NCLE Basic Exam Review
Domain III: Instrumentation for Measurement and Observation

Developed by the National Federation of Opticianry Schools

Mr. Steven B. Indelicato

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Mr. Steven B. Indelicato has no financial interests to disclose.

NCLE Basic Exam Review
Domain III: Instrumentation for Measurement and Observation (16%)
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I. Instrumentation:

A. Rigid Lens Verification:

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

B. **Contact Lens Parameters**:

a. CPC specified to .01 mm
b. Diameter specified to the nearest .1 mm
c. POZ specified to the nearest .1 mm
d. PC's specified to the nearest .1 mm
e. Thickness specified to the nearest .01mm
f. Power specified to the nearest .12 D

C. **ANSI Standards**:

a. Formed in 1918
b. Private, non-profit based membership to establish voluntary quality standards for American made products
c. Latest Version 2010

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

a. Also known as the base curve
b. Primary curve on the concave surface (Fitting Curve)
c. Contains the Optical Qualities of the Lens
d. Radius of curvature measured
e. **Radiuscope** is used to verify.
    a. Measures to 0.01 mm
    b. Concave surface (Back surface)
    c. Convex Surface (Front Surface)
    d. Measure Front Radius (PCC)
    e. Measure Back Radius (ACC)
    f. Warpage
    g. Toric Lens Verification
    h. Surface Scratches

E. **Measuring CPC**:

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

F. **Lensometry:**

a. Concave surface is held against lens stop
b. Careful not to bend lens
c. Sphere and cylinder lines are read

G. **V-Gauge:**

a. Measures diameter

H. **Shadowgraph:**

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

I. **Hand held magnifier:**

a. Used to determine diameter of lens and optical zone
b. Used to examine front surface of contact lens
c. Check Edge Contour

J. **Optical zone:**

a. Specified to nearest 0.1 mm
b. Seeing area of the lens
c. Chord length of CPC
d. Measured with hand held magnifier or shadowgraph

K. **Peripheral Curves:**

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

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

a. Diameter = POZ 2 (PPC/w + PIC/w)
b. E.g. A lens has a 9.5 Diameter, PPC/w = .3 mm and the PIC/w = .2 mm. What is the size of the POZ?
c. 9.5 = 2 (.3 + .2)
d. 9.5 = 1.0 mm

e. 9.5 – 1.0 = 8.5 POZ

M. **Profile Analyzer:**

a. Checks blends

N. **Contact Lens Tints:**

a. Colors – Blue, Gray, Green, Brown, Rose
b. RGP's – usually Blue, Gray or Green
c. Density:
d. #1 – 10%
e. #2 – 20%
f. #3 – 30% +

O. **Keratometer**:

a. Measures curvature of cornea
b. "K" readings
c. Principal meridians and axis
d. Amount of corneal astigmatism
e. Oldest and most widely used instrument to measure the curvature of the eye
f. May be referred to as the ophthalmometer
g. Mires
h. Capabilities
i. Procedure
j. Recordings Examples: O.D. 43.00 @ 180 / 43.50 @ 90
k. O.D. 43.00 x 180 / 43.50 x 90
l. Measured in diopters
m. Average reading between 42.00D & 45.00D
n. Only measuring the center corneal cap 2.5mm – 4.00mm
o. Range of keratometer is 36.00D to 52.00D
p. Record horizontal reading first
q. Record axis for horizontal
r. Record vertical reading
s. Record axis for vertical
t. Higher number in diopters signifies a steeper curve
u. Lower number in diopters signifies a flatter curve

P. **Astigmatism**:

a. Regular
b. Irregular
c. Symmetrical (ex: "K" 43.00 @ 180 / 44.00 @ 90)
d. Asymmetrical (ex: "K" 43.00 @ 180 / 44.00 @ 70)

e. With The Rule (WTR)- Flattest Meridian at 180 (ex:"K" 43.00 @ 180 / 44.00 @ 90) – Most corneas are WTR
f. 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
g. Oblique--"K" 43.00 @ 135 / 44.00 @ 45
h. Extending the Keratometer Range: +1.25 – 9.00 Diopters = 52.00 – 61.00
i. -1.00 – 6.00 Diopters = 36.00 – 30.00

Q. **Slit Lamp (Biomicroscope):**

a. For viewing eye under magnification
b. Eye structures (mostly anterior segment)
c. Refractive principles utilized w/ addition of light and filters
d. Procedures
e. Illuminations
f. Diffuse

R. **Direct**:
a. microscope trained directly into the slit – Parallelpiped, Optic section, Specular reflection
    a. **Diffuse**: Overall view of anterior segment. Lens position and movement of contact lenses. Surface quality of lens.
    b. **Paralellpiped**: 1-2mm slit, medium to high magnification, Cross-sectional view of cornea, Corneal clarity, Lens deposits
    c. **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
    d. **Specular Reflection**: 1-2mm slit, Medium to high mag., Fine lens deposits, Subtle corneal imperfections, corneal endothelium

S. **Indirect**: microscope trained adjacent to the slit – Indirect, Retroillumination, Sclerotic Scatter:

a. **Indirect**:
    a. 1-2mm slit, Medium to high magnification, View area adjacent to the slit
    b. Opaque structures – lids, sclera, conjunctiva. Vascularization, pingueculae, pigmentation
b. Retroillumination:
    a. 1-2mm slit,
    b. medium to high magnification, light is reflected off an opaque structure behind the area being viewed, corneal neo-vascularization
c. Sclerotic Scatter:
    a. 2-4mm slit, aimed at limbus from a wide angle, Look for circumcorneal halo, View straight ahead w/ no magnification

b. Classic use is to view patch edema
c. Corneal Scars
d. Incisions
e. SCL edge lift

T. **Instrumentation**:

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

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

c. **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

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

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

NCLE Basic Exam Review
Domain IV: Prefitting (14%)
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II. Fitting & Evaluation:

U. Soft Lens Indications:

a. Cosmetics
b. Better Vision especially at the periphery
c. Prosthetic use

V. Advantages:

a. Lenses are more comfortable than conventional rigid lenses
b. Easily Adaptable
c. Flexible Wearing Schedule
d. Less debris gets under the contact lens
e. Safer lens for athletics/will not dislodge as easily compared to rigid lenses

W. Disadvantages:

a. Vision not as sharp as rigid lenses
b. Is more fragile than rigid lenses
c. GPC and infections are more common with soft lenses compared to rigid lenses

X. Soft Lens Classification:

a. Mini – 12.5 mm – 13.0 mm
b. Para-Limbal – 13.5 mm – 14.5 mm
c. Semi-Scleral – 14.5 mm – 16.0mm
d. Water Content
e. Low Water – 30% - 40%
f. Medium Water – 50% - 60%
g. High Water – 60% - 80%
h. Center Thickness
i. Normal - .10 mm or more
j. Thin - .05 mm to .10 mm
k. Superthin or Ultrathin - .035mm - .04mm

Y. Lens Materials & Design:

a. HEMA – Hydroxymethylmethacrylate
b. HEMA + Other Polymers
c. Silicone Hydrogel
d. Silicone
e. Spherical Lenses
f. Toric or Astigmatic Lenses
g. Bifocals or Multifocals

Z. **Types of Hydrogel Modalities:**

a. *Daily Wear (Conventional Wear)* – is worn during waking hours. 12-13 hours. Replace every 12 months
b. *Extended Wear* – may be worn during sleep usually up to 7 days. FDA regulations state 14 days and new silicone hydrogel lenses are approved for 30 days
c. *Flexible Wear* – can be worn as both a daily wear and extended wear lens
d. *Disposables* – These lenses can be slept with and used as a Daily wear lens
e. *Disposable "Dailies"* – are discarded after one day of use every day. Usually comes in 90 and 30 day supplies packs
f. Planned Placement – involves scheduled replacement of lenses from every month or three months as determined by eyecare professional

AA. **FDA Classification of Hydrogel Materials:**

a. The FDA has classified hydrophyllic lens materials according to their water content and ionic charge
b. The rationale for this classification is the fact that water content and ionic charge determine how a hydrogel lens material will interact with contact lens solutions
c. The FDA gives every lens material a generic name
d. Hydrogel lenses are categorized into five groupings
e. These groupings take into account water content (Low Water or High Water and Surface reaction (Ionic and Nonionic)
f. Group I (< 50% H^2O) Nonionic Hydrogel Polymers
g. Group II (> 50% H^2O) Nonionic Hydrogel Polymers
h. Group III (< 50% H^2O) Ionic Hydrogel Polymers
i. Group IV (> 50% H^2O) Ionic Hydrogel Polymers
j. Group V – is in the process of being evaluated and subdivided

BB. **Groups:**

a. **Group I**: Low Water (<50%) – Nonionic
b. Have lower Dk values and low water content and are not generally suitable for extended wear except in an ultrathin design.

c. Due to their neutral charge and low water content, these classification of lenses are generally least deposit prone

d. **Group II**: High Water (>50%) – Nonionic
e. Have higher Dk values and are therefore used for extended wear
f. Their neutral, non-ionic nature makes them more resistant to deposit formation than ionic water lenses

g. **Group III:** Low Water (<50%) – Ionic
h. The negative charged surfaces provide greater attraction for positively charged tear proteins and lipids
i. Group 3 lenses tend to exhibit more deposits than lenses in nonionic groups
j. The low water and low Dk values make this group suitable only for daily wear lenses, except in some ultrathin designs

k. **Group IV:** High Water (>50%) – Ionic
l. This group is used primarily for extended wear (They provide good oxygen transmission)
m. 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
n. This group is more prone to dehydration and may yellow prematurely if heat treated

CC. **Manufacturing and Parameter:**

a. Spin Casting, Lathe Cutting, Cast Molding
b. Parameters- base curve, power, diameter, water content, availability

DD. **Fitting Techniques:**

a. Soft lenses are fitted flatter than the flattest "K" reading
b. A normal fitting soft lens should have a "3 Point Touch"
c. Keratometry should be used as a starting point in the fitting process
d. Spherical soft lenses do not neutralize corneal astigmatism, therefore the amount of refractive astigmatism should be limited to .75 – 1.00 D.
e. With borderline astigmats, sometimes a thick or stiffer soft lens might mask some corneal astigmatism

EE.**Patient Selection:**

a. Motivation
b. Personal Hygiene
c. Willing to comply with all directions, instructions and restrictions for proper lens wear and aftercare
d. Appropriate refractive error based on manufacturer availability

FF. **Criteria for a Well Fitted Soft Lens**

a. Good Centration and Corneal Coverage
b. Adequate Movement
c. Stable and Consistent Vision
d. Comfort
e. Undistorted Keratometer Reflex
f. Good Retinoscopic Reflex

GG. **Good Centration and Corneal Coverage:**

a. The soft lens should be large enough to cover the entire cornea
b. The soft lens should be reasonably well centered
c. Establish a 3 Point Touch
d. Initial Selection should be determined by measuring the HVID and Palpebral fissure
e. Rule of Thumb – add 2 mm to the HVID as a starting point

HH. **Movement:**

a. Factors to Consider: Base Curve, Water Content, Diameter,Thickness, Eyelid Forces
b. Thin soft lenses move less that soft lenses that are thicker
c. Thin soft lenses usually have a lower water content
d. Thicker soft lenses usually have a higher water content
e. Contact Lens Practitioners should be aware of the lens materials that they are fitting

II. **Movement Characteristics and Evaluation:**

a. Primary Gaze – lens should move .5mm – 1mm with the blink
b. Upward Gaze – lens should drop .5 mm – 1mm
c. Ideal Movement – 1mm – 2 mm
d. Evaluation – Slit Lamp
e. Push Up Test
f. When a patient blinks, the vision should be clear and crisp before and after the blink
g. Variable vision may indicate a problem with the fit, improper power of the contact lens or residual astigmatism
h. During the initial fitting, variable vision is to be expected until the contact lens settles in
i. If the vision does not improve with Over-refraction, an astigmatic clock should be used to evaluate the presence of residual astigmatism

JJ. **Fitting:**

a. Keratometer readings and Corneal Diameter (HVID) help determine the starting base curve for a soft lens
b. Lens Selection: Transpose/ ½ the cylinder power added to the sphere
c. Guidelines
d. Use Flattest "K" as your reference point
e. 42.00 or < - Choose an 8.90
f. 42.00 – 45.00 – Choose an 8.90
g. 45.00 – 46.00 – Choose an 8.60
h. 46.00 or > - Choose an 8.30

KK. **Characteristics of a Flat or Loose Fit:**

a. Variable Vision
b. Awareness
c. Excessive Movement
d. Edge Standoff
e. Lens may fall out
f. Vision is clear before the blink and blurry after the blink
g. Keratometer reflex blurs after the blink
h. Lens displacement
i. Some Lenses that are **Loose or Flat**, may ride high
j. This is usually seen in a minus lens and not in a plus lens because of the edge thickness
k. **Correction**- Switch to a larger Diameter or Steeper base curve or combination of both. In clinical practice, you will probably only change the base curve.

l. Steep or Tight Fit: Lens is initially comfortable but becomes more uncomfortable as the day goes on
m. Keratometer Reflex blurs before the blink
n. Vision improves after blinking
o. Correction:
p. Switch to a smaller or flatter base curve or a combination of both
q. Visual Acuity with Astigmatism
r. Follow up

LL.**Optics of Contact Lens and Spectacles**

a. Convergence with contact lenses compared with spectacles:

b. For a myope there is ***base-in*** prism for convergence

c. For a hyperope there is ***base-out*** prism for convergence

d. When a myope converges with spectacles, ***less*** eye convergence is needed

e. When a myope converges with spectacles, *less* eye convergence is needed.

f. When a myope converges with contact lenses, *more eye* convergence is needed

g. When a hyperope converges with spectacles, *more* convergence is needed

h. When a hyperope converges with contact lenses, *less* convergence is needed

MM. **Accommodation with contact lenses compared with spectacles**

a. When a patient changes from spectacles to contact lenses, there is a change in the amount of accommodation to focus at an object which is at a fixed distance

b. A myope does *not* need to accommodate as much with spectacles as with a contact lens correction

c. A hyperope *does not* need to accommodate as much with contact lenses as compared to their eyeglasses

d. Magnification effects of contact lenses and spectacles

e. **Myope**: retinal image is enlarged with contact lenses and minified with spectacles

f. **Hyperope**: retinal image is enlarged with spectacles and minified with contact lenses

g. When fitting a pre-presbyope, accommodation and convergence requirements should be analyzed carefully to meet the visual expectations of the patient.

    a. **Presbyopia**, is also known as the "short arm syndrome"
    b. The natural lens can no longer control the eye's way of changing its focusing distance
    c. The lens thickens, increasing its inability to focus close-up.
    d. At about the age of 40, the lens becomes less flexible and accommodation is gradually lost.
    e. It's a normal process that everyone eventually experiences.

h. **Accommodation**- the adjustment in lens shape of the crystalline lens to focus at various distances

i. Signs and Symptoms: Difficulty seeing clearly for close work, Print seems to have less contrast, Reading material must be held further away to see

NN. **Bifocal Contact Lenses:**

a. **Good** Candidates:
    a. Motivated Patients
    b. Vision demands are not very critical
    c. Normal lid tonicity
    d. Good ocular health and good tear quality

b. **Bad** Candidates:
    a. Unmotivated
    b. First time contact lens wearers
    c. Poor tear quality
    d. Irregular Cornea
    e. Amblyopia

OO. **Reading Glasses over Contact Lenses:**

a. Full distance prescription in contact lenses (Rigid, Soft, Disposable, Extended Wear, Astigmatic)
b. Add Power in Glasses
c. Excellent optical system
d. Cosmetically unacceptable
e. Will need to put glasses on every time patient wants to read
f. May have a problem just looking down doing simple tasks

PP. **Compromise Rx with Distance Glasses:**

a. Single vision contact lenses (Rigid, Soft, Disposable, Astigmatism, Extended Wear)
b. Under correct myope by 1.00 or so
c. Overcorrect Hyperope by 1.00 or so
d. Good only for early moderate presbyopes
e. Reduced distance acuity to improve near vision
f. Put under correction or overcorrection in glasses
g. Beware of Driving Requirements

QQ. **Monovision:**

a. correcting one eye for distance and one eye for near
b. Can be done with GP lenses, Soft, Disposable, Extended Wear, Astigmatic lenses
c. 75% success rate
d. Uninterrupted vision out of each eye separately
e. Alters binocular vision
f. **Fitting**:
    a. Determine distance correction

b. Determine near add and ranges
c. Determine dominant eye
d. Demonstrate with trial fitting
e. Advise patients to avoid driving or operating dangerous machinery during the first 2 – 3 weeks of adaptation
f. Eye dominance

g. **Modified Monovision**- One eye is fit with a single vision contact lens and the non-dominant eye is usually fit with the multifocal design

RR. **Simultaneous Vision:**

a. Entrance pupil exposed to both distance and near at all times (Soft and Rigid)
b. Eye accepts rays of light that permit focus at near and far
c. Design for Distance and Near can vary
d. Lens design does not require prism for stabilization

SS. **Alternating (Translating) Vision:**

a. Are prism-ballasted/truncated lens designs (Rigid lenses)
b. They utilize the lower lid for translation
c. Used for patients having critical vision demands
d. Various add powers for moderate to advance presbyopes
e. Inability to provide intermediate vision
f. Good centration and translation needed for success

TT. **Aspheric Multifocals:**

a. Have a gradual change in curvature based on "E" Value – Eccentricity
b. Aspheric surface (front or back)
c. Aspheric GP Multifocals have better optical quality then soft lenses
d. Fit steep to center lenses

UU. **Fitting Pearls for Soft Multifocal Lenses:**

a. Start with steeper base curve
b. Remind patients that lighting is important and adjust working distance
c. Use normal room illumination
d. Let lenses settle for 15-20 minutes
e. Assess vision binocularly
f. Use handheld lenses to overrefract
g. Overrefract in .25 steps
h. Overrefract monocularly with both lenses open and recheck any overrefraction at near and distance
i. Use everyday reading material
j. Test vision at the distance required by the patient (e.g. computer operator needs intermediate vision and may accept reduced near vision

k. It is acceptable to use unequal add powers
l. It is acceptable to use two different multifocal brands

VV. **Edge Design**

a. Hyperflange/ CN Bevel
   a. If a high minus lens is riding too high or the edge of the lens is too thick, but the base curve relationship is adequate

b. Myoflange
   a. If a high plus is riding too low, a minus carrier lenticular can be designed to pull the lens under the upper lid and center the lens after the blink

WW. **Residual Astigmatism:**

a. an astigmatic error left over after a contact lens is placed on the eye
b. Usually associated with ATR astigmatism and Internal Astigmatism
c. Reduced Acuity
d. Shadows around images
e. .50 to .75 D of uncorrected residual astigmatism is usually tolerated by patients
f. Soft Lenses do not neutralize corneal astigmatism but drapes the cornea

XX. **Toric Lenses**

a. New Astigmatic Patients
b. Soft Lens Patients with Residual Astigmatism
c. Astigmatic Patients who want to wear Extended Wear and Disposable/Frequent Replacement Lenses
d. Designs
   a. Prism
   b. Truncation
   c. Thin zones or Double Slab Off
   d. Peri-Ballast
   e. Combination Designs
e. Soft Toric Cylinder Surfaces
   a. Soft Toric lenses are made with the cylinder manufactured on the front
   b. Soft Toric lenses are made with the cylinder manufactured on the back
f. Availability
g. Fitting Guide
   a. Transpose Rx in minus cylinder form
   b. Compensate for Vertex distance >+/- 4.00
   c. Follow same procedure for choosing a base curve for soft lenses

d. >45.00 - fit 8.6 or 8.7
e. <45.00 – fit 8.7 or 8.9

i. Vertex Distance:

a. Minus Prescriptions from -4.00 on take less minus at the cornea
b. Plus Prescriptions from +4.00 on take more plus the cornea

j. Compensate for Axial Alignment

a. Locate base prism mark or lens marking consistent with that lens brand
b. Estimate displacement from center line
c. Compensate Axis from Spectacle Rx

k. Mislocation

a. Observe then measure and correct
b. '**LARS**' – LEFT ADD, RIGHT SUBTRACT
    i. Example
    - 3.00 – 1.75 x 180
    ii. Lens rotates to the right by 20 degrees
    iii. LARS!
    iv. Left Add
    v. Right Subtract
    vi. 180 – 20 = 160
    vii. Lens to be ordered:
    viii. -3.00 – 1.75 x 160
c. If relative difference is clockwise, **ADD** difference to the Spectacle Rx not the Trial lens axis
d. If relative difference is counterclockwise, **Subtract** difference from Spectacle Rx not the Trial Lens Axis

l. Over-Refraction

a. The last step in Astigmatic lens fitting
b. Over-Refraction – If the trial lens has a cylinder power, Over-Refract with spheres ONLY!

m. Cylinder Axis Orientation

a. Cylinder Axis ordered is ***only*** correct if lens continues to orient at the position compensated for

n. Front Toric Soft Lenses vs. Back Toric Soft Lenses

a. If all astigmatism is on the cornea, choose a soft toric design where the cylinder is ground on the back
b. This provides better physical fit and has a better stabilizing effect on the eye
c. Ex: - 3.50 – 1.75 x 180 "K" 42.00/43.75 x 90

d. If most of the astigmatism is internal, choose a soft toric lens that has the cylinder ground on the front.
e. Ex: -2.75 – 1.75 x 180 “K” 42.25/42.75 x 90

o. Spherical Equivalent

a. ½ the refractive cylinder added to the sphere