as the background for an expert panel discussion of evaluation and management strategies to optimize outcomes for patients undergoing cataract and refractive surgery.

CONTACT LENS WEAR CHALLENGES

A young girl who is an avid reader by the time she begins kindergarten is diagnosed with myopia at age 6 years. She is originally prescribed spectacle correction; at the age of 13 years she is given daily wear contact lenses. She begins using extended-wear soft contact lenses in high school. At age 18 years, she presents to her ophthalmologist with contact lens intolerance, ocular irritation, and a persistent itching and foreign body sensation in both eyes. Her myopia has progressed over time. On refraction, she has −8.0 D spherical error OU with no cylinder.

Other findings are a best corrected visual acuity (BCVA) of 20/20 OU, 1+ (mild) meibomian gland dysfunction (MGD), 1+ conjunctival injection, and stringy mucus and debris in the tear film, with a clear cornea.

Dr Donnenfeld: There are many reasons for contact lens intolerance. What do you suspect is the diagnosis for this patient, or is more information needed?

Dr Kim: She may have dry eye associated with MGD or contact lens wear, or both. Itching, foreign body sensation, and conjunctival injection are consistent with allergy. Adding her contact lens wear and the stringy mucus to these findings suggests giant papillary conjunctivitis (GPC).

Giant papillary conjunctivitis is most often associated with contact lens wear, and the risk is higher in soft than rigid lens wearers and with less frequent replacement.3 Eversion of the superior lids to evaluate the tarsal conjunctiva for papillary changes is necessary to establish the diagnosis of GPC, and it should be done for any contact lens wearer with lens intolerance complaints and evidence of irritation and inflammation.

Further examination shows Schirmer scores with anesthetic of 4/5, 1+ lissamine green conjunctival staining, and giant papillae on the superior tarsal conjunctiva OU as shown with lid eversion (Figure 1).

Figure 1. Eversion of superior lid reveals giant papillae on the tarsal conjunctiva that are diagnostic of giant papillary conjunctivitis.

Photo courtesy of Terry Kim, MD
Dr Donnenfeld: This patient has dry eye and GPC. Certainly, dry eye can contribute to GPC by allowing for more friction between the lens and the lids.

How would you manage this patient?

Dr Dell: First, I would change the contact lenses. I think patients who develop GPC do better with a daily disposable lens that minimizes the potential for mechanical irritation caused by lenses surface deposits. My medical management regimen for GPC includes a topical corticosteroid, an antihistamine/mast cell stabilizer, and artificial tears. Cyclosporine might also be used to control inflammation, although I do not prescribe it very often for GPC.

Dr Kim: Since the lens on the eye is inciting inflammation and poor lens wearing habits may be an exacerbating factor, I would recommend that the patient discontinue contact lens wear temporarily. When readapting lens wear after GPC, I also would switch to a daily disposable contact lens, preferably one that enables surface moisture retention.

In this particular patient, I would give strong consideration to cyclosporine because of her dry eye findings.

The patient discontinues her contact lenses and is started on a topical antihistamine/mast cell stabilizer and topical cyclosporine. However, she complains of burning and irritation from the cyclosporine.

Dr Donnenfeld: Although the ocular surface damage in this patient may resolve with cessation of contact lens wear alone, anti-inflammatory treatment will hasten the improvement and allow the patient to return to contact lens wear. Cyclosporine is certainly a safe drug, but it sometimes can be associated with bothersome burning and irritation, particularly in patients with more severe ocular surface damage. Adding a topical corticosteroid improves patient comfort with cyclosporine and provides faster control of inflammation.4,5

The patient is switched to daily wear disposable contact lenses, managed with a topical antihistamine/mast cell stabilizer and is able to discontinue the topical cyclosporine after several months as the GPC resolves.

CORNEAL REFRACTIVE SURGERY CHALLENGES

The patient continues to wear her contact lenses without problems, and her visual acuity remains stable over the next 12 years. She gradually grows tired of wearing contact lenses and wants to explore the possibility of LASIK (laser-assisted in situ keratomileusis).

Dr Donnenfeld: What should be included in the preoperative assessment of a LASIK candidate?

Dr Dell: Corneal topography is necessary to identify irregular astigmatism and keratoconus, and I include imaging of the posterior corneal surface to screen for keratoconus. Contact lens patients need to discontinue their lenses wear and wait for their topography to stabilize before the imaging. According to a study we conducted (unpublished), 1 week is an adequate washout period for patients with soft contact lenses. However, that is a general rule, and surgeons need to apply clinical judgment in assessing the topography for resolution of contact lens-induced corneal warpage.

If the patient is wearing a rigid lens, the standard practice for a washout period has been 1 month per decade of wear.

Dr Henderson: I manage my pre-LASIK patients the same as my precataract surgery patients in terms of using multiple tools for evaluating the cornea surface. I look for irregular astigmatism on topography, and then compare the topographic keratometry (K) value with the data from non-contact biometry and manual keratometry. If the K values are consistent with each other, then I feel more comfortable that the topography is stable and reliable. If the K values are inconsistent, I will wait another 3 to 4 weeks before reassessing the K value for patients who wore rigid lenses, or 2 weeks for patients who wore soft lenses.

Dr Kim: I also think the posterior cornea should be assessed in screening LASIK candidates. Using a Scheimpflug device for that evaluation, I have excluded patients from LASIK who otherwise appeared to be acceptable candidates, based on the Randleman criteria for ectasia risk (Table 1).

Table 1. Ectasia Risk Factor Score System

<table>
<thead>
<tr>
<th>Parameter</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topography pattern</td>
<td>FFKC</td>
<td>Inferior steepening/ SRA</td>
<td>ABT</td>
<td>Normal/ SBT</td>
<td></td>
</tr>
<tr>
<td>RSB thickness (μm)</td>
<td>&lt;240</td>
<td>240–259</td>
<td>260–279</td>
<td>280–299</td>
<td>&gt;300</td>
</tr>
<tr>
<td>Age (yrs)</td>
<td>18–21</td>
<td>22–25</td>
<td>26–29</td>
<td>&gt;30</td>
<td></td>
</tr>
<tr>
<td>CT (μm)</td>
<td>&lt;450</td>
<td>451–480</td>
<td>481–510</td>
<td>&gt;510</td>
<td></td>
</tr>
<tr>
<td>MRSE (D)</td>
<td>≥14</td>
<td>≥12 to –14</td>
<td>≥10 to –12</td>
<td>≥8 to –10</td>
<td>≥8 or less</td>
</tr>
</tbody>
</table>

ABT = asymmetric bowtie; CT = preoperative corneal thickness; D = diopters; FFKC = forme fruste keratoconus; MRSE = manifest refraction spherical equivalent; RSB = residual stromal bed; SBT = symmetric bowtie; SRA = skewed radial axis.

Recommendations for laser vision correction are based on the cumulative risk scale score. 0 to 2 = low risk: proceed with LASIK or surface ablation. 3 = moderate risk: proceed with caution, consider special informed consent; safety of surface ablation has not been established (consider MRSE stability, degree of astigmatism, between-eye topographic asymmetry, and family history). ≥4 = high risk: do not perform LASIK; safety of surface ablation has not been established.

Dr Donnenfeld: I disagree about the need to look at the posterior cornea in the setting of a normal topography and a normal pachymetric map because there is no conclusive evidence that posterior surface elevation alone is a risk factor for post-LASIK ectasia.7

In my practice, patients found to have a posterior surface abnormality are told about the finding, but they are also told that, in my opinion, this isolated abnormality is unimportant because I rely more on the surface topography and a normal pachymetric map.

What else is included in the preoperative examination for LASIK?

Dr Dell: LASIK candidates also need a thorough ocular surface evaluation. I am not concerned about pupil size in patients having a wavefront-guided ablation. However, I think it is important to look for retinal pathology in someone with high myopia.
Dr Donnenfeld: Do you think a high-risk patient should be referred to a retinal specialist for an examination as part of the preoperative assessment for LASIK?

Dr Henderson: It depends on the individual surgeon’s comfort level. I do scleral depression, which is actually easier to perform in a longer eye. However, if the examination is difficult—perhaps because the patient is photophobic—or if I am having trouble visualizing the peripheral retina for any other reason, I definitely would enlist the help of a retinal colleague.

Dr Donnenfeld: Let us talk in more depth about the ocular surface evaluation and dry eye. Although post-LASIK dry eye is less common now than in the past because of better preoperative evaluations and changes in surgical techniques, dry eye is still the most common complaint after LASIK. How should a patient be evaluated for dry eye prior to LASIK?

Dr Dell: The preoperative assessment for LASIK should include a Schirmer’s test, lid margin evaluation, conjunctival and corneal staining, and corneal sensation testing. We also measure tear film osmolarity, which has been shown to correlate with dry eye. I have found that some other markers of dry eye, such as superficial punctate keratopathy (SPK), do not correlate well with the level of post-LASIK dry eye complaints. According to a study we will be submitting for publication, there is no correlation between tear break-up time (TBUT) and post-LASIK dry eye complaints (Figure 2).

Dr Kim: I use fluorescein and lissamine green for staining, and I use a strip—not a solution—to avoid flooding the tear film with fluorescein. Subtle anterior corneal pathology can be missed when there is too much fluorescein, which is important in LASIK screening because you do not want to overlook corneal surface lesions such as anterior basement membrane dystrophy. Too much fluorescein also makes the evaluation of tear breakup time unreliable.

In addition, I do a careful lid evaluation because I think MGD is the leading cause of dry eye in these patients.

Dr Donnenfeld: I agree that there is a need to focus on the eyelid examination, and I believe it has been overlooked in the past. I think lid expression to evaluate the meibum may be the most vital test in my preoperative evaluation for LASIK.

What is your technique, and what are you looking for?

Dr Kim: I have the patient look up, and I use a cotton-tipped applicator to apply pressure on the inferior lid margin. I look for gland obstruction and then make a qualitative assessment of the turbidity and consistency of any expressed meibum. I am surprised how many times I see toothpaste-like thick, white meibum in patients wanting to have refractive surgery. Not only is that evidence of severe MGD, but it has also been associated with dyslipidemia. Therefore, patients with thick white meibum may want to consider having a serum lipid profile done.

Clinical examination shows the following: -8.00 D OU, BCVA 20/25 OU, mild conjunctival injection, mild superior corneal neovascularization, 2+ lissamine green conjunctival staining, 2+ central corneal fluorescein staining, central pachymetry 590/595 microns with a normal pachymetric map, irregular Placido corneal topography (Figure 3) with mild dropout of mires on the Placido image (Figure 4), and normal dilated fundus examination.

Dr Dell: I would encourage all surgeons to look at the Placido image on the topography printout because the appearance of the mires is one of the most sensitive indicators of the quality of the ocular surface and the scan.

Dr Kim: Irregularity on the topography map or dropout of the mires on the topography Placido image or on manual keratometry can be associated with dry eye as well as with other surface lesions, such as anterior basement membrane dystrophy or Salzmann nodular degeneration.

**Figure 2.** Mean preoperative TBUT vs postoperative dry eye. A total of 32,070 patients who underwent laser vision correction were surveyed at 3 months postoperatively about the degree of difficulty they experienced with dry eye symptoms. There was a trend for the severity of problems to increase with shortening preoperative TBUT, but clinically it is not possible to differentiate between a TBUT of 8.6 seconds and one of 8.1 seconds.

Dr Kim: I use fluorescein and lissamine green for staining, and I use a strip—not a solution—to avoid flooding the tear film with fluorescein. Subtle anterior corneal pathology can be missed when there is too much fluorescein, which is important in LASIK screening because you do not want to overlook corneal surface lesions such as anterior basement membrane dystrophy. Too much fluorescein also makes the evaluation of tear breakup time unreliable.

**Figure 3.** Irregular corneal topography with dropout (OU) that is consistent with dry eye disease.

*Images courtesy of Terry Kim, MD*
Dr Donnenfeld: An irregular ocular surface secondary to dry eye likely explains why this 30-year-old woman has a BCVA of only 20/25. Given her relatively young age, the presence of such significant dry eye is also an indication to do a workup for autoimmune/collagen vascular disease. LASIK should not be performed in patients until the ocular surface is rehabilitated. Not only will such patients have dry eye after surgery that will cause discomfort and affect their vision, but the irregular ocular surface makes it impossible to get accurate preoperative data for guiding the ablation.

The patient is diagnosed with grade 2/3 dry eye and contact lens overwear.

Dr Donnenfeld: Different clinicians may have different perspectives on the optimal management of preexisting dry eye in a patient who will undergo LASIK. I know surgeons who prescribe cyclosporine in all LASIK patients, and there is some evidence that cyclosporine improves outcomes even in patients without dry eye. However, I think the use of a gentle corticosteroid is helpful for achieving more rapid rehabilitation of existing ocular surface damage. It is always important to monitor intraocular pressure (IOP) when the patient is using a steroid. Flurometholone and loteprednol have lower potential to cause IOP elevation than some other steroids. I prefer loteprednol gel because the gel has the potential to provide increased contact time and protect the ocular surface.

The patient discontinued contact lens wear, was cautioned about avoiding eye rubbing, and was started on loteprednol gel and cyclosporine. After 1 month, her ocular surface irritation resolved. She is now considered ready to undergo LASIK. However, she is concerned about postoperative infection with methicillin-resistant Staphylococcus aureus (MRSA) because she is a health care worker.

Dr Donnenfeld: What is the role of MRSA as the cause of infections after LASIK?

Dr Kim: The American Society of Cataract and Refractive Surgery (ASCRS) Cornea Clinical Committee conducted several surveys to characterize post-LASIK infectious keratitis. Findings published in 2003 showed atypical mycobacteria was the most common cause. A second survey, which was conducted after fourth-generation fluoroquinolones became available for use as antibiotic prophylaxis, found MRSA was the leading pathogen in post-LASIK infections.

Dr Donnenfeld: The shift in infection etiology was suggested to be due, in part, to the improved activity of fourth-generation fluoroquinolones against atypical mycobacteria compared with earlier fluoroquinolones. Interestingly, the Ocular Tracking Resistance in U.S. Today (TRUST) laboratory investigation showed high levels of in vitro MRSA resistance to quinolones available in 2008, with an overall MRSA susceptibility of 15.2%. The subsequent Antibiotic Resistance Monitoring in Ocular micRorganisms (ARMOR) surveillance study showed that, based on the minimum inhibitory concentration required to inhibit the growth of 90% of organisms (MIC90) values, besifloxacin was the most potent of the tested fluoroquinolones against MRSA and more active than tobramycin and azithromycin. University of Miami researchers reported similar results from in vitro testing of clinical ocular isolates.

Dr Dell: The information on MRSA susceptibility to besifloxacin is important because I think clinicians automatically think about using vancomycin whenever there is any concern about MRSA coverage. However, I believe vancomycin should be reserved for therapeutic purposes and should not be overused for prophylaxis.

Dr Donnenfeld: While we are talking about preventing postoperative infections, the stakes for choosing an effective prophylactic antibiotic are even higher in cataract surgery than in refractive surgery because cataract surgery is an intraocular procedure. We also know from a study that Dr Dell and I participated in that the risk of MRSA colonization increases with age. In that study of routine cataract surgery patients, MRSA was cultured from the nonsurgical eye in 39% of the patients. The MRSA positive rate was similar among health care workers and those who are not health care workers, and it approached 50% among patients aged >80 years.

Dr Kim: Studies have found that cases of postcataract surgery endophthalmitis from MRSA and methicillin-sensitive S aureus (MSSA) are becoming more prevalent and increasingly resistant to older fluoroquinolone antibiotics.

Dr Donnenfeld: Some cataract surgeons routinely use generic ofloxacin for antibiotic prophylaxis because of its lower cost. However, a retrospective study from the John Moran Eye Center showed the rate of postcataract surgery endophthalmitis was much lower for patients who received fourth-generation fluoroquinolones (ie, gatifloxacin, moxifloxacin) compared with those who received second-generation quinolones (ie, ciprofloxacin, ofloxacin).

Dr Henderson: The European Society of Cataract & Refractive Surgeons (ESCRS) endophthalmitis prophylaxis study and other studies show that cefoxime or various other antibiotics used intracameral decreases endophthalmitis risk. Still, intracameral antibiotics are not widely used in the United States.
Dr Donnenfeld: That is because there is no US Food and Drug Administration (FDA)-approved antibiotic for intracameral use. After we began routinely using vancomycin intraoperatively in the irrigating solution or as a postoperative intracameral injection, our postcataract surgery endophthalmitis rate decreased significantly.

Dr Kim: Although available evidence supports the efficacy of intracameral antibiotics, there are concerns about toxic anterior segment syndrome (TASS) and formulation errors from using a compounded product.26,27

Dr Henderson: Although an off-label use, some surgeons use moxifloxacin ophthalmic solution straight out of the bottle for intracameral injections.28,29 There are 2 formulations of 0.5% moxifloxacin—Vigamox and Moxeza—and both are preservative-free. However, the newer version, Moxeza, contains additional ingredients in the vehicle and should not be used for intracameral injections because it has been associated with severe TASS.30

Dr Donnenfeld: Returning to the patient in our case study, in addition to an antibiotic, the postoperative regimen for patients after LASIK typically includes nonpreserved artificial tears and a corticosteroid. I prescribe loteprednol gel twice a day for 5 days. Other steroids formulated in non-gel vehicles offer alternatives, including difluprednate, fluorometholone, prednisolone acetate, prednisolone sodium phosphate, and rimexolone; some of these are available as generic drug formulations.

Dr Dell: We draw up a topical antibiotic, a topical NSAID, and a topical corticosteroid into a single syringe and instill that mixture intraoperatively. When bromfenac, 0.07%, became available, we began using that as the NSAID. However, we were administering the medications at the start of the surgical procedure and began having problems with suction loss during femtosecond laser flap creation because the new formulation of bromfenac has a very slippery vehicle. Now, we only use a topical anesthetic preoperatively and administer the off-label cocktail of medications at the end of the procedure.

Dr Donnenfeld: Any drugs administered intraoperatively should be put on top of the flap, never beneath it.

CATARACT REFRACTIVE SURGERY CHALLENGES
At 48 years of age, the patient presents with complaints of decreased vision and difficulties with night driving. While she was plano after LASIK, she now has −2.0 D of myopia in both eyes. She is in contact lens monovision, wearing a contact lens in her dominant eye only to correct for distance vision. She likes the monovision, but her distance BCVA is only 20/30 OU.

Dr Donnenfeld: Although patients can spontaneously become myopic after LASIK, it is unusual to see this amount of refractive regression 10 years after surgery. What might explain her myopia?

Dr Kim: Kaufman and Sugar described discrete nuclear sclerosis as the cause for progressive vision loss in younger myopic patients.31

Dr Donnenfeld: I often see patients with reduced BCVA of 20/30 or 20/40 and vigorous vision complaints who have no remarkable findings on ocular surface staining, optical coherence tomography (OCT), computed tomography scan, or dilated examination. However, with retroillumination during direct ophthalmoscopy, I almost always find some nuclear sclerosis that explains the complaints. Ametropes and hyperopes are not affected by mild lens changes, but a little sclerosis is visually significant for myopes because of their nodal point. Cataract surgery is usually an effective solution.31 Dilated examination reveals mild nuclear sclerosis (Figure 5). Topography rules out ectasia, but shows approximately 1.0 D of cylinder OU.

Figure 5. Mild nuclear sclerosis.
Photo courtesy of Eric D. Donnenfeld, MD

Dr Donnenfeld: What would account for the difference between the refractive and topographic cylinder measurements in this patient?

Dr Dell: The topographic cylinder measurement reflects anterior corneal astigmatism, but total corneal astigmatism and refractive cylinder may be different because of the contribution of posterior corneal astigmatism.32 Lenticular astigmatism might also explain the discrepancy between refractive and topographic cylinder.

Dr Henderson: Corneal astigmatism compensated for by lenticular astigmatism is important to recognize because the corneal astigmatism will manifest itself after cataract surgery. An effect on postoperative uncorrected vision will depend on the amount of corneal astigmatism and its axis.

In this situation, patients must understand that although they never needed cylinder correction, they may need glasses to correct it after surgery unless something is done intraoperatively to address the corneal astigmatism.

Dr Donnenfeld: The first question I ask patients whom I see for cataract surgery is whether or not they want reduced dependency on glasses. Some patients who are wearing glasses say they love their glasses or think they look better with glasses, and then I forgo any discussion of premium intraocular lenses (IOls). When patients are interested in reducing spectacle dependency, I learn about their goals,
perform my examination, and use that information to recommend what I think is in the best interest for that individual and leave it to the patient to make an informed decision based on my input.

What objectives do you have when conducting your presurgical discussion with cataract surgery patients?

Dr Henderson: I want to educate patients so that they understand the benefits, risks, and outcomes of cataract surgery. In addition, I want to identify their concerns and goals because that information provides the foundation for recommending a surgical plan to meet their expectations.

Dr Dell: We rely heavily on questionnaires to determine the patient's visual goals (Figure 6). For example, patients who are myopic might assume they will be myopic after surgery. If they do not realize that spectacle independence for distance is possible, they might not express that as a goal.

Dr Kim: I also want to assess how vested patients are in their outcome and the likelihood they will comply with the treatment plan I prescribe, such as for rehabilitating the ocular surface if needed and for controlling postoperative inflammation. The surgical outcome depends in part on whether or not patients adhere to their instructions and recommended medication regimen.

Dr Donnenfeld: What diagnostic testing do you perform prior to cataract surgery?

Dr Henderson: The expansion in our IOL options has generated the need for a more extensive preoperative evaluation to guide appropriate implant selection. Topography is an extremely critical component to make sure we have properly diagnosed any corneal abnormalities that will limit outcomes with the premium IOLs.

Dr Donnenfeld: I perform topography routinely in all patients having cataract surgery, and it is amazing how often I find previously undiagnosed pellucid marginal degeneration. These patients have to be counseled that their irregular astigmatism cannot be treated effectively with a toric lens, so they should be advised about different options.

Dr Dell: I would remind surgeons that all of the diagnostic testing should be done before any anesthetic or dilating drops are put into the eyes. Having all of the diagnostic testing completed before I see the patient also allows for efficiency in counseling on IOL options. If the information is not yet available, patients have to return for a second visit to discuss the IOLs.

Date________________ Name________________

Cataract and Refractive Lens Exchange Questionnaire

The term “cataract” refers to a cloudy lens within the eye. When a cataract is removed, an artificial lens is placed inside the eye to take the place of the human lens that has become the cataract. Occasionally, clear lenses that have not yet developed cataracts are also removed to reduce or eliminate the need for glasses or contacts. If it is determined that surgery is appropriate for you, this questionnaire will help us provide the best treatment for your visual needs. It is important that you understand that many patients still need to wear glasses for some activities after surgery. Please fill this form out completely and give it to the doctor. If you have questions, please let us know and we will assist you with this form.

1. After surgery, would you be interested in seeing well **without glasses** in the following situations?

   Distance vision (driving, golf, tennis, other sports, watching TV)
   - Prefer no Distance glasses.  I wouldn’t mind wearing Distance glasses.

   Mid-range vision (computer, menus, price tags, cooking, board games, items on a shelf)
   - Prefer no Mid-range glasses.  I wouldn’t mind wearing Mid-range glasses.

   Near vision (reading books, newspapers, magazines, detailed handwork)
   - Prefer no Near glasses.  I wouldn’t mind wearing Near glasses.

2. Please check the single statement that best describes you in terms of night vision:

   a. Night vision is extremely important to me, and I require the best possible quality night vision.
   b. I want to be able to drive comfortably at night, but I would tolerate some slight imperfections.
   c. Night vision is not particularly important to me.

3. If you **had** to wear glasses after surgery for one activity, for which activity would you be most willing to use glasses?

   ____ Distance Vision  ____ Mid-range Vision  ____ Near Vision

4. If you could have good **Distance Vision during the day without glasses**, and good **Near Vision for reading without glasses**, but the compromise was that you might see some halos or rings around lights at night, would you like that option?

   ____ Yes  ____ No

5. If you could have good **Distance vision during the day and night** without glasses, and good **Mid-range Vision** without glasses, but the compromise was that you might need glasses for reading the finest print at near, would you like that option?

   ____ Yes  ____ No

6. Surgery to reduce or eliminate your dependence upon glasses for **Distance, Mid-range and Near Vision** may be partially covered by insurance if you have a cataract that is covered by insurance. Would you be interested in learning more about this option?

   ____ Yes  ____ No  ____ Maybe, it depends on how much is covered by insurance.

7. Please place an “X” on the following scale to describe your personality as best you can:

   [-----------------------------------------------]  [-----------------------------]
   Easy going  Perfectionist

Please Sign Here ____________________

Figure 6. This short questionnaire was developed by Steven J. Dell, MD, to determine patient interest in advanced IOLs and to help guide IOL selection.
Dr Donnenfeld: I think everyone on the panel would agree about the value of topography. In addition, I have come to consider OCT as an important component in the precataract surgery examination for identifying macular pathology, and especially in a high myope who is at high risk. I do OCT routinely in patients interested in a premium IOL because it may generate some finding that will change my management plan.

Dr Henderson: I started evaluating all patients who have cataracts with preoperative OCT about 12 months ago, and it led to the unexpected identification of macular pathology in 4 patients. In each case, the OCT finding affected patient management.

Dr Donnenfeld: A study of cataract surgery patients who had retinal photographs taken 1 month postoperatively showed that 13.9% had an epiretinal membrane. Identification of an epiretinal membrane is important not only because it exacerbates reduced contrast sensitivity with a multifocal IOL, but it also increases the risk of cystoid macular edema (CME) after cataract surgery.³⁴

Dr Dell: I am also concerned about precipitating a posterior vitreous detachment after cataract surgery in a high myope. Therefore, I would send these individuals to a retina specialist for a peripheral retinal examination.

Dr Donnenfeld: I completely agree.

Returning to this case, we are talking about a patient who has not worn glasses for 18 years and will have high expectations for perfect vision after cataract surgery. However, accurate IOL power calculation is challenging in a post-LASIK eye.

I find that the ASCRS IOL calculator³⁵ (Figure 7) is an invaluable aid for helping to pick the right IOL for eyes with previous corneal refractive surgery, and with its use, I have reduced the need for postoperative refractive enhancement. Nevertheless, I always inform these patients that they have a much higher chance of needing an enhancement because of their history.

What IOL would you offer to a patient like this who has a history of myopic LASIK and has done well with monovision?

Dr Dell: First, I want to point out that I believe surgeons should always think about what their rescue strategy will be if they do not hit the refractive target for a patient getting a premium lens. If the options are not good ones, they should adjust their surgical plan.

Regarding this patient, I would avoid a multifocal IOL because she has previously undergone corneal refractive surgery for a relatively high degree of myopia. I expect she would be happiest having monovision targeting some defocus in the nondominant eye. That can be done by implanting standard monofocal IOLs. However, I would favor a toric IOL to correct her corneal astigmatism. There are multiple toric IOLs currently available in the United States (Table 2). They vary in materials and asphericity, but all perform well. The toric presbyopic costs a little more than the other toric IOLs, but has the added benefit of offering an expanded range of focus, whether it is targeted for near or far.³⁶

To provide the best near vision, I would target –1.00 to –1.25 D for the nondominant eye and plano for the dominant eye.

I have found that alignment is easy with the toric presbyopic lens because the IOL can be rotated either clockwise or counterclockwise, and a nice pearl I learned recently is to use the femtosecond laser to create a notch on the cornea as an axis alignment guide. It is much more precise than ink markings.

Since the accommodating IOL platform is very sensitive to capsular contraction, surgeons implanting this lens must be compulsive about thoroughly removing lens epithelial cells from behind the anterior capsule. That is even more important in younger patients, who tend to have a more aggressive fibroptic response.

Dr Donnenfeld: I use the femtosecond laser to create a limbal relaxing incision at the axis that serves as an alignment guide and then can be opened later if additional cylinder correction is needed.

I also believe in using intraoperative wavefront aberrometry to increase the accuracy of IOL power selection and toric IOL alignment, especially in a case such as this one in which a toric lens is being implanted in a post-LASIK eye. It takes only a few seconds to get the readings—benefits of real-time aberrometry have been demonstrated in the literature³⁷—and in our practice, its use has reduced the enhancement rate in challenging cases from approximately 40% to approximately 10%.

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**Figure 7.** The ASCRS IOL calculator.³⁵

Source: IOLCALC.org

**Table 2. IOLs for Toric and Presbyopic Correction Available in the United States**

<table>
<thead>
<tr>
<th>Toric IOLs</th>
<th>Presbyopic IOLs</th>
<th>Toric Presbyopic IOL</th>
</tr>
</thead>
<tbody>
<tr>
<td>AcrySof IQ Toric (Alcon)</td>
<td>AcrySof IQ ReSTOR (Alcon)</td>
<td>Trulign Toric (Bausch + Lomb)</td>
</tr>
<tr>
<td>Staar Toric (Staar)</td>
<td>Crystalens (Bausch + Lomb)</td>
<td></td>
</tr>
<tr>
<td>Tecnis Toric (Abbott)</td>
<td>Tecnis and ReZoom (Abbott)</td>
<td></td>
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</tbody>
</table>
What other factors affect success with multifocal IOLs?

Dr Henderson: Angle kappa is another factor that should be considered because patients with significant angle kappa may be more likely to experience photic symptoms with a multifocal IOL.35

Corneal higher-order aberrations (HOAs) also affect the likelihood of photic symptoms with a multifocal IOL, and I think it is important to consider both coma and trefoil. As a rule of thumb, if the level of these HOAs exceeds .33 microns, visual quality may be reduced with a multifocal optic.

Pupil size is also an issue, specifically with the apodized diffractive multifocal IOL, as near vision is reduced in patients whose pupil is larger than the apodization zone.

Dr Donnenfeld: The presence of a decentralized ablation in patients with a history of laser refractive surgery is another situation in which surgeons need to be careful with IOL selection. I would not implant a multifocal IOL or a lens with negative spherical aberration in such an eye because the patient will experience significant HOA-related photic symptoms if the IOL alignment is decentralized with respect to the ablation. These patients should receive a spherical aberration neutral IOL.

Dr Henderson: Patients who have had hyperopic LASIK have negative spherical aberration in the cornea and also should not be implanted with a negative spherical aberration IOL. In such patients I use either one of the spherical aberration neutral lenses or a standard spherical IOL.

Dr Donnenfeld: I find that patients with a history of hyperopic LASIK who want presbyopia correction are my best candidates for the accommodating IOL. These patients seem to get more reading vision with that lens than other patients.

Another surgical option to discuss with cataract surgery patients is the use of a femtosecond laser, and there are multiple platforms that can be used for various steps in the procedure (Table 3).

What are the benefits of using the laser?

Dr Dell: Studies using different femtosecond lasers and objective metrics to investigate various outcomes show that, compared with conventional cataract surgery, femtosecond laser cataract surgery is associated with more precise capsulotomy creation and significant reductions in ultrasound energy use as well as postoperative corneal edema, aqueous flare, macular edema, and outer zone retinal thickening.39-42

Dr Donnenfeld: Let us move on to discussing postoperative management. In addition to an antibiotic for preventing infection, we want to use medications to control pain and inflammation. There are a number of NSAID products with indications for cataract surgery (Table 4). They vary as to whether they are approved for managing inflammation only or inflammation and pain, availability as a generic formulation, and dosing frequency. However, I think bromfenac, .07%, and nepafenac, .3%, the newest NSAIDs, offer

### Table 3. Approved Femtosecond Laser Cataract Surgery Systems in the United States

<table>
<thead>
<tr>
<th>System Name</th>
<th>Manufacturer</th>
<th>Interface Design</th>
<th>Ocular Surface Identification</th>
<th>FDA Indications</th>
<th>Imaging Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catalys</td>
<td>Abbott Medical Optics</td>
<td>Liquid optics (immersion lens)</td>
<td>Automatic/ User-Adjustable</td>
<td>Anterior capsulotomy, lens fragmentation, creation of arc cuts/incisions in the cornea</td>
<td>3D SD-OCT</td>
</tr>
<tr>
<td>LenSx</td>
<td>Alcon</td>
<td>Curved lens</td>
<td>Manual</td>
<td>Anterior capsulotomy, lens fragmentation, creation of arc cuts/incisions in the cornea, creation of corneal flap in patients undergoing LASIK or other treatment requiring initial lamellar resection of the cornea</td>
<td>3D SD-OCT</td>
</tr>
<tr>
<td>LensAR</td>
<td>LensAR Inc.</td>
<td>Robozone (immersion lens)</td>
<td>Automatic</td>
<td>Anterior capsulotomy, lens fragmentation, creation of arc cuts/incisions in the cornea</td>
<td>3D-CXI (confocal structured illumination)</td>
</tr>
<tr>
<td>Victus</td>
<td>Technolas/ Bausch + Lomb</td>
<td>Curved lens</td>
<td>Manual</td>
<td>Creation of corneal flap in patients undergoing LASIK or other treatment requiring initial lamellar resection of the cornea, anterior capsulotomy, arc cuts/incisions in the cornea</td>
<td>Real-time OCT</td>
</tr>
<tr>
<td>iFS</td>
<td>Abbott Medical Optics</td>
<td>Hard flat interface</td>
<td>Manual</td>
<td>Initial lamellar resection of the cornea, penetrating and intrastromal arcuate incisions</td>
<td>None</td>
</tr>
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</table>

SD-OCT=spectral domain-optical coherence tomography.

Table 4. NSAIDs With Indications for Cataract Surgery

<table>
<thead>
<tr>
<th>Medication</th>
<th>Strength (trade name)</th>
<th>Cataract surgery indication</th>
<th>Dosing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bromfenac</td>
<td>.07% (Prolensa) .09% (generic)</td>
<td>Inflammation Pain</td>
<td>Once daily Twice daily</td>
</tr>
<tr>
<td>Diclofenac</td>
<td>.1% (Voltaren) .1% (generic)</td>
<td>X X</td>
<td>4 times daily 4 times daily</td>
</tr>
<tr>
<td>Ketorolac</td>
<td>.5% (Acuvail)</td>
<td>X X</td>
<td>4 times daily 4 times daily</td>
</tr>
<tr>
<td>Nepafenac</td>
<td>.1% (Nevanac) .3% (llevro)</td>
<td>X X</td>
<td>3 times daily Once daily</td>
</tr>
</tbody>
</table>

Voltaren: http://www.accessdata.fda.gov/drugsatfda_docs/label/2012/020037s031b1.pdf
distinct advantages for improving patient compliance and reducing ocular toxicity relative to older NSAID formulations because of the once-daily dosing frequency. Dr Kim: Corneal toxicity has been a particular problem in patients undergoing cataract surgery. While that does not occur often among cataract surgery patients, she was at an increased risk for an axial length 35.7%. While IOP should be monitored in all patients Dr Kim: with generic formulations of NSAIDs. I have seen a lot of New technologies have raised the outcomes of corneal Donnenfeld: These drops can increase the risk of postcataract surgery complications, most notably inflammation and CME. Dr Kim: The take-home message I have about NSAIDs is that they should be considered in all patients approaching cataract surgery; an increasing number of studies are showing that NSAIDs have synergistic benefit with used a topical corticosteroid for treating or preventing CME.44,45 I start the NSAID 1 day preoperatively. After surgery, I continue the NSAID for 1 month in routine patients and for 3 months in patients at high risk for CME. The patient is started postoperatively on an antibiotic, an NSAID, and a corticosteroid. She returns after 2 weeks complaining that her eye has been aching for the past week. BCVA is 20/50 OD, IOP is 47 mm Hg OD, the angles are open, and the anterior chamber depth is normal. Dr Donnenfeld: The patient has a steroid-induced IOP response, and while that does not occur often among cataract surgery patients, she was at an increased risk for this response. A study by Chang and colleagues found 2.4% of the 1613 cataract surgery patients treated with prednisolone, 1%, for at least a week were steroid responders and identified higher myopia and younger age as risk factors.40 Among patients aged 40 to 54 years with an axial length ≥29 mm, the steroid responder rate was 35.7%. While IOP should be monitored in all patients treated with a corticosteroid, Chang and colleagues suggested shortening the course of steroid treatment in high-risk patients, a preference for using loteprednol or fluorometholone, or even treating with an NSAID alone.45

**SUMMARY**

New technologies have raised the outcomes of corneal refractive and cataract surgery to new levels. However, the ability to consistently deliver on this promise depends on comprehensive preoperative evaluation and an individualized approach to patient care. Prior to undertaking refractive and cataract surgery, ophthalmologists must understand their patients’ goals, set realistic expectations, and undertake proper diagnostic examinations to develop an appropriate surgical plan. There are many elements to consider but, in particular, surgeons must be aggressive in rehabilitating and maintaining ocular surface health, in careful consideration of the numerous factors that can affect outcomes of premium IOL surgery, and in judicious selecting in medication regimens that will reduce surgical risks as well as maximize the benefits.

**REFERENCES**


Studies comparing conventional phacoemulsification and femtosecond laser cataract surgery outcomes metrics have shown all of the following, except:

A. Laser technique is associated with more precise capsulotomy creation
B. Conventional phacoemulsification requires less ultrasound energy use
C. Laser technique is associated with less aqueous flare
D. The safety profiles between the 2 techniques are comparable

2. The most common nonviral cause of early-onset infectious keratitis after LASIK is:
   A. Atypical mycobacteria
   B. Streptococcal infection
   C. MRSA
   D. Candida

3. According to ARMOR surveillance data, the medication associated with the lowest minimum inhibitory concentration in the treatment of MRSA is:
   A. Azithromycin
   B. Ciprofloxacin
   C. Tobramycin
   D. Besifloxacin

4. Among the following, the cataract surgery patient who would represent the greatest risk of steroid response is:
   A. A 42-year-old with an axial length of 30 mm
   B. A 44-year-old with an axial length of 24 mm
   C. A 68-year-old with an axial length of 29 mm
   D. A 70-year-old with an axial length of 23 mm

5. Intracameral antibiotics for endophthalmitis prophylaxis:
   A. Are FDA-approved
   B. Have been demonstrated in clinical studies to reduce endophthalmitis risk
   C. Include 2 formulations of moxifloxacin that have been demonstrated to be safe
   D. Are widely used in the United States

6. With respect to assessment of ocular surface disorders prior to cataract and refractive procedures, all of the following are important modalities to employ, except:
   A. Corneal topography
   B. Lid eversion
   C. Fluorescein solution staining
   D. Tear osmolarity

7. The combination of NSAID and corticosteroid therapy for the treatment or prevention of CME:
   A. Is FDA approved for this indication
   B. Involves mutually antagonistic elements and should always be avoided
   C. Has not been supported by clinical studies
   D. May have some synergistic benefits

8. When considering the use of cyclosporine for management of dry eye, the addition of a topical corticosteroid:
   A. May exacerbate burning sensation associated with cyclosporine
   B. May hasten rehabilitation of existing ocular surface damage
   C. Is universally contraindicated
   D. Worsens Schirmer scores

9. New NSAID formulations may have advantages over older formulations with respect to all of the following, except:
   A. Lower dosing frequency
   B. Lower cost
   C. Lower toxicity profile
   D. Patient compliance

10. Studies have shown that the use of NSAID therapy in patients who are at high risk for developing CME after cataract surgery have been used safely for periods of up to:
    A. 2 weeks
    B. 1 month
    C. 3 months
    D. 1 year
**Activity Evaluation/Credit Request**

**Kicking It Up A Notch: New Perioperative Strategies for Improved Cataract and Refractive Surgery Outcomes**

To receive AMA PRA Category 1 Credit™, you must complete this Evaluation form and the Post Test. Record your answers to the Post Test in the Answer Box located below. Mail or Fax this completed page to New York Eye and Ear Infirmary of Mount Sinai—ICME, 310 East 14th Street, New York, NY 10003 (Fax: 212-353-5703). Your comments help us to determine the extent to which this educational activity has met its stated objectives, assess future educational needs, and create timely and pertinent future activities. Please provide all the requested information below. This ensures that your certificate is filled out correctly and is mailed to the proper address. It also enables us to contact you about future CME activities. Please print clearly or type. Illegible submissions cannot be processed.

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- OD
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**OUTCOMES MEASUREMENT**

- **Yes** [ ] **No** [ ] Did you perceive any commercial bias in any part of this activity? **IMPORTANT!** If you answered “Yes,” we urge you to be specific about where the bias occurred so we can address the perceived bias with the contributor and/or in the subject matter in future activities.

Circle the number that best reflects your opinion on the degree to which the following learning objectives were met:

1. **Assess and treat ocular surface disorders prior to cataract and refractive surgery** [5] [4] [3] [2] [1]
4. **Evaluate conventional and femtosecond cataract surgery techniques with respect to inflammation and patient outcomes** [5] [4] [3] [2] [1]

1. Please list one or more things, if any, you learned from participating in this educational activity that you did not already know. _____________________________

2. As a result of the knowledge gained in this educational activity, how likely are you to implement changes in your practice? 4 = definitely will implement changes 3 = likely will implement changes 2 = likely will not implement any changes 1 = definitely will not make any changes

Please describe the change(s) you plan to make: ____________________________________________________________

3. Related to what you learned in this activity, what barriers to implementing these changes or achieving better patient outcomes do you face? ____________________________________________________________

4. Please check the Core Competencies (as defined by the Accreditation Council for Graduate Medical Education) that were enhanced for you through participation in this activity.  

- [ ] Patient Care
- [ ] Practice-Based Learning and Improvement
- [ ] Professionalism
- [ ] Medical Knowledge
- [ ] Interpersonal and Communication Skills
- [ ] Systems-Based Practice

5. What other topics would you like to see covered in future CME programs?  ____________________________________________________________

**ADDITIONAL COMMENTS**

__________________________________________________________

__________________________________________________________

_________________________________________________________________________________________________________________________________

**POST TEST ANSWER BOX**

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