NCLE Basic Exam Review

Domain III: Instrumentation for Measurement and Observation
Domain IV: Prefitting

Developed by the National Federation of Opticianry Schools

Professor Robert J. Russo

NCLE Basic Exam Review
Domain III - Instrumentation for Measurement and Observation (12 questions)

A. **Keratometer**:

- Measures curvature of cornea
- “K” readings
- Principal meridians and axis
- Amount of corneal astigmatism
- Oldest and most widely used instrument to measure the curvature of the eye
- May be referred to as the ophthalmometer
- Mires
- Capabilities
    1. Initial "K" readings
    2. Follow-up "K" readings
    3. Check fit of soft lens with 3-point touch
    4. Check base curve of Rigid contact lens
- Procedure
    1. Focus Eyepiece
- Recordings Examples: O.D. 43.00 @ 180 / 43.50 @ 90
  O.D. 43.00 x 180 / 43.50 x 90
- Measured in diopters - newer models have both diopter and mm meaurements
- Average reading between 42.00D & 45.00D
- Only measuring the center corneal cap 2.5mm – 4.00mm
- Range of keratometer is 36.00D to 52.00D
- Record horizontal reading first
- Record axis for horizontal
- Record vertical reading
- Record axis for vertical
- Record to the nearest .12 D
- Higher number in diopters signifies a steeper curve
- Lower number in diopters signifies a flatter curve

$$D = \frac{N2-N1}{r}$$

D = Diopters
N2 = Index of Cornea
N1 = Index of Air
R – radius of curvature

42.50 convert to mm

$$R = \frac{1.3375 - 1.00}{42.50}$$

$$\frac{.3375}{42.50\ D} = \frac{337.5\ mm}{42.50\ D}$$

= 7.94 mm

B. **Astigmatism**:

- Regular - clarity of mires
- Irregular - mires are distorted
- Symmetrical (ex: “K” 43.00 @ 180 / 44.00 @ 90)
- Asymmetrical (ex: “K” 43.00 @ 180 / 44.00 @ 70)
- With The Rule (WTR)- Flattest Meridian at 180 (ex:“K” 43.00 @ 180 / 44.00 @ 90) – Most corneas are WTR
- Against The Rule (ATR)- Flattest Meridian at 90 (ex:“K” 44.00 @ 180 / 43.00 @ 90) -- This astigmatism is usually associated with Lenticular or Internal astigmatism
- Oblique--“K” 43.00 @ 135 / 44.00 @ 45
- Extending the Keratometer Range: +1.25 – 9.00 Diopters = 43.00 - 52.00 = 61.00
- -1.00 – 6.00 Diopters = 42.00 - 36.00 = 30.00

C. **Biomicroscope (Slit Lamp)**

- For viewing eye under magnification
- Eye structures (mostly anterior segment)
- Refractive principles utilized w/ addition of light and filters
- Procedures
- Illuminations

Direct:

- microscope focused directly into the slit – Parallelpiped, Optic section, Specular reflection
    - **Diffuse**: Overall view of anterior segment. Lens position and movement of contact lenses. Surface quality of lens.
    - **Paralellepiped**: 1-2mm slit, medium to high magnification, Cross-sectional view of cornea, Corneal clarity, Lens deposits
    - **Optic Section**: Slit width < 1mm, Medium to high magnification, Cross-sectional view of corneal layers, Depth of corneal irregularities, Surface topography of bumps and indentations
    - **Specular Reflection**: 1-2mm slit, Medium to high mag., Fine lens deposits, Subtle corneal imperfections, corneal endothelium

Indirect: microscope focused adjacent to the slit – Indirect retro illumination, Sclerotic Scatter:

- **Indirect**:
    - 1-2mm slit, Medium to high magnification, View area adjacent to the slit
    - Opaque structures – lids, sclera, conjunctiva. vascularization, pingueculae, pigmentation

- **Retroillumination:**
    - 1-2mm slit,
    - medium to high magnification, light is reflected off an opaque structure behind the area being viewed,
    - corneal neo-vascularization

- **Sclerotic Scatter:**
    - 2-4mm slit, aimed at limbus from a wide angle, Look for circumcorneal halo, View straight ahead w/ no magnification
    - Classic use is to view patch edema
    - Corneal Scars
    - Incisions
    - SCL edge lift

Lens Classifications

Corneal Contact Lens – a lens that fits within the dimensions of the cornea
Diameters can vary from 7.5 mm to 11.5 mm
Soft Contact Lenses – are fit over the limbus
Mini – 12.5 mm to 13.5mm
Semi-Scleral – 14.0 mm to 14.5 mm
Scleral – 15.0 mm to 16.0 mm
Scleral lenses – (Haptic Lens)
Mini Scleral – 15.0 mm – 18.0 mm
Full Scleral – 18.0 mm – 24 mm +

C. **Rigid Lens Verification:**

- Rigid Contact Lenses are verified before dispensing to the patient
- We make sure the parameters requested are what we receive
- CPC or Base Curve, Power, Diameter, Optic Zone, Center Thickness, Peripheral Curves and Tint

D. **Contact Lens Parameters**:

- CPC specified to .01 mm
- Diameter specified to the nearest .1 mm
- POZ specified to the nearest .1 mm
- PC's specified to the nearest .1 mm
- Thickness specified to the nearest .01mm
- Power specified to the nearest .12 D

E. **ANSI Standards**:

- Formed in 1918
- Private, non-profit based membership to establish voluntary quality standards for American made products
- Latest Version 2020, Updated version are reviewed every 5 years

Contact Lens Tolerances

American National Standard Institute; ANSI Z80.20-

The following chart provides information on the tolerances established for general manufacturing. It is advised to know what a contact lens measures before modification. Some procedures may cause a change in lens parameters and understanding tolerances will prove beneficial.

	Power	Tolerance
Sphere Power	0.0 to 5.00D	+/- 0.12D
	5.12 to 10.00D	+/- 0.18D
	10.12 to 15.00D	+/- 0.25D
	15.12 to 20.00D	+/- 0.50D
Cylinder Power	0.0 to 2.00D	+/- 0.25D
	2.12 to 4.00D	+/- 0.37D
	Over 4.00D	+/- 0.50D
Cylinder Axis	any	+/- 5 degrees

	Parameter	Tolerance
Base Curve	Toric base curve	+/- 0.05mm
	dd r o to 0.20mm	+/- 0.05mm
	dd r 0.21 to 0.40mm	+/- 0.06mm
	dd r 0.41 to 0.60mm	+/- 0.07mm
	dd r more than 0.60mm	+/- 0.09mm
Lens Parameters	Diameter	+/- 0.05mm
	Optic Zone	+/- 0.10mm
	Center Thickness	+/- 0.02mm
Bifocal Refractive	Add power	+/- 0.25D
	Seg height	+/- 0.10mm

**dd = difference between radii of principal meridians*

Base Curve (spherical) - Tolerance ± 0.05 mm

F. **Central Posterior Curve (CPC):**

- Also known as the base curve
- Primary curve on the concave surface (Fitting Curve)
- Contains the Optical Qualities of the Lens
- Radius of curvature measured

G. **Radiuscope** is used to verify.

- Measures to 0.01 mm
- Concave surface (Back surface)
- Convex Surface (Front Surface)
- Measure Front Radius (PCC)
- Measure Back Radius (ACC)
- Warpage
- Toric Lens Verification
- Surface Scratches

H. **Measuring CPC**:

- Drop of saline is placed in lens holder, not alcohol because of evaporation
- Lens floats on saline concave side up
- Concave side dry

I. **Lensometry: (Focimeter)**

- Concave surface is held against lens stop
- Careful not to bend lens
- Sphere and cylinder lines are read
- Toric Lenses – Verification of Power with a Lensometer

Lens Type	Radiuscope	Lensometer
Front Cylinder	Spherical target at concave mount	Sphero-Cylinder
Back Toric	Toric image at concave mount	Sphero-Cylinder
Bitoric	Toric Image at concave and convex mount	Sphero-Cylinder
Warped Lens	Toric Image at concave mount	Spherical

J. **V-Gauge:**

- Measures diameter

K. **Shadowgraph:**

- Determines size of both diameter and optical zone.
- Used to examine surface of contact lens and edge of contact lens.

L. **Hand held magnifier:**

- Used to determine diameter of lens and optical zone
- Used to examine front surface of contact lens
- Check Edge Contour

M. **Optical zone:**

- Specified to nearest 0.1 mm
- Seeing area of the lens
- Chord length of CPC
- Measured with hand held magnifier or shadowgraph

N. **Peripheral Curves:**

- Curves flatten towards the periphery as the cornea flattens.
- Specified to nearest 0.1 mm
- Important to check the blend between the curves.

O. **Diameter, POZ and Peripheral Curve Calculations:**

Diameter = POZ 2 (PPC/w + PIC/w)

Example # 1

A lens has a 9.5 Diameter, PPC/w = .3 mm and the PIC/w = .2 mm.
What is the size of the POZ?

9.5 = 2 (.3 + .2)
9.5 = 1.0 mm
9.5 – 1.0 = 8.5 POZ

Example # 2

A lens has a POZ of 7.5 mm, PPC/w = .3 mm and the PIC/w = .2 mm.
What is the Diameter of the lens?
POZ = 2 (PPC/w + PIC/w)
7.5 = 2 (.3 mm + .2 mm)
7.5 = 2 (1.0mm)
7.5 + 1.0 mm = 8.5 mm Diameter

P. **Profile Analyzer:** used to check edge contour and proper blending

Burton Lamp – has black light and fluorescent light. The instrument can be used for fluorescein evaluation and peripheral curve blending.)

- Checks blends and edge contour

Q. **Thickness:**

- Refers to center thickness
- Specified to the nearest .01 mm

R. **Contact Lens Tints:**

- Colors – Blue, Gray, Green, Brown, Rose
- RGP's – usually Blue, Gray or Green
- Density:
- #1 – 10%
- #2 – 20%
- #3 – 30% +

S. **Soft Lens Inspection**

- Lens Power with a Lensometer/Focimeter
- Wet Cell

  Vertometer Reading x Converstion Factor = Power
  N = 1.43, Conversion Factor = 4.57
- Boyle's Loop - magnifier to evaluate lens surface, deposits etc.
- Slit Lamp - Overall inspection of soft lens

T. **Contact Lens Adjustments**

Adjustments to an original lens:

- Cut down diameter
- Increase PC width, reduces POZ
- Reduce POZ
- Round out edges
- Clean and Polish scratches
- Smooth out peripheral curves
- Add -.50 to (Topad Spinner)
- Add +.50 to Plus lenses

Adjustments that require a new lens

- Increase Diameter
- Change Center Thickness
- Make POZ larger
- Add more than -.50 of minus power
- Add more than .+.50 of plus power
- Change Base Curve

U. **Instrumentation**:

- **Phoropter**- Refraction device combining a large variety of spherical and cylindrical lenses, prisms, occluders and pinholes; used in determining an eye's optical correction

- **Trial Set**- A large variety of spherical and cylindrical lenses, prisms, occluders and pinholes; used in determining an eye's optical correction

- **Retinoscope**- Hand-held device for measuring the eye's refractive error, with no verbal response required from the patient. Light movement is neutralized by lenses from either the phoropter or trial lenses

- **Ophthalmoscope**- Device used for examining the interior of the eye, especially the fundus and retina

- **Autorefractor**- Electro-mechanical or computerized device used for determining an eye's refractive error

- **Corneal Topogometer or Aberrometer –**
    - Every map has a color scale that assigns a particular color to a certain keratometric dioptric range
    - Warm colors such as red and orange show steeper areas, cool colors such as blue and green denote flatter areas
    - **Axial Map**
    - Best for defining astigmatism
    - Best for apical radius
    - **Tangential/True**
    - Best for determining curvature shape with smaller, more detailed patterns at a specific point

Domain IV: Prefitting (15 questions)

Patient Selection:

Health History
Refraction
Pre-fitting examination with Slit Lamp
Keratometry

- Motivation
- Personal Hygiene
- Willing to comply with all directions, instructions and restrictions for proper lens wear and aftercare
- Appropriate refractive error based on manufacturer availability and Lens Design

General Health

- Respiratory Disorders – such as hay fever, asthma, sinusitis tend to produce conjunctival injection and ocular sensitivity
- Diabetes – high sugar levels indicate a slow healing process
- Thyroid condition - dryness due to proptosis (protrusion of the eyeball
- Endocrine changes (Pregnancy and menopause)
- Skin conditions
- Hypertension

Systemic Medications

- Currently taking any medications?
- Whether prescribed or over-the-counter medications can affect the eye
- Symptoms can include but not limited to ocular dryness, decreased vision, photophobia, decreased comfort with contact lenses and increased lens deposits and discoloration

Decreased Lacrimation

Drugs associated with antihistamines, tranquilizers, diuretics, muscle relasants, and anti- depressants and beta-blockers

- Acutane – treatment of Acne
- Dyazide and Lasix – treatment of Hypertension
- Valium – tranquilizer used to reduce anxiety

Topical Agents

- The use of solutions preserved with Benzalkonium Chloride (BAK) with soft lenses can cause a toxic reaction
- Glaucoma medications can cause soft lens discoloration
- Decongestants with Epenephrine or Tetrahydrozoline can cause soft lens discoloration
- Artifical Tears – with viscosity builders and cause contact lens discomfort

Medications have side effects and should be considered when fitting a patient with contact lenses. PDR – Physicians Desk Reference, Blue Book for Nursing

- Occupation/Hobbies: Consider environment (fumes, dust, dirt etc.)

- Sports Activities: Physical contact (Safety eyewear?) Does the sport require helmets??
- Any visual difficulties with spectacles? (Acuity? Distortion? Asthenopia)
- Allergies or hypersensitivities? Do they take medications? Is it seasonal?
  Identify (Fall, Spring or Summer)

- Why does the patient want to wear contact lenses? Motivation? Expected
- Wearing time? (social or everyday) Only for sports?
- Flexible vs. ExtendedWear
- Disposables vs. One Day lenses

Any Previous Lens Wear? If yes

- Date of original fitting
- Name of practitioner, address, and pertinent information if available. Can it be obtained?
- Lens type and brand
- Method of care (Cold vs. Thermal) Preserved/Unpreserved solutions
- Date of last lens change. How long are they wearing their present lenses. When was the last time they had their eyes examined?
- Wearing history
- Any problems with lenses? (Vision, comfort, allergy)
- If the patient stopped wearing their lenses, why?
- Stress the importance of maintaining personal hygiene
- Policy of visits and fees – Refunds?
- What can and cannot be expected of contact lenses
- (Doctrine of Informed Consent, Duty to Warn)
- You may have to explain advantages and disadvantages of the various lens materials and type of lenses.

B. Spherical Lenses (Soft or Rigid Lens Design)
C. Toric Lenses - (Soft or Rigid Lens Design)
D. Hybrid lenses - rigid center with soft lens skirt
E. Scleral lenses – (Haptic Lens)
    Mini Scleral – 15.0 mm – 18.0 mm
    Full Scleral – 18.0 mm – 24 mm +
F. Bifiocal/Multifocal
G. Cosmetic/Prosthetic
H. Therapeutic/Bandage lenses

Accommodation and Convergence, Magnification Concerns

WHEN A MYOPE CONVERGES WITH SPECTACLES,
LESS EYE CONVERGENCE IS NEEDED. Uses Base-In Prism
Less Accommodation needed with spectacles

WHEN A MYOPE CONVERGES WITH CONTACT LENSES, *MORE EYE* CONVERGENCE IS NEEDED No Base-In Prism with contact lenses
More Accommodation is needed

WHEN A HYPEROPE CONVERGES WITH SPECTACLES, *MORE* CONVERGENCE IS NEEDED because of Base-Out Prism
More Accommodation is needed with spectacles

WHEN A HYPEROPE CONVERGES WITH CONTACT LENSES, LESS, CONVERGENCE IS NEEDED Less Accommodation is needed with contact lenses

Magnification

Myope – Retinal Image enlarged with contact lenses, minified with spectacles
Hyperope – Retinal image enlarged with spectacles, minified with contact lenses

Properties of Lens Materials

Refractive Index - Refractive index of a lens material is the ratio of the speed of light in air to the speed of light in the material. Materials with higher refractive indices cause more refraction of incident light (have a greater light bending action) The refractive index of a material is important for obvious optical reasons

Specific Gravity - Specific gravity is the ratio of the weight in air of a material to the weight of an equal volume of water in air at the same temperature. For practical purposes, this is the same thing as the material's density**.**

Transparency - Transparency refers to the clearness or clarity of a material. It is a function of the chemistry, purity and hydration of the material. No material is completely transparent, as some light will always be reflected, absorbed and/or scattered

Hardness and Stiffness - The hardness of a lens material is an important quality which can affect its ability to be machined for contact lenses, as well as its durability. Hardness is usually more relevant to rigid lens materials than soft materials

Tensile Strength - The tensile strength of a material is a value that expresses how much stretching force can be applied before it breaks. Materials with a high tensile strength tend to be more durable

Modulus of Elasticity - The modulus of elasticity is a constant value that expresses a material's ability to keep its shape when subjected to stress.

Wettability - is determined by measuring the angle formed between the lens surface of a known polymer and a drop of saline placed on the lens surface. Wettability is important to maintain because patient comfort and visual acuity can be affected.

Hydration - Most contact lenses, both rigid and soft, absorb some water. The amount absorbed is usually expressed as a percentage of the total weight. When a material absorbs water its swells, a fact that must be considered during manufacturing

Ionic Charge - The FDA has classified hydrophilic materials according to their water content and ionic charge. Contact lens materials may carry an electric charge. This attribute is especially important in soft lens materials, as it affects factors such as solution

Materials that carry an electric charge are said to be ***ionic.*** Ionic charge also causes the material to be more prone to deposit formation. Materials that are electrically neutral are said to be ***nonionic*** These materials tend to be more deposit resistant.

Group I: Low Water (<50%) – Nonionic
Have lower Dk values and low water content and are not generally suitable for extended wear except in an ultrathin design.
Due to their neutral charge and low water content, these classification of lenses are generally least deposit prone
Group II: High Water (>50%) – Nonionic
Have higher Dk values and are therefore used for extended wear
Their neutral, non-ionic nature makes them more resistant to deposit formation than ionic water lenses
Group III: Low Water (<50%) – Ionic
The negative charged surfaces provide greater attraction for positively charged tear proteins and lipids
Group 3 lenses tend to exhibit more deposits than lenses in nonionic groups
The low water and low Dk values make this group suitable only for daily wear lenses, except in some ultrathin designs
Group IV: High Water (>50%) – Ionic
This group is used primarily for extended wear (They provide good oxygen transmission)
The ionic nature combined with the high water content causes these lenses to the most reactive with solutions and the most prone to deposit formation
This group is more prone to dehydration and may yellow prematurely if heat treated
Group V: Silicone lens materials

Oxygen Permeability/Oxygen Transmissibility:

- DK= Oxygen Permeability
- DK/L = Oxygen Transmissibility (t)
- Atmosphere = 21% Oxygen
- Thickness affects Oxygen Transmission

- **Sagital Depth**: Measurement from the flat plane at a given diameter to the highest point of a concave surface of the contact lens – also described as the degree of corneal elevation for a given chord diameter
- Apical Vault = S1 – S2
  S1 = Sag of the Cornea
  S2 = Sag of the Contact Lens

- Apical Vault is formed because the radius of the cornea flattens outside the apical zone but the radius within the POZ remains constant.
- As long as the curvature of the cornea is less than the curvature of the contact lens, apical vault will be formed

- **CENTRAL POSTERIOR CURVE –** If the POZ is kept constant and the CPC is made steeper, Apical Vault is increased therefore lens movement is decreased forming a tighter fit. Ex. Change base curve from 7.80 to 7.70 *Any change in the base curve requires a new lens.*
- If the POZ is kept constant and the CPC is made flatter, Apical Vault is decreased therefore lens movement is increased forming a looser fit. Ex. Change 7.70 to 7.80

- **POSTERIOR OPTICAL ZONE –** If the CPC is kept constant and the POZ is made smaller, Apical Vault will be decreased and therefore increase lens movement. Ex. Change POZ from 8.0 to 7.0 *If you make the POZ smaller, this does not require a new lens and can be made by adjustment of the original lens.*
- If the CPC is kept constant and the POZ is made larger, Apical Vault will increase and therefore decrease lens movement. Ex. Change POZ from 7.0 to 8.0 *If you want to make the POZ larger, you have to order a new lens.*

- **Small POZ** → decrease sagittal value of the lens, decrease Apical Vault → increase lens movement →loosen the fit of the contact lens.
- **Larger POZ** → increase sagittal value of the lens, increase Apical Vault → decrease lens movement → tighten the fit of the contact lens.
- **DIAMETER** – As diameter increased, the POZ is usually increased accordingly. As this occurs, apical vault increases increasing therefore tightening the fit of the lens. *If you want to make the diameter larger this will require a new lens.*
- As diameter is decreased, the POZ is usually decreased accordingly. As this occurs, apical vault decreases and loosens the fit of the contact lens. *If you want to make the diameter smaller, this can done by adjustment and does not need a new lens.*

- **THICKNESS –** As thickness decreases, surface tension will increase causing a tighter fit. As thickness increases, this will loosen the fit of the lens. *Any change in thickness requires a new lens.*

- **PERIPHERAL CURVES –** If peripheral curves are made wider, and will decrease the size of the POZ, apical vault will decrease which will loosen the fit of the contact lens. *Widening peripheral curves can be done by adjustment on the original lens. Peripheral curves cannot be* *made smaller and will require a new lens. If the fitter wants a larger POZ, a new lens will have to be ordered*.

- **POWER** – corrects the patient's refractive error. In a minus lens, up to 1.00 D of minus can be added to the original lens with reordering a new lens. *It is recommended that no more than .50 D of power be added to an original contact lens due to the ultrathin gas permeable designs used today in contact lens fitting.* For plus lenses, up to .50 D of power can be added to the original lens.

- When the contact lens fitter uses the terms **TIGHT** and **LOOSE**, this refers to movement of the lens.
- When the contact lens fitter uses the terms **STEEP** and **FLAT,** this refers to apical vault and the amount of tears under the lens. A lens that is tight is steep and a lens that is flat is loose. These terms also refer to the central lens corneal relationship that was discussed in previous lectures

Good Luck on the NCLE

My contact information is: Professor Robert Russo,
Email: rrusso9117@aol.com