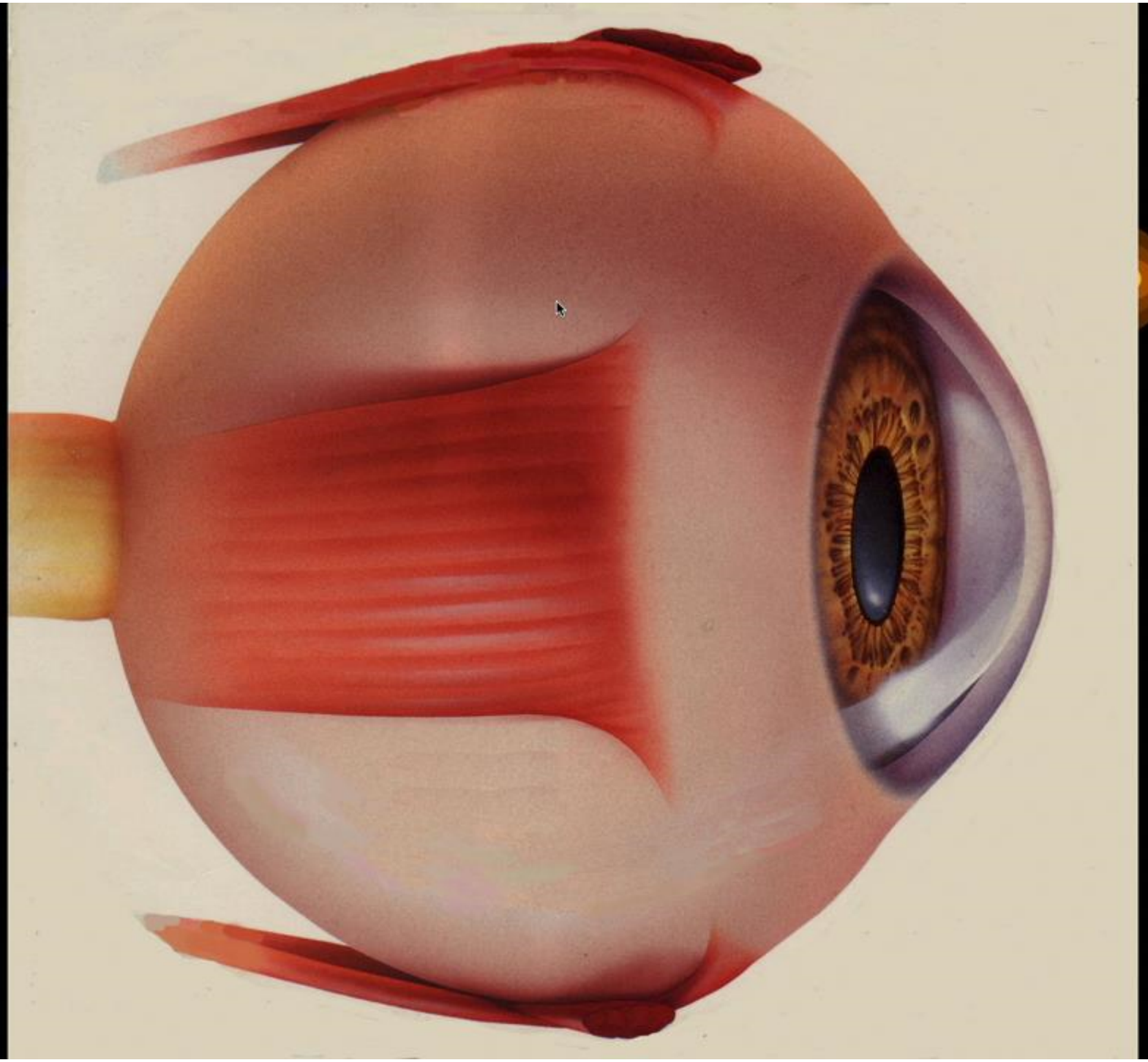
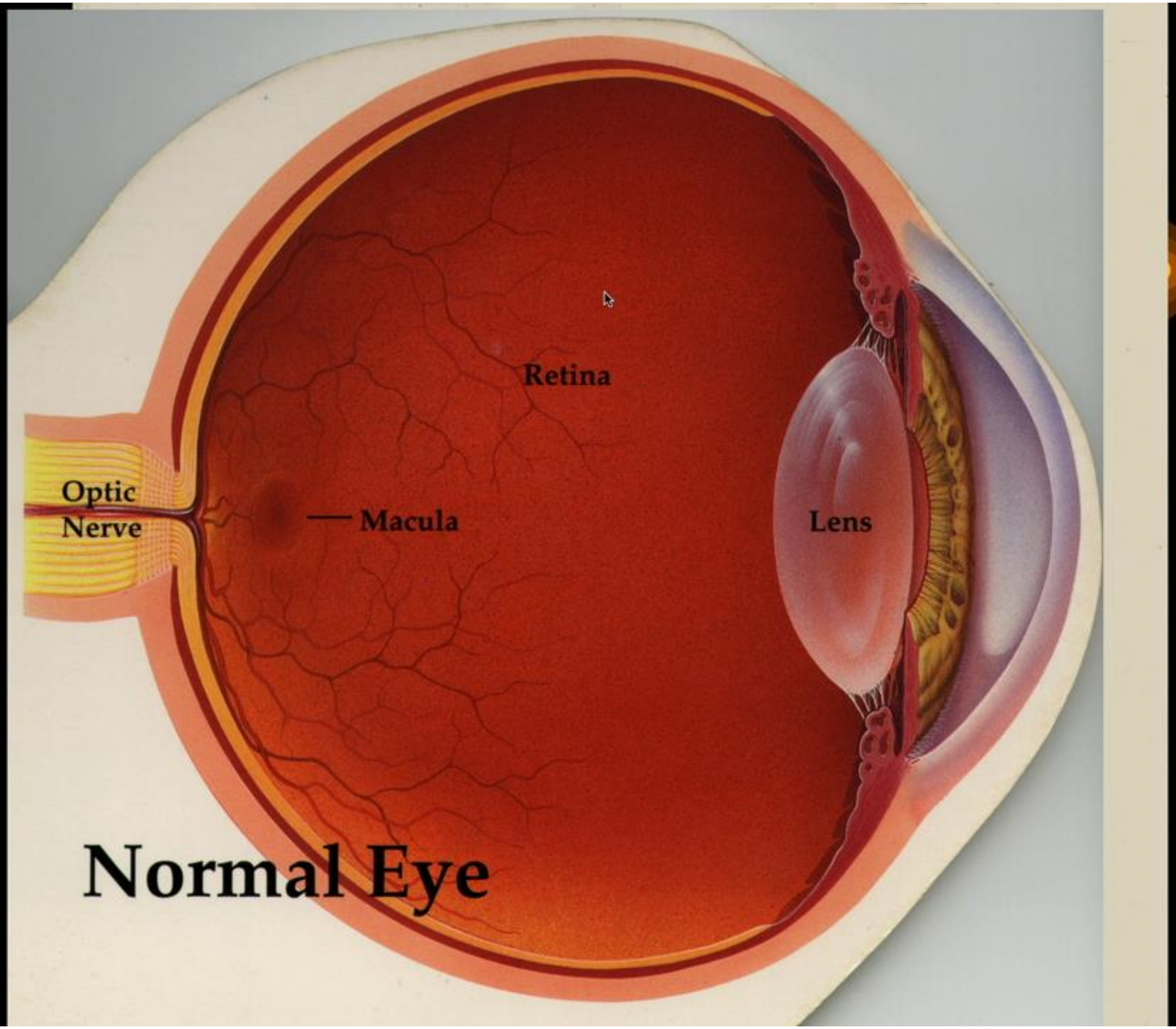
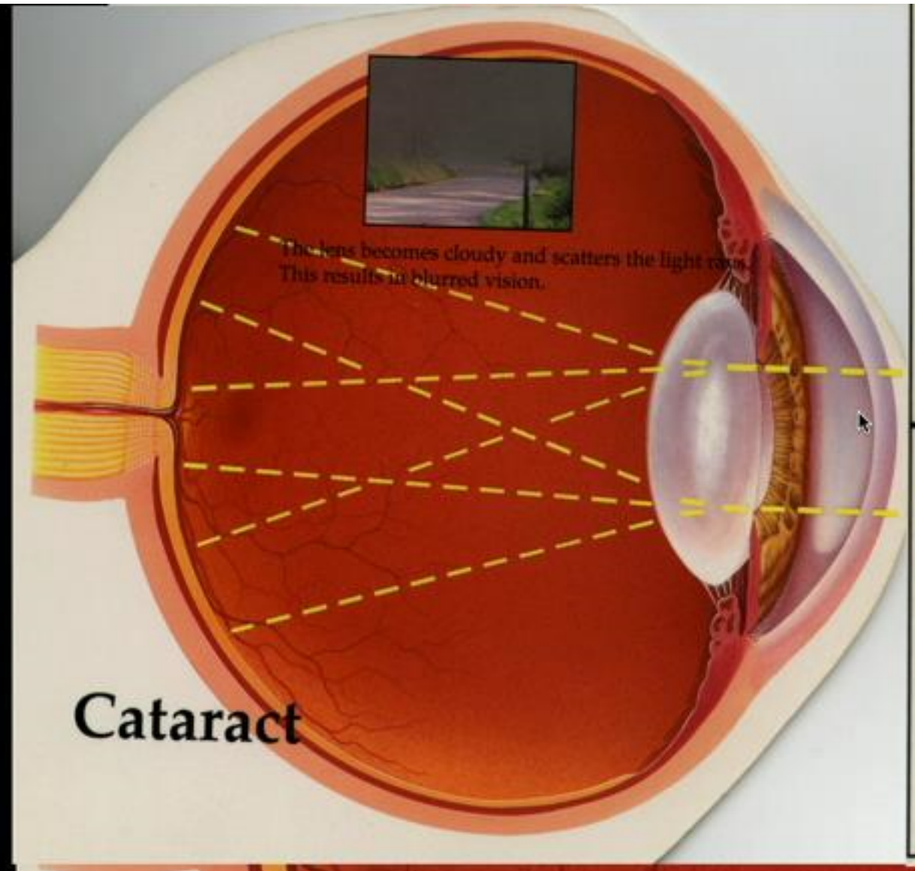
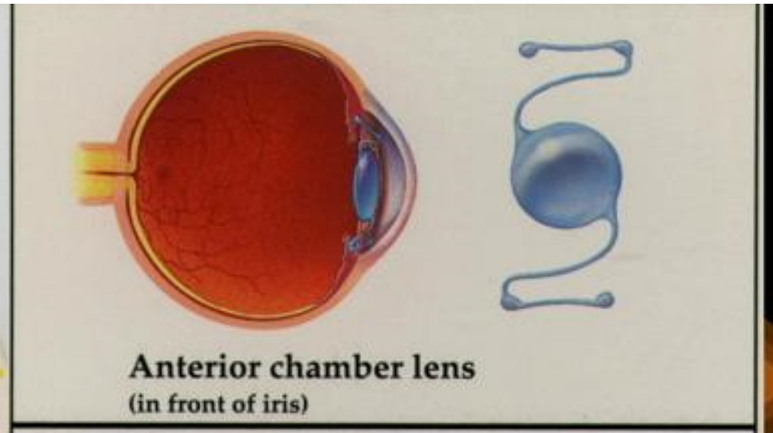
The VIP (Visually Impaired Person): To Assess and Assist

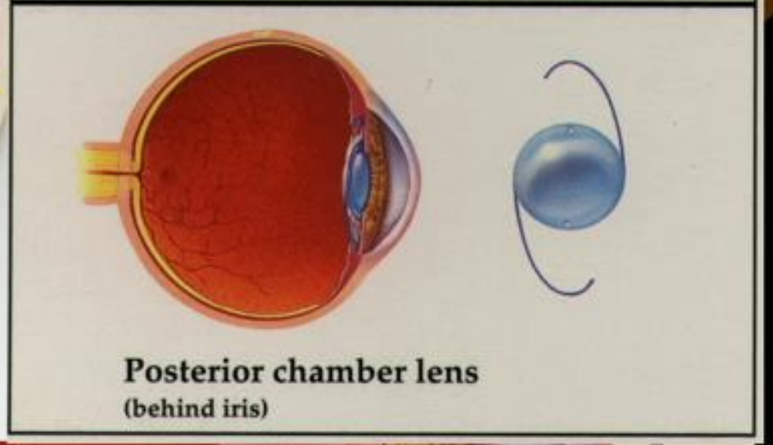
Stephen H. Sinclair, MD

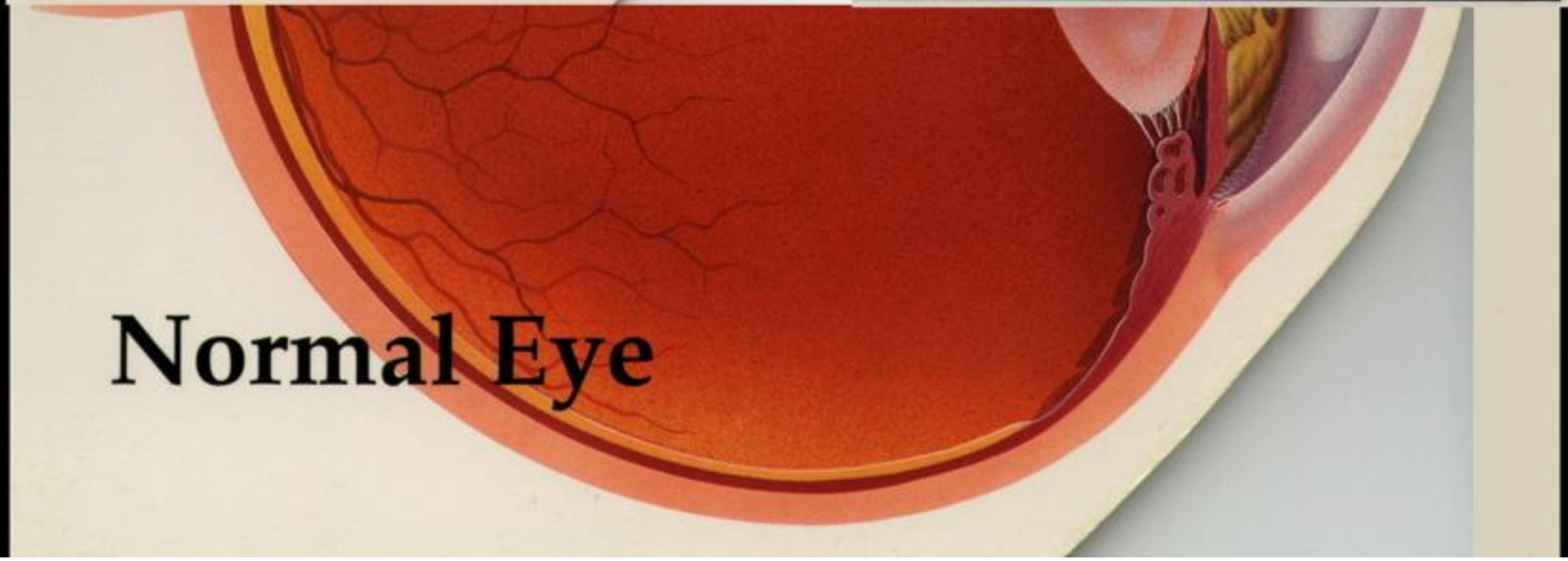



Retina
Optic
Nerve
Macula
Lens
Normal Eye


The lens becomes cloudy and scatters the light rays.
This results in blurred vision.
Cataract


Anterior chamber lens
(in front of iris)


Posterior chamber lens
(behind iris)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Vision Loss due to Macular Disease

Until recently, the primary focus of ophthalmic and optometric care givers and optical industry has been on perfecting the ocular focus

- Macula now leading cause moderate or severe vision loss world-wide
  - Diabetes: 33M US, 30% ➡ 83% retinopathy >20 yr DM duration
  - Macular Degeneration: 15M US, 1/3 persons > 70 yr of age
  - Glaucoma: 6M US

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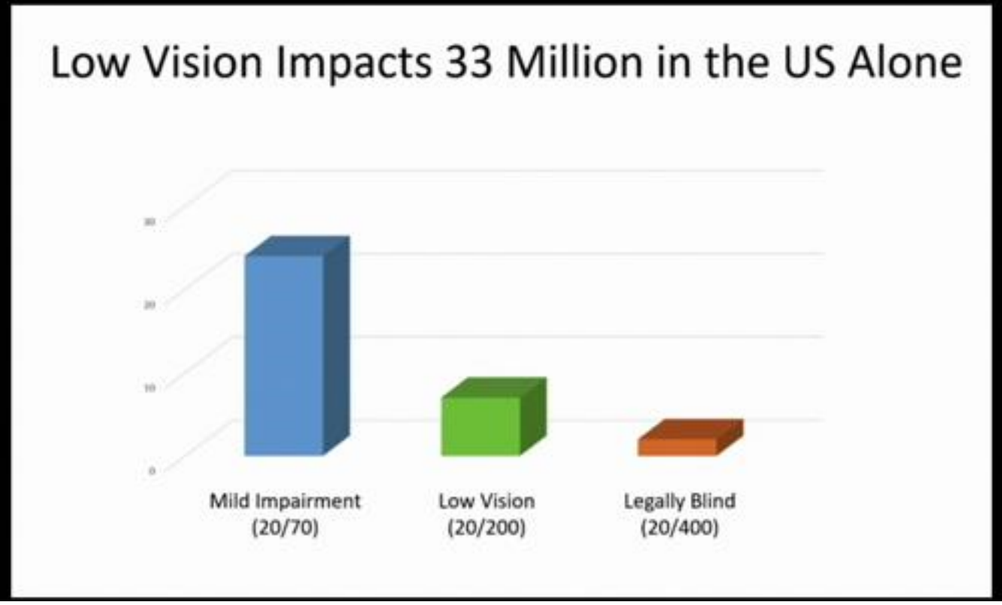

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  - Instead of the surgeon's mentality--
    - Must adopt oncologic mindset for management: Screening to detect onset and predict progression

Macular Disease: Failure to "Predict and Prevent"

- Failure of patients to "comply"
  - DM: 15% to 35% compliance with recommended annual exam
  - Physician examination requires pupil dilation
  - Patient doesn't perceive the deficit until affects life style
    - Often not until 2nd eye affected
- Screening by physician examination:
  - Poor lesion detection
    - Conducted under white light with poor depth
  - Cannot define changes occurring over time
  - Comparison examinations with "base-line photograph" inadequate

Macular Disease: Failure to "Predict and Prevent"

Improved Retinal Imaging through undilated pupils:

- White light "non-myd" cameras ($16 K)
  - Fair imaging but only of vascular, pigment lesions
- Laser Scanned Optical Coherence Tomography ($30-$60 K)
  - Provide enhanced structural analysis
  - Cost ➡ Primarily only Referred Physicians

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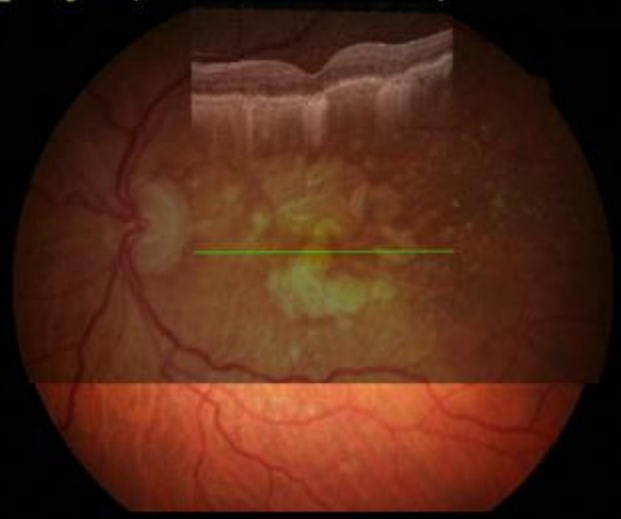

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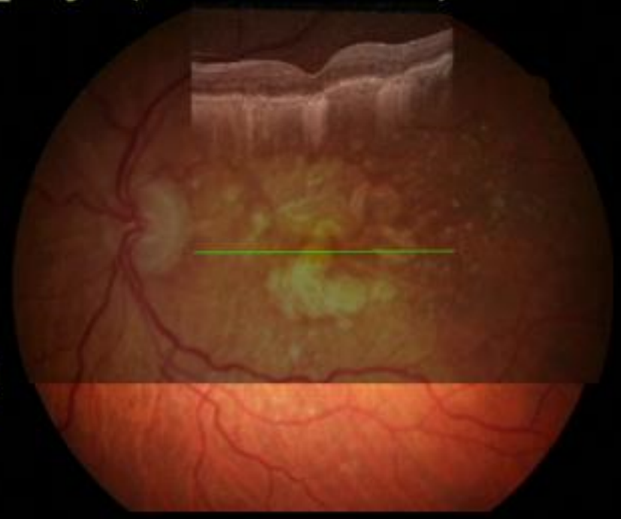

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- Fails to attach digital quantification to identified lesions or uses device engineered descriptive measurements (e.g. retinal thickness) that are poorly related to functional vision alterations

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Physician fails to understand "Real-World" vision deficit:

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- Doesn't measure distortions ➡ motion artifact

Failure to Treat, Monitor and Assist Patients with Macular Vision Loss

- Misunderstanding of patient's disability
  - Physician does not understand:
    - Vision loss caused by the macular disease
  - Physician fails to measure "functional vision"

Physician fails to understand "Real-World" vision deficit:

- Failure of Physician to understand Ocular Surface Abnormalities:
- Dry Eye Syndrome (30M+ US):
  - Reduced Tear volume (with aging)
  - Inflammation of underside of lids ➡ obstruction of oil glands producing surface lipids
  - Severely reduced blinking rates with straight forward fixation tasks:
    - Reading monitor viewing, highway driving, surgery,
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- Devices in Development:
  - Raman hyperspectral analysis of ocular surface tear film
  - Need spectacle-mounted Blink monitor with tear meniscus and eye movement monitoring-and stimulator!

Devices Available to Improve Structural Assessment

Improved Retinal Imaging through undilated pupils:

- Lowered cost devices:
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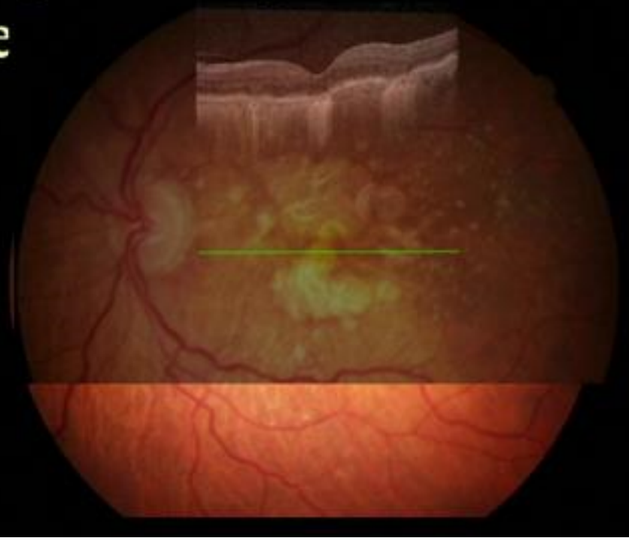
(i.e. Smart Medical Image Processing System).



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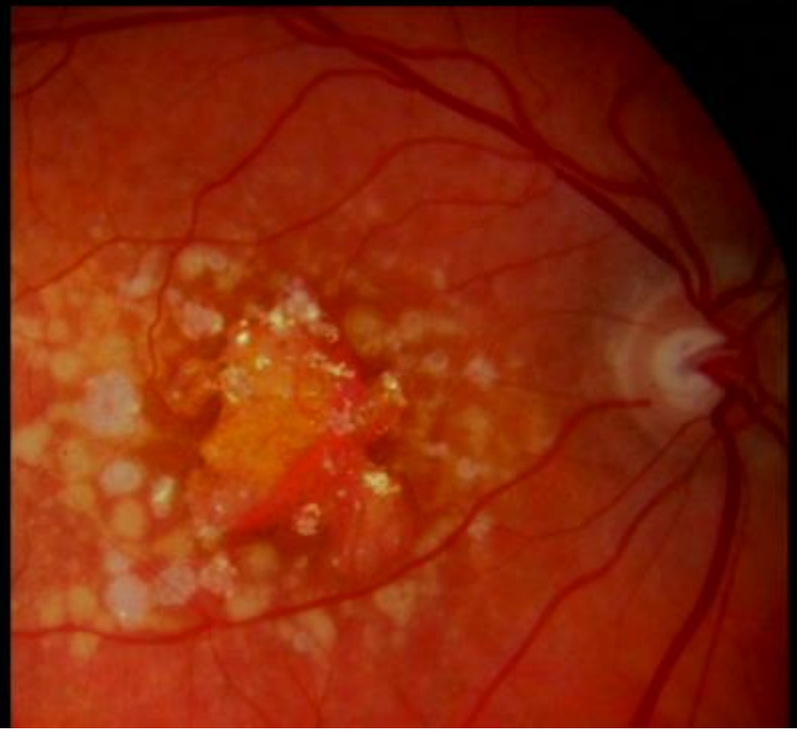

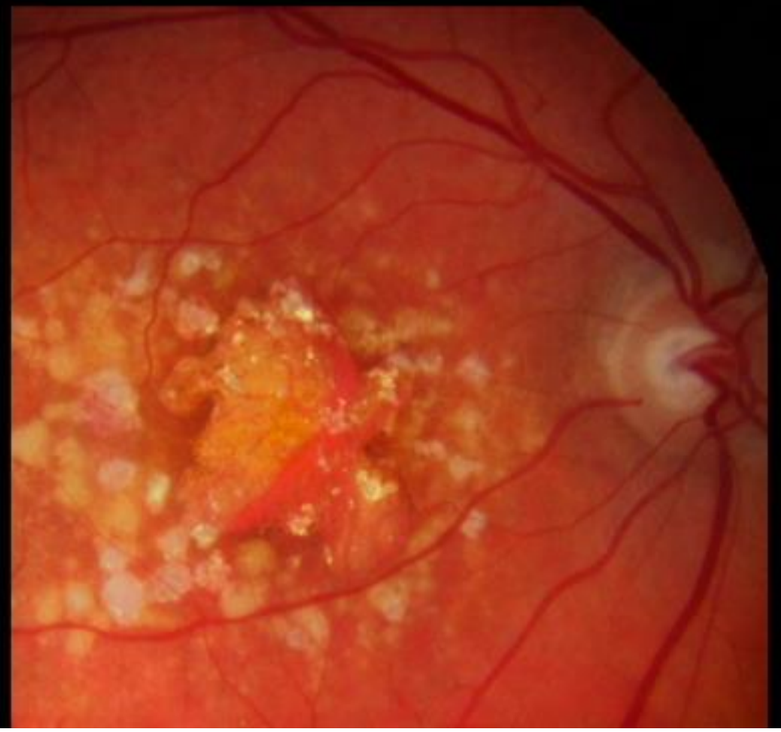

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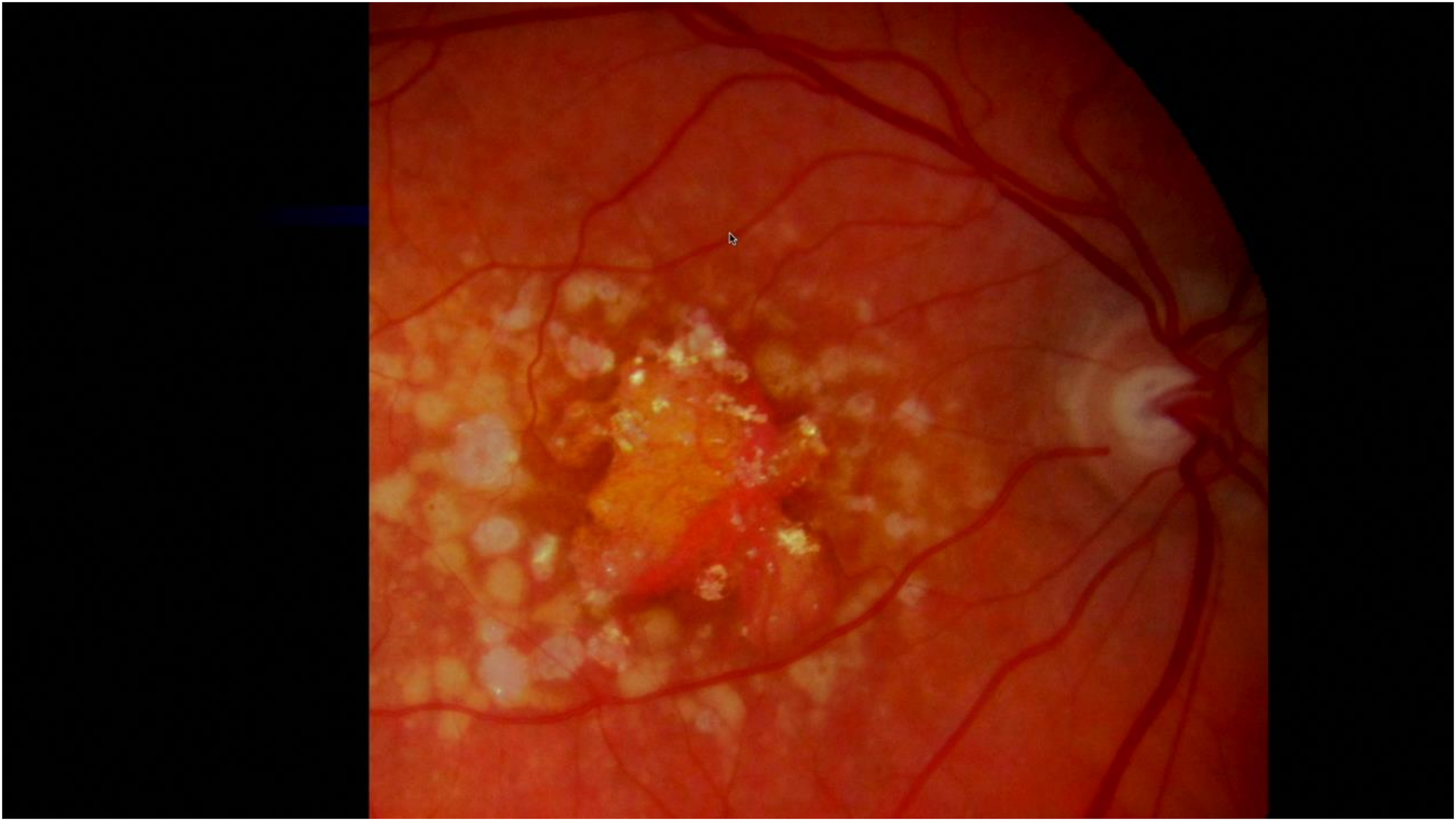
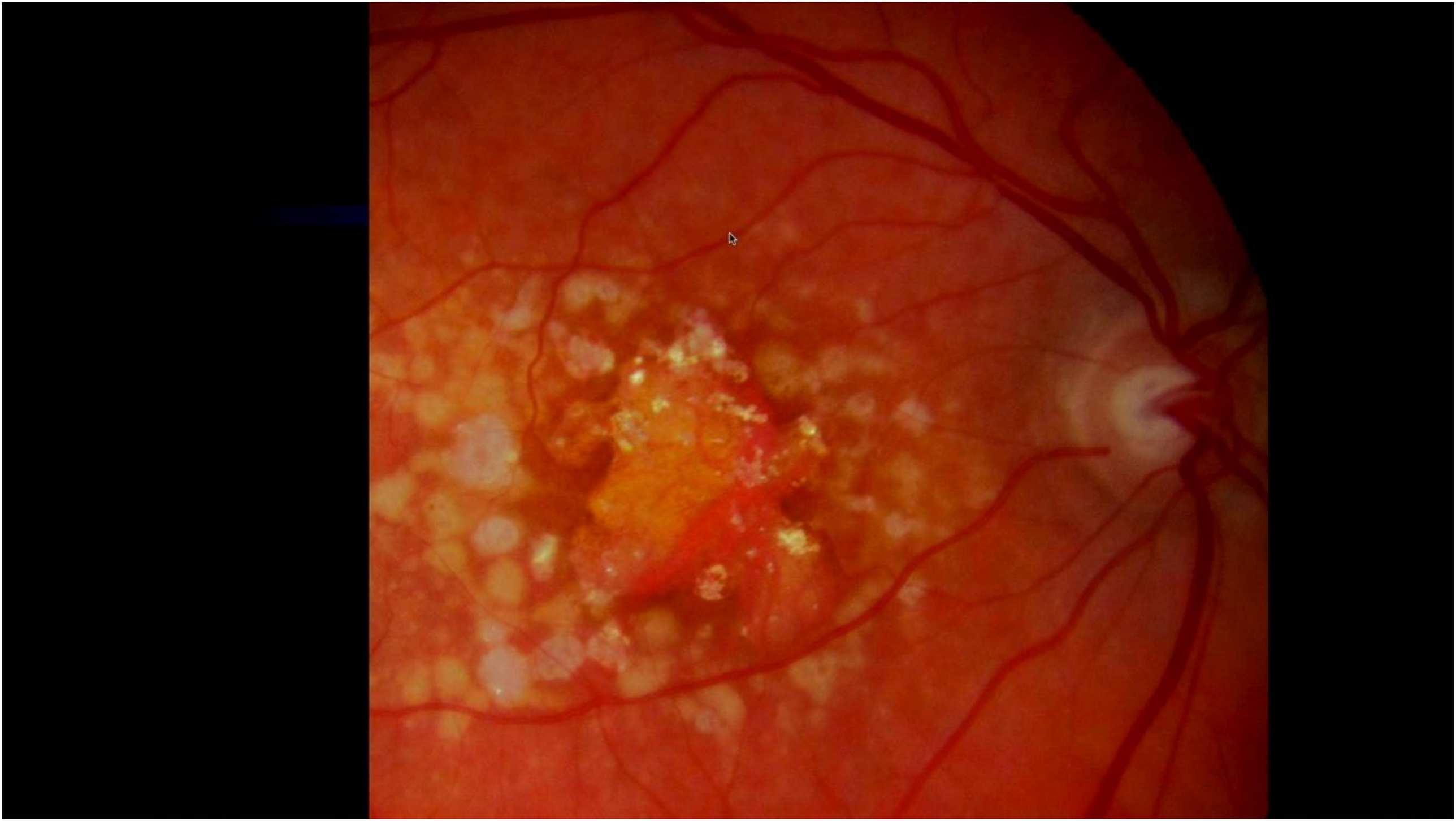
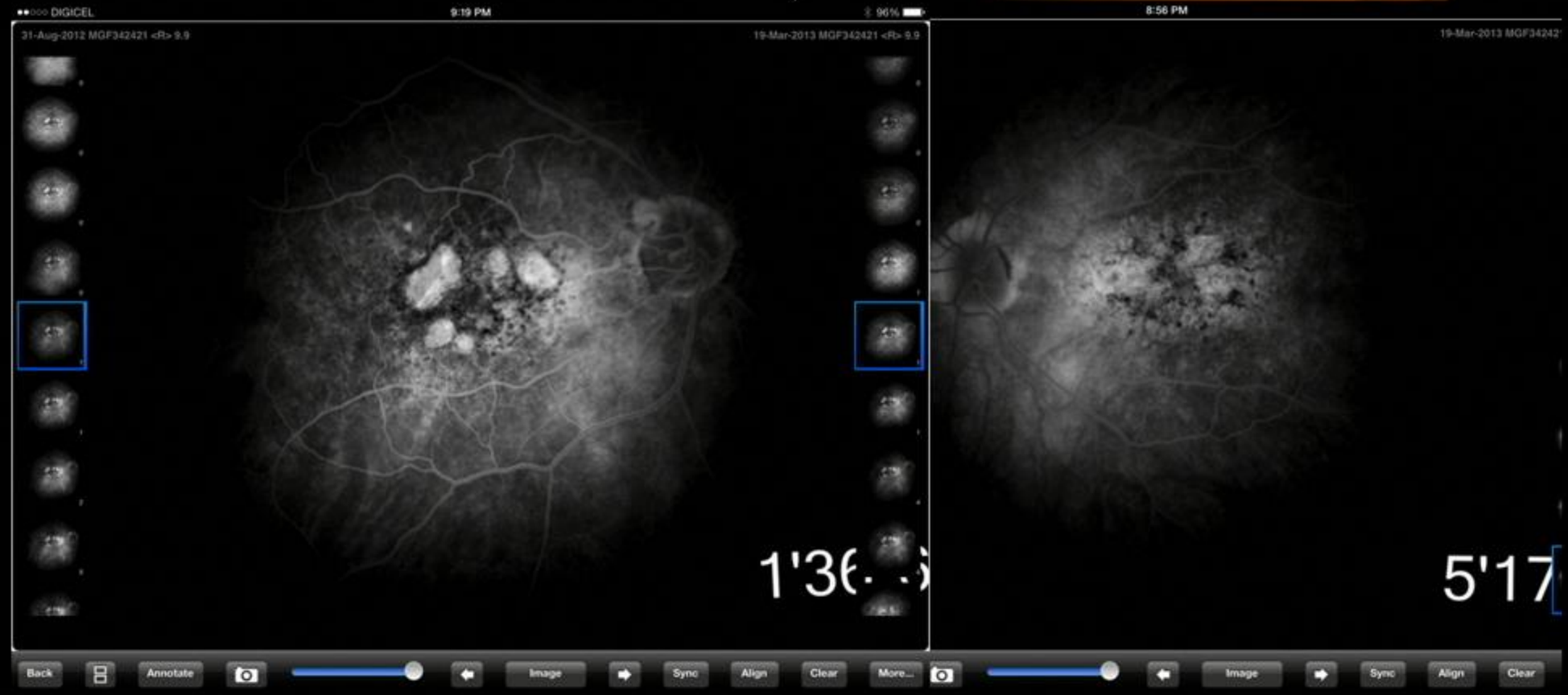




Results

- Progression of Geographic Atrophy Lesions



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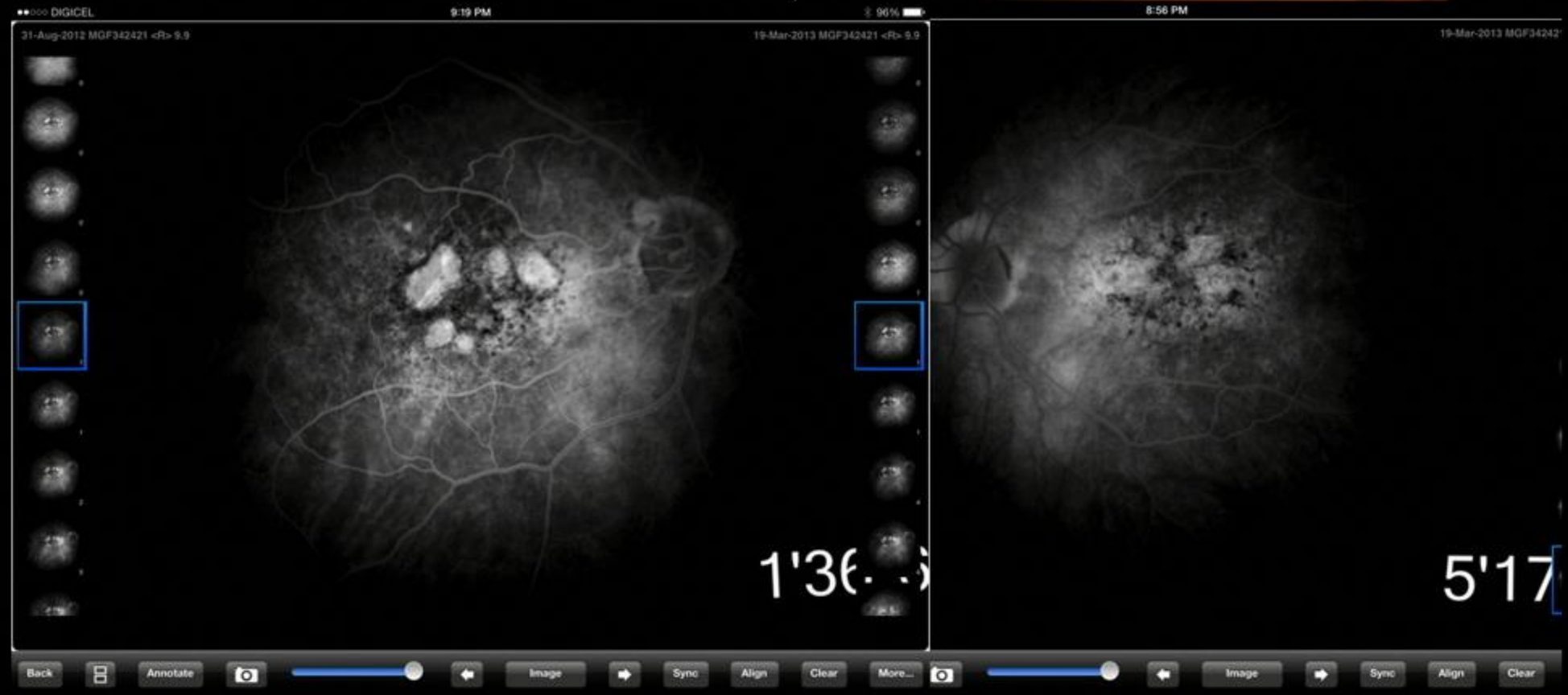
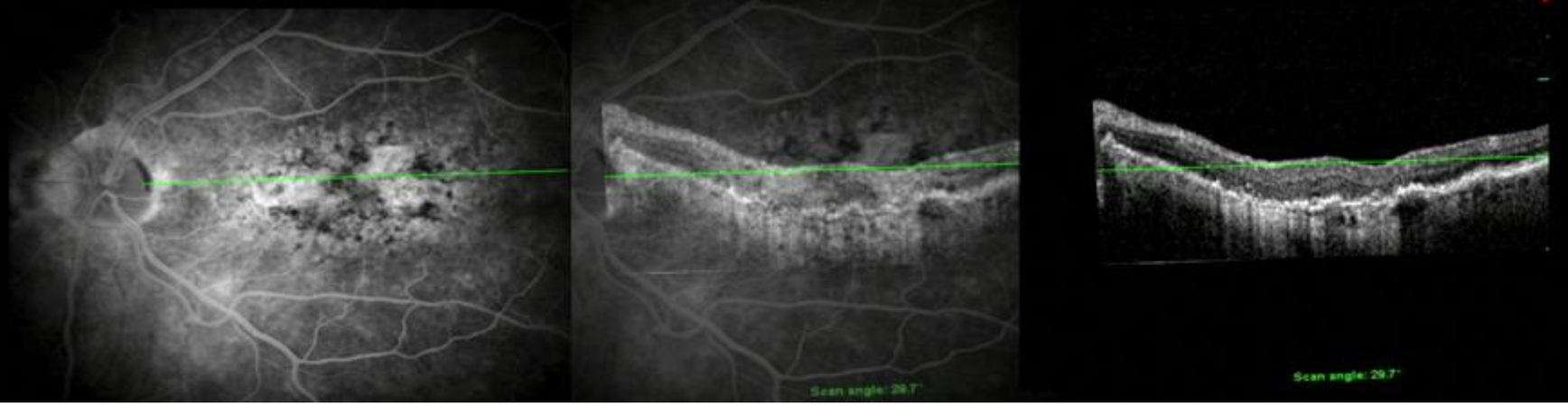


Devices to Improve Structural Assessment

Need assessment of progressive changes of the pathology:
Define: "Individual's multivariate chronologic risk prediction"

- Need to develop digital quantification of retinal pathologies that are associated with vision abnormalities and define an individual's risk for progression
- Currently only population-based risks (IDx-Dr), or device engineered (poor & cannot compare devices)
- Need: Digital quantification of physician identified structural changes



Ocudraw: Quantitative Pathologic Annotation of Retinal Images

- Allows drawing on images (or templates) with palette of pathologies: quantitative area, perimeter, distance of lesions from fovea or disc

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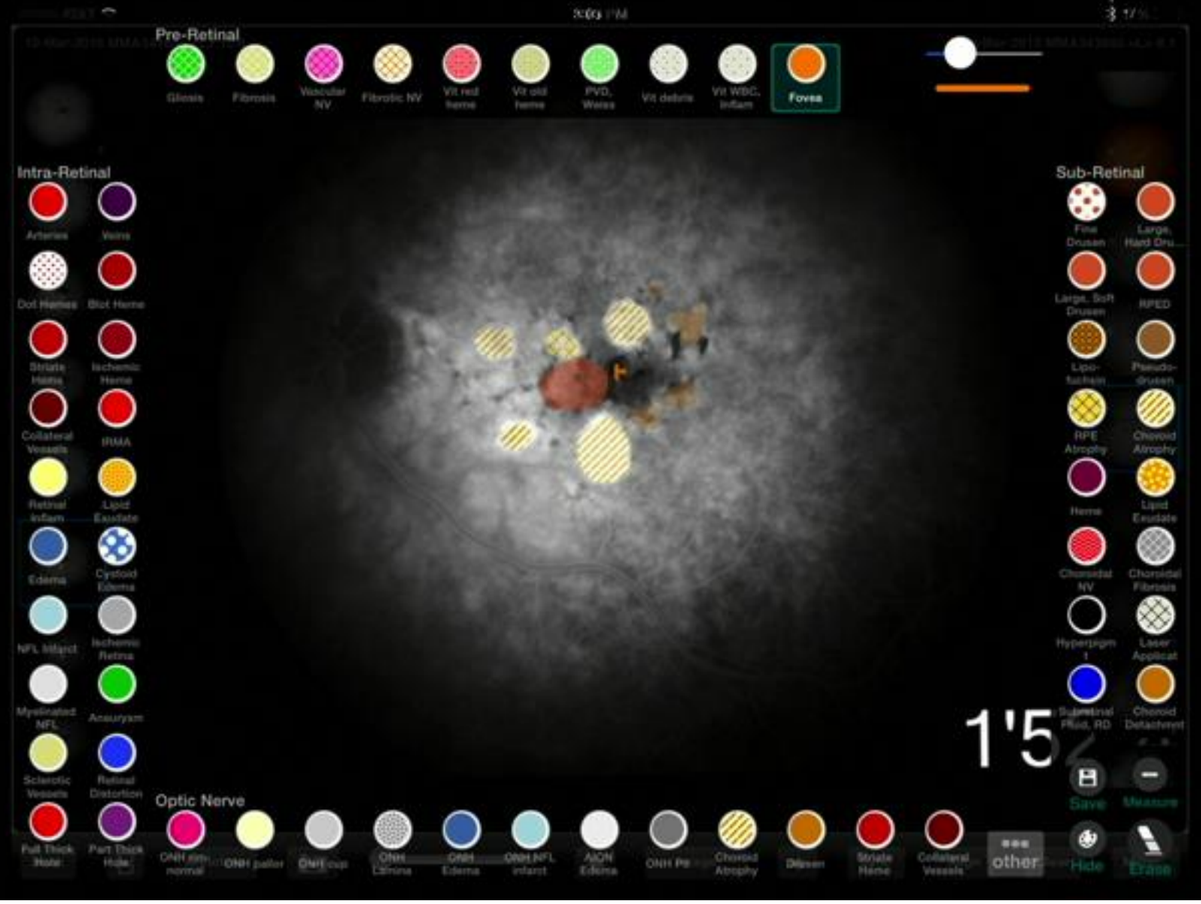

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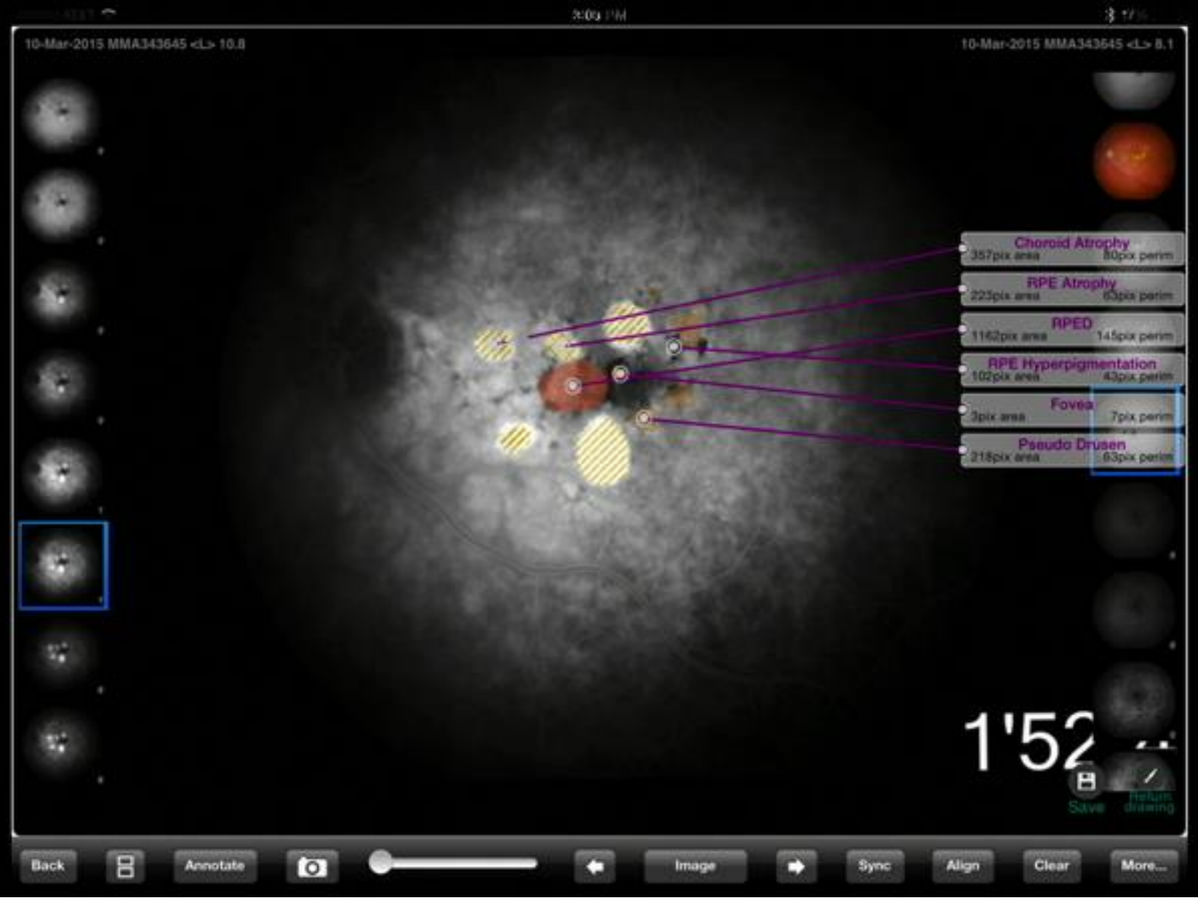

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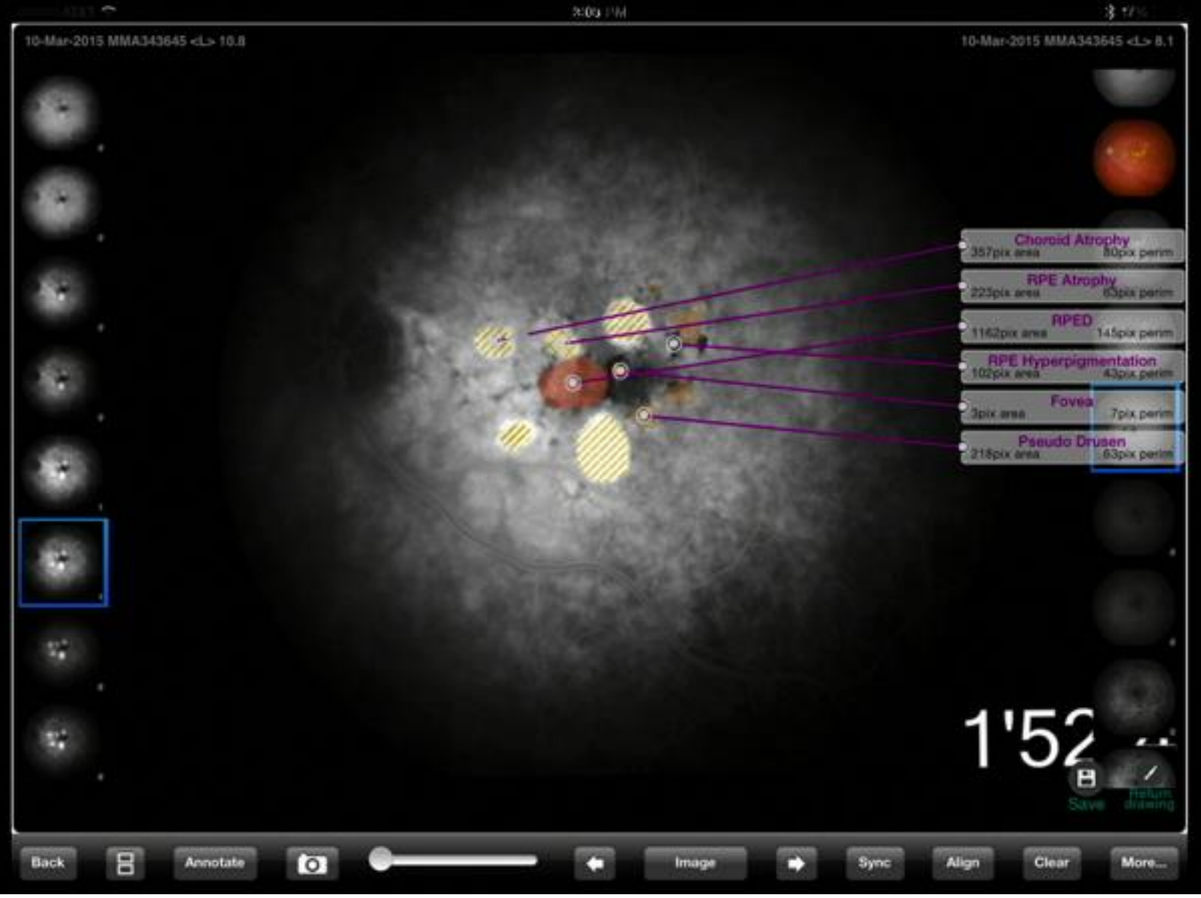

Provides Quantitative Definition of changes occurring over time: Crowd-sourcing to improve risk prediction

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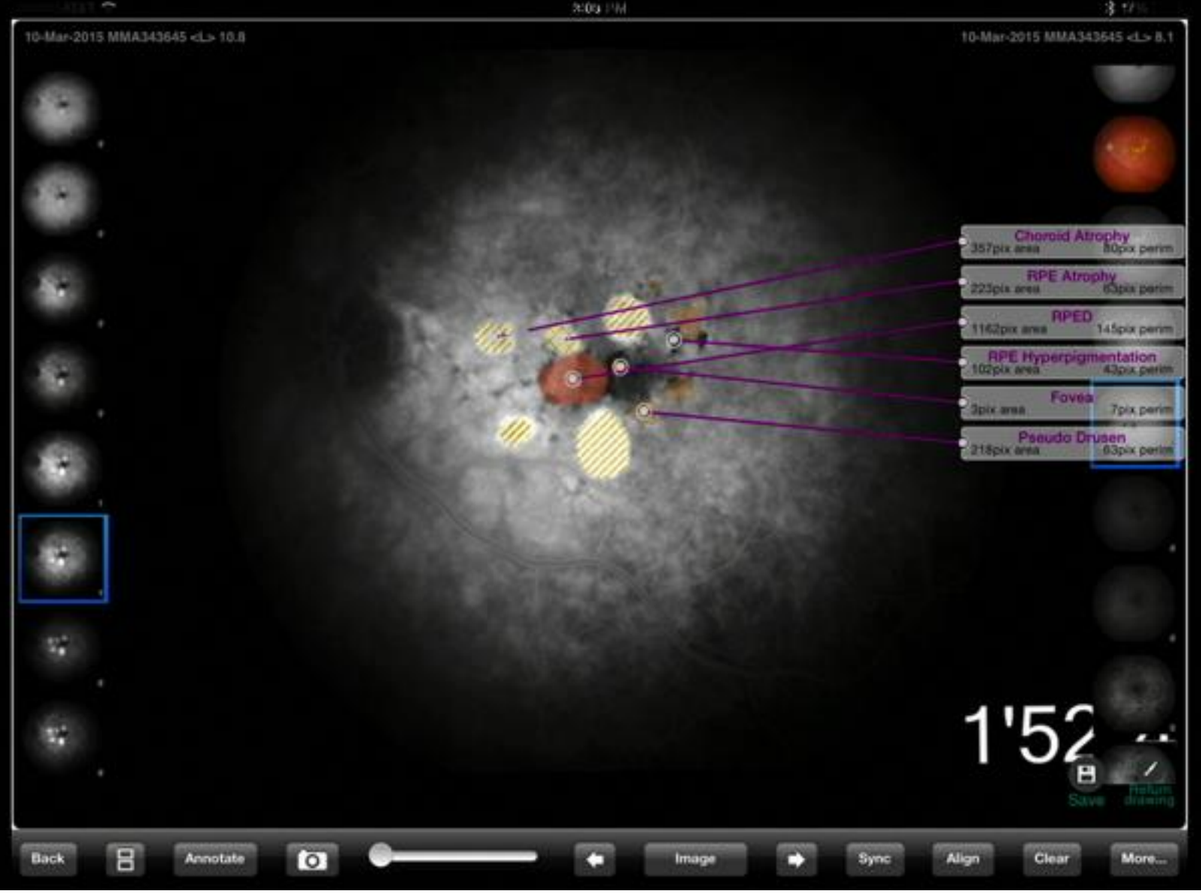

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Explore Additional Applications:

- Neuroradiology- lesion progression over time
- Dental photography- Caries detection
- Dermatologic- photographic whole-body scanning

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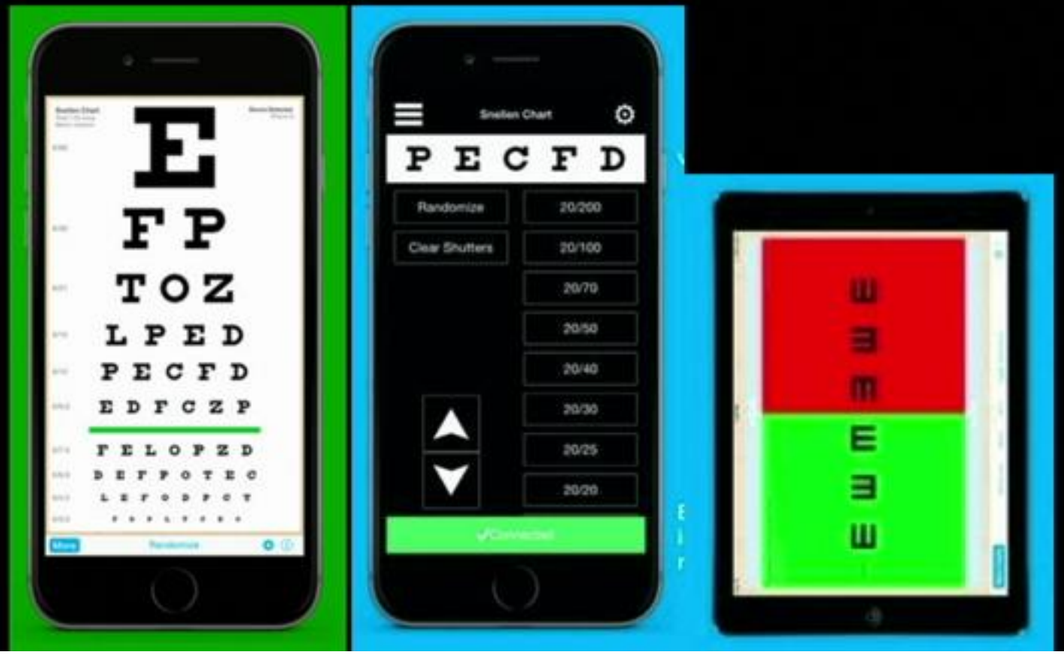

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  - Microperimetry: $37 K -Laser scanning camera allows overlay on single wavelength retinal enface image

Devices to Improve Vision Assessment

Assessing Distortion:

- ForSee (Home): Measures single line deviation(s) at fixed intercepts in visual field-
- Designed to detect development of neovascular AMD,
- Crude and non-quantitative:
- Will not help development Assist Device or App

Assessing Veiling Glare

– BAT: glowing hemisphere around central vision of distant chart
  - Performed only to get permission for cataract surgery
  - Does not provide measurements to help understand vision problems or recommend assist devices

Automated Measurement of Central Vision

Interactive Computer Graphics, Independent of Examiner

- Central Vision Screening

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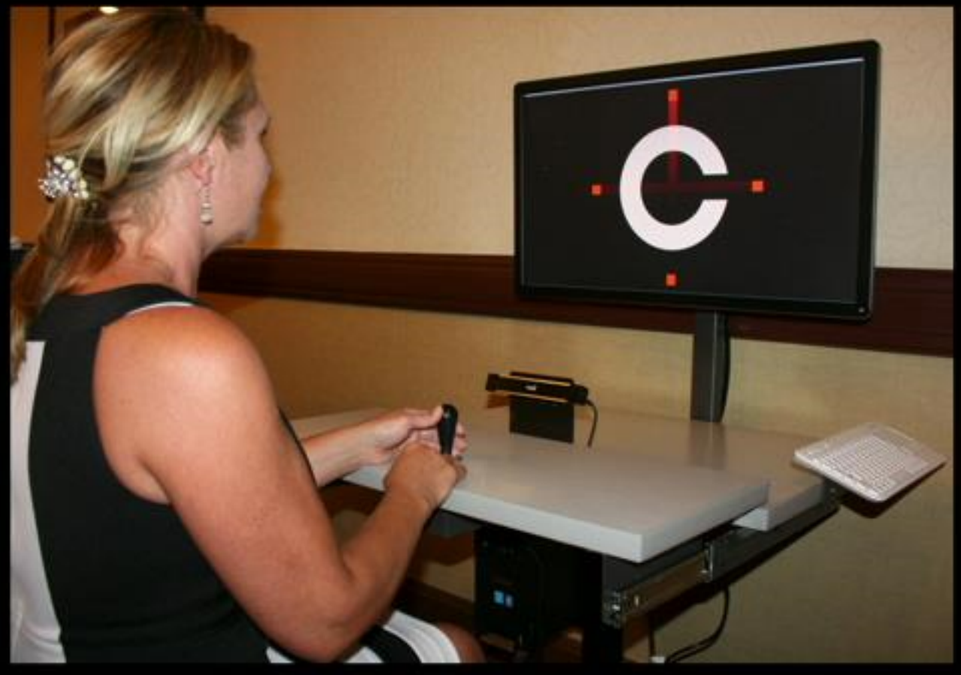
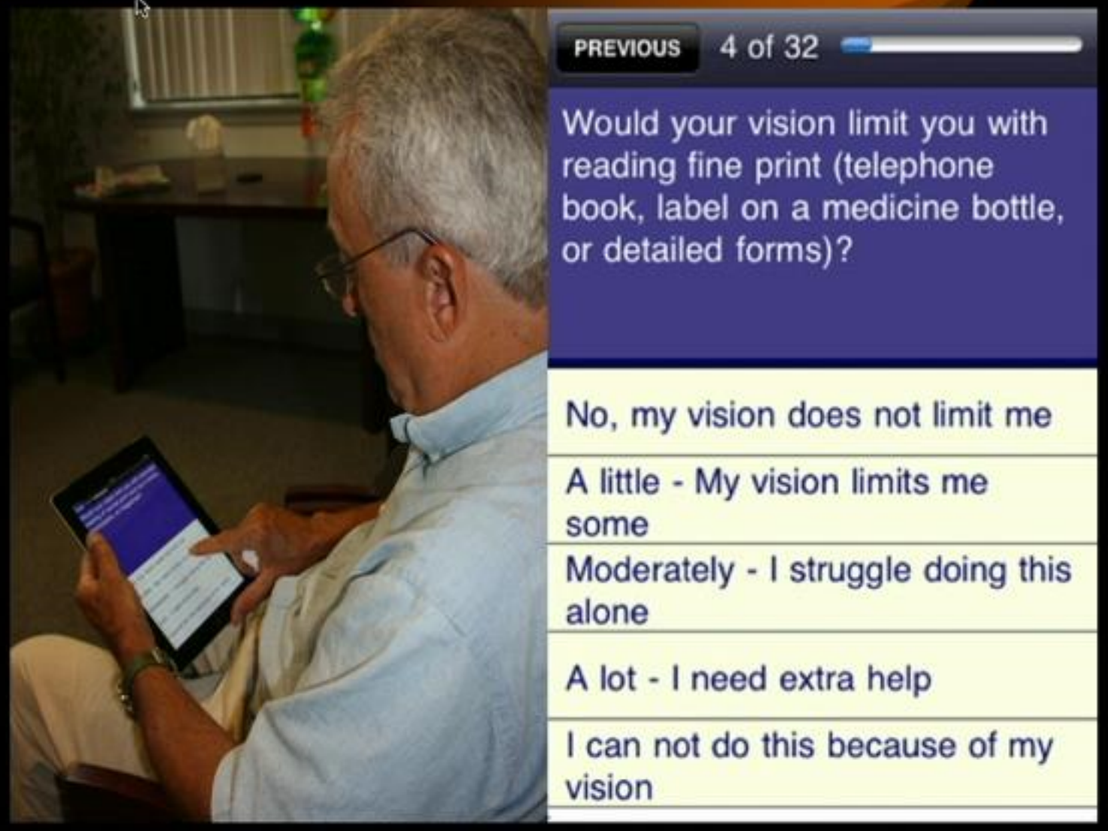
- Central Vision Screening
- Central Field Acuity Perimetry



Vision Task Measurement = Empowered Management

CVA

- Mesopic:
  - Romantic Restaurant
  - Driving at dusk
- Photopic Glare
  - Golf /tennis with overhead sun
  - Golf/tennis with sun off-axis 20°

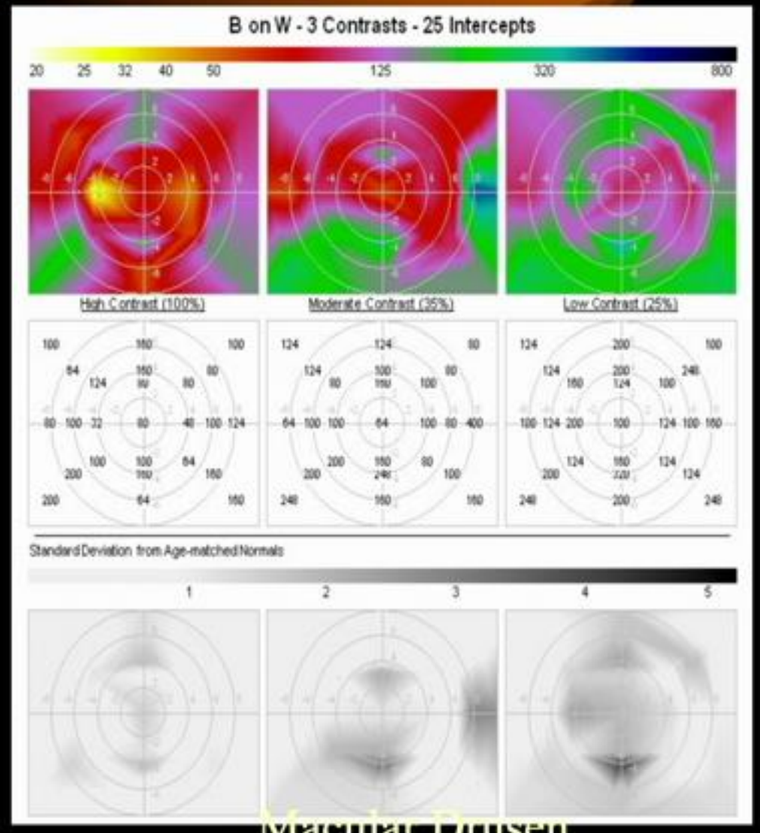


- Images altered with band-pass filtering that have been validated
- FDA Approved, Validated against iVFQ (NEI VFQ 25 of ADL tasks)

Omnifield Acuity Perimetry

Results:

- Pseudocolor = instant recognition of height and breath of "hill of vision"
- Comparison with age-stratified normal



Macular Drusen

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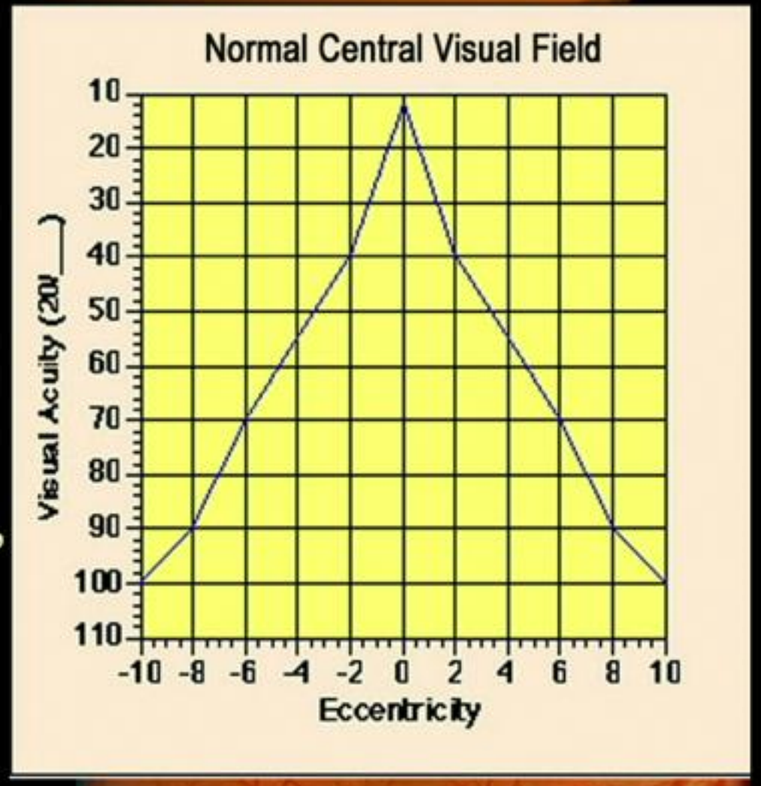
- Normal at high, 99% MC, dark screen:
  - "Cone of vision decline" -linear reduction from ~20/20 at fixation to 20/100 at 10° eccentricity from fixation
  - 20/40 or better out to 3.5° radius all ages, 5.7° for young, only 2.8° degrees ages 70+
  - Legally blind (20/200) beyond 15°
  - Periphery designed to see motion, flicker



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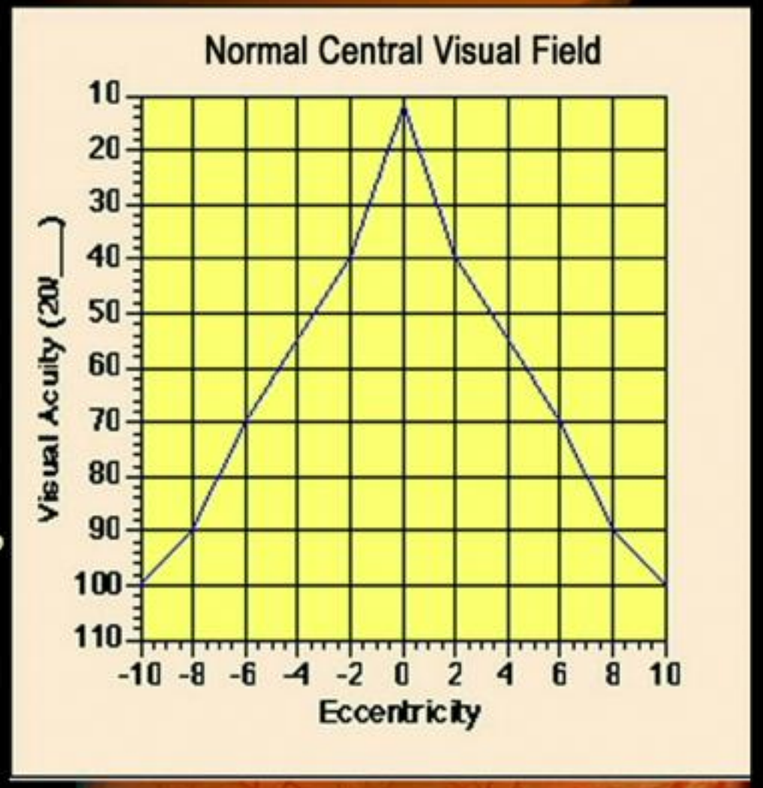
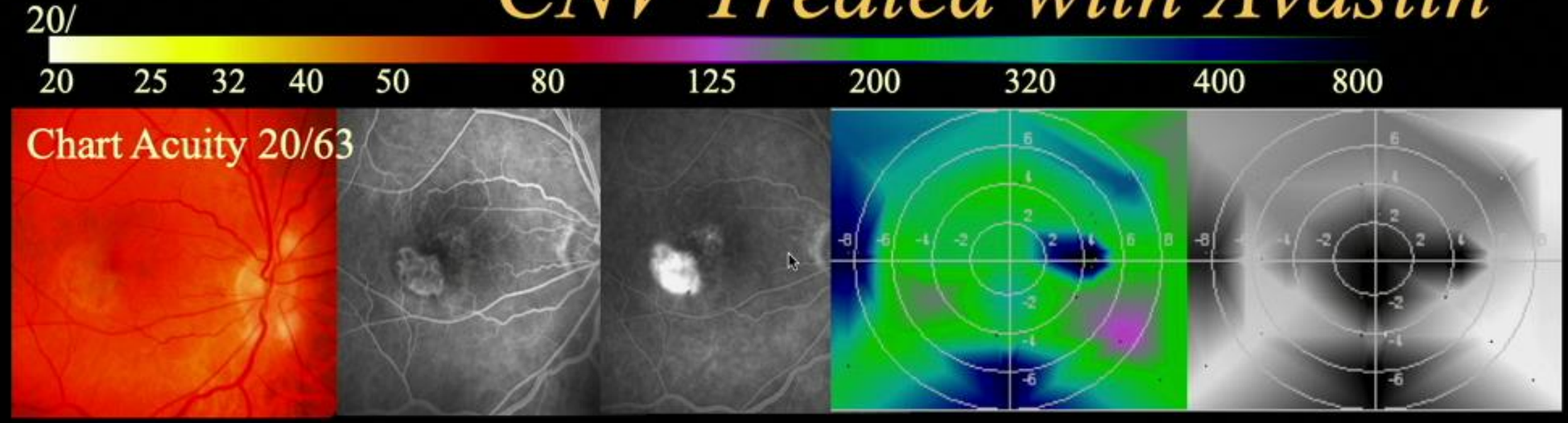
  - Periphery designed to see motion, flicker
- Therefore, beyond 4-6 degrees must move eyes to see more widely

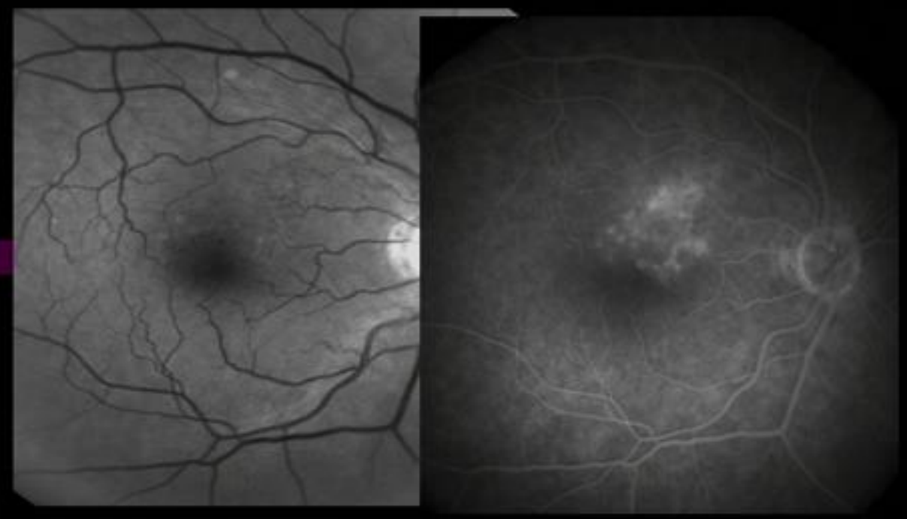


CNV Treated with Avastin



L.G. *tertiary BRVO*

V.A. 20/160



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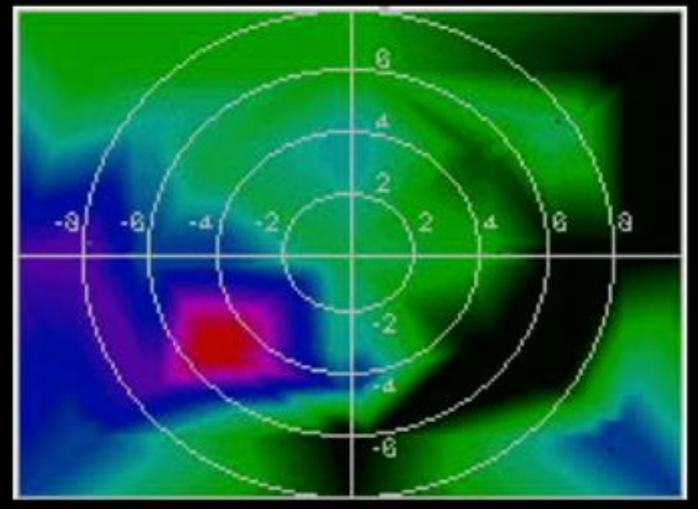

Electronic Vision Assessment Devices in Development

Omnifield

- Device (in physician office) limited by current technology and fixation monitoring :
  - Central 20º diameter field of view, can measure resolution better than 20/20 (1 pixel per arc minute)
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    $7,000-$9,000 w cart + shipping

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  - MS Hololens: Pupil Labs eye tracker 1250 P across FOV32° (48p/deg), external PC (?cost)

Microsoft Hololens Binocular Add-on

Discriminated Target Visual Fields In Macular Disease

- Central Visual Fields and pathology more complex than anticipated
- Central Vision not defined by chart visual acuity
- Stop using visual acuity as primary outcome in trials
- Resolution VF's (Omnifield) assist in understanding complex scotoma(s), real visual function difficulties

Vision Assessment Devices in Development

Tablet-Based Near Vision Testing App

- For office and home use: Includes 4 Tests

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  - Central Vision Analyzer- measures central vision under real world task conditions of luminance, contrast, and timing

Assist Devices for VIP's: Currently Available

Lens Magnification:

- OTC Hand held Magnifiers: Problems
  - Limited FOV
  - Failure to understand swiss cheese vision with distortions
  - Poor positioning, tremors

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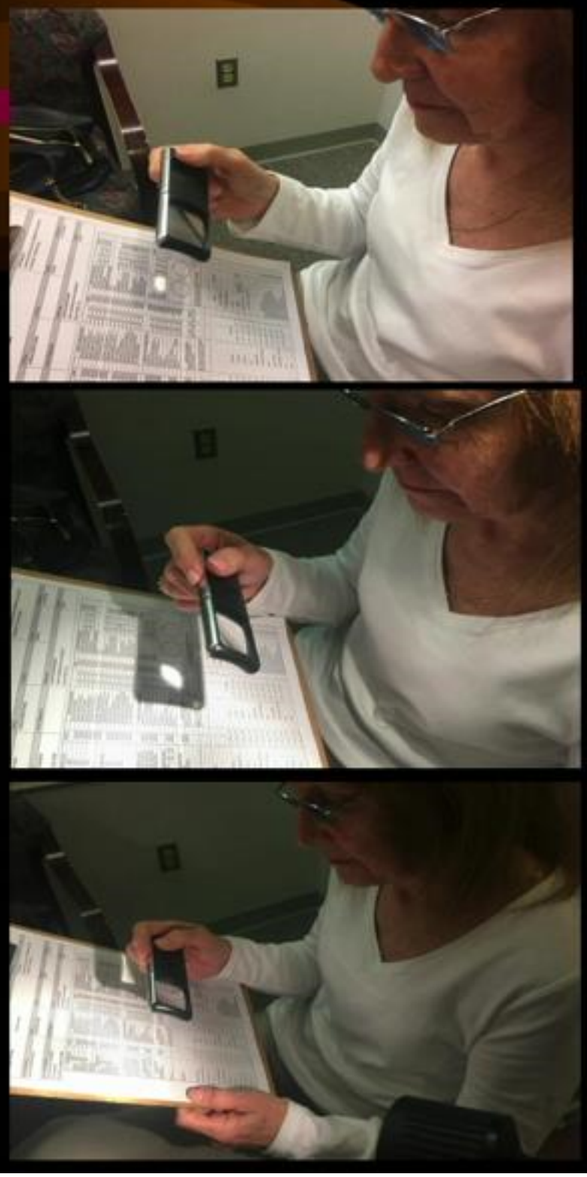

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  - Current reading rates: 15-18 wpm, unsatisfactory
- Distance Magnifiers
  - OTC Adjustable: Watching television, sports, computer
  - Rx Telescopes: Walking, driving, surgery
    - Reduces field of view, depth perception (lighting dependent)

Assist Devices Currently Available: OTC Glare Reducing Spectacles

- Must detect target contrasts over large range of light intensities,
  - 12 log units.
    - Pupil area 1.3 log units (~10 % luminance adaptation)
    - Automatic gain control over at least 3 log units of cone function in the normal retina
    - Severely reduced in eyes with macular disease with sig delay.
- Contrast increment for detection ~ to background luminance intensity.
  - Breaks down:
  - @ higher light levels = retinal saturation
  - @ lower levels when contrast reduction reduces edge detection, etc

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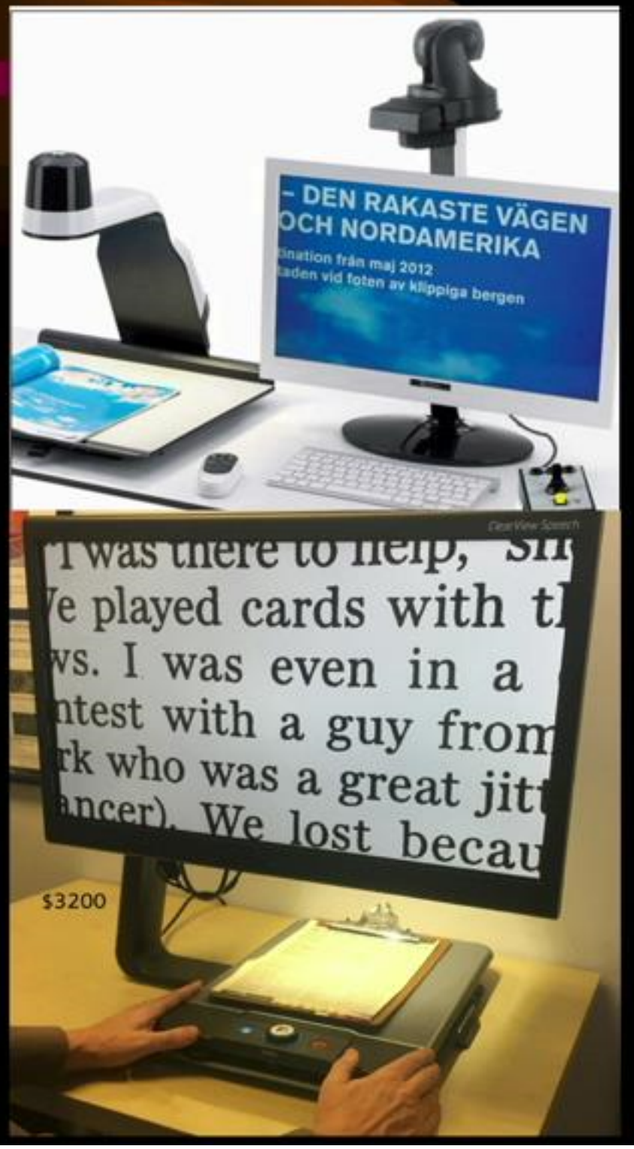
- Most often select pale amber for sunlight environments
- Extreme variability among patients
  - Not “one shoe size fits all”
  - Task dependent: Need electronic tint kiosk

Currently Available Assist Devices: Electronic

- Paper video magnifier:
  - Interactive magnification
  - Some OCR= audible, not internet connected
    - Office/home-based, non-portable
      - Optolec $3500, Nordic eye $7000



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Computer, Lap-Top, Tablet Based:

- Being used by elderly <u>much more than expected</u>
- Frequently used for:
  - Reading newspaper
  - Document creation,
  - Email, Facebook
  - Banking, bill paying,
  - Facetime (with kids/friends),
  - Book reading/entertainment (Apple TV), gaming
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Currently Available Assist Devices: Electonic

Computer, Laptop, Tablet Based:

- Problems: OS interactions still poor
  - Mouse – pointer difficult to follow
  - Touch-screen finger spreading used for magnification
    - But selection methodology is poor and results in screen disorientation
  - Often does not allow for personal screen contrast, illumination or color management
    - For internet/on-line interaction
  - OCR often does not function
    - Patients often complain about poor ability of audible output.
  - Tablet is portable but difficult to view up close without telescopic

Currently Available Assist Devices

Commercial Electronic

- On-line books/audible books and reading apps:
  - Most are purchased through Amazon/Audible with my patients using Nooks or Kindles
    - Problem with neighborhood libraries- varying reader apps
  - Difficulty with screen interface for those severely impaired
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- Seeing AI:Free MS iphone app=narrates world around person
  - Harnesses AI to describe people, emotions, document text, barcodes and object/ positioning, distance. Remarkable app.

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HMD, Glasses Mounted: Augmented Reality

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    - Adjustable mag, brightness control, Rx lens holder
  - Esight: ($10,000-$15,000) video camera looking forward
    - Images: alter contrast, focus, color- adjustable on handset

Assist Devices In Development

MS VR for the VIP: for severely impaired

- Blind Cane: "Cane Troller": for severe vision impairment- cane is used for ground texture:
- MS 3D Soundscape: Audio through bone conducting headphones give 3D audio interpretation of surroundings, use Windows or iphone for indoor and outdoor sensors, unobtrusive, helps to personalize space map around person

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- Mount Rodgers Project: MS MR headset increases field of view by tracking head motion, and utilization of both dominant hand and non-dominant to track documents
- MSR's **PRISM** project:Low cost cameras added to MS MR goggles to add real world to video based AR –HMD (teathered) with high resolution real-time video as input along with processed video and computer graphics- 5-10 ms delay

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VIP Tablet:

- Near Vision Tasks- portable but provides sufficient visualization space to manage documents and allow movement and magnification:
  - Enhanced interface for VIP that "understands their vision impairment"
  - Will image print, objects photographed beneath tablet in stand
    - Stand must be lightweight, lit with natural light LED's, portable with the tablet
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  - Speeds text reading from 15-17 WPM to 100+ WPM
  - Requires knowledge of visual field areas for word presentation

Project Suggestions

VIP Shopping:

- Middle distance task recognizing objects on the shelf, then converting to arm's length tasks to allow assessment, comparison both prepared and fresh foods.



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- Prepared foods: Read constituent labels, compare prices on the shelf.
  - Enable reading UPC or QR code (shelf enabled) – not with phone but laser or finger pointing or vision tracking with specs ⟹ audible read or VR display
- Cheese, chicken, meat, fish, fleshy fruits- define weight, cost, fresh/ripe
  - Haptics, Raman hyperspectral imaging (penetrates 3 mm)
- Breads, muffins – define freshness (?10 days shelf life?)
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Shopping on Line: ? Independent observer

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  - Need enhanced app for CAD: to optimize illumination
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Social acceptance of AR/VR Goggles in every day space

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- ? Develop app on tablet or with MS Xsens
  - MTw Awinda
  - Test in school hall at distance with kids interactions

ssinclair@stephensinclairmd.com

Slide deck: https://www.dropbox.com/s/ii3ul8ov2zrv5di/%20VIP-%20to%20Assess%20and%20Assist-%20Sinclair%20Lecture%204.18.2019.pptx?dl=0Sinclair Retina Associates (http://sinclairretinaassociates.com)

- Sinclair Technologies, LLC (http://sinclairtechnologiesllc.com)
- Clear Vision Foundation (http://clearvision.org)