### Quick Reference Guide

<table>
<thead>
<tr>
<th><strong>Corneal Crosslinking (CXL)</strong></th>
<th><strong>Myopia Control</strong></th>
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<tbody>
<tr>
<td><strong>Approved for keratoconus &amp; post-refractive ectasia</strong></td>
<td>Orthokeratology and soft multifocal contact lenses – 40-50% reduction in myopia progression</td>
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<tr>
<td><strong>US progression criterion for ectasias = 1 or more of:</strong></td>
<td><strong>Center-distance soft multifocal designs</strong></td>
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<td>Increase of 1D or more in the steep K</td>
<td>Currently widely available in the US:</td>
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<tr>
<td>Increase of 1D or more in the manifest cylinder</td>
<td>- Biofinity “D” Multifocal</td>
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<tr>
<td>Increase of 0.50D or more in the manifest refraction sphherical equivalent</td>
<td>- Proclear “D” Multifocal</td>
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<td><strong>Residual corneal thickness should be ≥ 400µm</strong></td>
<td>- Acuvue Oasys for Presbyopia</td>
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<td>Dresden protocol: 3mW/cm² 5.4J/cm², UVA 370nm, epithelial defect 7-9mm. Riboflavin: one drop every 1-5 min for 30 min. Isotonic 0.10% with 20% Dextran; Hypotonic 0.10% with no dextran to induce swelling for thinner corneas</td>
<td>- NaturalVue Multifocal 1 Day</td>
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<td>Most common complications: corneal haze, punctate keratitis, infectious keratitis, persistent corneal epithelial defects, corneal infiltrates, corneal scarring, corneal striae, pain, reduction of visual acuity, blurred vision, diffuse lamellar keratitis</td>
<td>With higher add powers, expect minus over-refraction to optimize vision (between -0.50 to -0.75 for Biofinity “D” +2.50 add)</td>
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<td>Average 1 yr flattening in mean K after CXL: 1.6-2.68D</td>
<td>Orthokeratology possibly not as effective until moderate myopia (more myopic than -2.00 D)</td>
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### Contact Lens Complications

**Incidence rates for microbial keratitis with daily and extended contact lens wear (Daily/Extended Wear)**
- Silicone hydrogel: 12/10,000 DW, 25/10,000 EW
- Hydrogel: 2/10,000 DW, 20/10,000 EW
- Gas permeable: 1/10,000 DW, 0/10,000 EW

**Major non-modifiable risks factors**
- Age, refractive error > 5D, Poor/compromised systemic/ocular health

**Major modifiable risk factors**
- Closed eye wear, longer contact lens and/or case replacement, silicone hydrogel lenses, water exposure, multipurpose care products, topping off

**CIEs and resistance to drugs**
- Culture: >2mm, central, not improved w/in 48 hrs
- Report: fda.gov/Safety/MedWatch

### New Technologies

**FDA approved bandage contact lenses**
- Approved lenses: Acuvue Oasys, B&L Purevision, Air Optix Night and Day, United Contact Lenses 55/46.
  *Unilens Sof-Form 55 EW discontinued 3/31/17

**EyeYon Hyper-CL: Daily wear fenestrated soft CL for treatment of corneal disease**

**Prokera: Human amniotic membrane bandage lens for reducing ocular surface inflammation and healing**

**Anti-microbial and drug delivery contact lenses**
- Currently, no FDA approved devices

**Smart lens technologies**
- Glaucoma: Sensimed Triggerfish silicone-based CL for continual IOP measurement
- Glucose-sensing and accommodating contact lens: No FDA approved device available
Abstract
This fast-paced course will provide a summary of key findings in the recent peer-reviewed cornea and contact lens literature and guide practitioners on how to advance their practice today and what to watch out for down the road. Topics include crosslinking, risk of contact lens complications, myopia control and new contact lens technologies.

Objectives
In this course participants will learn about:
1) Levels of clinical research evidence
2) Recent research on the treatment and management of corneal disease and refractive error including updates on corneal crosslinking, contact lens related corneal complications, contact lens treatments for myopia progression and new contact lens technologies
3) FDA approved and off-label uses of devices and technologies in cornea and contact lenses
4) What can be put into practice now to improve patient care and what to watch for in the future

Course Outline
I. Introduction
   a. Evidence based medicine and levels of evidence
II. Corneal crosslinking
   b. Current FDA approved Avedro system for keratoconus or other ectasias (Greenstein, JCRS, 2010; Greenstein, J Cat Refract Surg, 2011; Hersh, Ophthalmology, 2017; Hersh, Ophthalmology, 2017; Raiskup, J Cat Refract Surg, 2017)
      i. Expected outcomes
         1. Average 1-2 D flattening of KMax at 1 year
         2. Stability or improvement in BCVA
         3. Potential for “treatment failure” (8-33%)
      ii. Safety
         1. Corneal haze (10-90%), usually resolved by 6-12 months
         2. SPK, striae, pain, reduced VA, reduced corneal sensitivity, infiltrative/infectious keratitis
         3. Potential for endothelial damage (<400µ)
      i. New delivery methods
         1. Accelerated treatments
         2. Transepithelial cross-linking (aka “epi-on”)
            a. Iontophoresis
      ii. Potential new indications
         1. Infectious keratitis
         2. Bullous keratopathy/corneal edema
         3. Combination treatments
   d. Putting it into practice
      i. Identifying, educating and referring appropriate patients
III. Contact lens complication
   a. Primary complications
b. Incidence of microbial keratitis (MK)
   i. Rates in adults (Schein, NEJM, 1989; Poggio, NEJM, 1989; Cheng, Lancet, 1999; Schein Ophth 2005; Stapleton, Ophth, 2008; Bullimore, OVS, 2013)
      1. Hydrogel (2/10,000 daily wear (DW), 20/10,000 extended wear (EW))
      2. Silicone hydrogel (12/10,000 DW, 25/10,000 EW)
      3. Gas permeable (1/10,000 DW, 0/10,000 EW)
   ii. Rates in children, teens and young adults
      1. Highest risk in patients age 13-25 years (Wagner, OVS, 2011; Chalmers, IOVS, 2011)

c. Risk factors for corneal infiltrative events and other interruptions to contact lens wear
   i. Non-modifiable
      1. Age (teenage/young adult) (Wagner, OVS, 2011; Chalmers, IOVS, 2011)
      2. High refractive error (>5 D) (Chalmers, OVS, 2007; Zadnik, OVS, 2001)
      3. Poor systemic health (Keay, OVS, 2009; Radford, Opthal, 2009; Morgan, IOVS, 2005)
   ii. Modifiable
      4. Multipurpose care products and topping off (Carnt, Arch Ophth, 2009; Joslin, AJO, 2007; Verani, Emerg Infect Dis; 2009; Chang, JAMA, 2006)
      5. Silicone hydrogel materials (Schein Ophth 2005; Stapleton, Ophth, 2008; Wagner, OVS, 2011; Chalmers, IOVS, 2011)

d. Microbial resistance (Asbell, JAMA Ophthalmol 2015; Richdale IOVS 2016)
   i. Concern for microbial resistance to drugs
   ii. New microbes associated known to be resistant to standard treatments

e. Putting it into practice
   i. Targeted education and prescribing of contact lenses with knowledge of risk profile
   ii. Culture: >2mm, central, not improving within 48 hours
   iii. Reporting adverse events: Med Watch (fda.gov/Safety/MedWatch)

IV. Contact lens treatments for myopia control
   a. Current myopia control treatments
      i. Predicting children who will be myopic by grade 8 (13 years old)
         1. Less hyperopic than +0.75 D for grade 1 (age 6 years) (Zadnik, JAMA Ophthalmol, 2015)
      ii. US Myopia Progression (Mutti, IOVS, 2007)
         1. Refractive error and axial length change before and after myopia onset
         2. Differences by race and ethnicity (Asian, Hispanic, Caucasian, African American)
      iii. Summary of multifocal contact lens evidence
         1. DIMENZ study / CooperVision MiSight Lens (Anstice, Opthalmol, 2011)
         2. Novel aspheric lens design (Sankaridurg, IOVS, 2011)
         3. BLIMP study / CooperVision Proclear Multifocal (Walline, OVS, 2013)
         4. DISC study and wear time influence on effect size (Lam, Br J Ophthalmol, 2014)
         5. CONTROL study / Acuvue Bifocal (Aller, OVS, 2016)
         6. Summary: Expect 34-50% reduction in axial length at 1 year versus single vision
      iv. Summary of orthokeratology evidence
         1. Association between corneal power changes and axial elongation (Zhong, OVS, 2014)
         2. CRAYON study / CRT (Walline, BJO, 2009)
         3. MCOS and ROMIO studies / OK vs specs (Santodomingo-Rubido, IOVS, 2012; Cho and Cheung, IOVS, 2012)
4. IOOALECM study; 5-year follow up (Hiraoka, IOVS, 2012)
5. Summary: Meta-analysis: 0.26mm less axial growth over two years (Si, OVS, 2015)

v. Multifocals vs orthokeratology
   1. Similar efficacy and acuity, but more (mild) adverse events and greater chair time with orthokeratology compared to soft daily disposable multifocals (Turnbull, OVS, 2016)

vi. Is there rebound after ceasing optical treatments?
   1. No evidence in PALs (Berntsen, IOVS, 2013)
   2. No evidence with positive spherical aberration soft contact lenses (Cheng, OVS, 2016)

b. Putting it into practice
   i. Treatment plans
      1. Measurement and standardization of methods
         a. Cycloplegic refractive error (GrandSeiko WAM-5500 or other open field)
         b. Axial length (Lenstar, IOLMaster, etc)
         c. Others: aberrometry, pupil size
      2. Multifocal and orthokeratology options and comparison to peripheral defocus with standard contact lenses (Moore, OVS, 2017)
         a. CooperVision Proclear & Biofinity Multifocal “D” (Berntsen, OVS, 2013)
            i. Toric and XR options available
         b. Vistakon Acuvue Oasys for Presbyopia
         c. Paragon CRT, Bausch + Lomb VST, custom
   ii. Patient education (Expected efficacy, risks and benefits, potential plateaus, off label use)

V. New contact lens technologies
   a. Drug delivery with contact lenses
      i. Methods
         1. Soaking, vitamin E coating, molecular imprinting, nanoparticles, etc.
      ii. FDA approved bandage lenses
         1. Acuvue Oasys, Purevision, Air Optix Night & Day, Unilens, United Contact Lenses
         2. Eyon Hyper contact lens
   b. Anti-microbial contact lenses (Dutta, OVS, 2014; Bandara, OVS, 2016)
      i. Methods
         1. Silver, NSAIDs, selenium, AMPs
   c. Smart lens technologies (Ascaso, OVS, 2016; Liu, PNAS, 2016)
      i. FDA approved Sensimed Triggerfish for monitoring of variation in IOP over 24 hours
      ii. Glucose sensing contact lens development
      iii. Accommodating contact lens development
   d. Putting it into practice
      i. Challenges and opportunities for optometry

VI. Conclusions
   a. Final considerations for current clinical practice and challenges for adoption of new technologies
   b. Open questions/discussion
REFERENCES

**Corneal Crosslinking**


**Contact Lens Complications**


Myopia Control


New Contact Lens Technologies


