Optometric Education Consultants

Ocular Disease

Interpretation and Utilization of New and Old Technologies

Greg Caldwell, OD, FAAO

Pittsburgh Primary Eye Care Conference
Saturday, February 18, 2023

Disclosures- Greg Caldwell, OD, FAAO

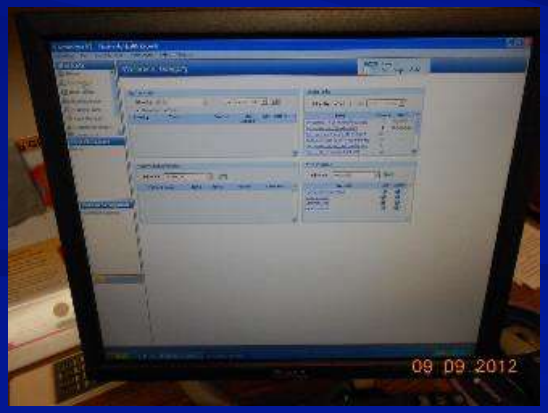
All relevant relationships have been mitigated

- Lectured for: Alcon, Allergan, Aerie, B&L, BioTissue, Kala, Maculogix, Optovue, RVL, Heru, Santen
  - Disclosure: Receive speaker honorariums
- Advisory Board: Allergan, Alcon, Dompe, Eyenovia Tarsus, Visus
- I have no direct financial or proprietary interest in any companies, products or services mentioned in this presentation
  - Disclosure: Non-salaried financial affiliation with Pharmanex
- Envolve: PA Medical Director, Credential Committee
- Healthcare Registries – Chairman of Advisory Council for Diabetes and AMD
- The content of this activity was prepared independently by me - Dr. Caldwell
- The content and format of this course is presented without commercial bias and does not claim superiority of any commercial product or service
- Optometric Education Consultants – Pittsburgh, PA, Sarasota, FL, Muncie, IN, Scottsdale/Phoenix, AZ, Orlando, FL, Mackinac Island, MI, Nashville, TN, and Quebec City, Canada - Owner

My Practice

I am a clinician first then a scientist

- Some are scientists first then clinician
- I need to simplify for patient and patient care.
- Science is great, but not good if there isn't a clinical application.
- Some lectures are science based without clinical application.
- My lecture will be a hybrid. Showing clinical applications of the science

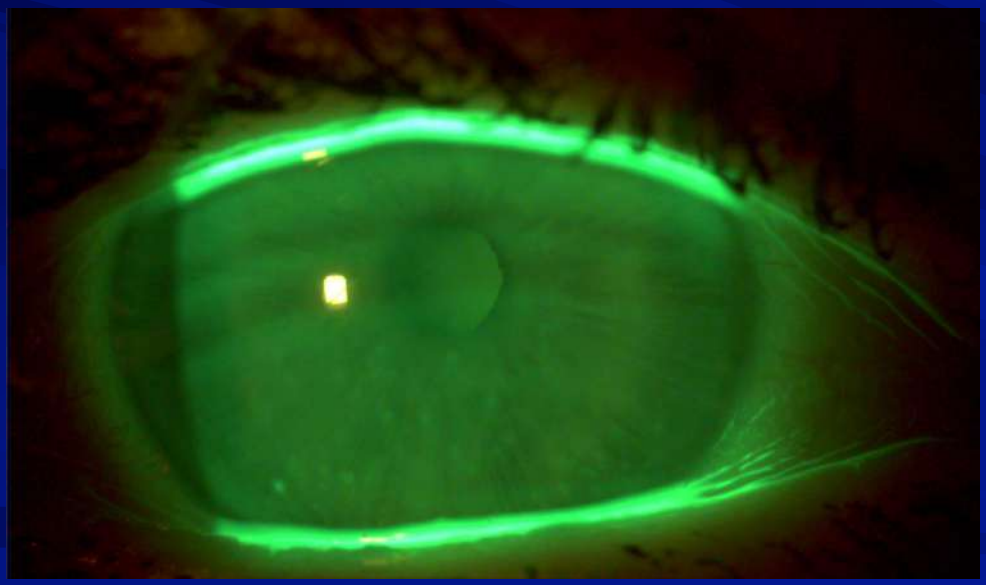


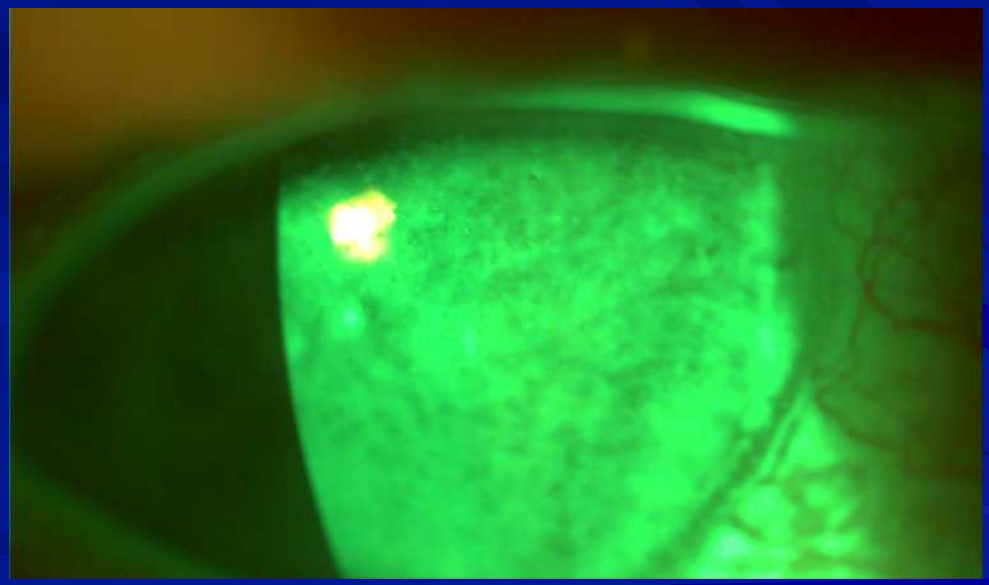
It is wonderful to have someone who's juggling so many aspects of optometry [scientific, clinical experience, teacher & lecturer]. It is refreshing and very informative. -Sarah

Neurotrophic Keratitis

Stain Without Pain!

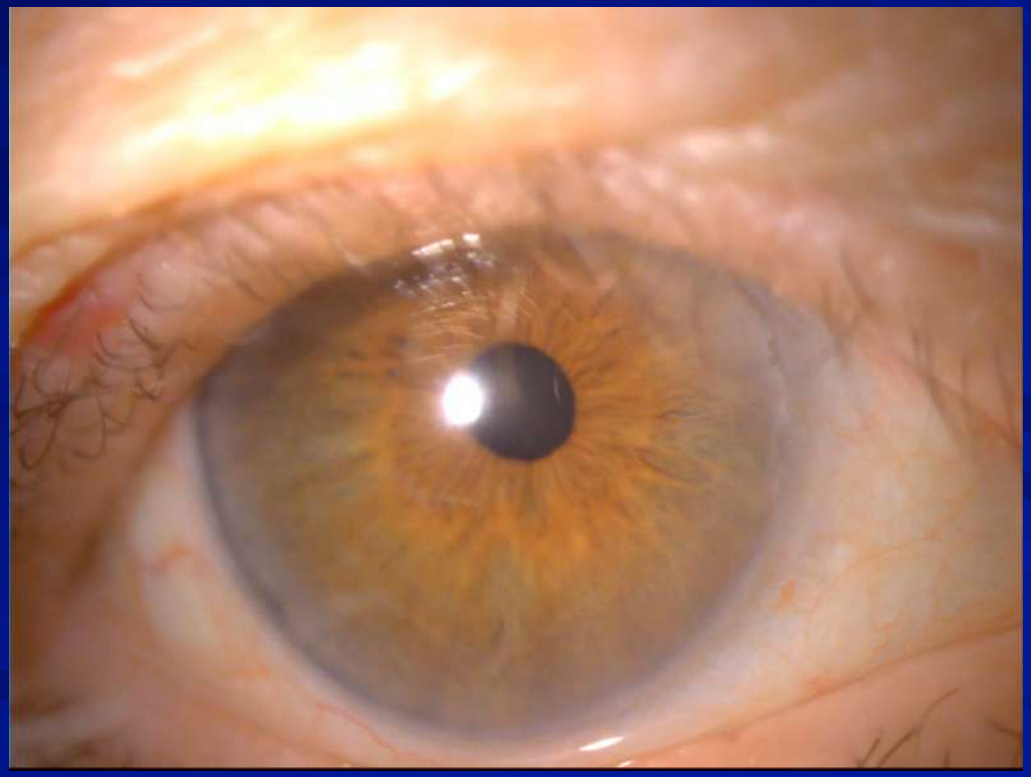
Actually, the OS is More Comfortable – What?



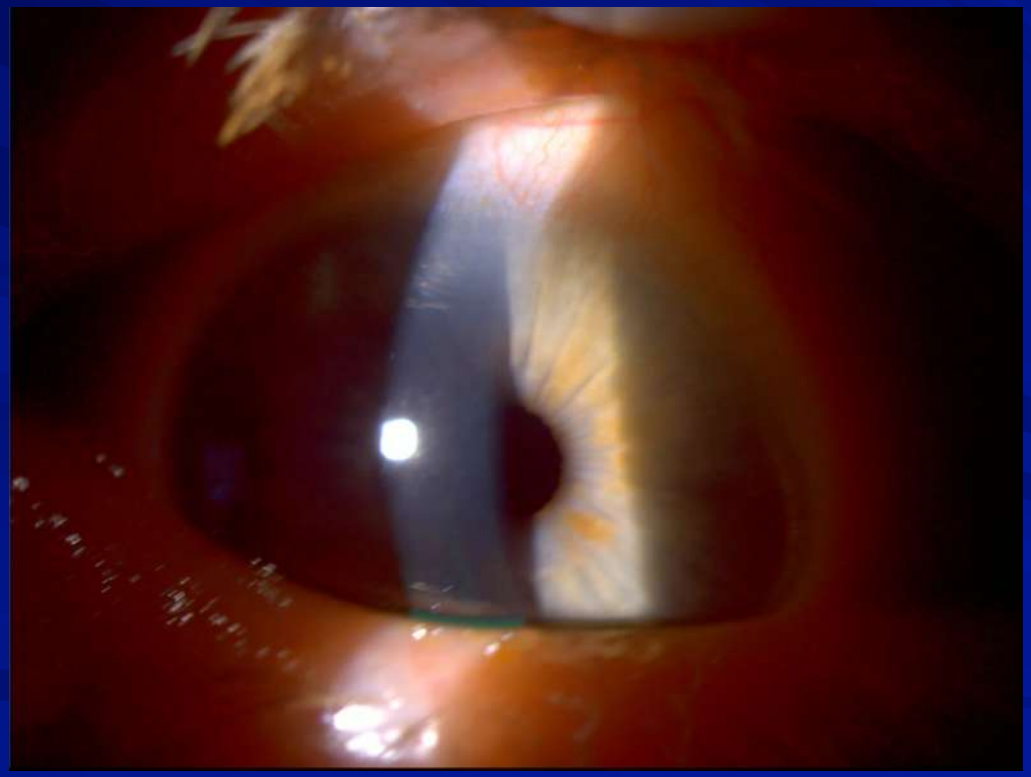


Corneal Sensitivity Testing

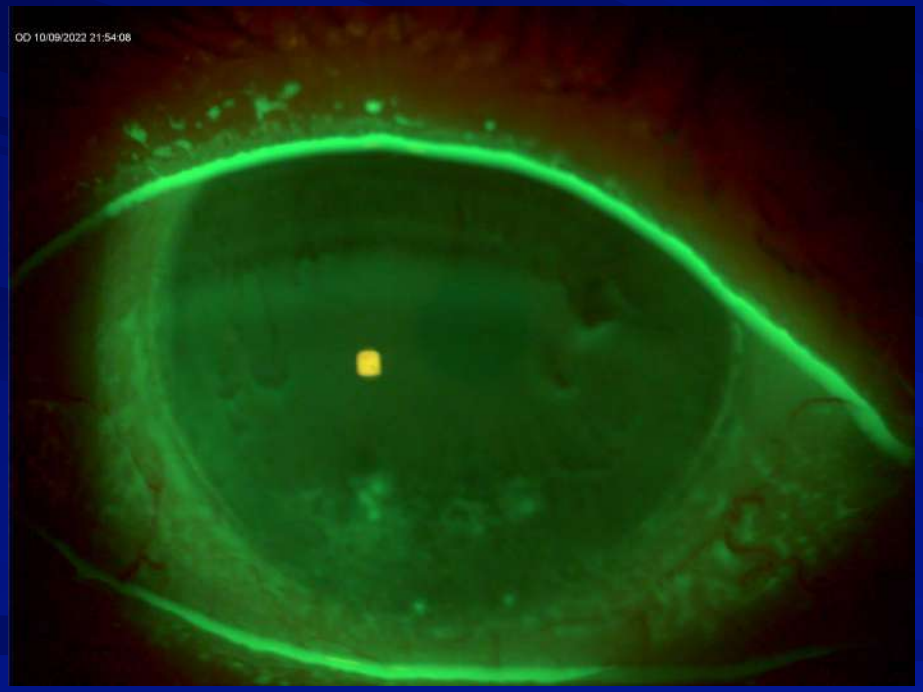
Cornea Sensitive Testing – Another Patient

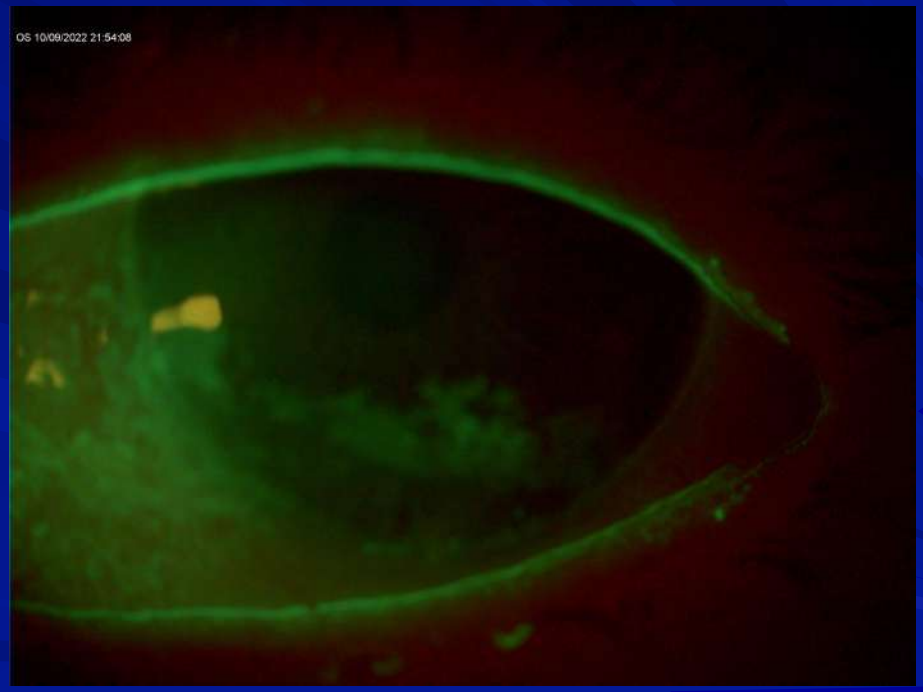


Cornea Sensitive Testing – Yet Another Patient

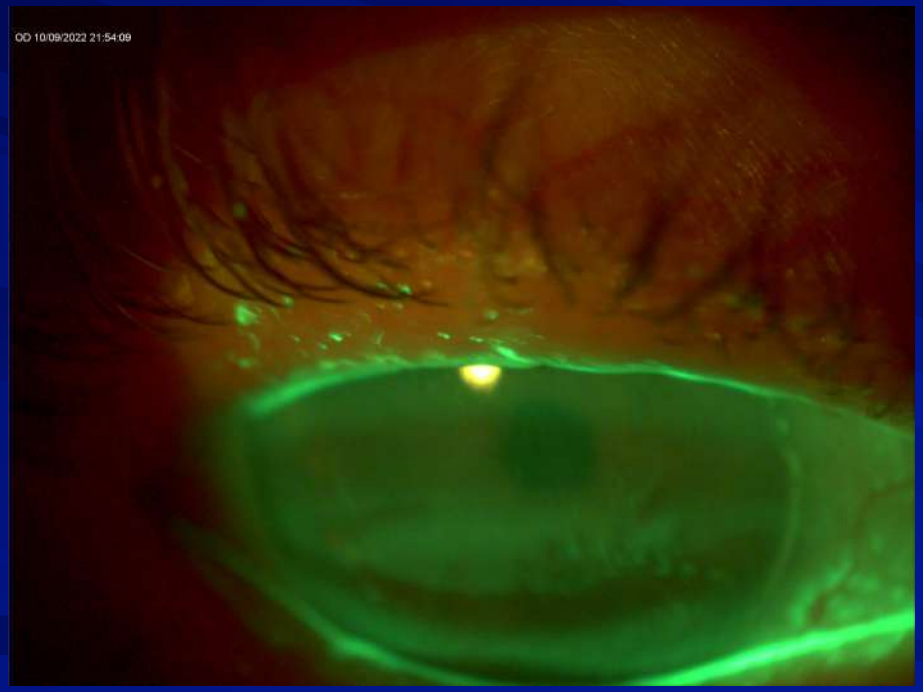


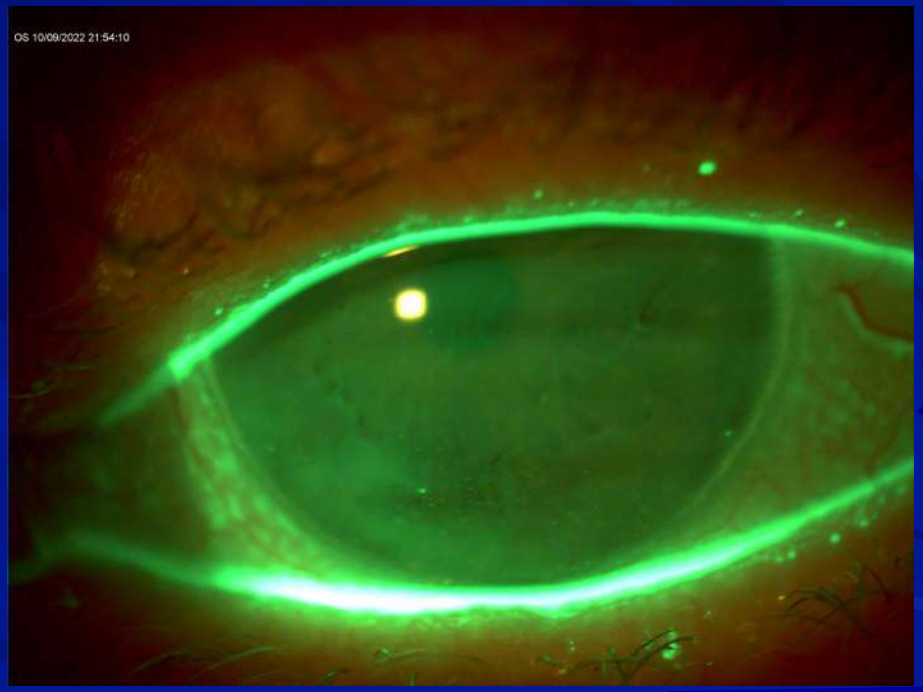
Before Oxervate™ (cenegermin-bkbj) Treatment





After Oxervate™ (cenegermin-bkbj) Treatment



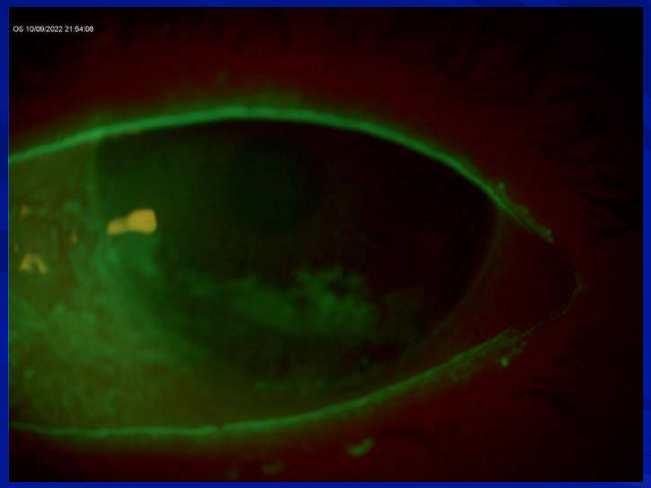


Oxervate™ (cenegermin-bkbj)

- Grading corneal sensitivity: (Cotton Tip)
  - Normal
  - Reduced
  - Absent

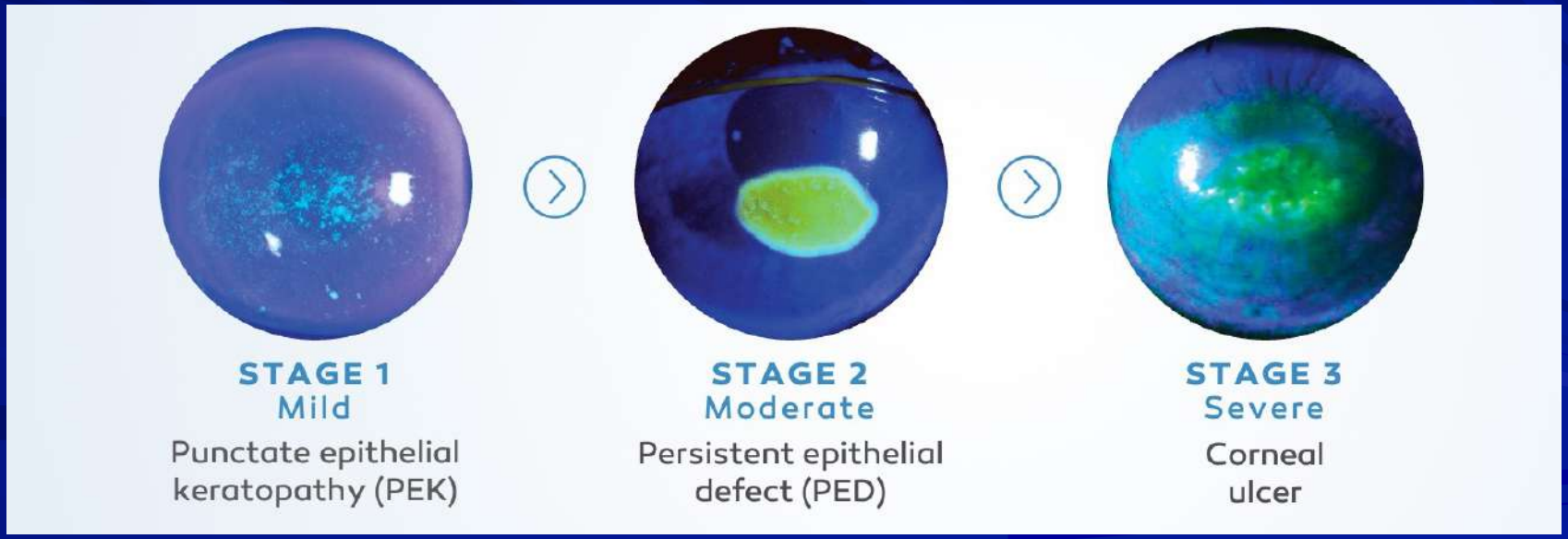
  - Reduced in all quadrants and centrally
  - Absent inferior quadrant, reduced everywhere else

- Neurotrophic Keratitis: (Staining)
  - Mild – Stage 1
  - Moderate – Stage 2
  - Severe – Stage 3



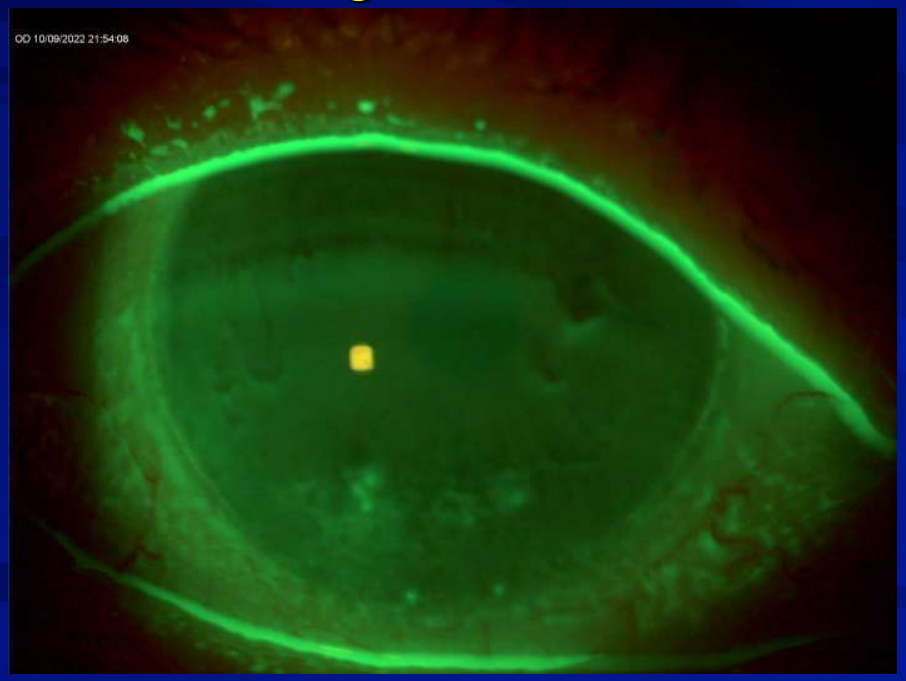
Neurotrophic Keratitis is a Degenerative Disease

- The Mackie classification represents one way to assess or grade NK – stage or progression

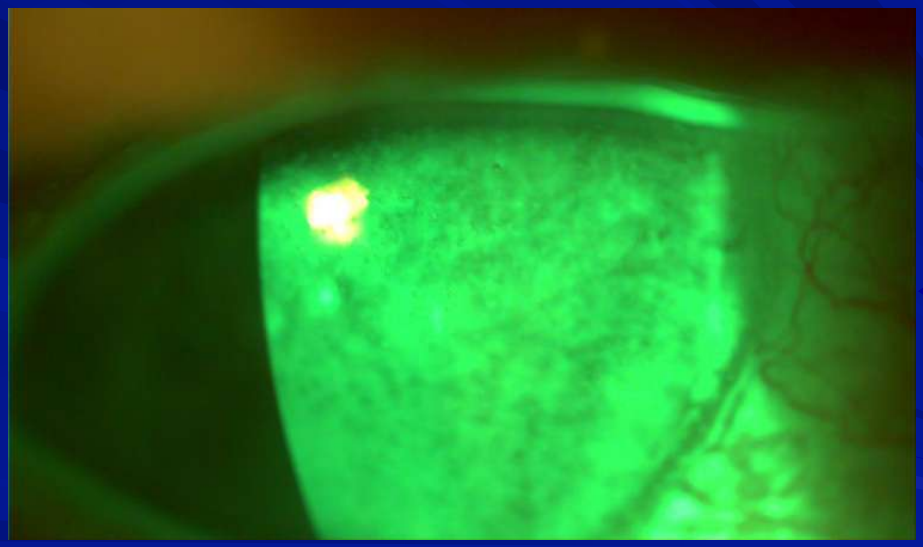


Mackie Classification

Moderate - Stage 2

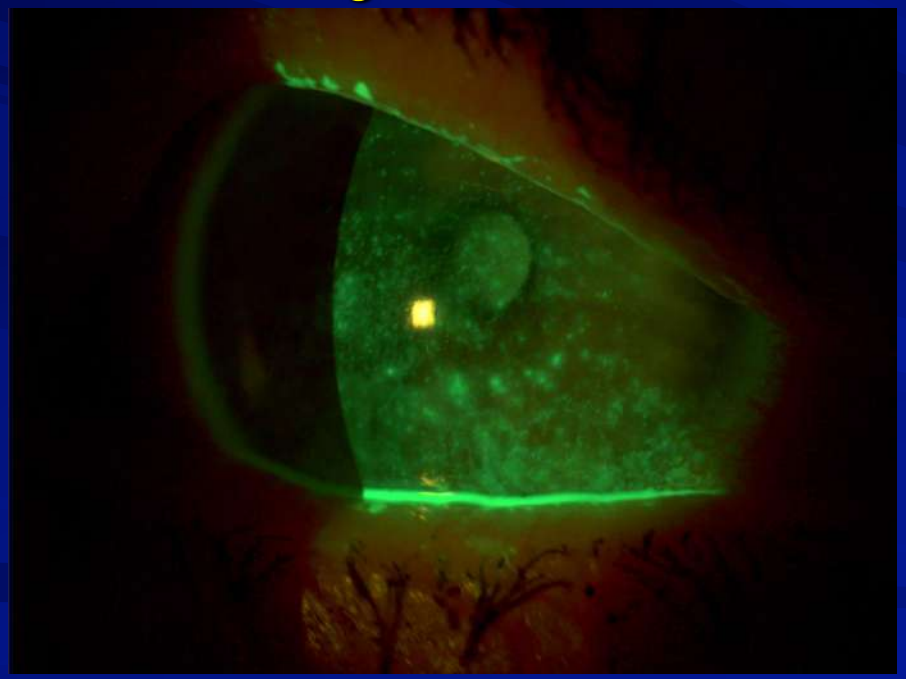


Moderate - Stage 2

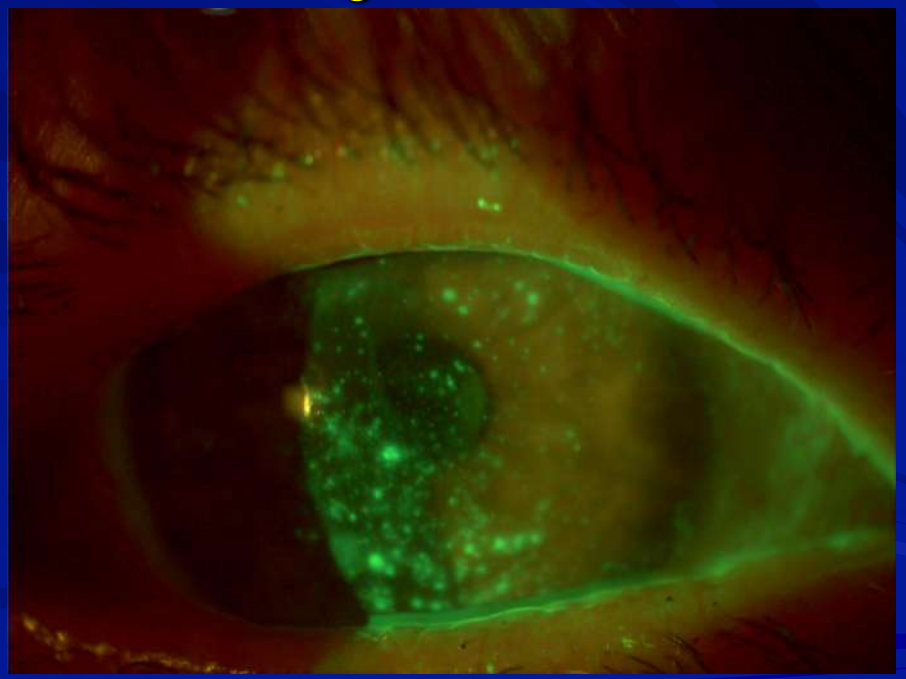


Mackie Classification

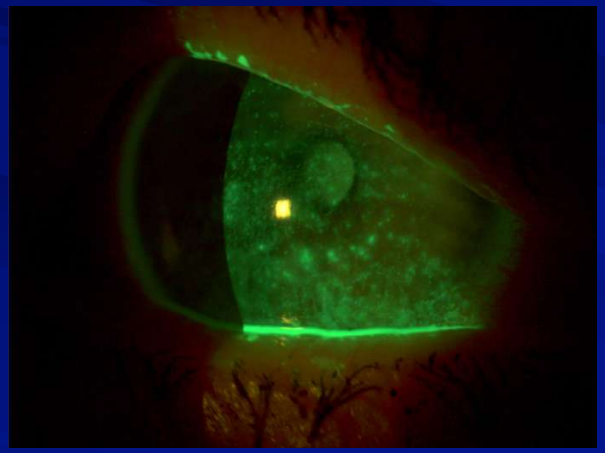
Moderate - Stage 2



Moderate - Stage 2



Resolved

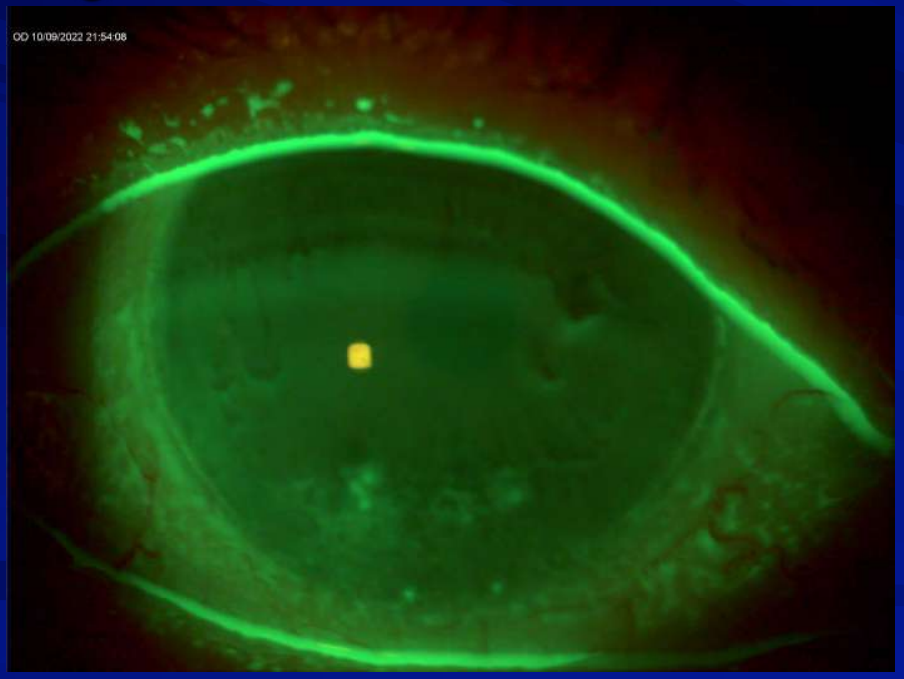


Oxervate™ (cenegermin-bkbj)

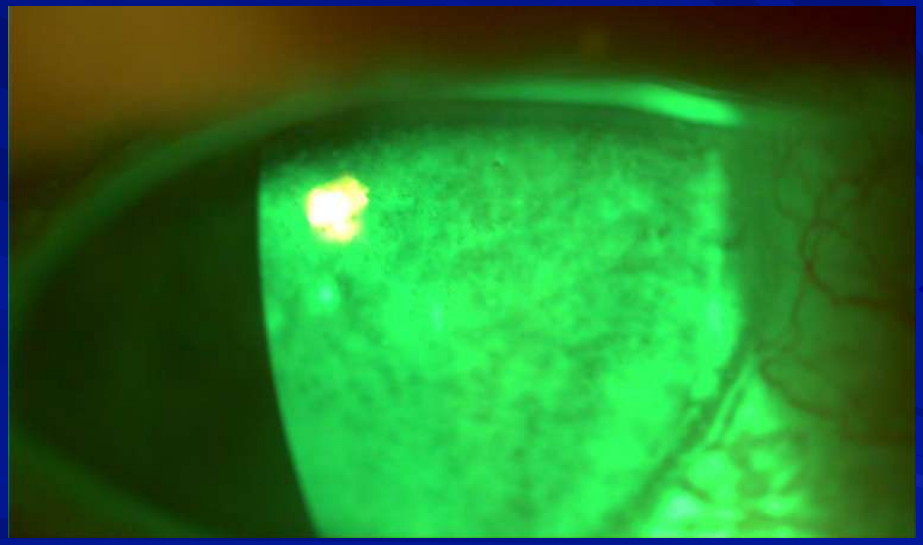
- Approved 2018 (August 28, 2018)
- Dompe farmaceutici SpA
- Ophthalmic solution indicated for the treatment of neurotrophic keratitis
- Dosing: Instill 1 drop in affected eye 6 times per day (at 2-hour intervals) for 8 weeks
  - Used as eye drop
    - Not infused or injected
- Storage issues: in the freezer at the pharmacy
  - Patient keeps the individual vials in the fridge – once "actively ready" for use, then it is only stable for 12 hours
- Contraindications
  - None

Mackie Classification

Stage 2

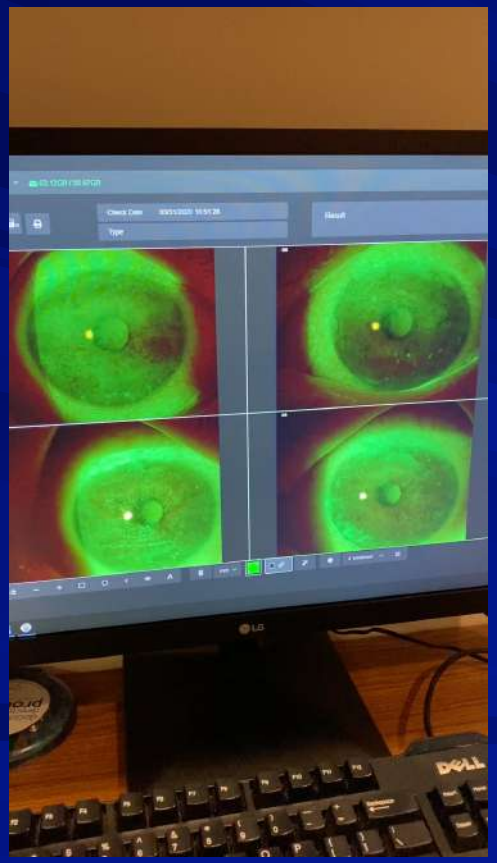


Stage 2

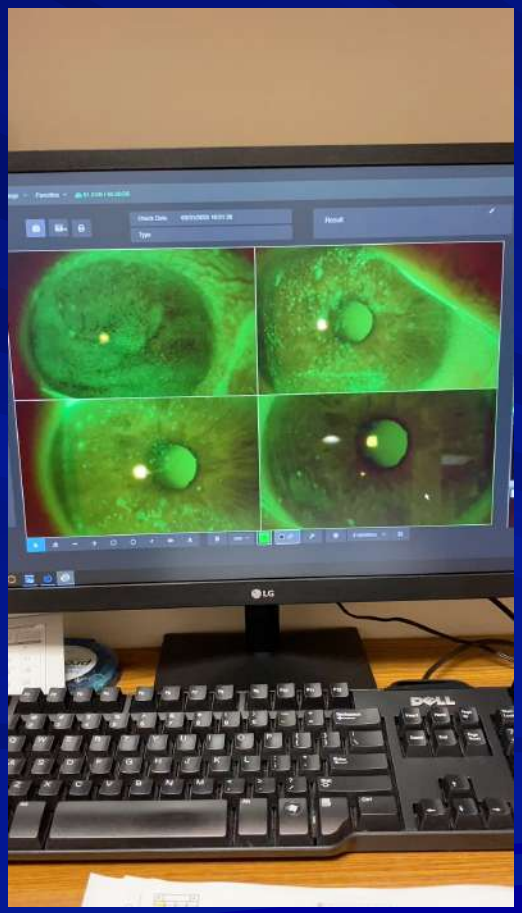


Let's Hear From a Patient

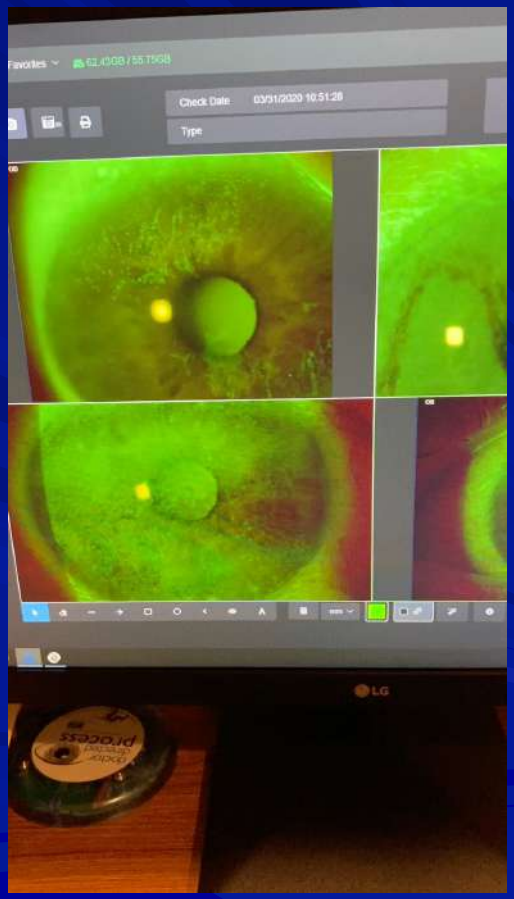
April 7, 2020 - After 1 week



April 21, 2020 - After 3 weeks



May 12, 2020 - After 6 weeks



Study Conclusions

After 8 weeks of treatment, 6 times daily

In the majority of patients across two clinical studies OXERVATE™ (cenegermin ophthalmic solution 0.002%) was well tolerated and more effective than vehicle in promoting complete corneal healing of moderate or severe NK.

Study NGF0212 (REPARO) (N=52 per group)
European patients with NK in one eye

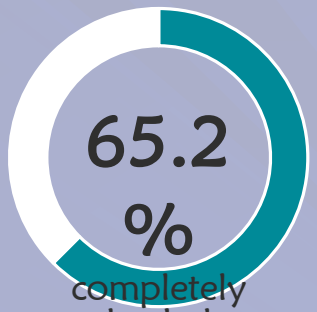
NCT01756456

Vehicle response rate 33.3%

Study NGF0214 (N=24 per group)

U.S patients with NK in one or both eyes

NCT02227147



Vehicle response rate 16.7%

Of patients who healed after one 8-week course of treatment…

80% Remained healed for one year*

*Based on REPARO, the study with longer follow-up

Safety: The most common adverse reaction was eye pain following instillation which was reported in approximately 16% of patients. Other adverse reactions occurring in 1-10% of OXERVATE™ patients and more frequently than in the vehicle-treated patients included corneal deposits, foreign body sensation, ocular hyperemia, ocular inflammation and tearing[3]

1. Bonini S, Lambiase A, Rama P et al. Phase II Randomized, Double-Masked, Vehicle-Controlled Trial of Recombinant Human Nerve Growth Factor for Neurotrophic Keratitis. Ophthalmology. 2018;125:1332-1343. 2. Chao W, J. BOC, R. D et al. Data on file. Healing of persistent epithelial defects or corneal ulcers by recombinant human nerve growth factor eye drops in patients with stage 2 or 3 neurotrophic keratitis. Presented at: Congress of the European Society of Ophthalmology (SOE) 10–13 June, 2017, Barcelona, Spain. 2017. 3. OXERVATE™ (cenegermin-bkbj) ophthalmic solution 0.002% (20 mcg/ml) [US package insert]. Boston, MA: Dompe U.S. Inc.; 2018.

OXERVATE™ (cenegermin-bkbj)

- Adverse reactions: very well tolerated
- The most common adverse reaction in clinical trials
  - eye pain, corneal deposits, foreign body sensation in the eye, ocular hyperemia, swelling of the eye, and increase in tears
- Contact lenses (therapeutic or corrective) should be removed before applying cenegermin
  - presence of a contact lens may limit the distribution of cenegermin-bkbj onto the corneal lesion
  - Lenses may be reinserted 15 minutes after administration.

Misalignment

- Many people experience the symptoms of eye misalignment
  - Headaches, eyestrain, dry eye sensation, neck pain, eye fatigue, motion sickness
- That number grows as we shift to remote working and learning
- Small misalignments can cause painful symptoms
- Small prism corrections can provide dramatic relief

Neurolens

Neurolens

Wearable Technology

A Wearable Technology

- Born out of the University of Miami's Bascom Palmer Eye Institute
- Their goal is to provide physicians and patients access to state-of-the-art, accurate, portable technology through real-time wearable diagnostics
- **re:Vive™ by Heru™** is the modern, gamified diagnostic solution using a **lightweight, wearable headset** to aid doctors in diagnosis
- Future developments include vision augmentation applications utilizing AI algorithms to personalize vision enhancement.

A Decade of Research, Innovation and Clinical Validation

- Artificial Intelligence (AI) driven diagnostics and vision augmentation platform is backed by ten years of research and clinical validation at the University of Miami's Bascom Palmer Eye Institute where it is continuously developed.

10 Years of Clinical and Scientific Research

40 U.S. and International Patents to Date

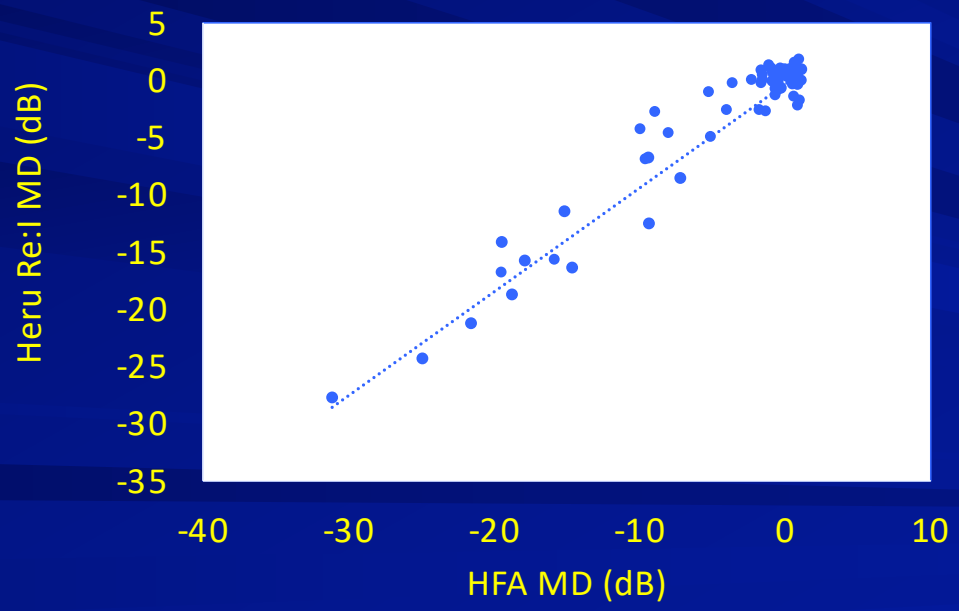
1,000+ Patients in Clinical Trials

450 Million Patients with Visual Field Defects

What is the Same?

re:Vive by Heru

Correlates strongly with the standard of care, throughout the dynamic range



R=0.91, P<0.001, in normal eyes and

R=0.81, P<0.001, in eyes with glaucoma and other pathologies

Patient:
Date of Birth: Mar 11, 1955
Gender: Other
Patient ID: 1955.0311.933E.7DB8.0703.9556

OD Single Field Analysis — Central 24-2 Threshold Test

Fixation Monitor:	Gaze/Blind Spot	Stimulus:	III, White	Date:	Feb 02, 2022
Fixation Target:	Central	Background:	31.5 asb	Time:	9:59 AM
Fixation Losses:	3/17	Strategy:	SITA Standard	Age:	66
False POS Errors:	2%	Pupil Diameter:			
False NEG Errors:	13%	Visual Acuity:			
Test Duration:	06:32	Rx:	+0.00 DS		
Fovea:	31 dB				

Total Deviation

Pattern Deviation

GHT: Outside Normal Limits

VFI: 48%
MD24-2: -12.55 dB P < 0.5%
PSD24-2: 14.30 dB P < 0.5%

:: P < 5%
P < 2%
P < 1%
P < 0.5%

Comments

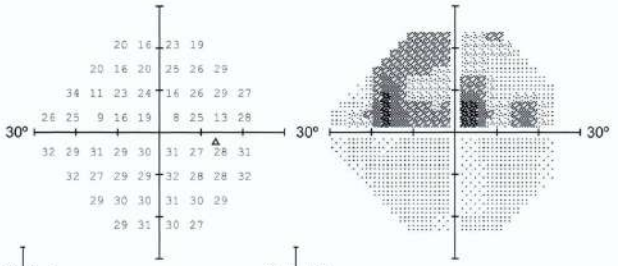
HFA 3 000-I307-H1 3.2.-I31 Version: 1.0.2.-1 Created: 2/2/2022 10:46:22 AM by Administrator Page 1 of 1

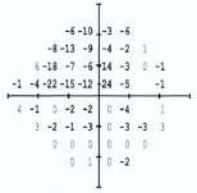
DOB: 1955-03-11
MRN: None

Central 24-2 Threshold Test
Feb 2, 2022 - 10:35 AM

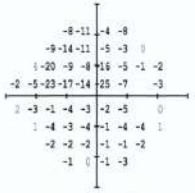
Right Eye

Fixation Monitor	ActiveTrack™	*Strategy*	re:Imagine™	*Age*	66
Stimulus	Dynamic, White	*Input*	Clicker	*VA*	Not Provided
Foveal Threshold	36 dB	*Fixation Losses*	NA	*Rx*	S C
Background	Black	*False POS Errors*	0/6 0%		
Test Duration	3:40	*False NEG Errors*	2/6 33%		





Total Deviation



Pattern Deviation

MD -4.24 dB
PSD 6.53 dB

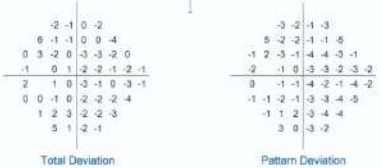
:: P < 5%
P < 2%
P < 1%
P < 0.5%

0.4.6 Clicker

Patient:
Date of Birth: Mar 11, 1955
Gender: Other
Patient ID: 1955.0311.933E.7DB8.0703.9556

OS Single Field Analysis — Central 24-2 Threshold Test

Fixation Monitor:	Gaze/Blind Spot	Stimulus:	III, White	Date:	Feb 02, 2022
Fixation Target:	Central	Background:	31.5 asb	Time:	10:07 AM
Fixation Losses:	4/14 XX	Strategy:	SITA Standard	Age:	66
False POS Errors:	5%	Pupil Diameter:			
False NEG Errors:	2%	Visual Acuity:			
Test Duration:	05:07	Rx:	+1.75 DS		
Fovea:	32 dB				



GHT: Within Normal Limits

VFI: 98%
MD24-2: -0.78 dB
PSD24-2: 2.00 dB P < 5%

*** Low Test Reliability ***

:: P < 5%
P < 2%
P < 1%
P < 0.5%

Comments

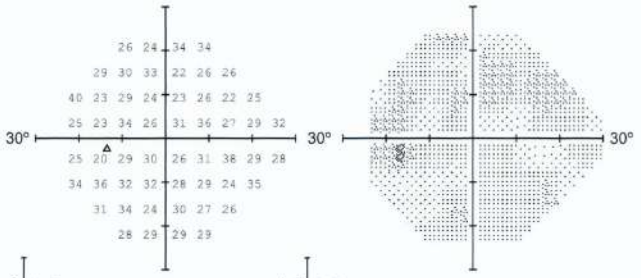
APA 9.860.1001#1.9.2.431 Version 1.0.2.4 Created: 2/2/2022 10:49:10 AM by Administrator Page 1 of 1

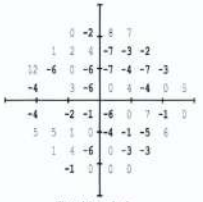
DOB: 1955-03-11
MRN: None

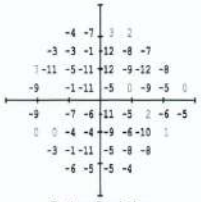
Central 24-2 Threshold Test
Feb 2, 2022 - 10:41 AM

Left Eye

Fixation Monitor	Blind spot	*Strategy*	**re:**Imagine™	*Age*	66
Stimulus	Dynamic, White	*Input*	Clicker	*VA*	Not Provided
Foveal Threshold	27 dB	*Fixation Losses*	NA	*Rx*	S C
Background	Black	*False POS Errors*	2/5 40%		
Test Duration	3:13	*False NEG Errors*	0/5 0%		







MD -0.72 dB
PSD 4.47 dB

:: P < 5%
P < 2%
P < 1%
P < 0.5%

0.4.6 Clicker

Patient:

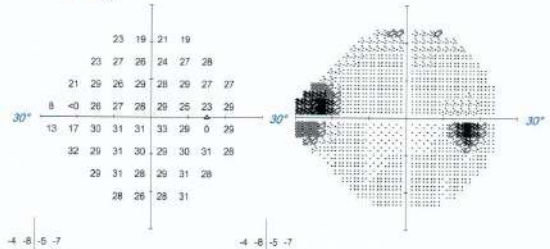
Date of Birth: Jan 12, 1955

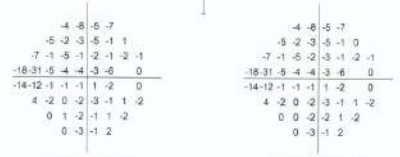
Gender: Other

Patient ID: 1955.0112.B204.E70C.5CF9.B435

OD Single Field Analysis — Central 24-2 Threshold Test

Fixation Monitor:	Gaze/Blind Spot	Stimulus:	III, White	Date:	Jan 11, 2022
Fixation Target:	Central	Background:	31.5 asb	Time:	12:02 PM
Fixation Losses:	0/15	Strategy:	SITA Standard	Age:	66
False POS Errors:	3%	Pupil Diameter:			
False NEG Errors:	0%	Visual Acuity:			
Test Duration:	05:14	Rx:	+2.25 DS		
Fovea:	31 dB				





GHT: Outside Normal Limits

VFI: 94%
MD24-2: -2.83 dB P < 2%
PSD24-2: 5.23 dB P < 0.5%

:: P < 5%
P < 2%
P < 1%
P < 0.5%

Comments

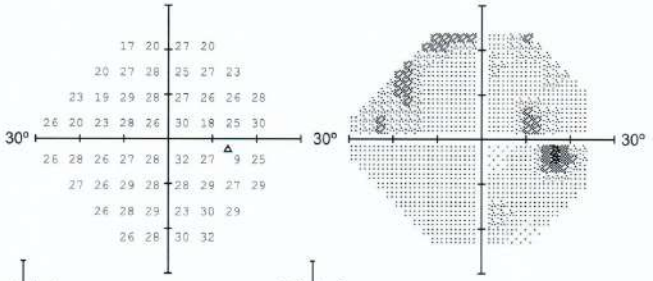
HFA 3 660-1207-11.0.2.43) Version 1.0.2.4 Created: 1/11/2022 2:39:32 PM by Administrator Page 1 of 1

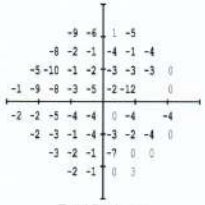
DOB: 1955-01-12
MRN: None

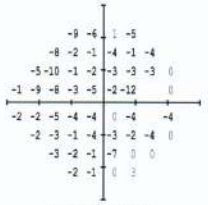
Central 24-2 Threshold Test
Jan 11, 2022 - 12:48 PM

Right Eye

Fixation Monitor	ActiveTrack™	*Strategy*	re:Imagine™	*Age*	66
Stimulus	Dynamic, White	*Input*	Clicker	*VA*	Not Provided
Foveal Threshold	30 dB	*Fixation Losses*	NA	*Rx*	S C
Background	Black	*False POS Errors*	1/6 17%		
Test Duration	3:44	*False NEG Errors*	0/6 0%		







MD -3.38 dB
PSD 3.06 dB

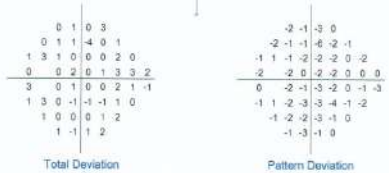
:: P < 5%
P < 2%
P < 1%
P < 0.5%

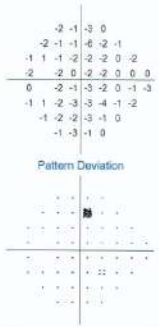
0.4.6 Clicker

Patient:
Date of Birth: Jan 12, 1955
Gender: Other
Patient ID: 1955.0112.B204.E70C.5CF9.B435

OS Single Field Analysis — Central 24-2 Threshold Test

Fixation Monitor:	Gaze/Blind Spot	Stimulus:	III, White	Date:	Jan 11, 2022
Fixation Target:	Central	Background:	31.5 asb	Time:	12:09 PM
Fixation Losses:	0/15	Strategy:	SITA Standard	Age:	66
False POS Errors:	0%	Pupil Diameter:			
False NEG Errors:	0%	Visual Acuity:			
Test Duration:	04:38	Rx:	+2.50 DS		
Fovea:	37 dB				





GHT: Within Normal Limits

VFI: 100%
MD24-2: 0.63 dB
PSD24-2: 1.30 dB

:: P < 5%
P < 2%
P < 1%
P < 0.5%

Comments

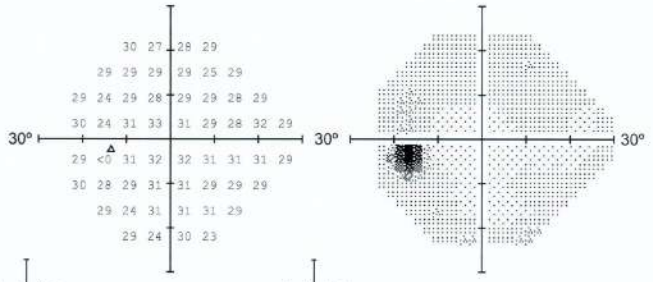
HFA 3 860-12/07a/1.5.2.431 Version 1.0.2.4 Created: 1/11/2022 2:56:46 PM by Administrator Page 1 of 1

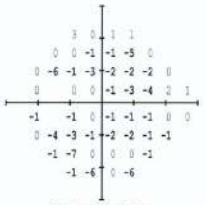
DOB: 1955-01-12
MRN: None

Central 24-2 Threshold Test
Jan 11, 2022 - 12:54 PM

Left Eye

Fixation Monitor	ActiveTrack™	*Strategy*	**re:**Imagine™	*Age*	66
Stimulus	Dynamic, White	*Input*	Clicker	*VA*	Not Provided
Foveal Threshold	33 dB	*Fixation Losses*	NA	*Rx*	S C
Background	Black	*False POS Errors*	0/5 0%		
Test Duration	2:53	*False NEG Errors*	0/6 0%		





MD -0.47 dB
PSD 2.08 dB

:: P < 5%
P < 2%
P < 1%
P < 0.5%

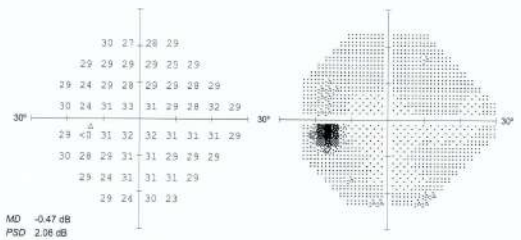
0.4.6 Clicker

DOB: 1955-01-12
MRN: None

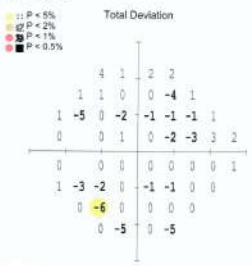
Central 24-2 Threshold Test
Jan 11, 2022 - 12:54 PM

Left Eye

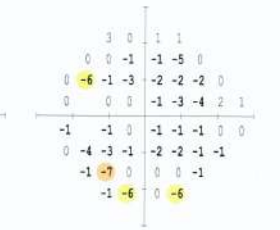
Fixation Monitor	ActiveTrack™	*Strategy*	re:Imagine™	*Age*	66
Stimulus	Dynamic, White	*Input*	Clicker	*VA*	Not Provided
Foveal Threshold	33 dB	*Fixation Losses*	NA	*Rx*	S C
Background	Black	*False POS Errors*	0/5 0%		
Test Duration	2:53	*False NEG Errors*	0/6 0%		



MD -0.47 dB
PSD 2.06 dB



Total Deviation



Pattern Deviation

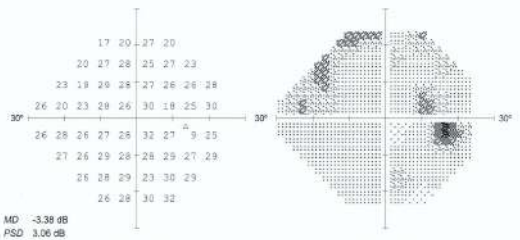
0.4.6 Clicker

DOB: 1955-01-12
MRN: None

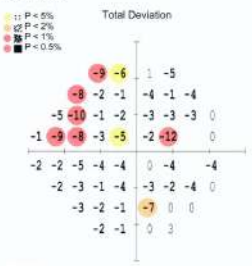
Central 24-2 Threshold Test
Jan 11, 2022 - 12:48 PM

Right Eye

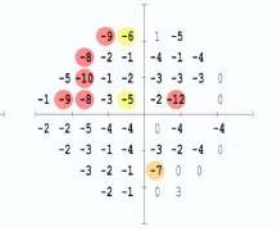
Fixation Monitor	ActiveTrack™	*Strategy*	re:Imagine™	*Age*	66
Stimulus	Dynamic, White	*Input*	Clicker	*VA*	Not Provided
Foveal Threshold	30 dB	*Fixation Losses*	NA	*Rx*	S C
Background	Black	*False POS Errors*	1/6 17%		
Test Duration	3:44	*False NEG Errors*	0/6 0%		



MD -3.38 dB
PSD 3.06 dB

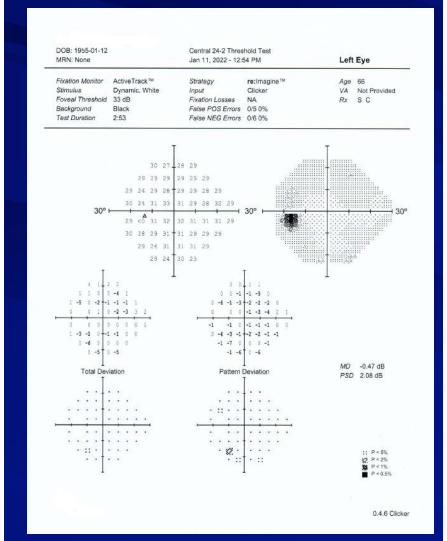


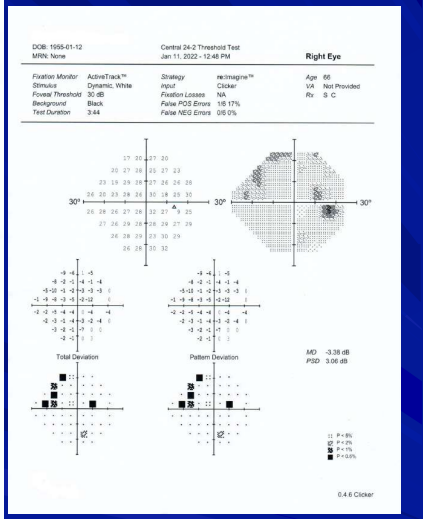
Total Deviation



Pattern Deviation

0.4.6 Clicker



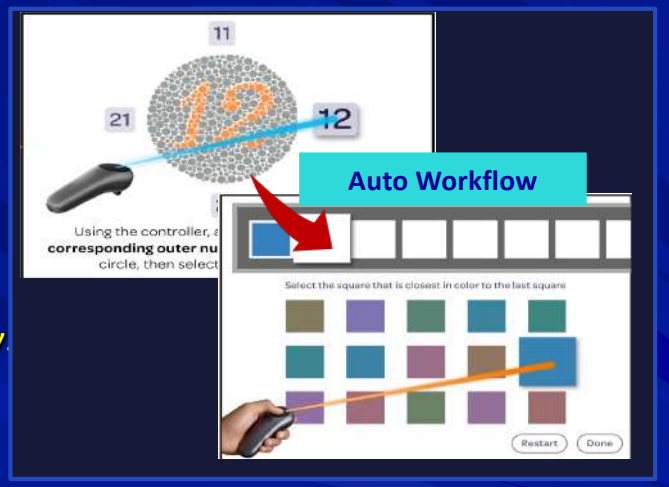


Patients' Thoughts

re:Vive 2.0 – Color Vision

Ishihara Color Vision Screening

- Ishihara color vision testing is a commonly used rapid, color vision screening modality.
- This test can be completed in under 2 minutes.
- 3 or more Ishihara plates incorrect will trigger the D-15 extended vision test using AutoWorkflow.™



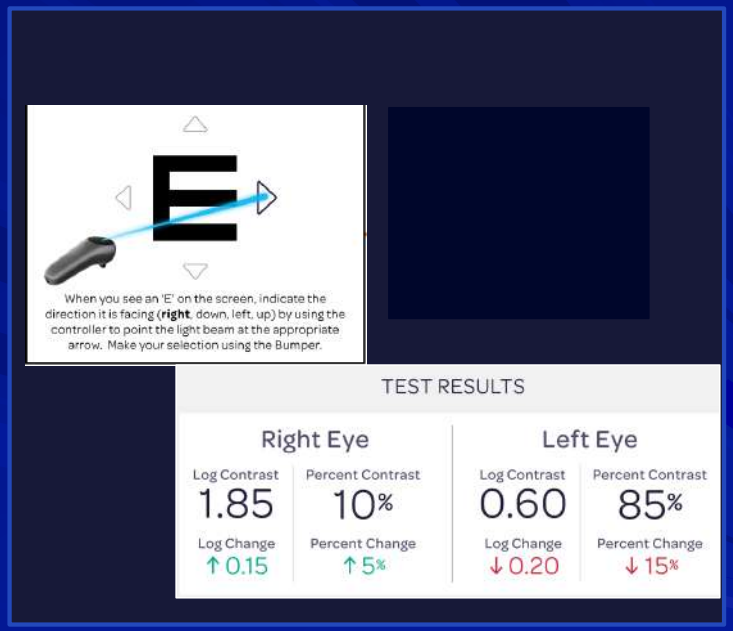
Farnsworth D-15 Extended Color Vision Test

- D-15 color vision testing is a commonly used color vision diagnostic modality.
- D-15 test is a **reimbursable** service: **CPT Code 92283**.
- **Average national reimbursement is $56.16[3].**
- This is more advanced than any color vision testing currently being offered by competitor goggle companies.

Technician and/or clinician not required to administer exam.

re:Vive 2.0 - Contrast Sensitivity

- Embracing the science connecting contrast sensitivity with detecting early AMD, re:Vive provides the most efficient way to document and monitor the functional macular health in conjunction with supplementation.
- We are reporting the change over time from the last visit. The doctor can use this change to communicate the benefits of lifestyle modifications, smoking cessation.
- Moves test out of the exam lane with the screening being performed in full room lighting.
- Contrast Sensitivity (and Dark Adaptation) are part of a broader AMD screening and diagnostic portfolio.



Technician and/or clinician not required to administer exam.

Corneal Hysteresis

Ocular Response Analyzer G3

- Evidence - Key findings from over 800 peer-reviewed publications
- Impact of corneal biomechanics on IOP

Hysteresis

What it is – What it is NOT

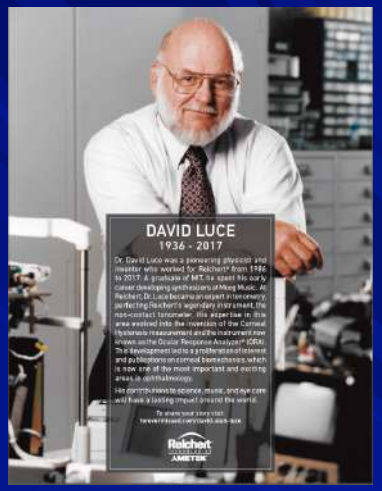
Hysteresis characterizes the response to application and removal of force in materials that ***dissipate a portion of applied energy*** [1]

- *Not a new concept (term defined in 1890)*
- *13,000+ medical publications on hysteresis in a variety of fields* [2]

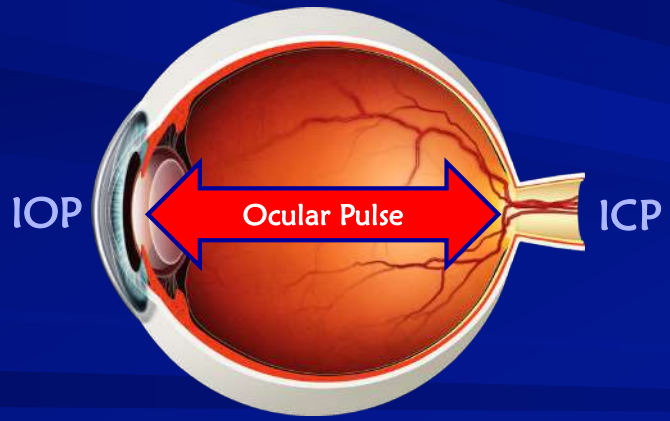
Corneal Hysteresis (CH)

Reflects cornea's ability to ***absorb and dissipate energy*** [3]

- An indication of "damping" capacity of the ocular tissue
  - **NOT an indication of "stiffness" or "rigidity"**



David Luce PhD 1935-2017
Pioneered Corneal Hysteresis



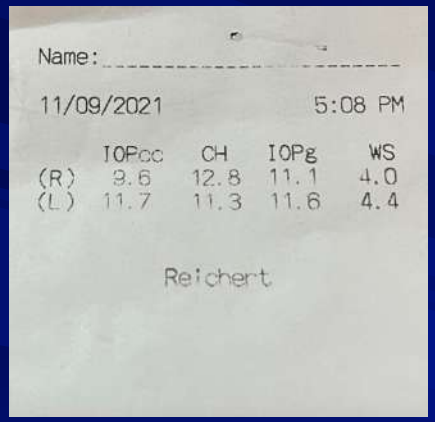
"The eye is under a constant assault"

Hysteresis tells us "How good of a shock absorber" the eye is.

1. Vincent J. Basic elasticity and viscoelasticity. In: Vincent J, ed. *Structural Biomaterials.* 3rd ed. Princeton, NJ: Princeton University Press; 2012:1-28.
2. PubMed Search for "hysteresis" on Mach 11, 2021 returned 13,766 results.
3. Luce DA. *J Cataract Refract Surg.* 2005;31:156-162.

Ocular Response Analyzer G3

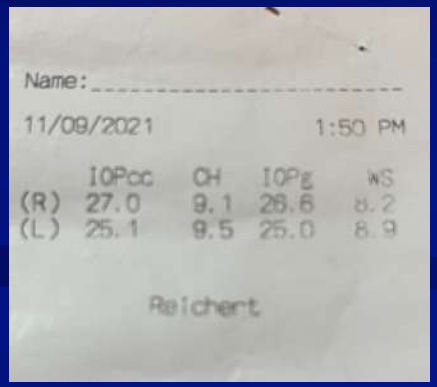
Measurement Values, Range, and Interpretation


Name:

11/09/2021 5:08 PM

	IOPcc	CH	IOPg	WS
(R)	9.6	12.8	11.1	4.0
(L)	11.7	11.3	11.6	4.4

Reichert


Name:

11/09/2021 1:50 PM

	IOPcc	CH	IOPg	WS
(R)	27.0	9.1	26.6	8.2
(L)	25.1	9.5	25.0	8.9

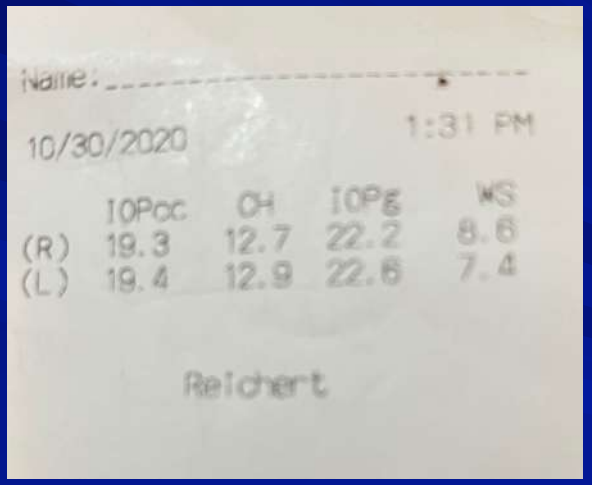
Reichert


Name:

11/09/2021 6:14 PM

	IOPcc	CH	IOPg	WS
(R)	17.3	8.6	14.8	6.3
(L)	15.2	9.6	13.6	7.1

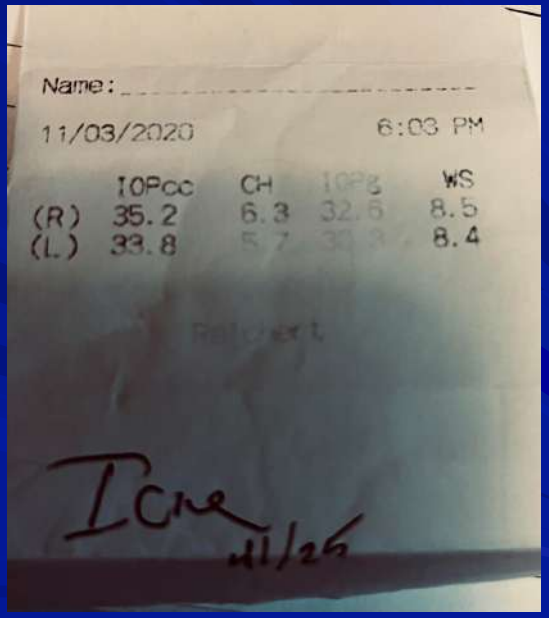
Reichert


Name:

10/30/2020 1:31 PM

	IOPcc	CH	IOPg	WS
(R)	19.3	12.7	22.2	8.6
(L)	19.4	12.9	22.6	7.4

Reichert


Name:

11/03/2020 6:03 PM

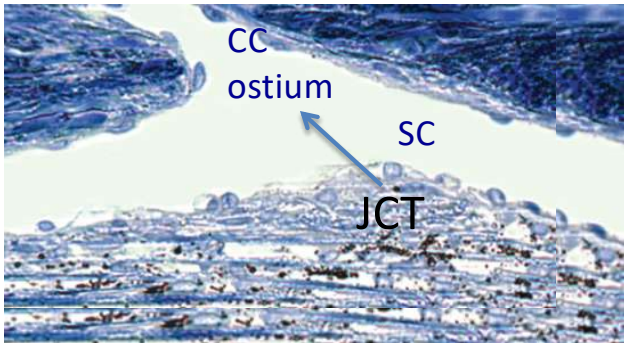
	IOPcc	CH	IOPg	WS
(R)	35.2	6.3	32.6	8.5
(L)	33.8	5.7	30.3	8.4

Reichert

ICM 11/25

Inflow versus Outflow

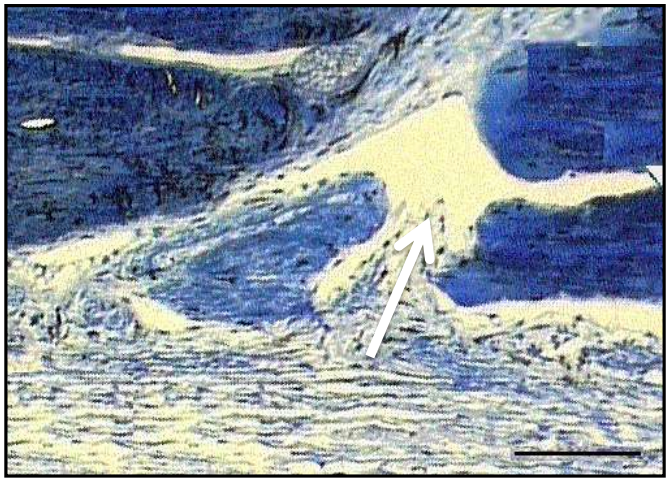
What is glaucoma?



PROGRESSIVE ELEVATIONS OF IOP CREATE PROGRESSIVELY GREATER HERNIATIONS OF THE JCT AND THE INNER WALL OF SCHLEMM'S CANAL INTO THE COLLECTOR CHANNELS LUMENS

7 mmHg

JCT



Partial

Complete

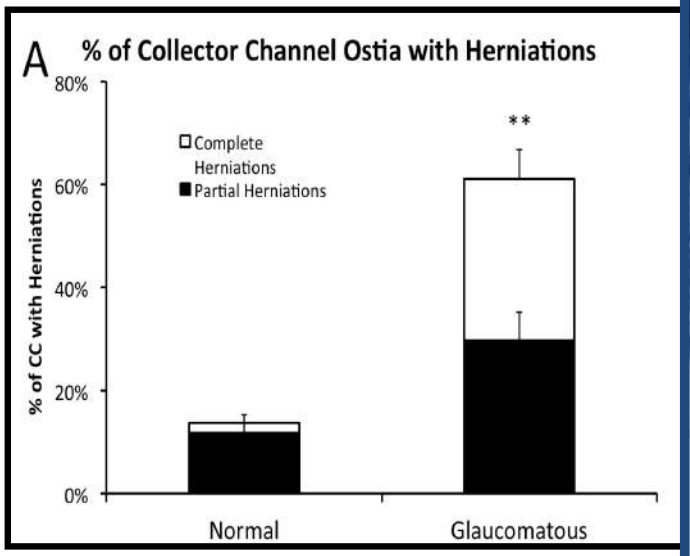
30 mmHg

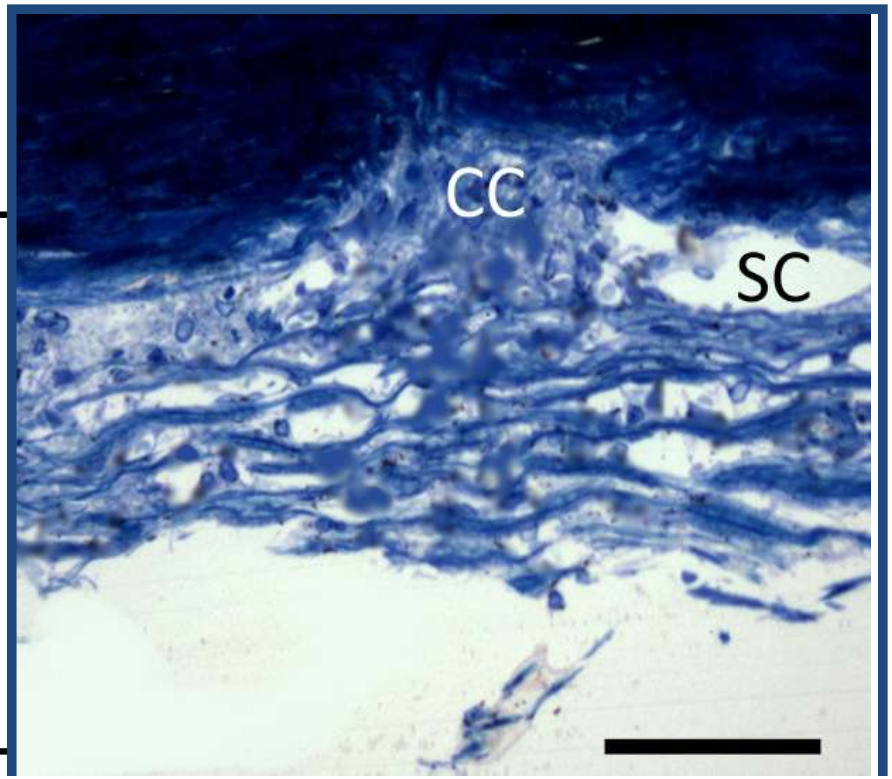
The pressure-induced herniations observed at 30 mmHg were either partially or completely reversible after the IOP was decreased to 7 mmHg in enucleated bovine eyes. So, in normal eyes, these herniations slide in and out with regular rise and fall of IOP.

Human eyes with POAG even at 0mmHg, exhibit herniations and many more than in age-matched normal eyes

A: Significantly more herniations of the TM into CC ostia were found in POAG eyes (33 of 54), than in normal eyes (7 of 51) (61% vs. 14%, $p<0.0001$). In normal eyes, herniations that were present were predominantly partial (86%) rather than complete (14%). In POAG eyes, over half of the larger total number of herniations were complete (52%).

Battista SA, Lu Z, Hofmann S, **Freddo TF**, Overby DR, Gong H**:** Acute IOP elevation reduces the available area for aqueous humor outflow and induces meshwork herniations into collector channels of bovine eyes. Invest. Ophthalmol. Vis. Sci., 49:5346-52, 2008.



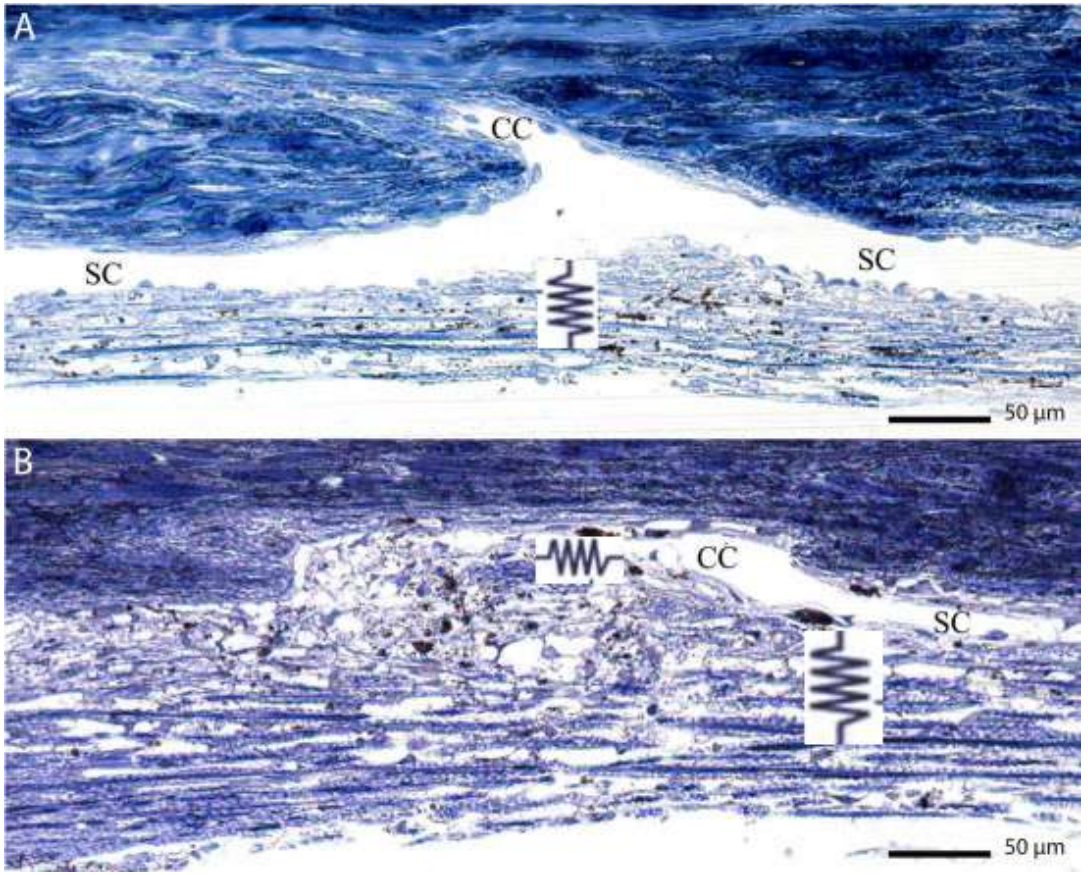


PRINCIPAL NEW FINDING

The presence of herniations, at O mm Hg, suggests they were permanent *in-vivo* obstructions in the ostia of CC, whether partial or complete. These are the only exits from Schlemm's canal. If enough of these 30 channels are fully or even partially blocked, IOP MUST go up.

This study is the first to document the existence of permanent herniations into CC ostia in POAG.

Since resistances in series are additive, it could be that these previously unreported permanent herniations, which obstruct CC ostia, represent an additional source of resistance, distal to the trabecular meshwork, in POAG.

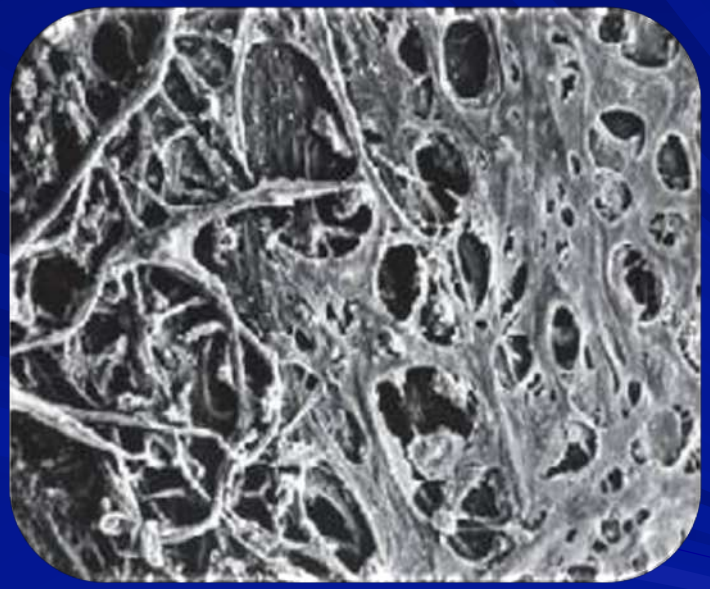


Disease at the TM is responsible for elevated IOP in glaucoma[1,2]

Healthy TM
Normal IOP

Cellular Damage
(eg, Oxidative Stress)

POAG TM Stiffness
Elevated IOP



Scanning electron microscopy (2000x) was used to examine human TM under physiological conditions and in patients with POAG.[2]
POAG, primary open-angle glaucoma; TM, trabecular meshwork.

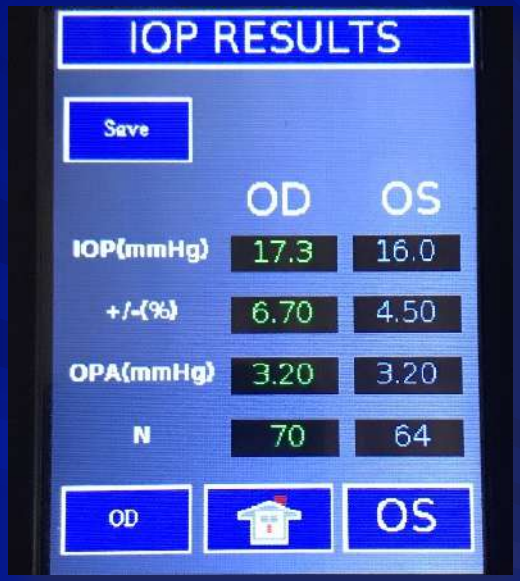
1. He et al. *Invest Ophthalmol Vis Sci*. 2008;49:1447.
2. Saccà et al. *J Cell Physiol.* 2015;230:510.

Falck Medical Multi-Function Device ™

- The First and Only Device Approved by the FDA for the Measurement of:
  - ★ Aqueous Outflow
  - ★ Ocular Perfusion Pressure
  - ★ IOP Variation

Tonometry

- Optical Applanation IOP Measurement
- Compensates for Corneal Biomechanics
- Serial Systolic and Diastolic IOP
- Ocular Pulse Amplitude
- Disposable Prism Blocks Infection



Ophthalmodynamometry

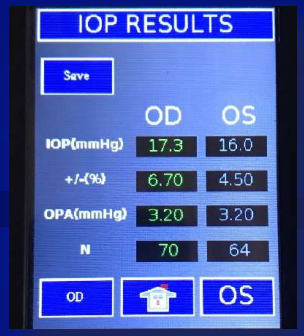
- Central Retinal Artery Pressure
- Intraocular Pressure
- Ocular Perfusion Pressure
- Vascular Disease Risk Assessment
- Screen for Carotid Vascular Disease

Tonography

- Optical Aqueous Outflow Measurement
- Intraocular Pressure
- Verify Outflow Therapy Interventions
- Glaucoma Risk Determination
- Glaucoma Management Tool

Aqueous Humor Outflow, Tonography

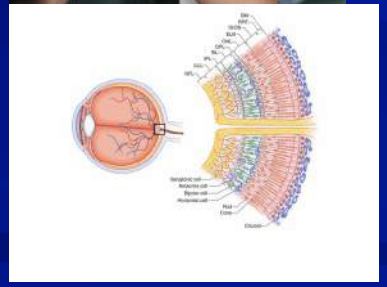
- IOP spikes are higher in an eye with impaired aqueous humor outflow
- When aqueous humor production increases
  - ★ The impaired outflow system cannot accommodate the increased aqueous volume
- Impaired aqueous humor outflow is the primary cause of glaucoma
- Eyes with untreated glaucoma have abnormal aqueous humor outflow
- Therapy should be directed at improving the rate of aqueous humor outflow

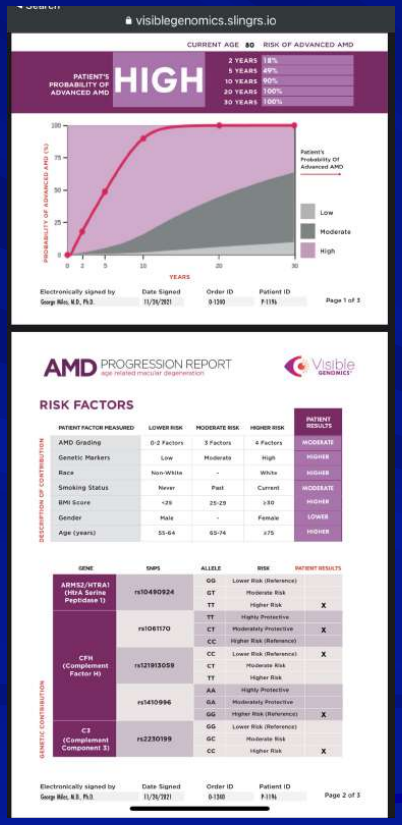


Early Detection and Allopathic Treatments

Rabin Cone Contrast Test

ERG and VEP





Early Detection

- Patients are expecting it
- Diagnostic equipment keeps evolving

- Rabin Cone Contrast Test
- Genetic Testing
- Dark Adaptation
- Preferential Hyperacuity Perimetry (PHP)
- ERG/VEP testing

Greg's Something to Think About or Advice:

One better understand lifestyle changes, the immune system, and nutrition.

As we are now in areas where "there isn't a pill for that ill"

"Doctors better become more like a nutritionist, or the nutritionist will become more like doctors."

Credit to: James LaValle, RPh, CCN

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2 of 3 PATIENT'S RISK OF ED AMD **LOW**

CONTRIBUTION TO RISK RESULTS

The AMD Lifetime Risk is calculated based upon the patient's genetics, ocular findings, demographic and behavior status. The table below lists the patient's individual factors contributing to their individual risk.

RISK FACTORS

DESCRIPTION OF CONTRIBUTION

PATIENT FACTOR MEASURED	LOWER RISK	MODERATE RISK	HIGHER RISK	PATIENT RESULTS
AMD Grading	0-2 Factors	3 Factors	4 Factors	LOWER
Genetic Markers	Low	Moderate	High	LOWER
Race	Non-White	-	White	HIGHER
Smoking Status	Never	Past	Current	LOWER
BMI Score	<25	25-29	≥30	HIGHER
Gender	Male	-	Female	LOWER
Age (years)	55-64	65-74	≥75	LOWER

Electronically signed by	Date Signed	Order ID	Patient ID
George Miles, M.D., Ph.D.	12/01/2021	0-1235	P-1192

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AMD LIFETIME RISK REPORT age related macular degeneration — Visible GENOMICS

RISK FACTORS

GENETIC CONTRIBUTION

GENE	SNPS	ALLELE	RISK	PATIENT RESULTS
ARMS2/HTRA1 (HtrA Serine Peptidase 1)	rs10490924	GG	Lower Risk (Reference)	X
		GT	Moderate Risk	
		TT	Higher Risk	
CFH (Complement Factor H)	rs1061170	TT	Highly Protective	X
		CT	Moderately Protective	
		CC	Higher Risk (Reference)	
	rs121913059	CC	Lower Risk (Reference)	X
		CT	Moderate Risk	
		TT	Higher Risk	
	rs1410996	AA	Highly Protective	
		GA	Moderately Protective	X
		GG	Higher Risk (Reference)	
C3 (Complement Component 3)	rs2230199	GG	Lower Risk (Reference)	X
		GC	Moderate Risk	
		CC	Higher Risk	

Electronically signed by	Date Signed	Order ID	Patient ID
George Miles, M.D., Ph.D.	[redacted]	[redacted]	[redacted]

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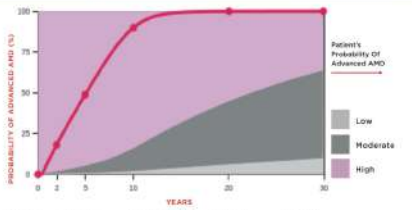
CURRENT AGE **60** RISK OF ADVANCED AMD

PATIENT'S PROBABILITY OF ADVANCED AMD **HIGH**

2 YEARS	18%
5 YEARS	49%
10 YEARS	90%
20 YEARS	100%
30 YEARS	100%



Electronically signed by	Date Signed	Order ID	Patient ID
George Miles, M.D., Ph.D.	11/24/2021	0-1200	P-1196

AMD PROGRESSION REPORT age related macular degeneration — Visible GENOMICS

RISK FACTORS

DESCRIPTION OF CONTRIBUTION

PATIENT FACTOR MEASURED	LOWER RISK	MODERATE RISK	HIGHER RISK	PATIENT RESULTS
AMD Grading	0-2 Factors	3 Factors	4 Factors	MODERATE
Genetic Markers	Low	Moderate	High	HIGHER
Race	Non-White	-	White	HIGHER
Smoking Status	Never	Past	Current	MODERATE
BMI Score	<25	25-29	≥30	HIGHER
Gender	Male	-	Female	LOWER
Age (years)	55-64	65-74	≥75	HIGHER

GENETIC CONTRIBUTION

GENE	SNPS	ALLELE	RISK	PATIENT RESULTS
ARMS2/HTRA1 (HtrA Serine Peptidase 1)	rs10490924	GG	Lower Risk (Reference)	
		GT	Moderate Risk	
		TT	Higher Risk	X
CFH (Complement Factor H)	rs1061170	TT	Highly Protective	
		CT	Moderately Protective	X
		CC	Higher Risk (Reference)	
	rs121913059	CC	Lower Risk (Reference)	X
		CT	Moderate Risk	
		TT	Higher Risk	
	rs1410996	AA	Highly Protective	
		GA	Moderately Protective	
		GG	Higher Risk (Reference)	X
C3 (Complement Component 3)	rs2230199	GG	Lower Risk (Reference)	
		GC	Moderate Risk	
		CC	Higher Risk	X

Electronically signed by	Date Signed	Order ID	Patient ID
George Miles, M.D., Ph.D.	11/24/2021	0-1200	P-1196

visiblegenomics.slingrs.io

2 of 3 PATIENT'S RISK OF ED AMD **MODERATE**

CONTRIBUTION TO RISK RESULTS

The AMD Lifetime Risk is calculated based upon the patient's genetics, ocular findings, demographic and behavior status. The table below lists the patient's individual factors contributing to their individual risk.

RISK FACTORS

DESCRIPTION OF CONTRIBUTION

PATIENT FACTOR MEASURED	LOWER RISK	MODERATE RISK	HIGHER RISK	PATIENT RESULTS
AMD Grading	0-2 Factors	3 Factors	4 Factors	LOWER
Genetic Markers	Low	Moderate	High	MODERATE
Race	Non-White	-	White	HIGHER
Smoking Status	Never	Past	Current	LOWER
BMI Score	<25	25-29	≥30	LOWER
Gender	Male	-	Female	HIGHER
Age (years)	55-64	65-74	≥75	LOWER

Electronically signed by	Date Signed	Order ID	Patient ID
George Miles, M.D., Ph.D.	11/24/2021	0-1239	P-1195

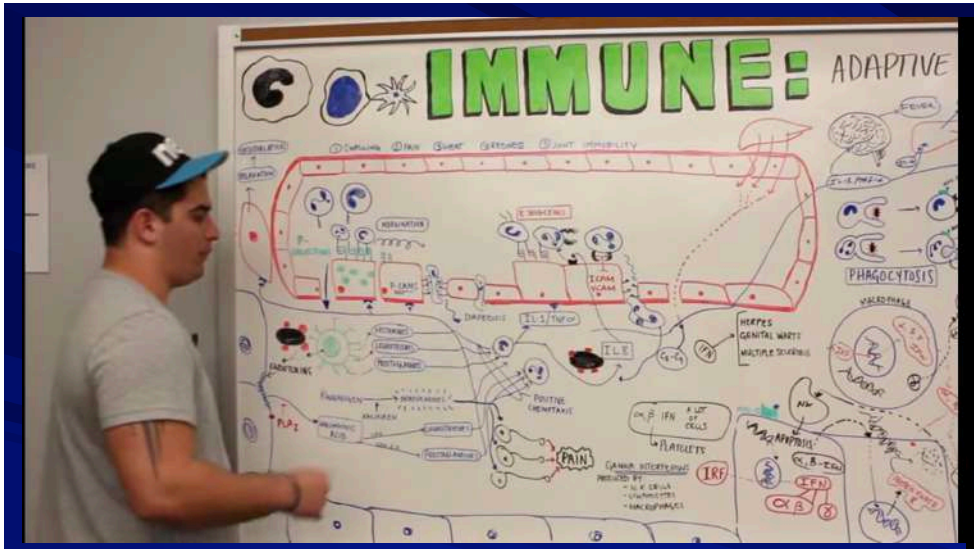
AMD LIFETIME RISK REPORT age related macular degeneration — Visible GENOMICS

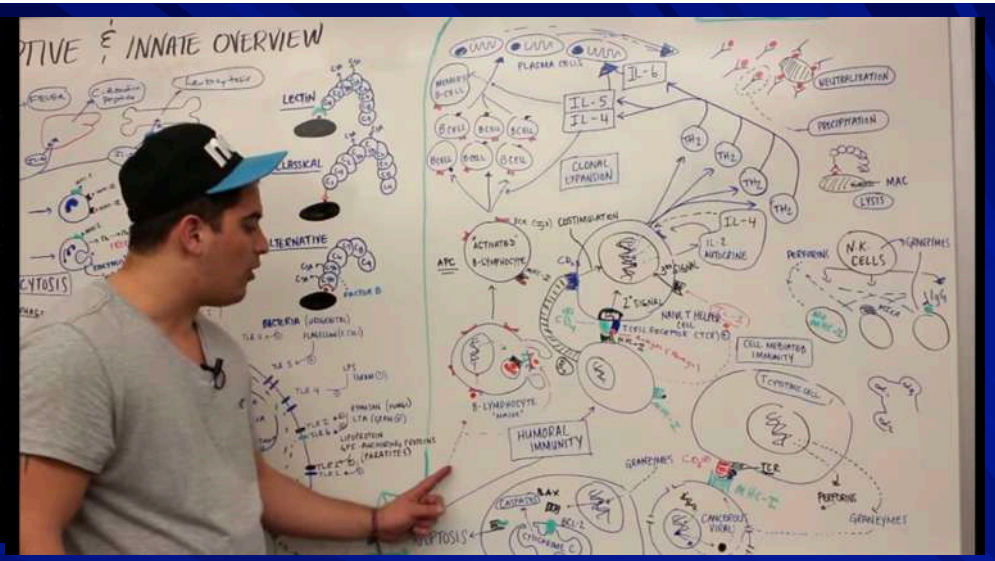
RISK FACTORS

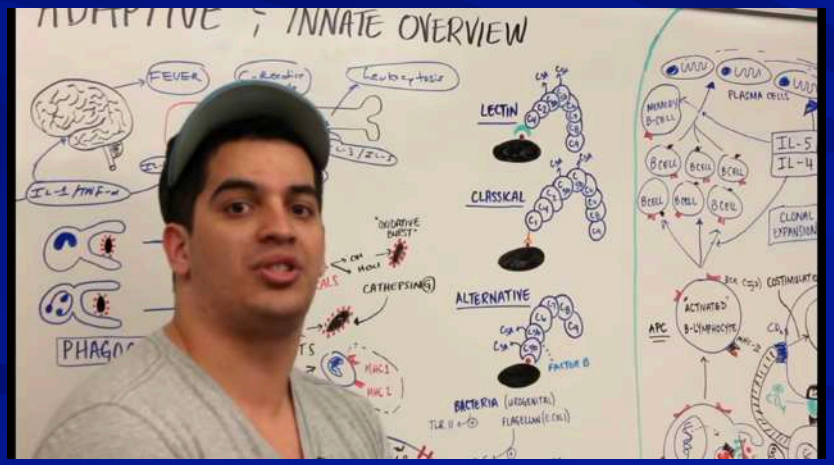
GENETIC CONTRIBUTION

GENE	SNPS	ALLELE	RISK	PATIENT RESULTS
ARMS2/HTRA1 (HtrA Serine Peptidase 1)	rs10490924	GG	Lower Risk (Reference)	
		GT	Moderate Risk	X
		TT	Higher Risk	
CFH (Complement Factor H)	rs1061170	TT	Highly Protective	X
		CT	Moderately Protective	
		CC	Higher Risk (Reference)	
	rs121913059	CC	Lower Risk (Reference)	X
		CT	Moderate Risk	
		TT	Higher Risk	
	rs1410996	AA	Highly Protective	
		GA	Moderately Protective	X
		GG	Higher Risk (Reference)	
C3 (Complement Component 3)	rs2230199	GG	Lower Risk (Reference)	
		GC	Moderate Risk	X
		CC	Higher Risk	

Electronically signed by	Date Signed	Order ID	Patient ID
George Miles, M.D., Ph.D.	[redacted]	[redacted]	[redacted]







Ninja Nerd Science
YouTube

Complement factor H in AMD: Bridging genetic associations and pathobiology

Christopher B. Toomey [a, b, 1] ... Catherine Bowes Rickman [a, b]

Show more

Outline | Share | Cite

https://doi.org/10.1016/j.preteyeres.2017.09.001

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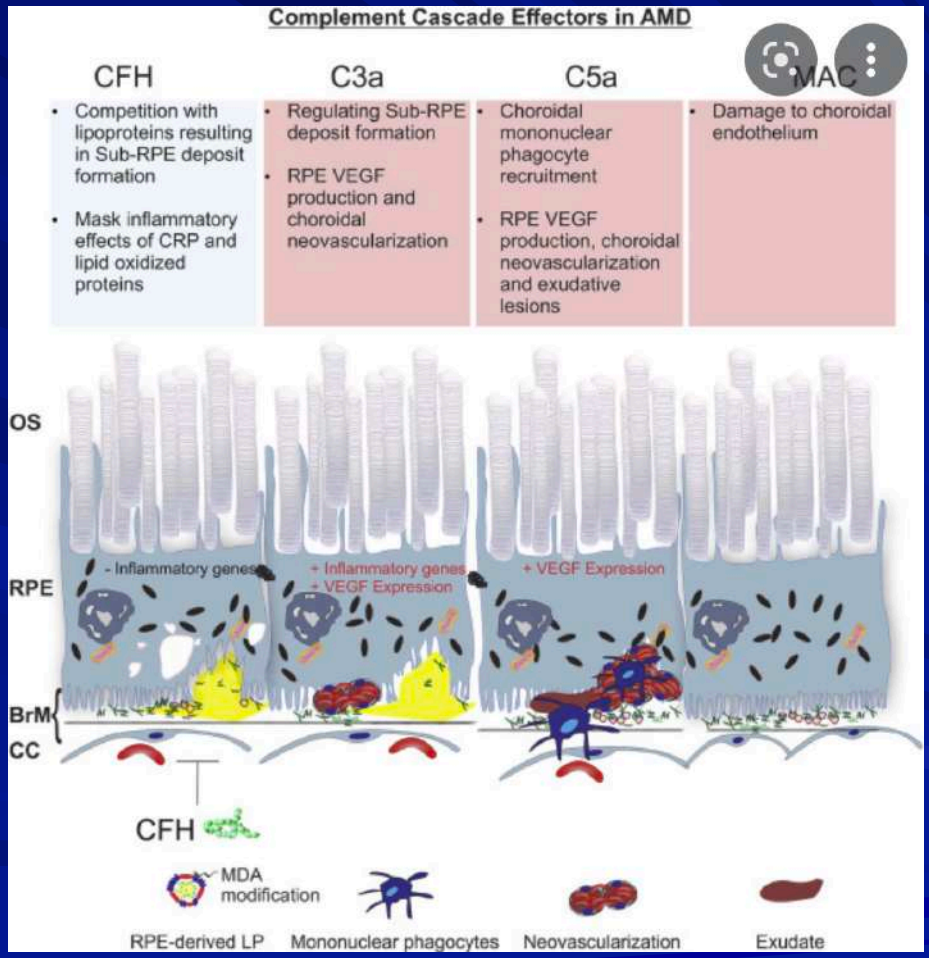
Abstract

Age-Related Macular Degeneration (AMD) is a complex multifactorial disease characterized in its early stages by lipoprotein accumulations in Bruch's Membrane (BrM), seen on fundoscopic exam as drusen, and in its late forms by neovascularization ("wet") or geographic atrophy of the Retinal Pigmented Epithelial (RPE) cell layer ("dry"). Genetic studies have strongly supported a relationship between the alternative complement cascade, in particular the common H402 variant in Complement Factor H (CFH) and development of AMD. However, the functional significance of the CFH Y402H polymorphism remains elusive. In this

FEEDBACK

sciencedirect.com



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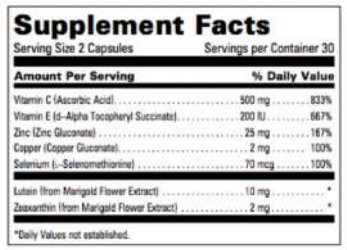
Home » Research at NEI » Clinical Trials » Age-Related Eye Disease Studies (AREDS/AREDS2) » AREDS/AREDS2 Frequently Asked Questions

AREDS/AREDS2 Frequently Asked Questions

Ingredients



Supplement Facts

Serving Size 2 Capsules — Servings per Container 30

Amount Per Serving		% Daily Value
Vitamin C (Ascorbic Acid)	500 mg	833%
Vitamin E (d-Alpha Tocopheryl Succinate)	200 IU	667%
Zinc (Zinc Gluconate)	25 mg	167%
Copper (Copper Gluconate)	2 mg	100%
Selenium (L-Selenomethionine)	70 mcg	100%
Lutein (from Marigold Flower Extract)	10 mg	*
Zeaxanthin (from Marigold Flower Extract)	2 mg	*

*Daily Values not established.

Other Ingredients: Gelatin, Microcrystalline Cellulose, Stearic Acid, Silicon Dioxide, Magnesium Stearate.

What is the basis for the concentration of zinc in the AREDS supplements? What concentration should I take?

In the AREDS trial, the 80 mg zinc dose (alone or in combination with antioxidant vitamins) was found to be effective compared to a placebo. Although zinc was found to be an essential component of the AREDS formulation, some nutritional experts recommended a lower dose. In the AREDS2 trial, there was no placebo control. Instead, participants were given the option to take the original formula or to be randomly assigned to receive a modified version, such as a formula containing 25 mg zinc. The investigators did not find a difference in the effects of 80 mg vs. 25 mg zinc. Because AREDS2 did not include a placebo control, results from AREDS, placebo-controlled trial, are still considered the gold standard.

Zinc is found in vegetables, grains, and meat. Vegetables and grains contain other molecules that can prevent zinc absorption and thus reduce its bioavailability. Supplements contain purified zinc, without these competing molecules. Although the chemical form of zinc affects its rate of absorption in the stomach, it is not clear how this affects bioavailability (i.e., the amount of zinc that reaches the retina). For more on this topic, please see the zinc fact sheet from the NIH Office of Dietary Supplements.

PubMed.gov

Advanced

Randomized Controlled Trial

Treatment response to antioxidants and zinc based on CFH and ARMS2 genetic risk allele number in the Age-Related Eye Disease Study

Carl C Awh et al. Ophthalmology. 2015 Jan.

Show details

Full text links | Cite | ...

Abstract

Objective: To evaluate the impact of complement factor H (CFH) and age-related maculopathy susceptibility 2 (ARMS2) risk alleles on the observed response to components of the Age-Related Eye Disease Study (AREDS) formulation.

Design: Genetic and statistical subgroup analysis of a randomized, prospective clinical trial.

Participants: White patients from the AREDS with category 3 or 4 age-related macular degeneration (AMD) with available DNA (n = 989).

Results: Patients with 2 CFH risk alleles and no ARMS2 risk alleles progressed more with zinc-containing treatment compared with placebo, with a hazard ratio (HR) of 3.07 (P = 0.0196) for zinc and 2.73 (P = 0.0418) for AREDS formulation (AF). Seven-year treatment-specific progression rates were: placebo, 17.0%; zinc, 43.2% (P = 0.023); and AF, 40.2% (P = 0.039). Patients with 0 or 1 CFH risk alleles and 1 or 2 ARMS2 risk alleles benefited from zinc-containing treatment compared with placebo, with an HR of 0.514 for zinc (P = 0.012) and 0.569 for AF (P = 0.0254). Seven-year treatment-specific AMD progression rates were as follows: placebo, 43.3%; zinc, 25.2% (P = 0.020); and AF, 27.3% (P = 0.011). Zinc and AF treatment each interacted statistically with these 2 genotype groups under a Cox model, with P values of 0.000999 and 0.00366, respectively. For patients with 0 or 1 CFH risk alleles and no ARMS2 risk alleles, neither zinc-containing treatment altered progression compared with placebo, but treatment with antioxidants decreased progression (HR, 0.380; P = 0.034). Seven-year progression with placebo was 22.6% and with antioxidants was 9.17% (P = 0.033). For patients with 2 CFH risk alleles and 1 or 2 ARMS2 risk alleles, no treatment was better than placebo (48.4%).

Conclusions: The benefit of the AREDS formulation seems the result of a favorable response by patients in only 1 genotype group, balanced by neutral or unfavorable responses in 3 genotype groups.

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RESEARCH ARTICLE | OPEN ACCESS

CFH and *ARMS2* genetic risk determines progression to neovascular age-related macular degeneration after antioxidant and zinc supplementation

Demetrios G. Vavvas, Kent W. Small, Carl C. Awh, +2, and Rafal Kustra Authors Info & Affiliations

January 8, 2018 | 115 (4) E696-E704

https://doi.org/10.1073/pnas.1718059115

Genetic Polymorphisms of *CFH* and *ARMS2* Do Not Predict Response to Antioxidants and Zinc in Patients with Age-Related Macular Degeneration

Independent Statistical Evaluations of Data from the Age-Related Eye Disease Study

Melissa J. Assel, MS,[1,2] Fan Li, MS,[1,2] Ying Wang, PhD,[1,2] Andrew S. Allen, PhD,[1,2] Kirk A. Baggerly, PhD,[3,4] Andrew J. Vickers, PhD[1,2]

Purpose: Considerable controversy has erupted in recent years regarding whether genotyping should be part of standard care for patients with age-related macular degeneration (AMD) who are being considered for treatment with antioxidants and zinc. We aimed to determine whether genotype predicts response to supplements in AMD.

Design: Three separate statistical teams reanalyzed data derived from the Age-Related Eye Disease Study (AREDS), receiving data prepared by the AREDS investigators and, separately, data from investigators reporting findings that support the use of genotyping.

Participants: The population of interest was AREDS participants with AMD worse than category 1 and genotyping data available. Data from the 2 groups overlap imperfectly with respect to measurements made; the largest common set involved 979 participants for whom the same *CFH* and *ARMS2* single nucleotide polymorphisms were measured by both groups.

Methods: Each team took a separate but complementary approach. One team focused on data concordance between conflicting studies. A second team focused on replicating the key claim of an interaction between genotype and treatment. The third team took a blank slate approach in attempting to find baseline predictors of treatment response.

Main Outcome Measures: Progression to advanced AMD.

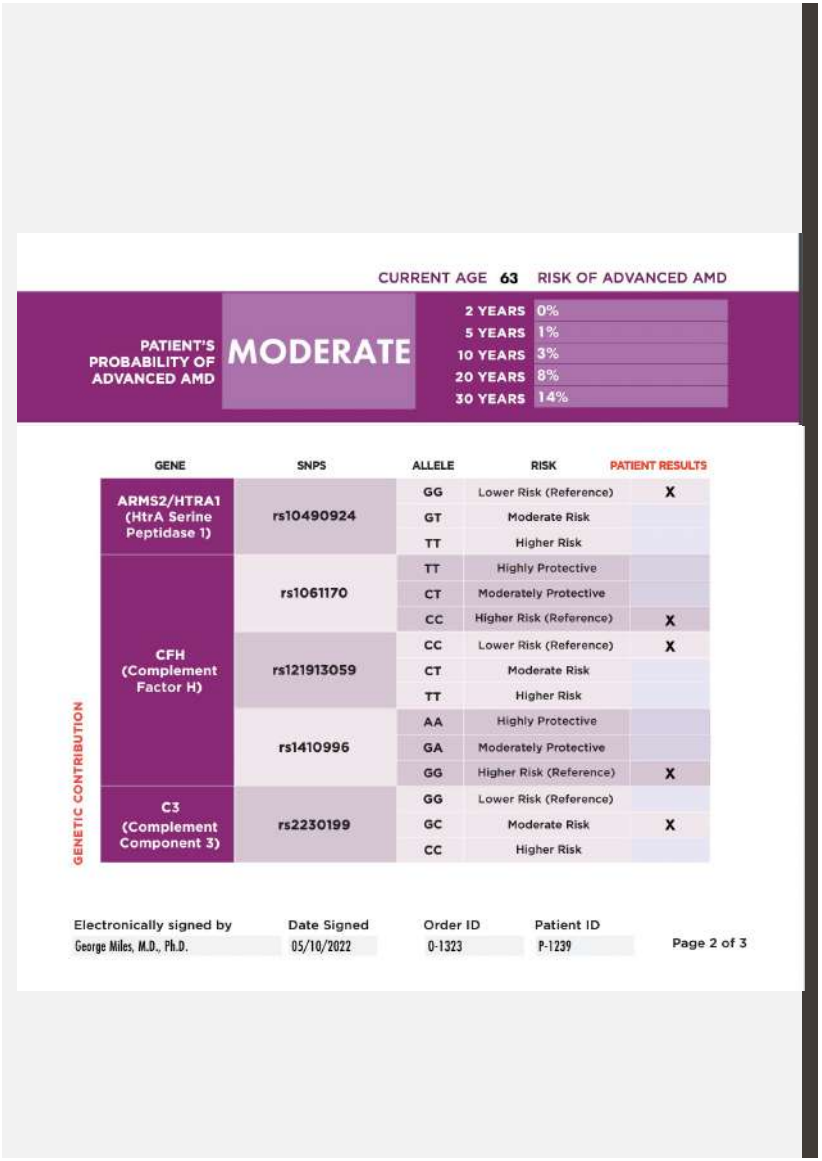
Results: We found errors in the data used to support the initial claim of genotype–treatment interaction. Although we found evidence that high-risk patients had more to gain from treatment, we were unable to replicate any genotype–treatment interactions after adjusting for multiple testing. We tested 1 genotype claim on an independent set of data, with negative results. Even if we assumed that interactions in fact did exist, we did not find evidence to support the claim that supplementation leads to a large increase in the risk of advanced AMD in some genotype subgroups.

Conclusions: Patients who meet criteria for supplements to prevent AMD progression should be offered zinc and antioxidants without consideration of genotype. Ophthalmology 2018;125:397-397 © 2017 by the American Academy of Ophthalmology

Supplemental material available at www.aaojournal.org.

The Age-Related Eye Disease Study (AREDS) was a large, multicenter, double-blind randomized trial to determine whether high-dose antioxidants, zinc, or their combination could reduce the risk of progression of age-related macular degeneration (AMD) in older patients. Excluding patients in AMD category 1, for whom the event rate was less than 1%, the combination of zinc and antioxidants was found to reduce the risk of progression to advanced AMD (odds ratio, 0.68; 95% confidence interval [CI], 0.49–0.93; $P = 0.002$).[1] The publication of the trial results led to rapid changes in practice, with at-risk patients routinely prescribed the zinc and antioxidant combination noted in the trial.

In 2008, Klein et al[2] published a pharmacogenomic study suggesting that the effects of antioxidants and zinc on AMD in AREDS may be influenced by genotype.



CURRENT AGE 63 RISK OF ADVANCED AMD

PATIENT'S PROBABILITY OF ADVANCED AMD: MODERATE

2 YEARS	0%
5 YEARS	1%
10 YEARS	3%
20 YEARS	8%
30 YEARS	14%

GENETIC CONTRIBUTION

GENE	SNPS	ALLELE	RISK	PATIENT RESULTS
ARMS2/HTRA1 (HtrA Serine Peptidase 1)	rs10490924	GG	Lower Risk (Reference)	X
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		GG	Higher Risk (Reference)	X
C3 (Complement Component 3)	rs2230199	GG	Lower Risk (Reference)	
		GC	Moderate Risk	X
		CC	Higher Risk	

Electronically signed by	Date Signed	Order ID	Patient ID	
George Miles, M.D., Ph.D.	05/10/2022	0-1323	P-1239	Page 2 of 3

Question

Would you recommend AREDS 2 or a supplement high dose Zinc?

A. Yes
B. No

Results: Patients with 2 CFH risk alleles and no ARMS2 risk alleles progressed more with zinc-containing treatment compared with placebo, with a hazard ratio (HR) of 3.07 (P = 0.0196) for zinc and 2.73 (P = 0.0418) for AREDS formulation (AF). Seven-year treatment-specific progression rates were: placebo, 17.0%; zinc, 43.2% (P = 0.023); and AF, 40.2% (P = 0.039). Patients with 0 or 1 CFH risk alleles and 1 or 2 ARMS2 risk alleles benefited from zinc-containing treatment compared with placebo, with an HR of 0.514 for zinc (P = 0.012) and 0.569 for AF (P = 0.0254). Seven-year treatment-specific AMD progression rates were as follows: placebo, 43.3%; zinc, 25.2% (P = 0.020); and AF, 27.3% (P = 0.011). Zinc and AF treatment each interacted statistically with these 2 genotype groups under a Cox model, with P values of 0.000999 and 0.00366, respectively. For patients with 0 or 1 CFH risk alleles and no ARMS2 risk alleles, neither zinc-containing treatment altered progression compared with placebo, but treatment with antioxidants decreased progression (HR, 0.380; P = 0.034). Seven-year progression with placebo was 22.6% and with antioxidants was 9.17% (P = 0.033). For patients with 2 CFH risk alleles and 1 or 2 ARMS2 risk alleles, no treatment was better than placebo (48.4%).

Conclusions: The benefit of the AREDS formulation seems the result of a favorable response by patients in only 1 genotype group, balanced by neutral or unfavorable responses in 3 genotype groups.

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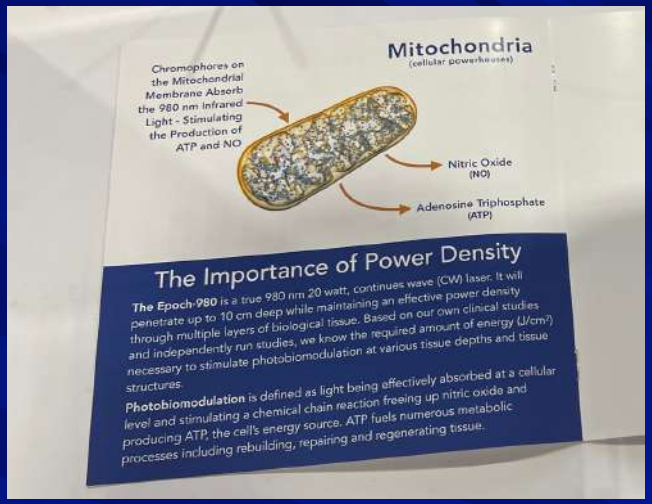
A4M
Longevity
FEST 2022
30TH ANNUAL WORLD CONGRESS
FRIDAY DECEMBER 9TH
10:30AM - 6:00PM

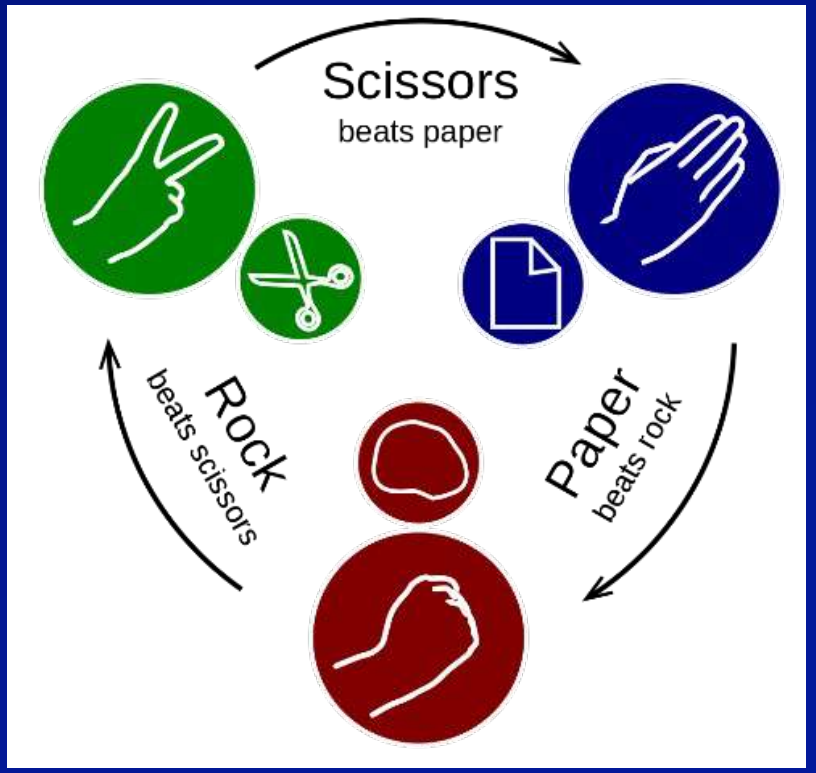

Mitochondria
(cellular powerhouses)
Chromophores on the Mitochondrial Membrane Absorb the 980 nm Infrared Light - Stimulating the Production of ATP and NO
Nitric Oxide (NO)
Adenosine Triphosphate (ATP)
The Importance of Power Density
The Epoch-980 is a true 980 nm 20 watt, continues wave (CW) laser. It will penetrate up to 10 cm deep while maintaining an effective power density through multiple layers of biological tissue. Based on our own clinical studies and independently run studies, we know the required amount of energy (J/cm²) necessary to stimulate photobiomodulation at various tissue depths and tissue structures.
Photobiomodulation is defined as light being effectively absorbed at a cellular level and stimulating a chemical chain reaction freeing up nitric oxide and producing ATP, the cell's energy source. ATP fuels numerous metabolic processes including rebuilding, repairing and regenerating tissue.


time—line
Mitochondrial health is key to healthy aging
Trillions of mitochondria in your body produce the energy critical to life
The decline of these powerhouses is a hallmark of aging
mitoPURE repairs and renews your mitochondria, to promote healthy aging
90% of our cellular energy (ATP) is generated by our mitochondria
Brain
Immunity
Joints
Heart
Metabolism
Muscle
timelinenutrition.com


ÉLEVÉ
HEALTH

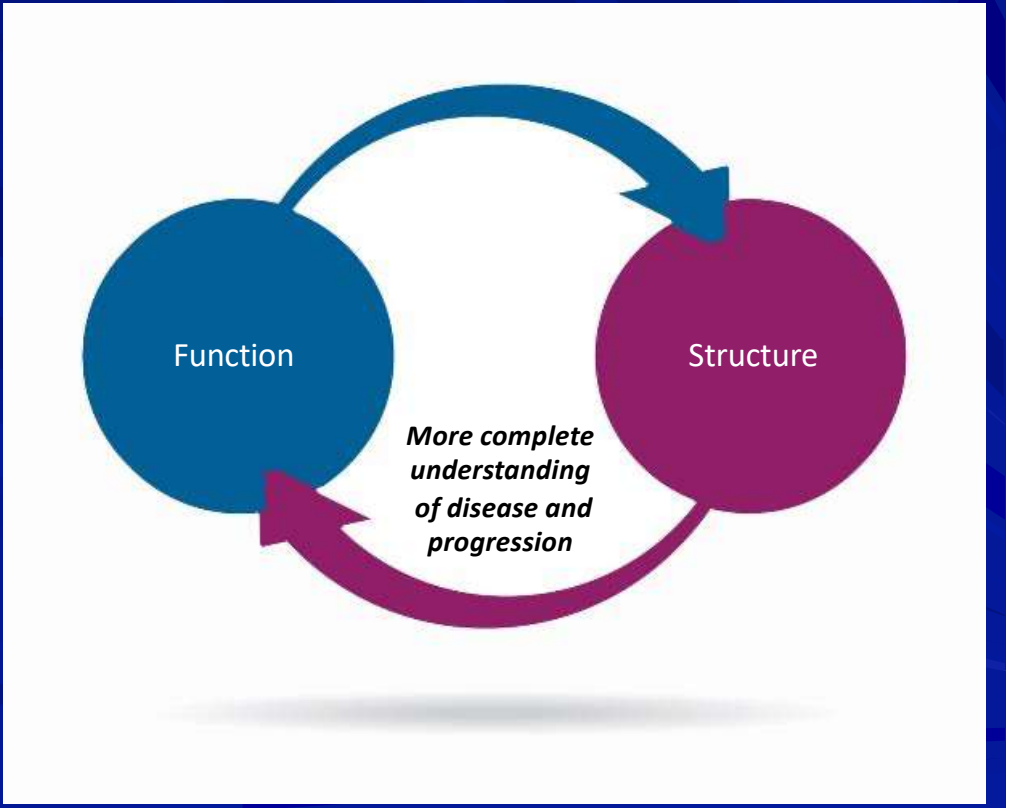
Ocular Structure and Visual Function

- Structure precedes functional damage
- Function precedes structural damage
- Both damage visible simultaneously



Value of Function *plus* Structure

- **Early Detection:** Function precedes structure in many conditions, highlighting problems before structural damage occurs
- **Progression:** Functional tests plays a critical role in detecting sub-clinical progression
- **Improvement:** Structural tests demonstrate stability; only functional tests can demonstrate improvement

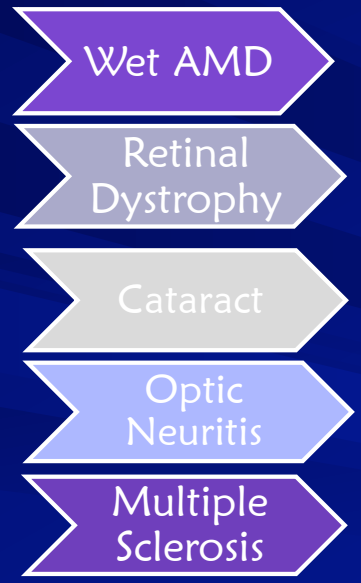


Color vision

Kollners rule:

Congenital is Red Green defects
Acquired is Blue Yellow Defects

Color Vision as a Biomarker of Disease



Loss of color vision is a major complaint in rapidly changing disorders

Color vison is also a biomarker of slow progressing diseases even though patients are unaware of color vision change

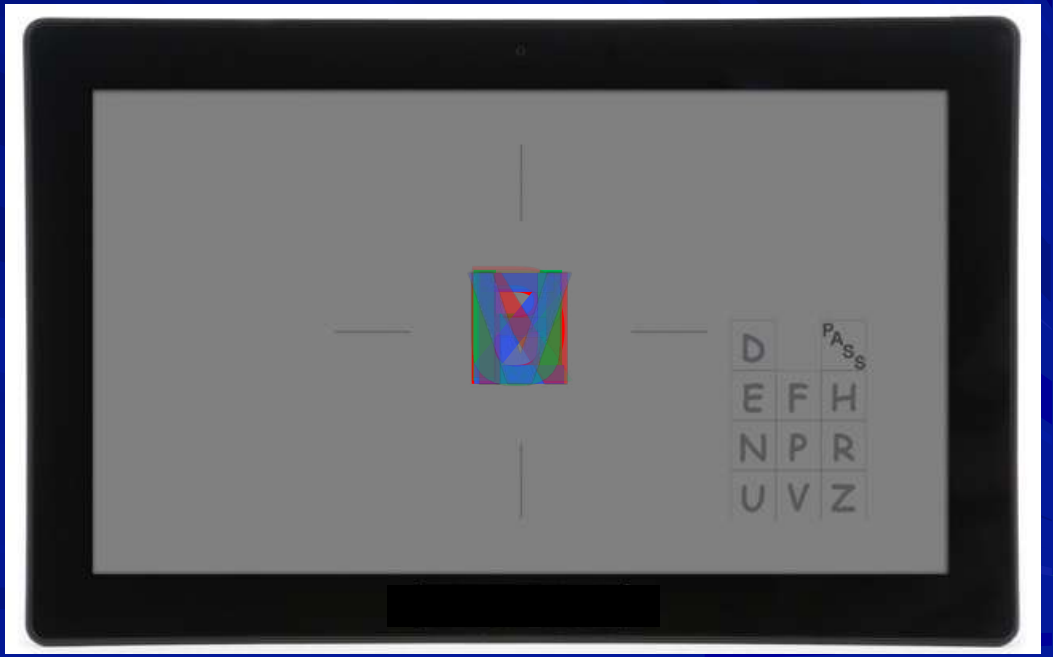
Rabin Cone Contrast Test

- Sensitive color contrasts testing
  - There is difference between traditional color vision tests

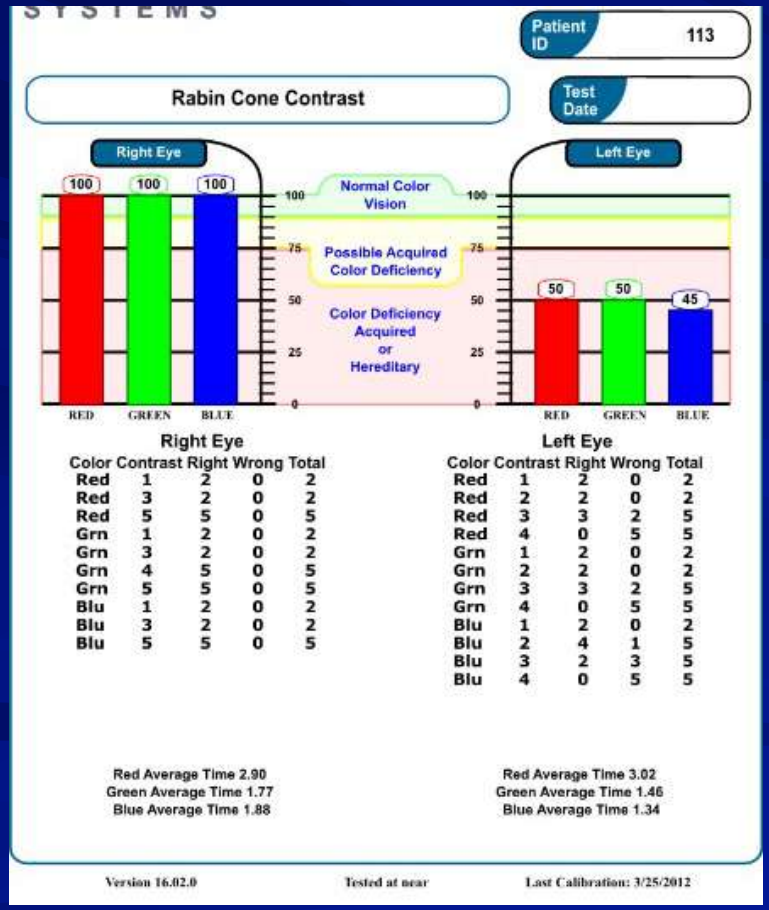
- Rabin Cone Contrast Test can be used for early detection:
  - Age related macular degeneration
  - Diabetic retinopathy
  - Glaucoma
  - Retinal disease

Rabin Cone Contrast Test

- Based in science
  - Co-developed between Innova Systems and US Air Force
- Combines Cone Isolation technology and Contrast Sensitivity
- Color vision technology sensitive enough to detect subtle changes from disease
- Threshold test, similar to visual field
  - But just faster…
  - CPT 92283-$57 national average



Cone Contrast Test Results



SYSTEMS

Patient ID 113

Rabin Cone Contrast

Test Date

Right Eye

Left Eye

100 100 100

50 50 45

Normal Color Vision

Possible Acquired Color Deficiency

Color Deficiency Acquired or Hereditary

100 75 50 25 0

RED GREEN BLUE

Right Eye

Color	Contrast	Right	Wrong	Total
Red	1	2	0	2
Red	3	2	0	2
Red	5	5	0	5
Grn	1	2	0	2
Grn	3	2	0	2
Grn	4	5	0	5
Grn	5	5	0	5
Blu	1	2	0	2
Blu	3	2	0	2
Blu	5	5	0	5

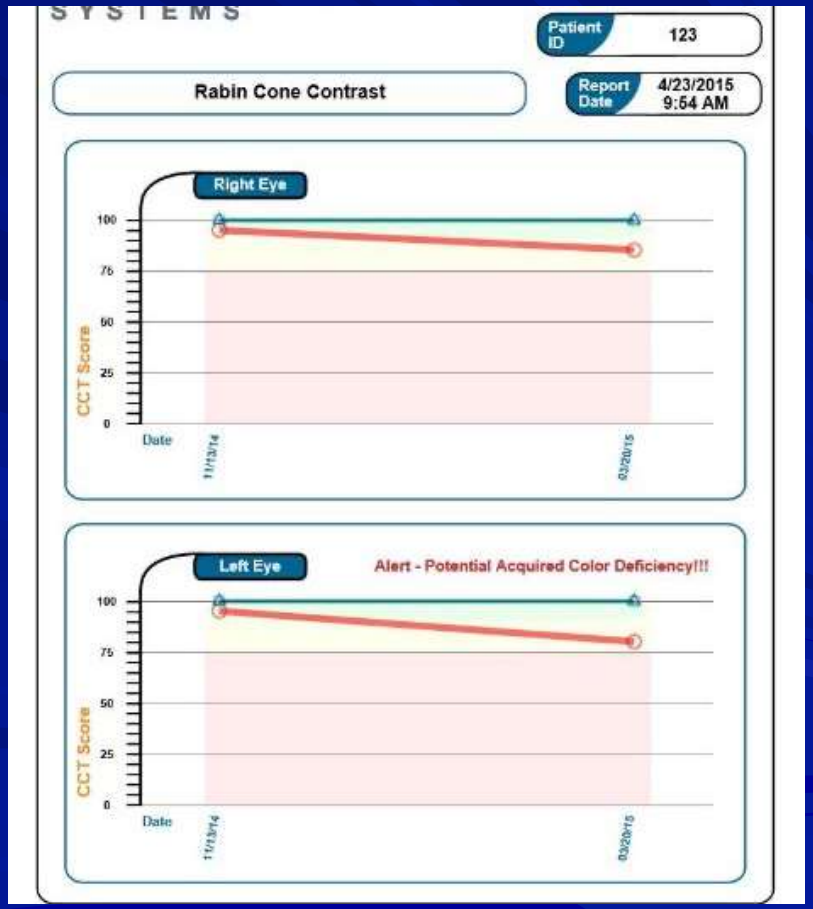
Red Average Time 2.90
Green Average Time 1.77
Blue Average Time 1.88

Left Eye

Color	Contrast	Right	Wrong	Total
Red	1	2	0	2
Red	2	2	0	2
Red	3	3	2	5
Red	4	0	5	5
Grn	1	2	0	2
Grn	2	2	0	2
Grn	3	3	2	5
Grn	4	0	5	5
Blu	1	2	0	2
Blu	2	4	1	5
Blu	3	2	3	5
Blu	4	0	5	5

Red Average Time 3.02
Green Average Time 1.46
Blue Average Time 1.34

Version 16.02.0 Tested at near Last Calibration: 3/25/2012



SYSTEMS

Patient ID 123

Rabin Cone Contrast

Report Date 4/23/2015 9:54 AM

Right Eye

CCT Score

100 75 50 25 0

Date

11/13/14 03/20/15

Left Eye

Alert - Potential Acquired Color Deficiency!!!

CCT Score

100 75 50 25 0

Date

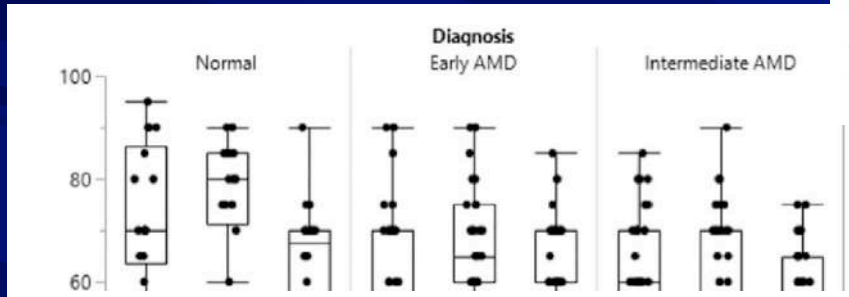
11/13/14 03/20/15

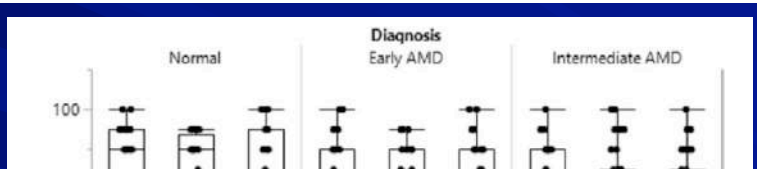
Duke University

AMERICAN ACADEMY OF OPHTHALMOLOGY®

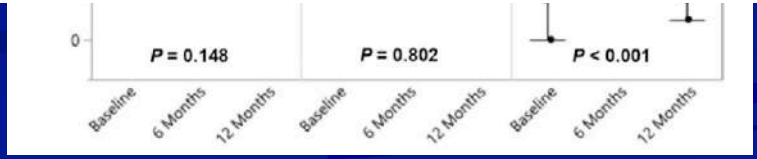
Longitudinal Study of Visual Function in Dry Age-Related Macular Degeneration at 12 Months

S. Tammy Hsu, BA,[1] Atalie C. Thompson, MD, MPH,[1] Sandra S. Stinnett, DrPH,[1] Ulrich F.O. Luhmann, PhD,[2] Lejla Vajzovic, MD,[1] Anupama Horne, MD,[1] Stefanie G. Schuman, MD,[1] Cynthia A. Toth, MD,[1] Scott W. Cousins, MD,[1] Eleonora M. Lad, MD, PhD[1]





- Rabin Cone Contrast Testing can detect progression in dry AMD within a 12 months.
- These functional markers may be useful end points in future clinical trials that assess the effect of potential treatments for AMD.

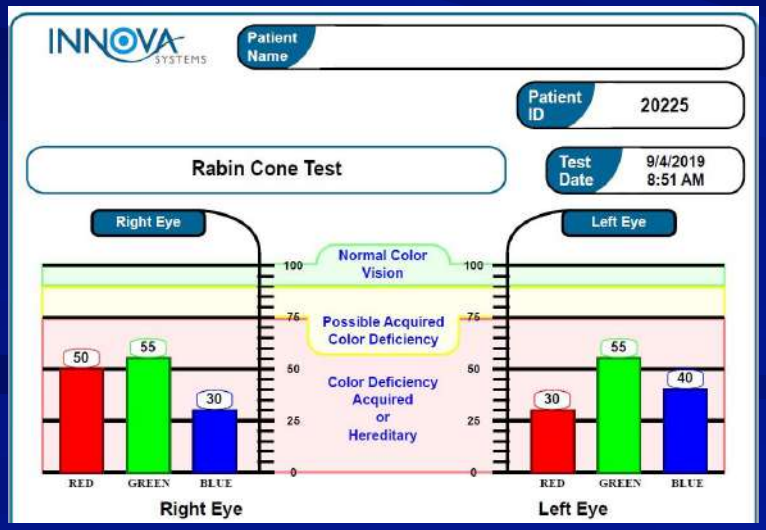


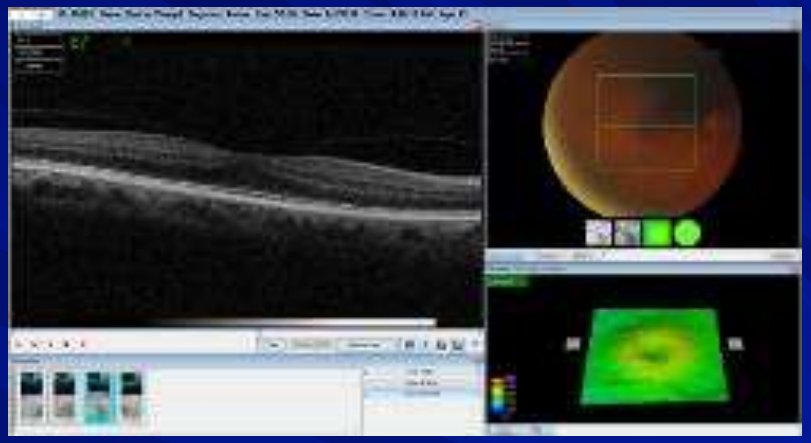
Ophthalmol Retina. 2019 August ; 3(8): 637–648. doi:10.1016/j.oret.2019.03.010

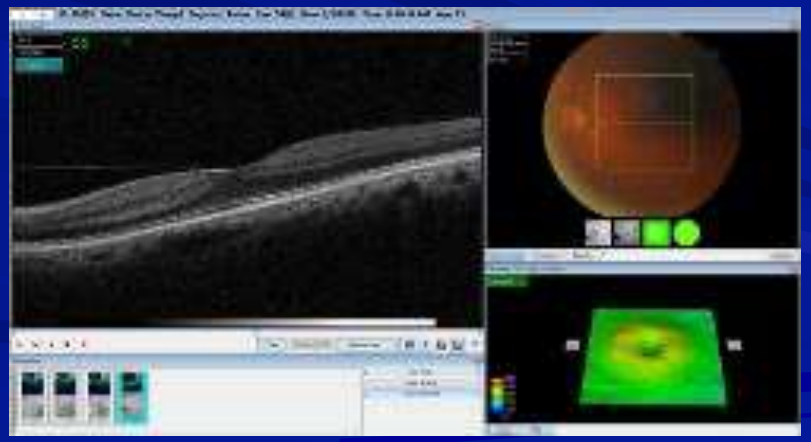
Case: Diabetes Exam- What's Your Diagnosis?

- 72 y/o Indian male
- Type 2 Diabetes
- 20/25 OU
- NS1+ Cataracts OU

What about now?







Case courtesy of Becky Verna, OD

Case: Diabetes Exam- What's Your Diagnosis?

Courtesy of Pinakin Davey OD, PhD

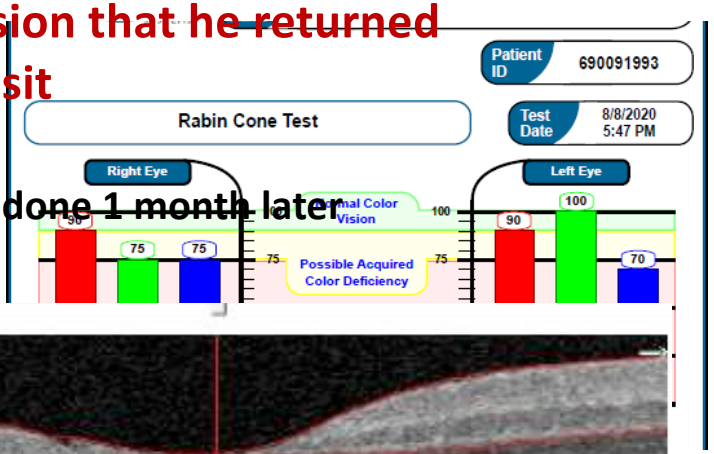
- 49 YO Asian male,
- HO DM type 2, 10 years "recently" not compliant with meds
- HO HTN x10 years
- Restarted metformin recently but has side effect of diarrhea
- Blood pressure today 168/96

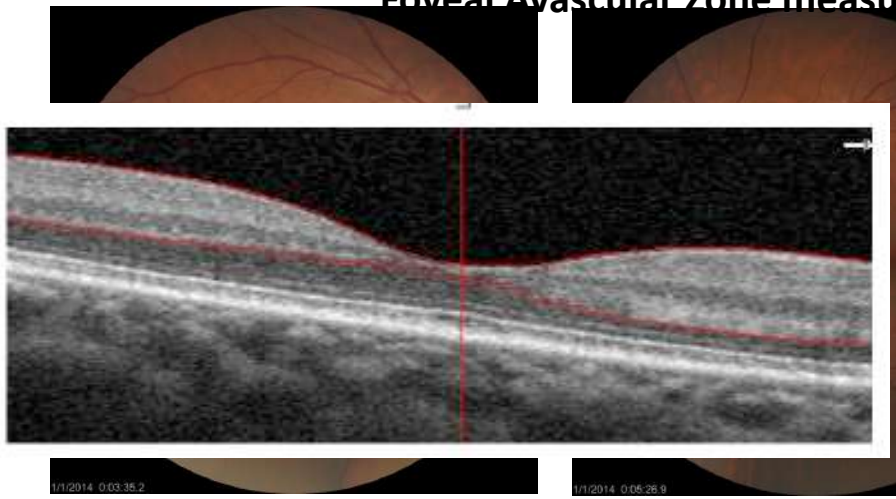
What about now?

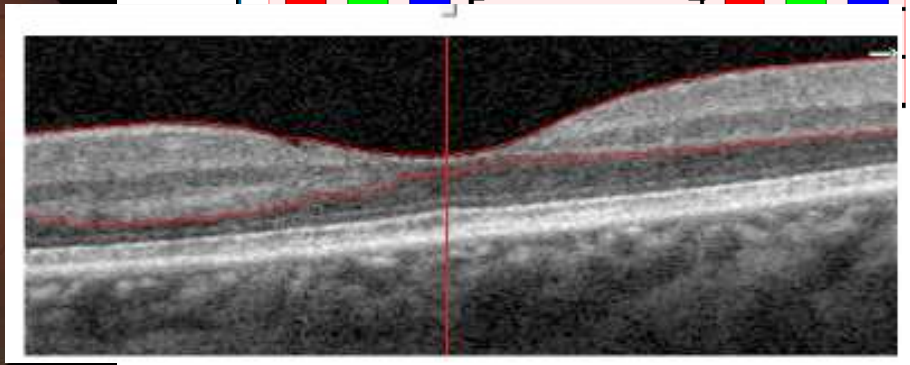
Patient worried enough about change in vision that he returned for 1 Month follow-up visit

Diabetic Eye Exam Standard of Care

Foveal Avascular Zone measurements OCT-A done 1 month later





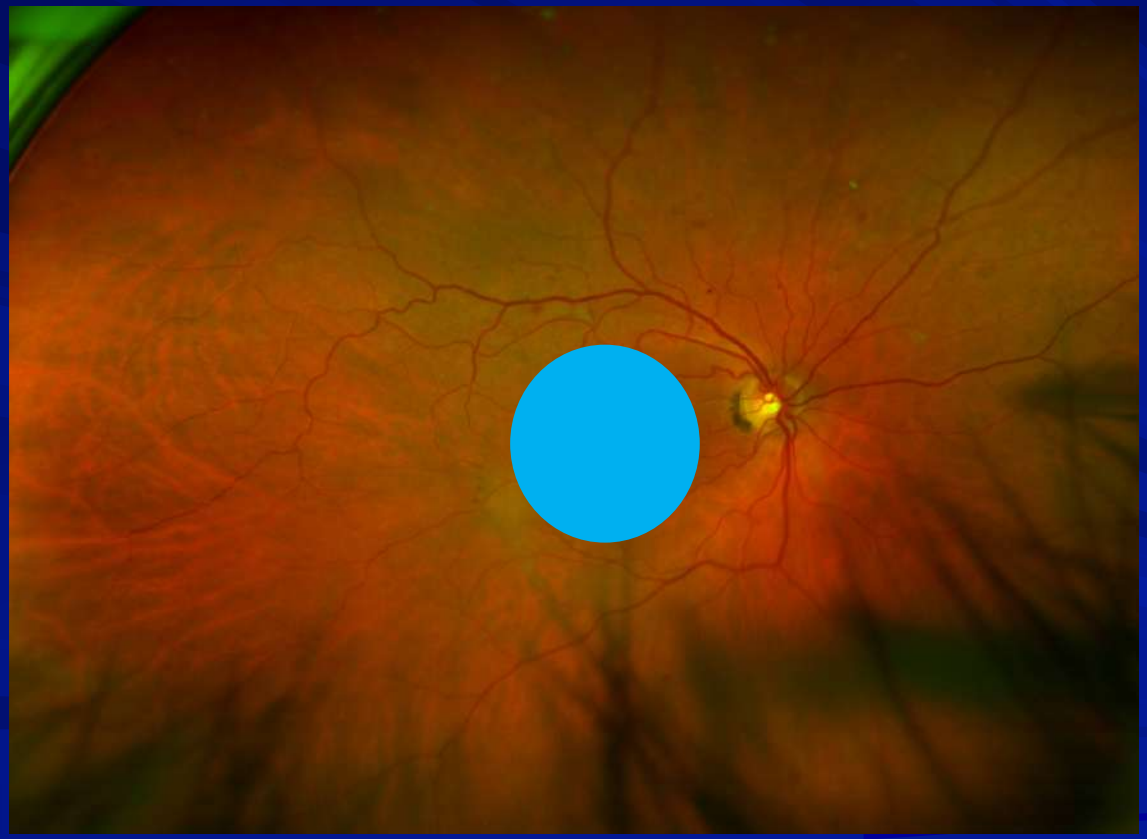


Based on RCCT, RTC in 1 month for OCT

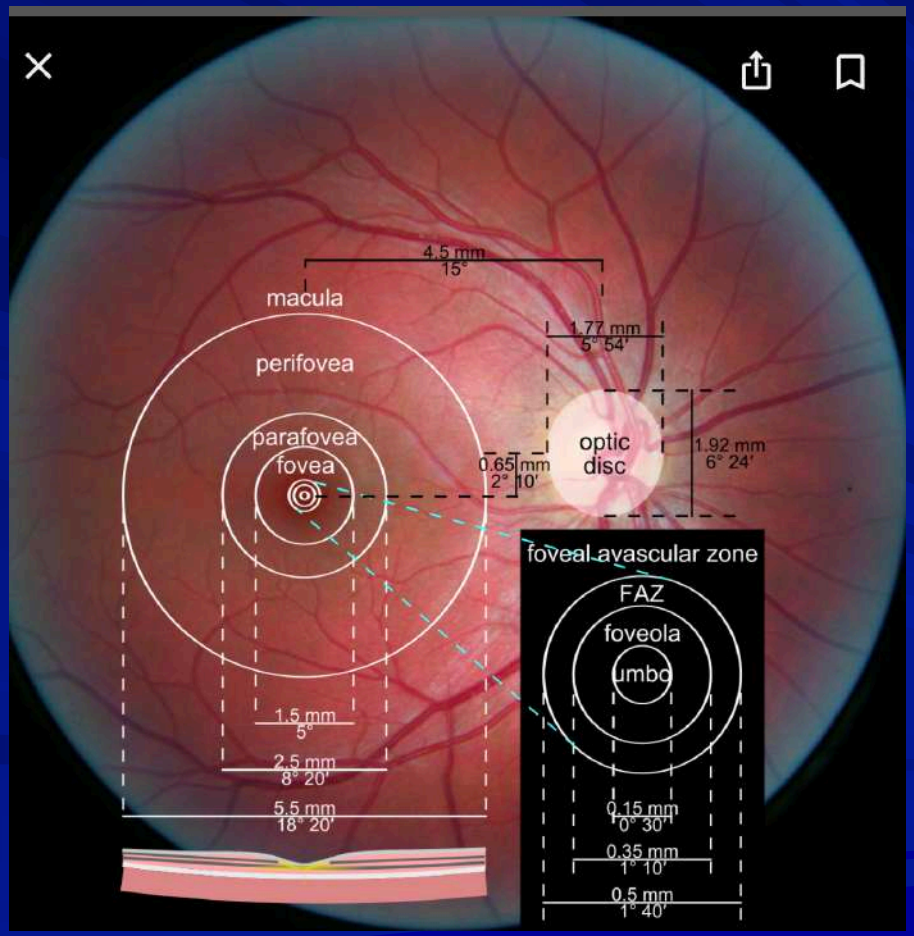
Rabin Cone Contrast Test

- Completes the comprehensive exam
- Early detection
- Progression
- Can see improvements with your treatments
- Nutritional therapies indeed play a role in management of AMD, diabetes, and glaucoma

Where is the macula?



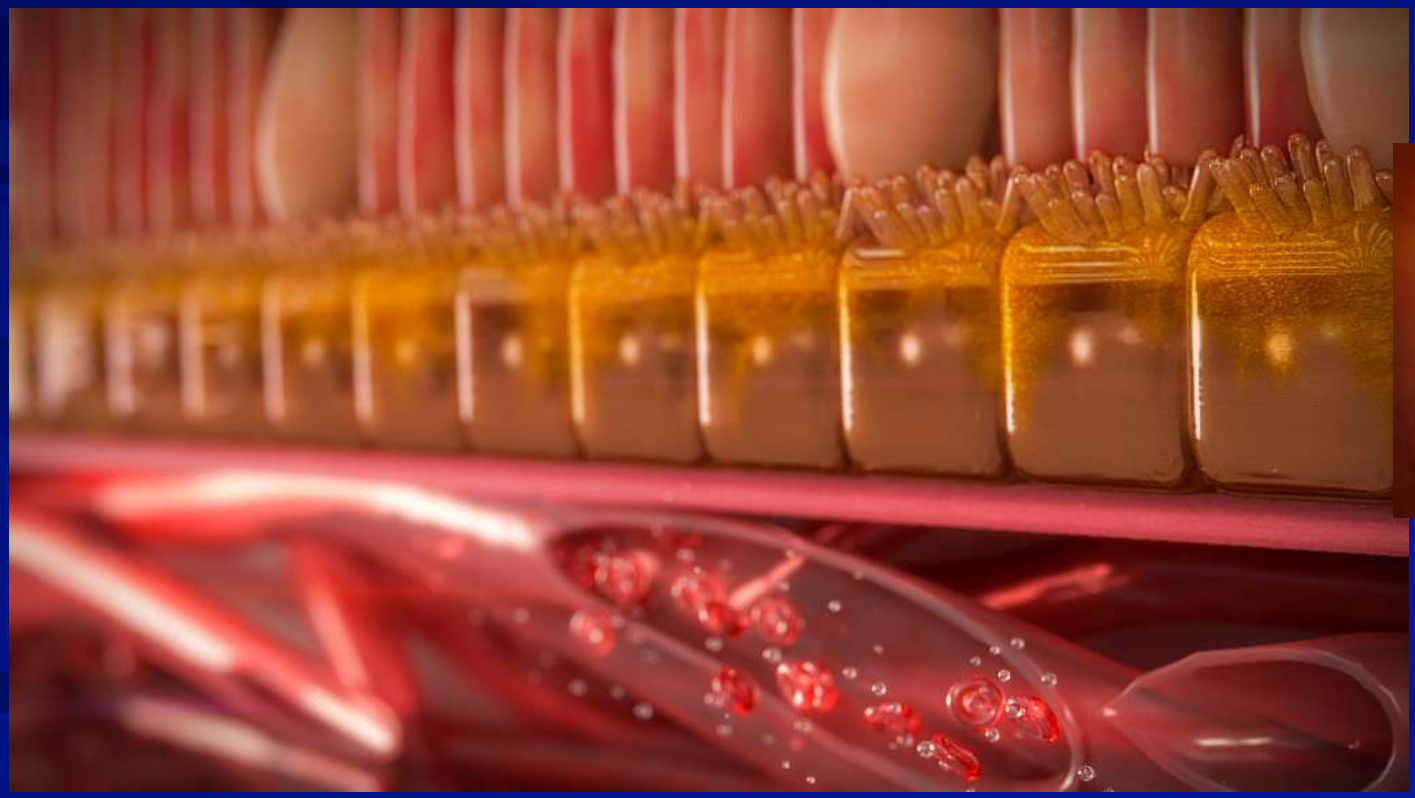
How large is the macula?



Early Onset Pathogenesis

- Drusen small or large are not makers for early stage AMD
  - Visible structural evidence of a pathological process
    - Underway for quite some time
- Cholesterol deposits exist beneath the surface long before drusen form
  - Cannot be seen with structure-based methods
  - Cholesterol produced by RPE and deposits into Bruch's membrane
  - Continue to layer in Bruch's membrane
- As this cholesterol accumulates the process unfolds with compromise to the outer retina
  - Inflammation
  - Oxidative stress
  - Disruption of oxygen and nutrients
  - Drusen formation
- Impaired Vitamin A across Bruch's membrane
  - Functional impairment can occur to dark adaptation

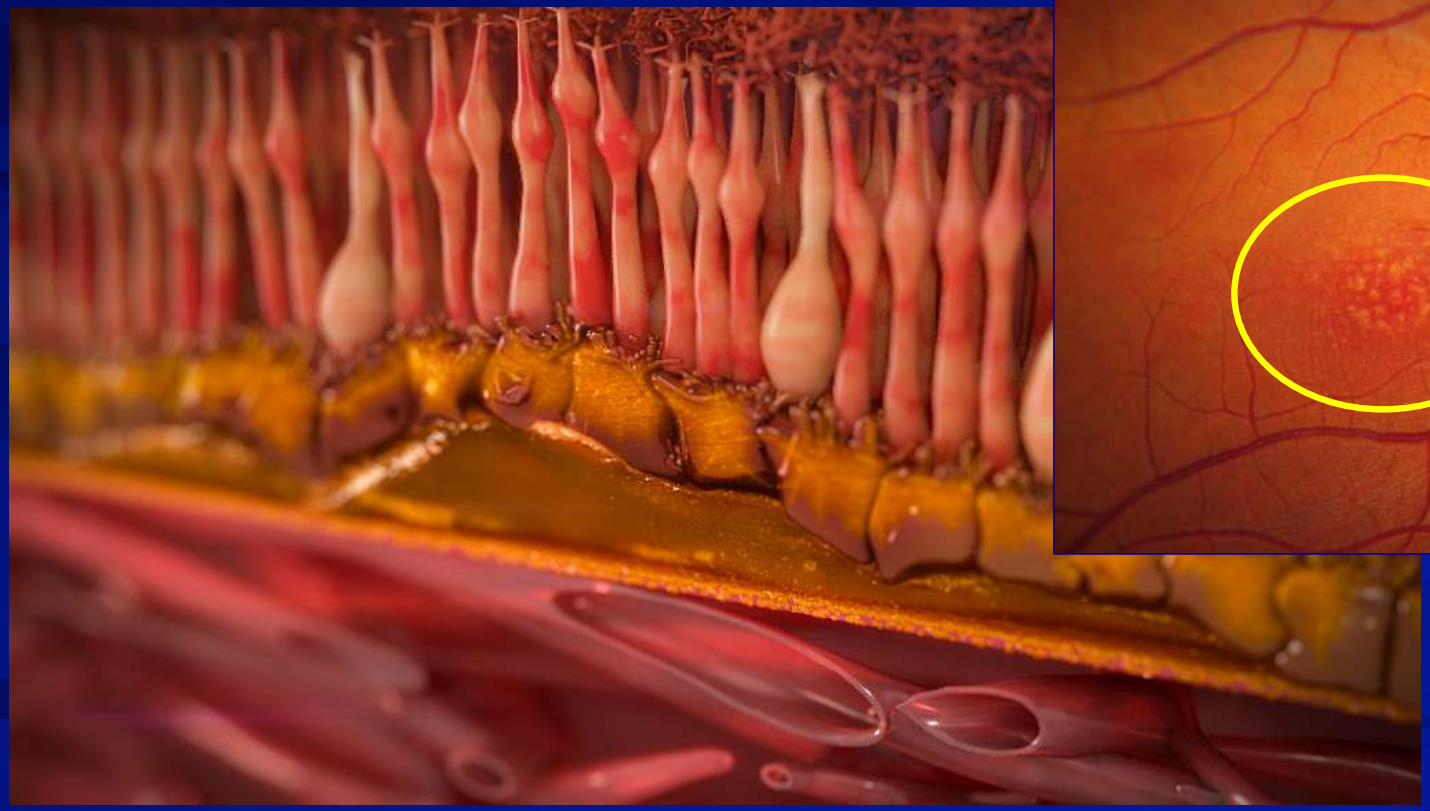
Healthy choriocapillaris, Bruch's, RPE, and Photoreceptors

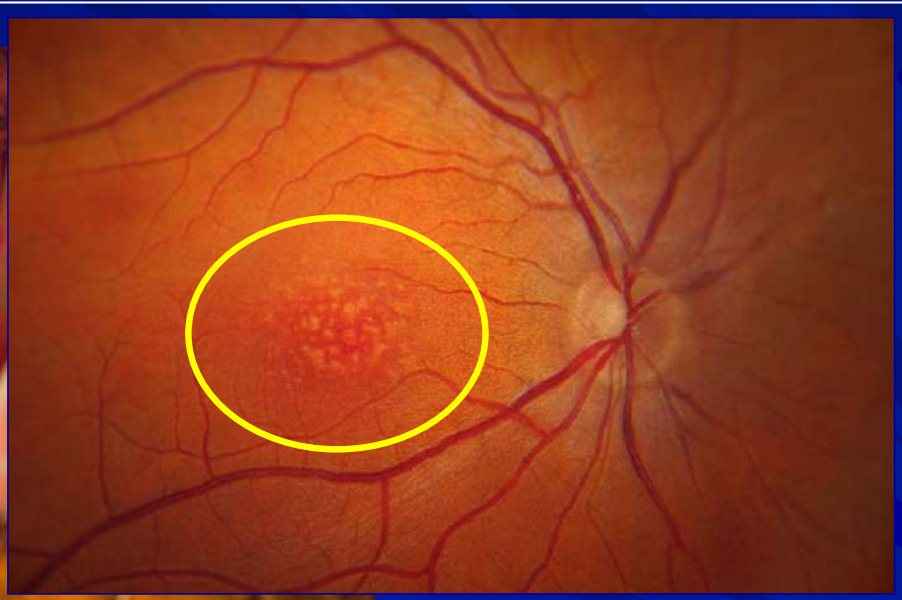


Cholesterol barrier deposited along Bruch's and RPE

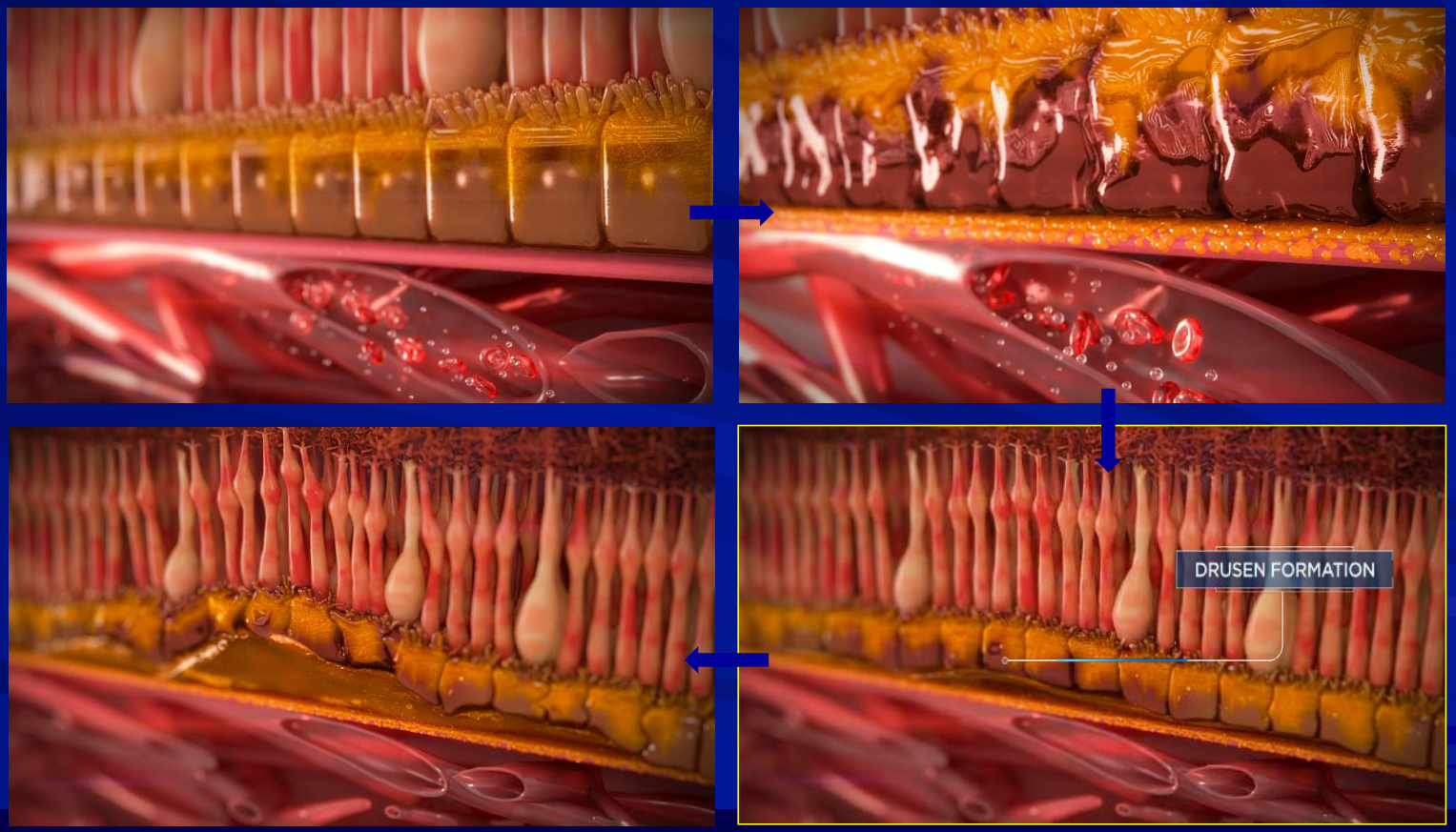
RPE Secretes even more cholesterol and degenerates

Finally, visibly evident drusen on fundus evaluation



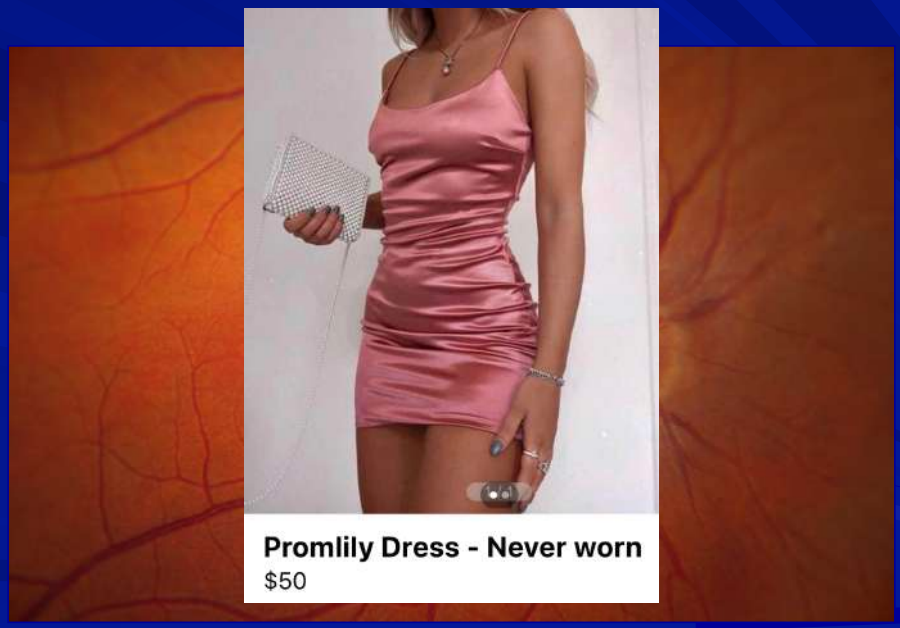


AMD is a Disease Process that Starts Below the Surface

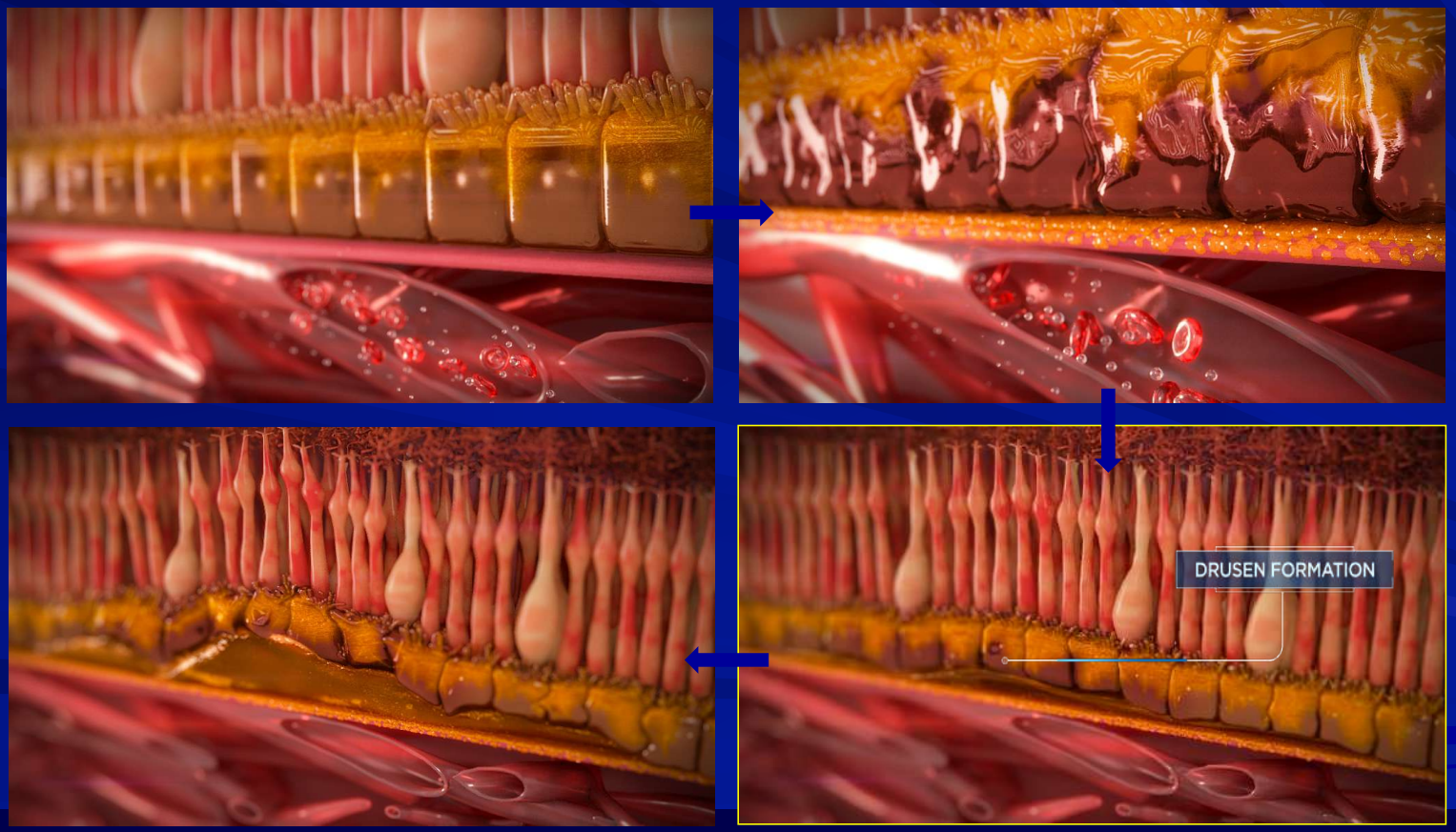


Beckmann Committee Classification of AMD

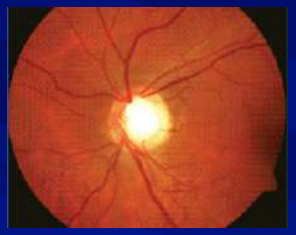
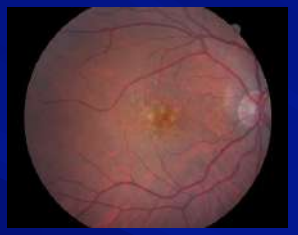
- Based on presence of lesions within 2 DD of fovea in either eye
  - ★ No AMD
    - None or few small drusen, < 63 microns
    - No AMD pigmentary abnormalities
  - ★ Early AMD
    - Medium drusen, > 63 – <125 microns
    - No AMD pigmentary changes
  - ★ Intermediate AMD
    - 1 large drusen, > 125 microns
    - Any AMD pigmentary changes
  - ★ Advanced AMD
    - Any geographic atrophy
    - Choroidal neovascularization (CNV)



AMD is a Disease Process that Starts Below the Surface



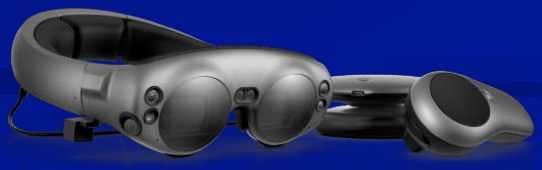
Applying a Familiar Standard of Care:
Two Multifactorial Diseases

	Glaucoma		AMD
Structure	 Cup-to-disc Ratio	→	 Drusen
Function	 Visual Field	→	 Dark Adaptation
Risk	Intraocular Pressure (IOP) Corneal Thickness Age/race Family history/etc. Health and Lifestyle (Diabetes)	→	Age Genetic Testing Health and Lifestyle (Smoking) Macular Pigment Optical Density (MPOD) Contrast Sensitivity.

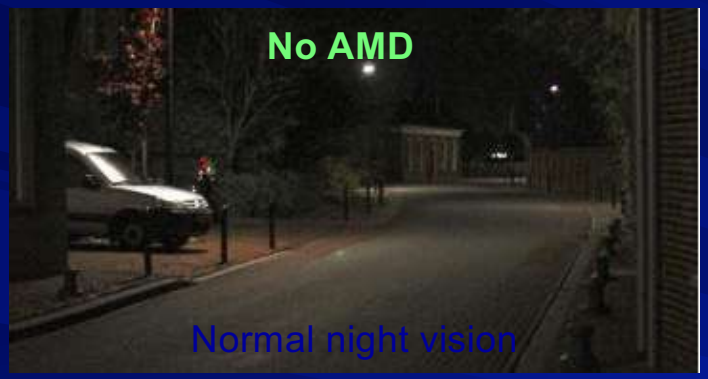
Dark Adaptation in AMD

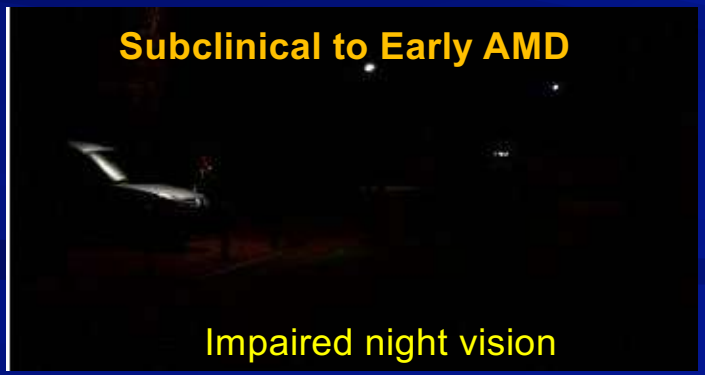
Function Test

- Measures how long to recover from bright light to darkness
  - ★ Rod intercept line (RI) time
- Functional test that can help overcome the challenges in diagnosing AMD
- Alabama Study on Early Are-Related Degeneration (ALSTAR)
  - ★ Able to detect subclinical 3 years before clinically visible
  - ★ 325 adults without clinically detectable AMD
- Rod deterioration happens in earliest stages of AMD
  - ★ Earlier defection before visual acuity
- Dark Adaptation 92284
  - ★ Sensitivity 90.6%
  - ★ Specificity 90.5%



This Means We Now Have an *Early* Symptom We Can Use to Help Diagnose AMD



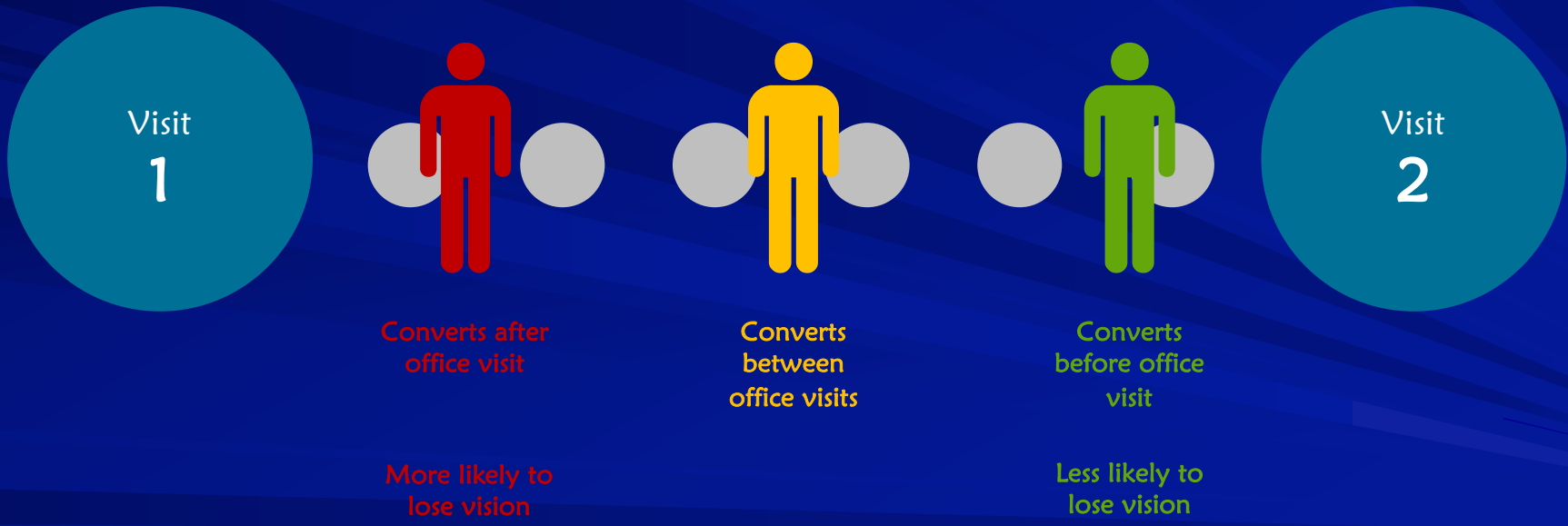


- Night vision impacted in early AMD: 30+ studies
- AMD patients often give up driving at night
- Night vision is impaired before day vision
- Typically ECP's chalk this complaint up to cataracts

Ask Every Patient Over 50 About Their Night Vision

Preferential Hyperacuity Perimetry (PHP)

At-risk Patients May Convert to Wet AMD at Any Point Between Follow-up Visits



Reference: Rauch R, et al. *Retina*. 2012;32(7):1260-1264.

Notal Vision - ForeseeHome® product overview

Uses **Preferential Hyperacuity Perimetry (PHP)**

Medicare covered

600+ active prescribers

6,000+ actively testing patients

Proven efficacy with level 1 evidence

Readjusting our point of view to preventable vision loss

AREDS
Dry AMD
Baseline

20/25
20/32

Wet AMD
Onset

BUT WHERE DID
WE START?

Preventable Vision Loss

Saving Lines

On average, those diagnosed at driving vision maintain vision

(CATT 1 & 2 year data)

+11.6/
+6.6
2 Years
ANCHOR/MARINA

+1.7
4 Years
HORIZON

-8.6
7.3 Years
7-Up Study

ForeseeHome Study Results[1]

- 20/32 average VA
- 94% 20/40 or better
- 0.23 median disc area size lesions

Current Standard of Care

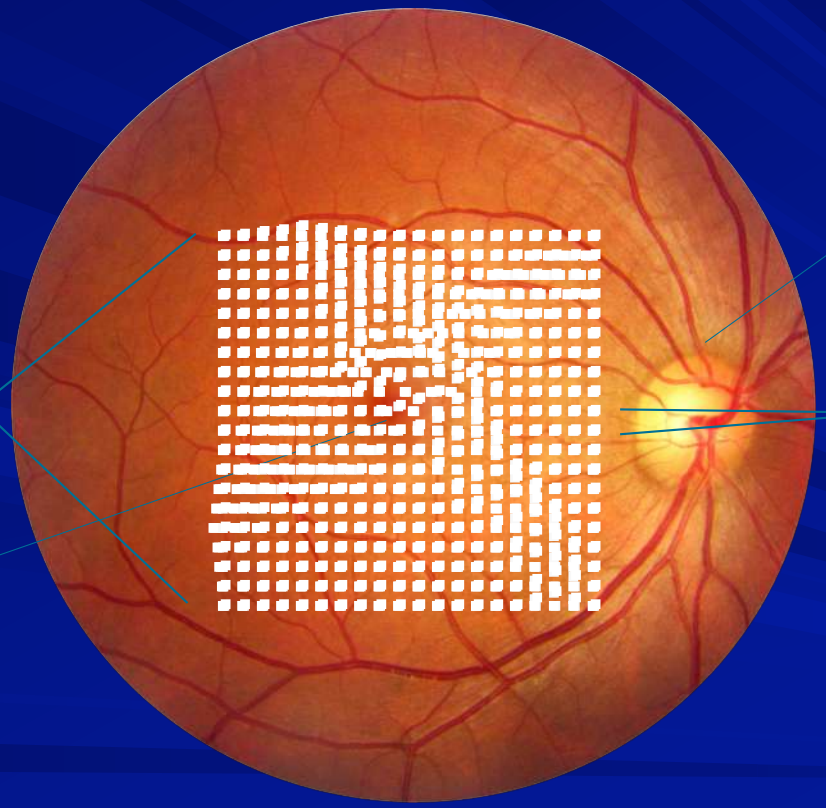
- 20/83 average VA[2]
- 13-41% 20/40 or better[3]
- 2.9-4.2 disc area size lesions[3]

1. Chew EY, Clemons TE, Bressler SB, et al; Ophthalmology. 2014;121:535-544. 2. Rao P, Lum F, Wood K, et al. Ophthalmology. 2018;125(4):522-528. 3. Ho AC, Albini TA, Brown DM, Boyer DS, Regillo CD, Heier JS. JAMA Ophthalmol. 2017;135(5):268-273.

Notal Vision- PERIMETRY: The ForeseeHome Test

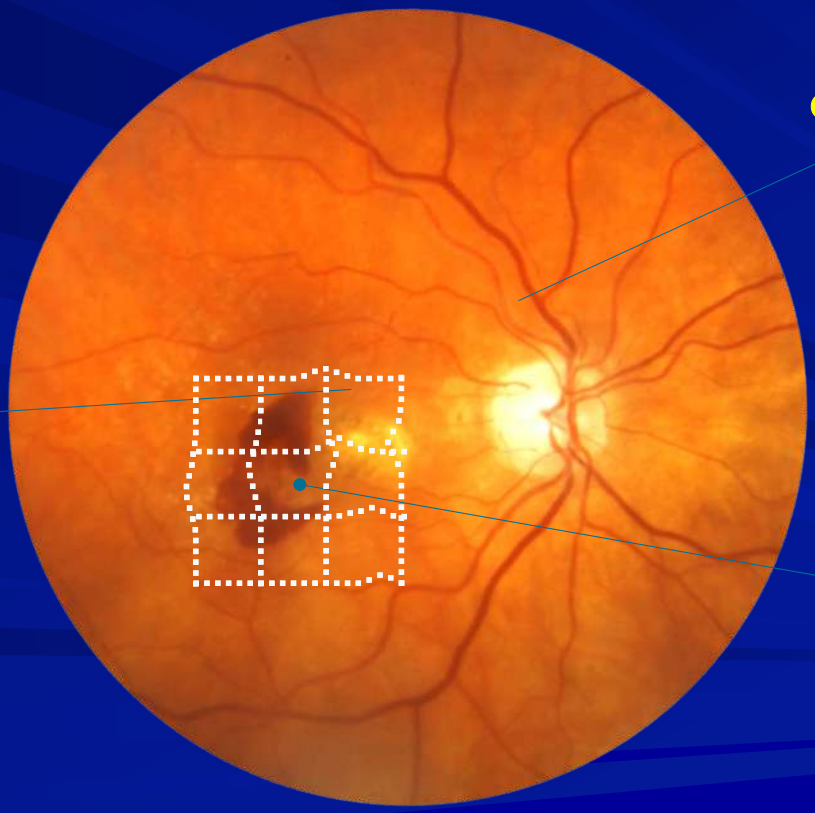
Total of 500 data points tested 3 to 5 times each

Stimuli are presented on screen for 160 ms



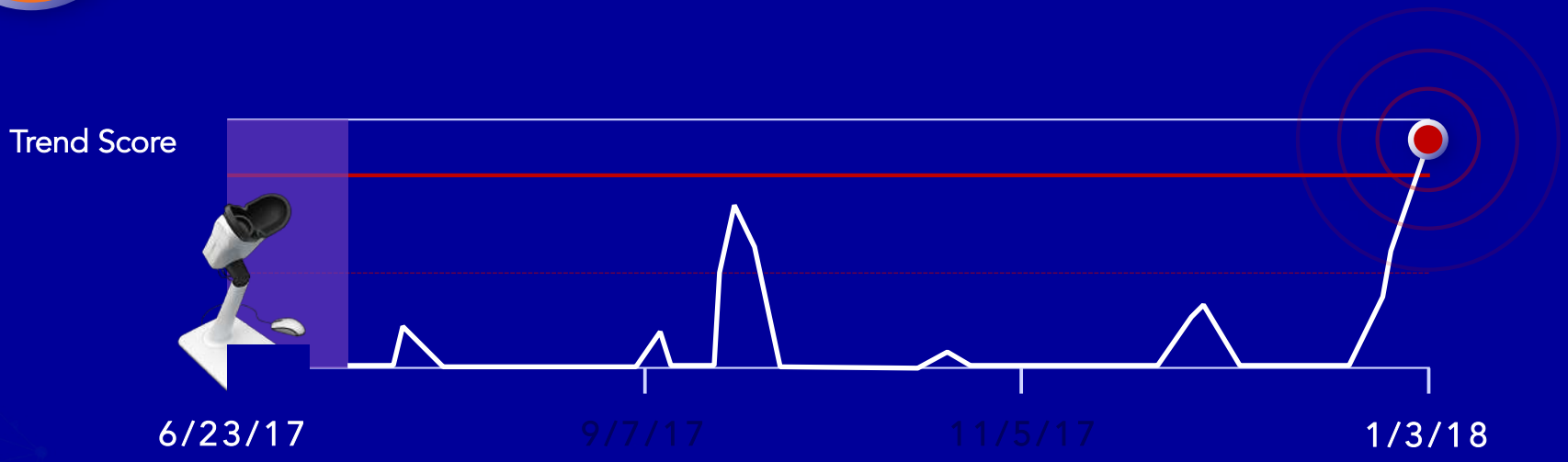
Once pathology is suspected, the area is bracketed to localize and quantify pathology

When a patient clicks on the "pathological distortion," the algorithm will present stimuli of various magnitudes over the location to determine the size and shape



CASE 1 →

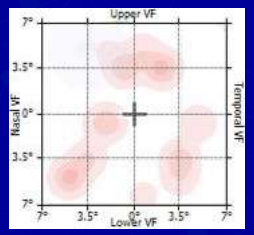
86 y/o Male | Baseline Vision: 20/30 OU

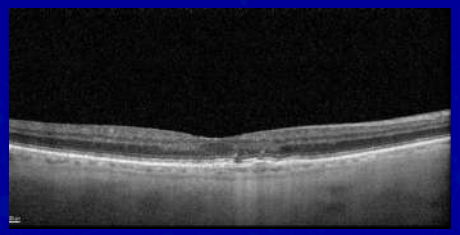


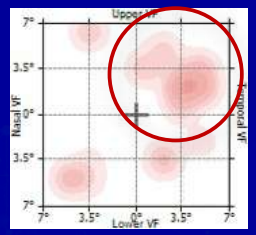
STARTED TESTING

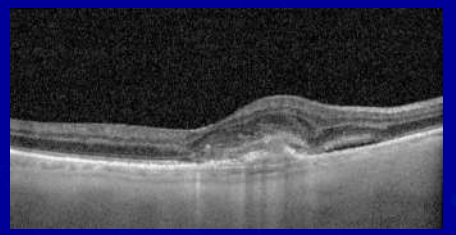
ALERTED

20/60 OD and asymptomatic









Optometric Education Consultants

Question

During the AREDS2 Study – were patients allowed to take a multivitamins?

A. No – they were testing the efficacy of AREDS2
B. Yes – 10 %
C. Yes- - 50%
D. Yes – 90%

Will taking the AREDS or AREDS2 supplements prevent AMD?

Nutritional supplements cannot prevent AMD. However, the AREDS/AREDS2 supplements may delay progression of intermediate to advanced AMD and may help you keep your vision longer. The participants AREDS trial have now been followed for more than 10 years, and the benefits of the AREDS formulation have persisted over this time.

Can I take a daily multivitamin if I am taking one of the AREDS/AREDS2 formulas?

Yes. The AREDS and AREDS2 formulas do not substitute for multivitamins. In AREDS, two-thirds of the study participants took multivitamins along with the AREDS formulation. In AREDS2, almost nine of ten participants took multivitamins.

Treatment for AMD

- Nutritional supplements
  - Sub-clinical/sub-structural or early disease
    - Controversy flourishes
      - No definitive guideline exists
      - Despite consensus evidence suggests using supplements
  - Intermediate – advance disease
    - No controversy on advocating for supplements
  - AREDS 1
    - Contains Beta-carotene and no lutein or zeaxanthin, no longer recommended
    - Investigated early AMD, no statistically significant benefit
  - AREDS 2
    - Recommended for intermediate and advanced AMD, study protocol
  - The Practical Guide for the Treatment of AMD - 3 primary options
    - Macular pigment supplement
      - Carotenoids: lutein, zeaxanthin, meso-zeaxanthin
    - Carotenoids, antioxidants, zinc, and vitamins C & E
      - AREDS 2
    - Carotenoid macular supplement in subclinical and early AMD. Carotenoid and antioxidant is intermediate and AMD that is progressing

Beckmann Committee Classification of AMD

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  - ★ No AMD
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    - No AMD pigmentary abnormalities
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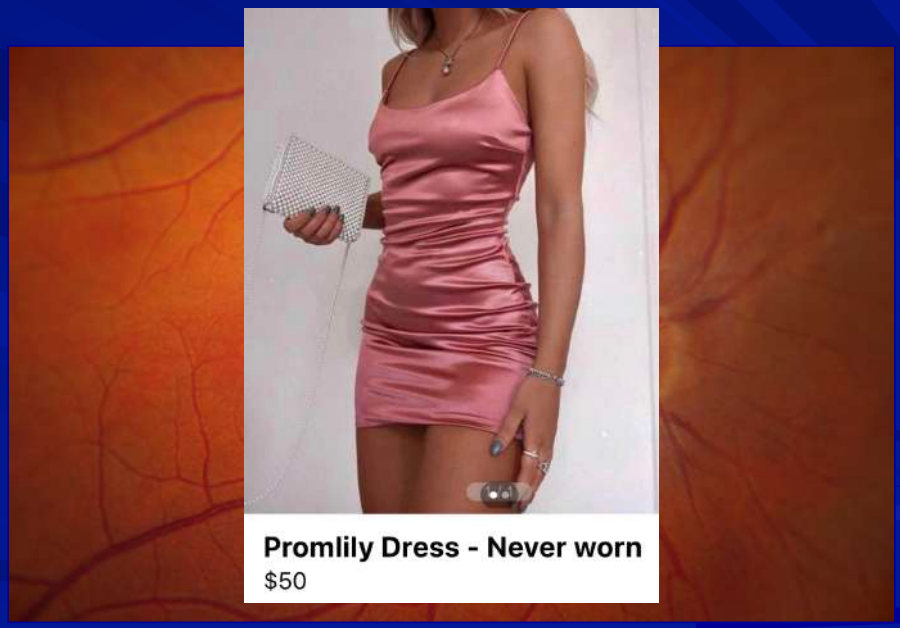
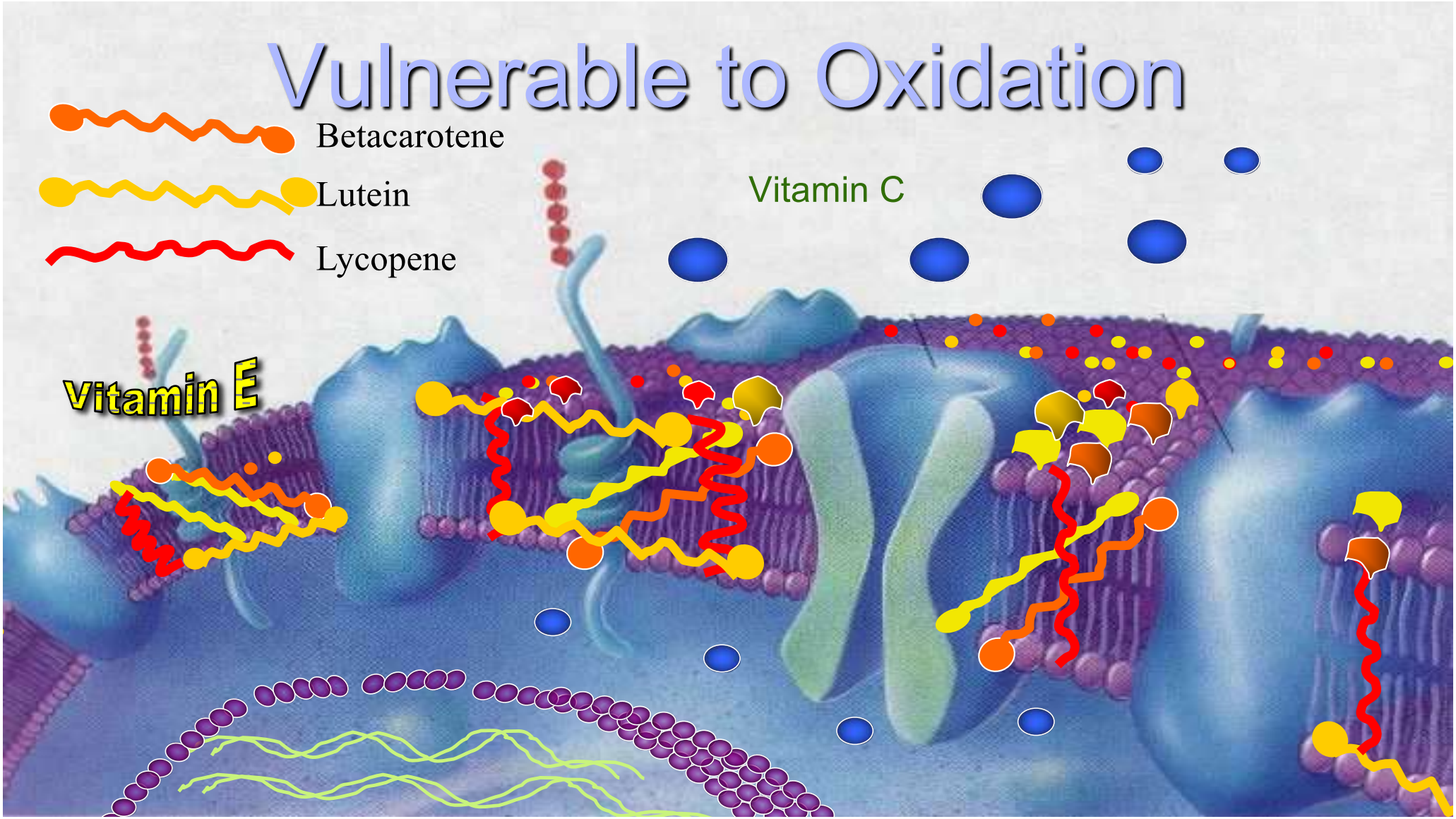
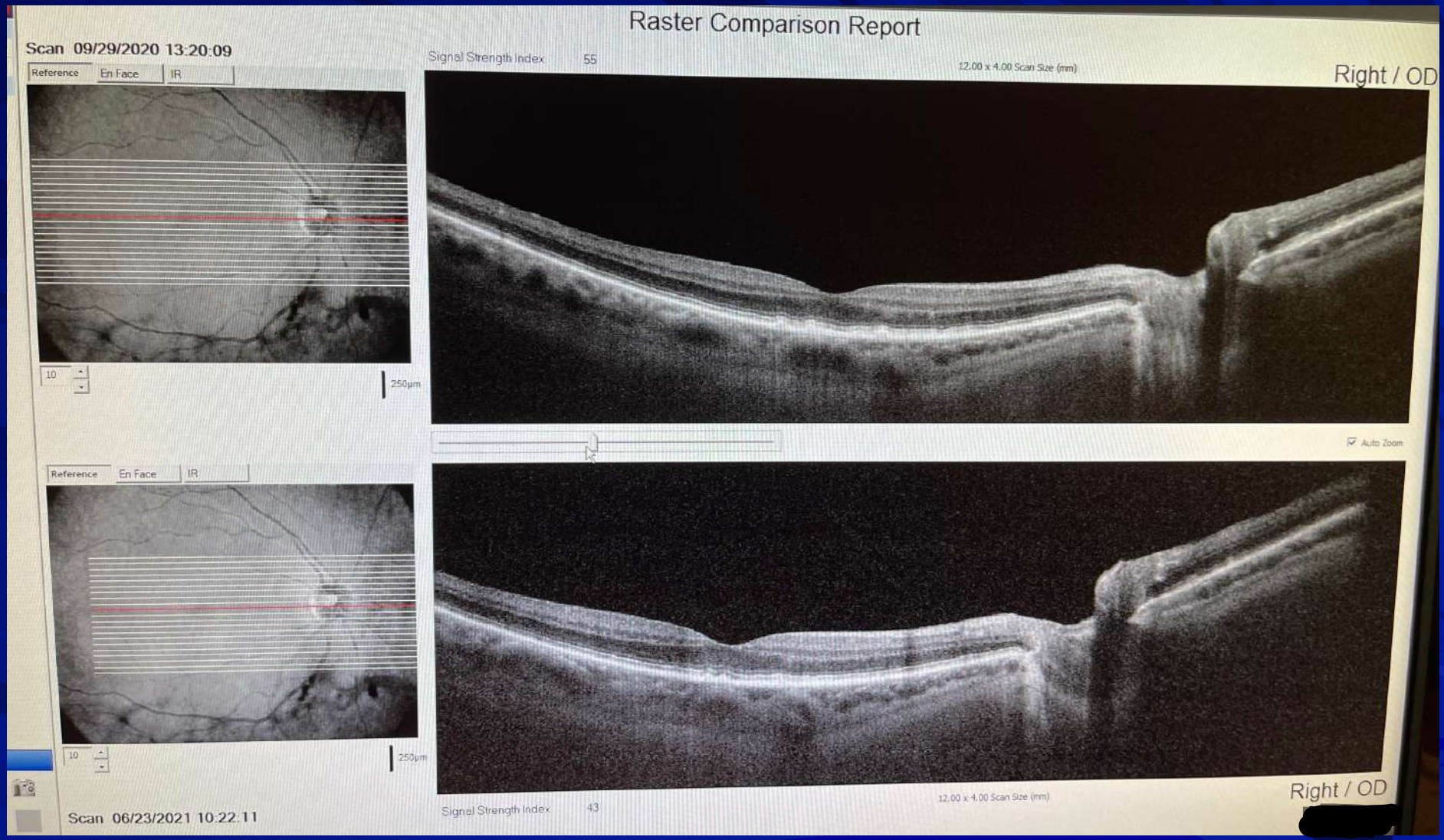



Vulnerable to Oxidation
Betacarotene
Lutein
Lycopene
Vitamin C
Vitamin E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En Face
IR
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Right / OD
10
250µm
Auto Zoom
Reference
En Face
IR
10
250µm
Scan 06/23/2021 10:22:11
Signal Strength Index 43
12.00 x 4.00 Scan Size (mm)
Right / OD


Cross Line Comparison Report
Scan 04/05/2021 14:33:33
Reference
En Face
IR
Signal Strength Index 58
16.00 Scan Size (mm)
Right / OD
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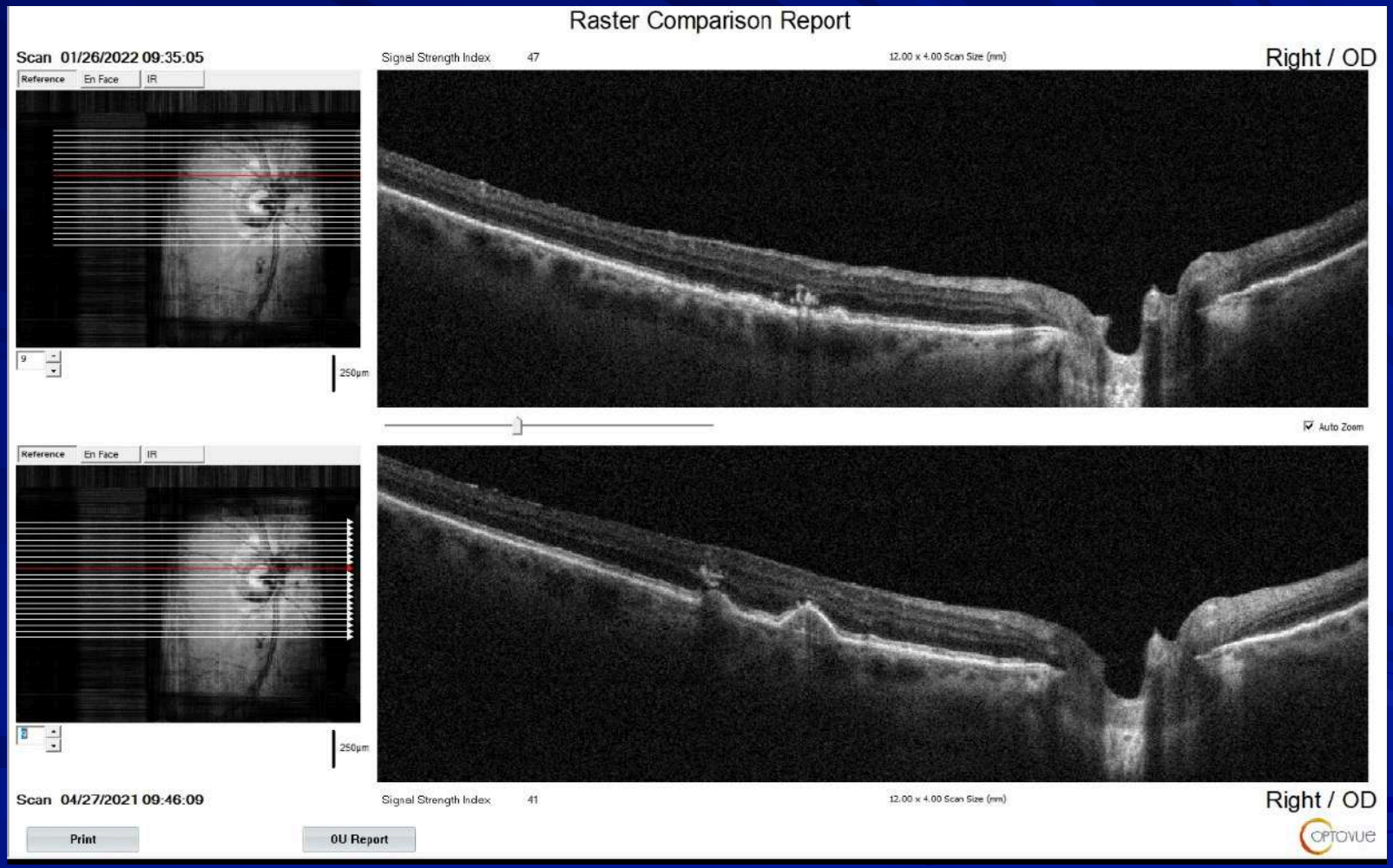
Auto Zoom
Scan 09/21/2020 10.40.42
Signal Strength Index 59
16.00 Scan Size (mm)
Right / OD
Print
OU Report


Raster Comparison Report
Scan 01/26/2022 09:35:05
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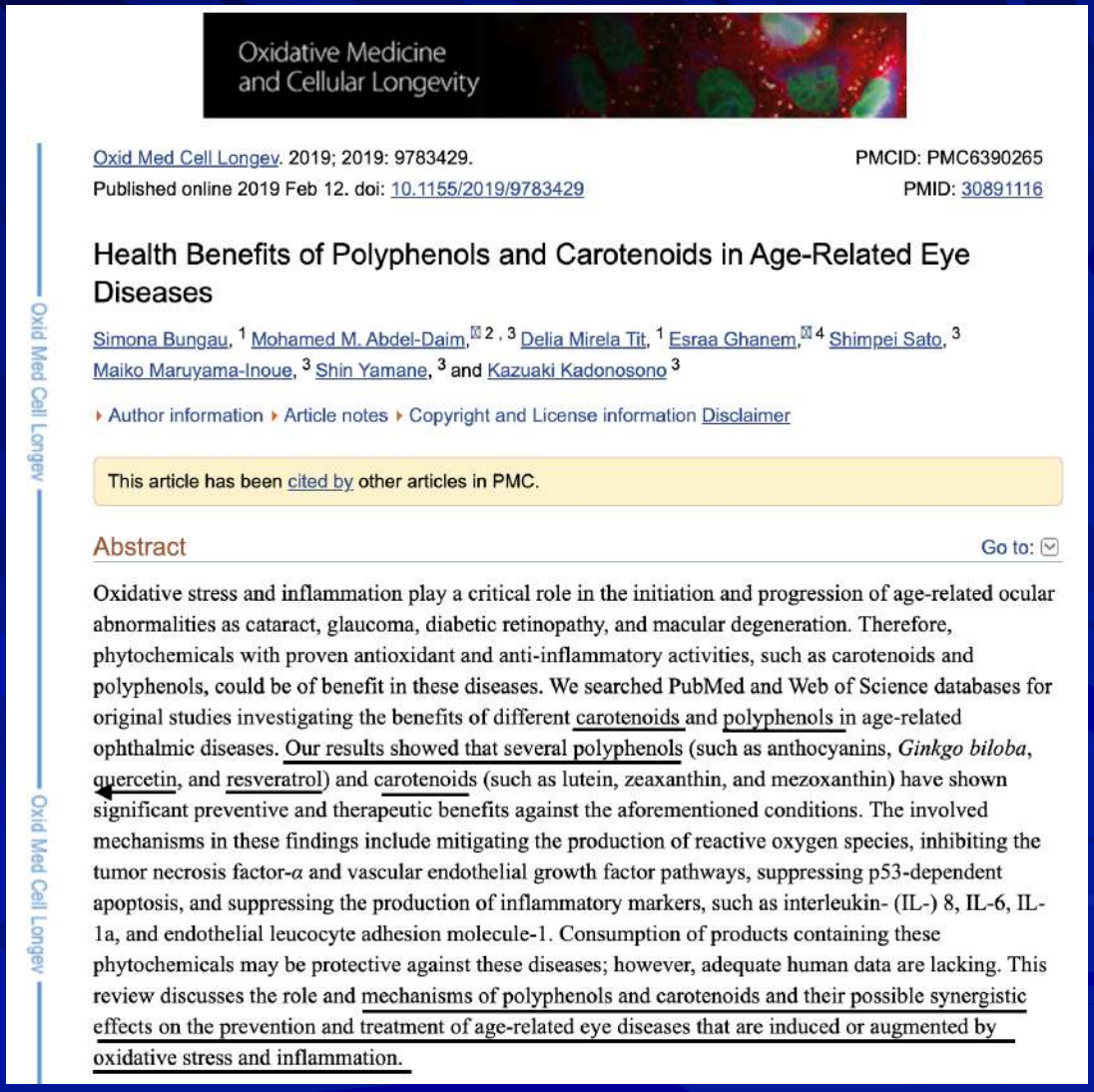
Reference
En Face
IR
250µm
Auto Zoom
Scan 04/27/2021 09:46:09
Signal Strength Index 41
12.00 x 4.00 Scan Size (mm)
Right / OD
Print
OU Report
OPTOVUE

Carotenoid Paradox

- It dawned on me during a lecture what we are actually doing
- We are measuring carotenoids to measure the level of the patient's overall antioxidant status
- We should be providing Antioxidant Replacement Therapy!
- We measure carotenoids to identify those low in carotenoids. This biomarker identifies those people who's antioxidant status needs help
- We should recommend a comprehensive Antioxidant Replacement approach

Treating Half the Retina?



Oxidative Medicine and Cellular Longevity

Oxid Med Cell Longev. 2019; 2019: 9783429.
Published online 2019 Feb 12. doi: 10.1155/2019/9783429
PMCID: PMC6390265
PMID: 30891116

Health Benefits of Polyphenols and Carotenoids in Age-Related Eye Diseases

Simona Bungau, [1] Mohamed M. Abdel-Daim, [2,3] Delia Mirela Tit, [1] Esraa Ghanem, [4] Shimpei Sato, [3] Maiko Maruyama-Inoue, [3] Shin Yamane, [3] and Kazuaki Kadonosono [3]

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Abstract

Go to:

Oxidative stress and inflammation play a critical role in the initiation and progression of age-related ocular abnormalities as cataract, glaucoma, diabetic retinopathy, and macular degeneration. Therefore, phytochemicals with proven antioxidant and anti-inflammatory activities, such as carotenoids and polyphenols, could be of benefit in these diseases. We searched PubMed and Web of Science databases for original studies investigating the benefits of different carotenoids and polyphenols in age-related ophthalmic diseases. Our results showed that several polyphenols (such as anthocyanins, *Ginkgo biloba*, quercetin, and resveratrol) and carotenoids (such as lutein, zeaxanthin, and mezoxanthin) have shown significant preventive and therapeutic benefits against the aforementioned conditions. The involved mechanisms in these findings include mitigating the production of reactive oxygen species, inhibiting the tumor necrosis factor-α and vascular endothelial growth factor pathways, suppressing p53-dependent apoptosis, and suppressing the production of inflammatory markers, such as interleukin- (IL-) 8, IL-6, IL-1a, and endothelial leucocyte adhesion molecule-1. Consumption of products containing these phytochemicals may be protective against these diseases; however, adequate human data are lacking. This review discusses the role and mechanisms of polyphenols and carotenoids and their possible synergistic effects on the prevention and treatment of age-related eye diseases that are induced or augmented by oxidative stress and inflammation.

Carotenoids and Polyphenols

www.oncotarget.com Oncotarget, 2018, Vol. 9, (No. 24), pp: 17181-17198

Review

Oxidative stress: role of physical exercise and antioxidant nutraceuticals in adulthood and aging

Carolina Simioni[1], Giorgio Zauli[1], Alberto M. Martelli[2], Marco Vitale[3,4], Gianni Sacchetti[5], Arianna Gonelli[1] and Luca M. Neri[1]

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[2]Department of Biomedical and Neuromotor Sciences, University of Bologna, Bologna, Italy
[3]Department of Medicine and Surgery, University of Parma, Parma, Italy
[4]CoreLab, Azienda Ospedaliero-Universitaria di Parma, Parma, Italy
[5]Department of Life Sciences and Biotechnology, Pharmaceutical Biology Laboratory, University of Ferrara, Ferrara, Italy

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Keywords: exercise training; nutraceuticals; flavonoids intake; aging; antioxidant supplementation

Received: January 26, 2018 **Accepted:** March 08, 2018 **Published:** March 30, 2018

Resveratrol can be implied in anti-aging actions by influencing the mitochondrial environment and metabolic diseases, by regulating the levels of some inflammatory mediators and cytokines and by modulating lipolysis [125, 152, 153]. Mitochondrial dysfunction has been proved to be associated with aging and disease development [154], and it was seen

Furthermore, resveratrol maintains the vascular fitness through its antioxidant and anticoagulant activities, and on the other hand is relevant in blocking the formation of new blood vessels, in inhibiting the VEGF release and attenuating Hypoxia-Inducible Factor (HIF-1α) in different tumor cells [163].

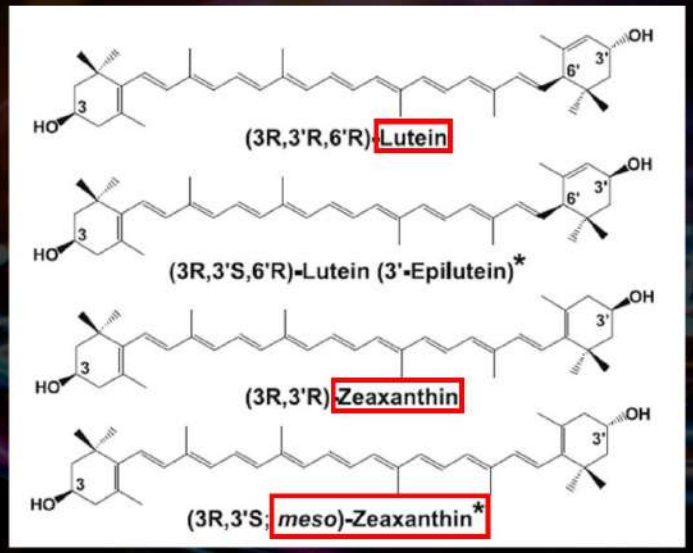
ASSESSMENT OF CAROTENOIDS

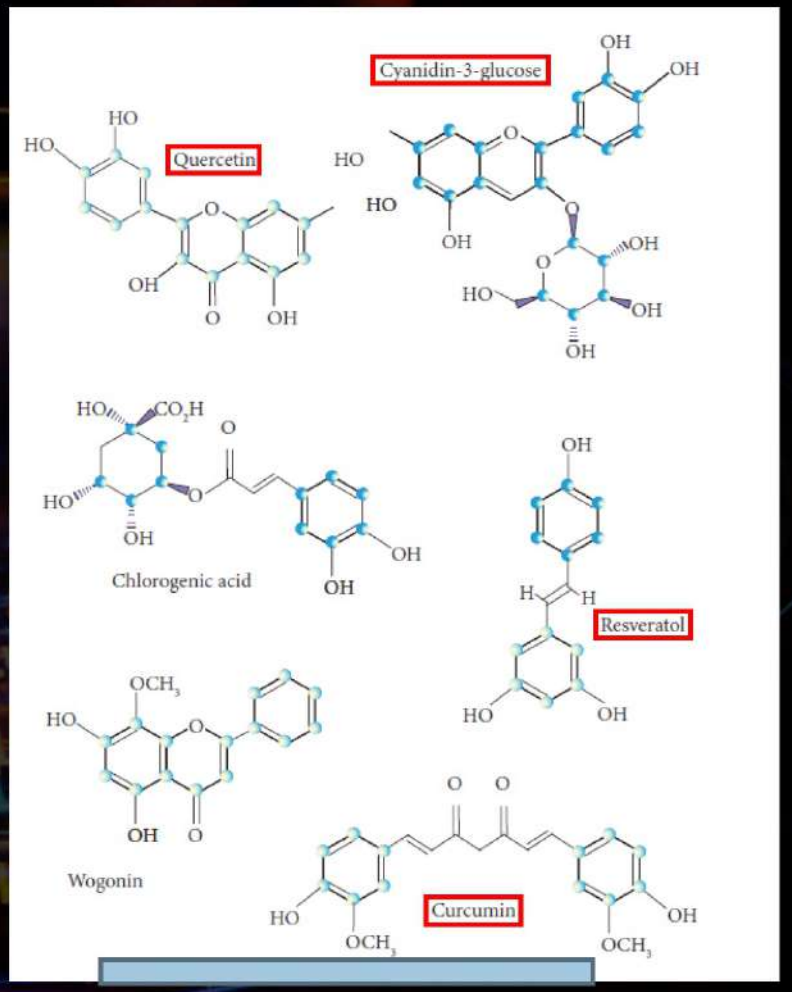
Impact of Carotenoid Assessment

Because carotenoids appear to play a key role in retinal diseases, intensive research has resulted in a variety of innovative carotenoid assessment techniques. The breadth of possibilities for assessing retinal carotenoids is often confusing because methodologies, units of measurement, and the presentation of results vary widely. Accurate readings of carotenoid status are important in order to correctly advise individuals with regards to supplementation. Furthermore, in diseases such as macular telangiectasia type 2 (MacTel), the assessment of carotenoids may be crucial to the diagnosis, as reduced MP levels as well as abnormal distributions are among the first signs of the disease. Therefore, the measurement of carotenoids can impact clinical practice, and the evaluation of MP may eventually become an integral part of comprehensive ophthalmological care. The following sections describe and aim to give an organized overview of different MP assessment techniques.

A large variety of methods are used to assess carotenoid status in humans, most of which are focused on the eye, but carotenoids can also be measured in tissue outside of the eye, such as the skin, blood, and the brain. Measurements of ocular carotenoids can be distinguished between subjective (psychophysical) and objective (optical) methods used to assess the amount of MP. In subjective methods, a direct answer from the patient is required, whereas objective measurement methods typically require just enough cooperation to generate an image (73).

Retinal nutraceuticals share a common thread....

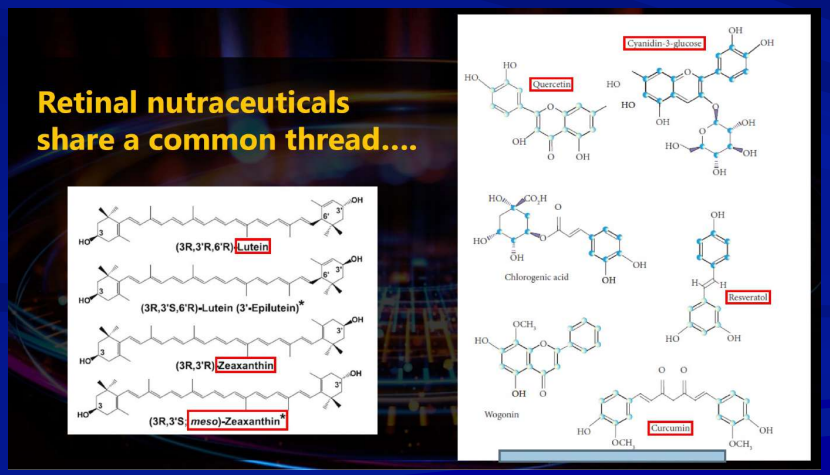




Thank you, Dr. Chris Putnam,

-OH

- -OH group donate an electron to mitigate the ROS and singlet oxygen generated from highly metabolic tissue
- -OH group is found on all of them and it's what makes them such a fantastic antioxidant



Polyphenols
Flavonoids
Quercetin

Thank you, Dr. Chris Putnam,

Quercetin inhibits choroidal and retinal angiogenesis *in vitro*.
Graefe's Arch Clin Exp Ophthal (2008) 246.3:373-378.

Singlet oxygen quenching-and chain-breaking antioxidant-properties of a quercetin dimer able to prevent AMD.
Biophysical chemistry 243 (2018): 17-23.

Quercetin and cyanidin-3-glucoside protect against photooxidation and photodegradation of A2E in RPE cells.
Experimental eye research 160 (2017): 45-55.

Neuroprotective effects of quercetin in diabetic rat retina.
J Bio Sciences. (2017) 24.6:1186-1194.

Protective effect of quercetin and chlorogenic acid, two polyphenols widely present in edible plant varieties, on visible light-induced retinal degeneration *in vivo*.
J Func Foods (2017) *33*, 103-111.

Polyphenols
Flavonoids
Anthocyanins

Thank you, Dr. Chris Putnam,

Antioxidant and anti-inflammatory effects of blueberry anthocyanins on high glucose-induced human retinal capillary endothelial cells.
Oxidative medicine and cellular longevity. (2018)

Protective effects of blueberry anthocyanins against H_2O_2-induced oxidative injuries in human retinal pigment epithelial cells.
J Agricultaral Food Chem. (2018) *66*(7):1638-1648.

Protective effect of anthocyanins and xanthophylls on UVB-induced damage in retinal pigment epithelial cells.
Food and Function (2016) *7*(2):1067-1076.

Effects of blueberry anthocyanins on retinal oxidative stress and inflammation in diabetes through Nrf2/HO-1 signaling.
J Neuroimmunology (2016) 301:1-6.

Identification of anthocyanins in the liver, eye and brain of blueberry-fed pigs
J Agric Food Chem (2008) 56.3:705-712

Polyphenols
Non-Flavonoids
Curcumin

Thank you, Dr. Chris Putnam,

Therapeutic potential of curcumin in major retinal pathologies.
Int ophth (2019) 39.3:725-734.

Vascular endothelial growth factor: An important molecular target of curcumin.
Crit Review Food Sci Nutrition (2019) 59.2:299-312.

Retinal protection and distribution of curcumin *in vitro* and *in vivo*.
Frontiers in pharmacology 9 (2018) 670.

Curcumin acts to regress macular drusen volume in dry AMD.
Invest Ophth Vis Sci (2020) 61.7:1036-1036.

Curcumin-Based Treatment for Macular Edema from Uncommon Etiologies: Efficacy and Safety Assessment.
Journal of Medicinal Food (2020) 23.8

Polyphenols

Non-Flavonoids

Resveratrol

Thank you, Dr. Chris Putnam,

Resveratrol based oral nutritional supplement produces long-term beneficial effects on structure and visual function in human patients.
Nutrients. (2014), 6.10:4404-4420.

Resveratrol suppresses expression of VEGF by human retinal pigment epithelial cells: potential nutraceutical for age-related macular degeneration.
Aging and disease (2014) 5.2:88.

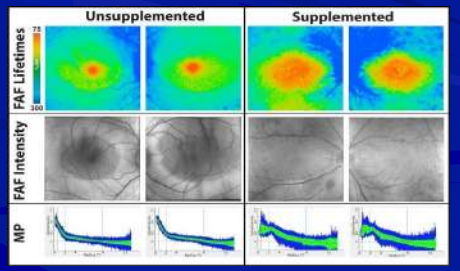
SIRT1 mediated inhibition of VEGF/VEGFR2 signaling by Resveratrol and its relevance to choroidal neovascularization.
Cytokine 76.2 (2015):549-552.

Anti-oxidant, anti-inflammatory and anti-angiogenic properties of resveratrol in ocular diseases.
Molecules 21.3 (2016):304.

Toxic effects of A2E in human ARPE-19 cells were prevented by resveratrol: A potential nutritional bioactive for age-related macular degeneration treatment.
Archives of Toxicology 94.2 (2020): 553-572.

Measuring Macular Pigment

- Retina macula biopsy
- Clinical Imaging
  - ★ Subjective
    - ZeaVision MPSII
    - Guardion Mapcat SF
  - ★ Clinical
    - ZeaVision MPR
    - Zeiss Visucam 200
    - Spectralis HRA+OCT
    - Spectralis MPOV



Thank you! Dr. Chris Putnam

Lutein and Zeaxanthin are Needed but are not Enough

Imaging lutein and zeaxanthin in the human retina with confocal resonance Raman microscopy

Binxing Li[a], Evan W. George[a], Gregory T. Rognon[a], Aruna Gorusupudi[a], Arunkumar Ranganathan[a], Fu-Yen Chang[a], Linjia Shi[a], Jeanne M. Frederick[a], and Paul S. Bernstein[a,1]

[a]Department of Ophthalmology and Visual Sciences, Moran Eye Center, University of Utah School of Medicine, Salt Lake City, UT 84132

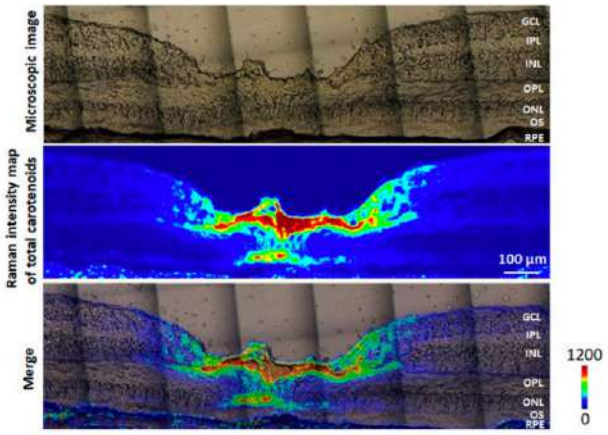
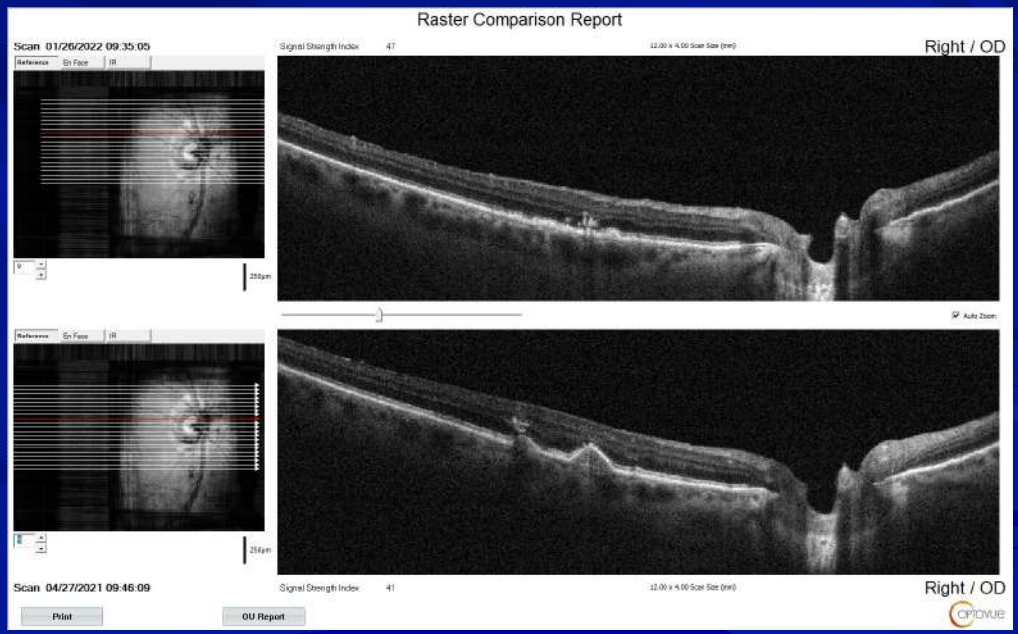
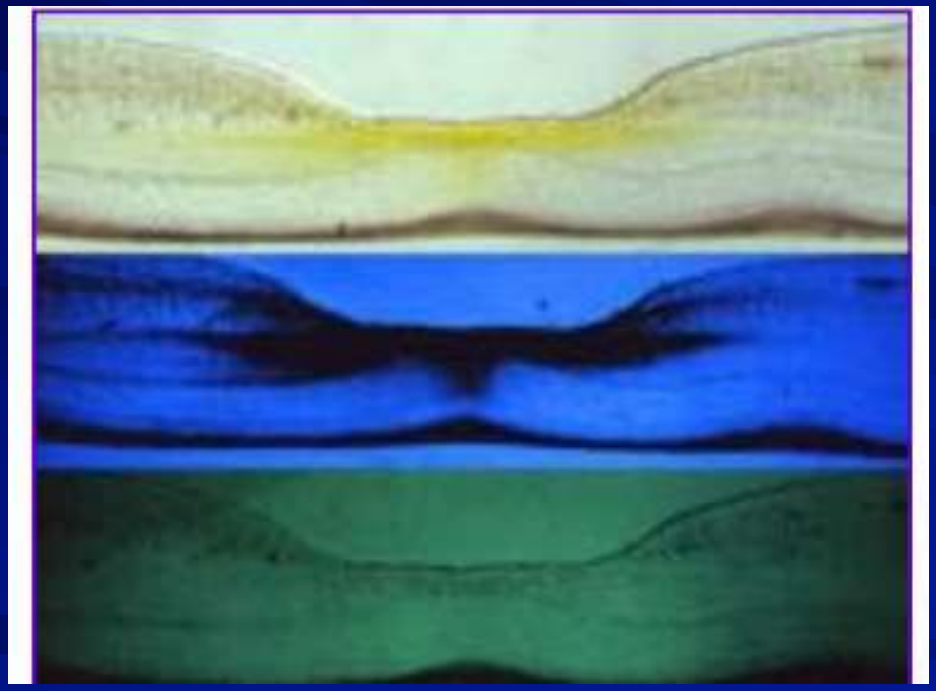
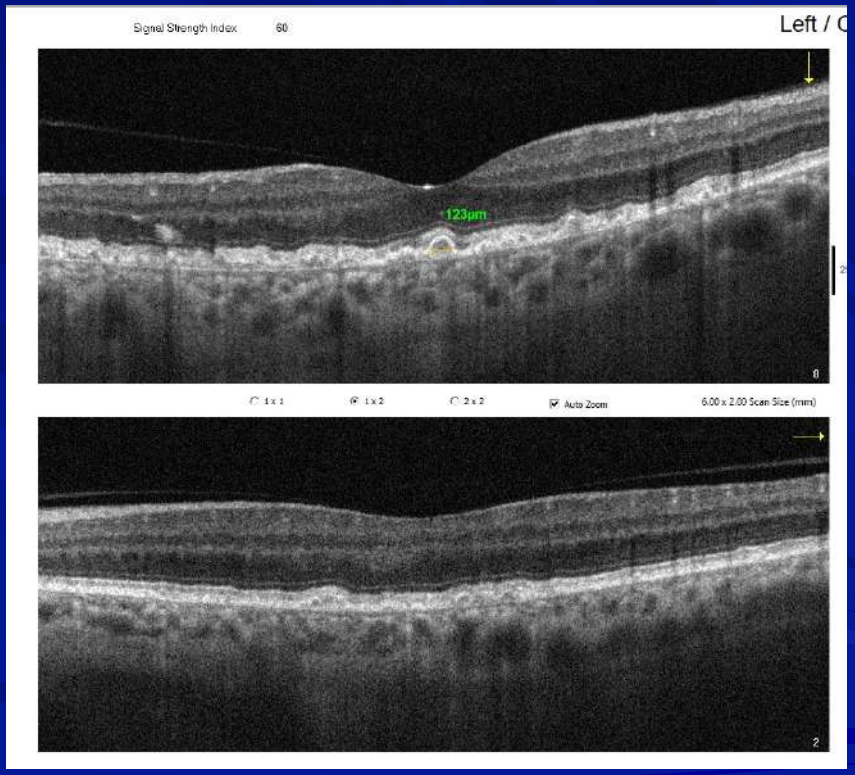


Fig. 4. Distribution of total carotenoids in a human retinal section. (*Top*) A



Chronic and Low-Grade Inflammation
Does the crime fit the punishment?



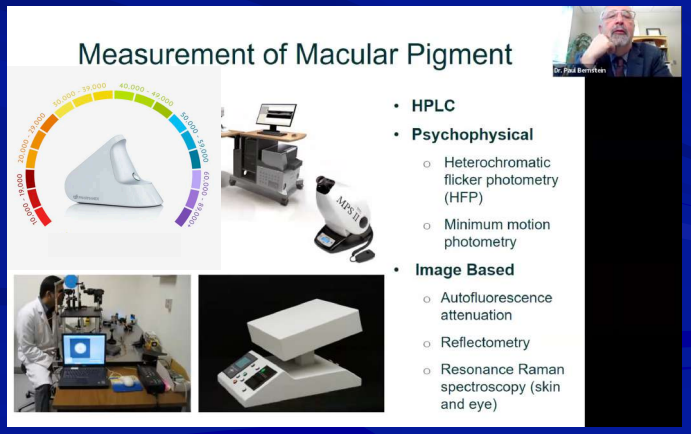


Biomarker

- Test that has meaning
- Biological molecule found in blood, other body fluids, or tissues that is a sign of a normal or abnormal process, or of a condition or disease.
- A biomarker may be used to see how well the body responds to a treatment for a disease or condition
- Blood pressure, blood work, heart rate, genetic testing, IOP

Predictive Biomarker

- Used to identify individuals who are more likely to respond to exposure to a particular medical product or environmental agent
- The response could be a symptomatic benefit, improved survival, or an adverse effect
- A value that we can guide therapy around
  - HbAlc
  - C-Reactive Protein
  - Plasma Homocysteine
  - Vitamin D (25-HydroxyD)
  - Omega 3 index
  - Carotenoid



Measuring Carotenoid Leves

- Biophotonic Scanner
  - ★ Measures carotenoids
  - ★ Based on an optical method known as Resonant Raman Spectroscopy (RSS)
    - Used for many years in research laboratories
  - ★ Skin RRS measurements
    - Noninvasive
    - Objective
    - Reliable methods to assess carotenoid levels
      - Ocular
      - Systemic

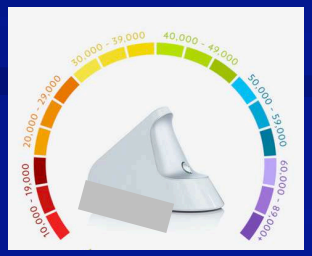
Carotenoid Levels

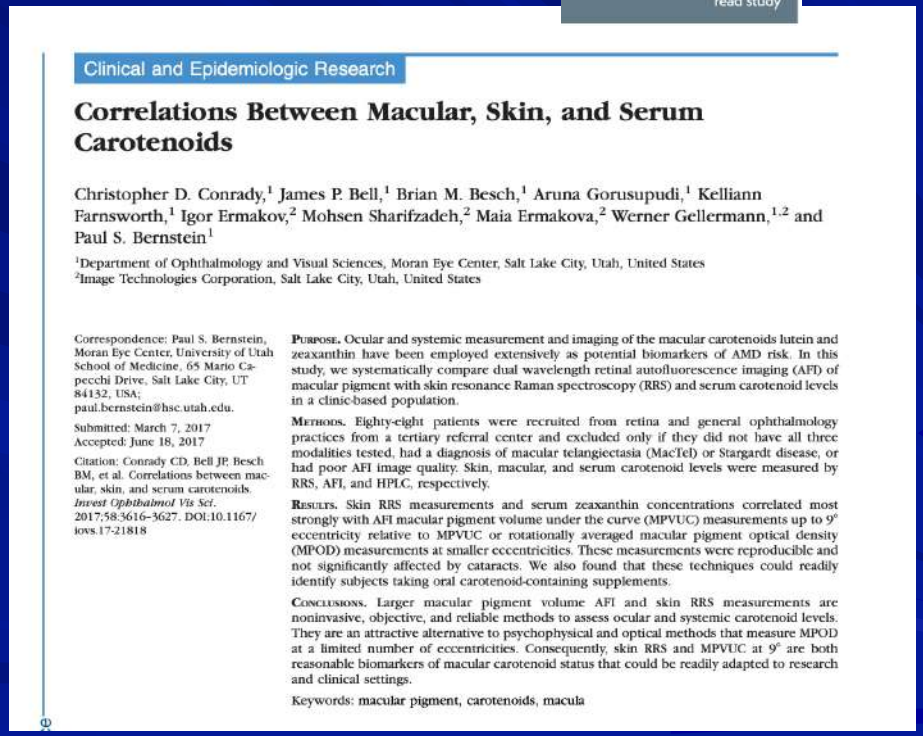
ARVO
The Association for Research in Vision and Ophthalmology

Scanner correlates to blood and macular pigment

read study

- Biomarker of health for diet and lifestyle
  - ★Yale University
- Phospholipid bi-layer
- Carotenoids, flavonoids, and polyphenols





Clinical and Epidemiologic Research

Correlations Between Macular, Skin, and Serum Carotenoids

Christopher D. Conrady,[1] James P. Bell,[1] Brian M. Besch,[1] Aruna Gorusupudi,[1] Kelliann Farnsworth,[1] Igor Ermakov,[2] Mohsen Sharifzadeh,[2] Maia Ermakova,[2] Werner Gellermann,[1,2] and Paul S. Bernstein[1]

[1]Department of Ophthalmology and Visual Sciences, Moran Eye Center, Salt Lake City, Utah, United States
[2]Image Technologies Corporation, Salt Lake City, Utah, United States

Correspondence: Paul S. Bernstein, Moran Eye Center, University of Utah School of Medicine, 65 Mario Capecchi Drive, Salt Lake City, UT 84132, USA; paul.bernstein@hsc.utah.edu.

Submitted: March 7, 2017
Accepted: June 18, 2017

Citation: Conrady CD, Bell JP, Besch BM, et al. Correlations between macular, skin, and serum carotenoids. *Invest Ophthalmol Vis Sci*. 2017;58:3616–3627. DOI:10.1167/iovs.17-21818

Purpose. Ocular and systemic measurement and imaging of the macular carotenoids lutein and zeaxanthin have been employed extensively as potential biomarkers of AMD risk. In this study, we systematically compare dual wavelength retinal autofluorescence imaging (AFI) of macular pigment with skin resonance Raman spectroscopy (RRS) and serum carotenoid levels in a clinic-based population.

Methods. Eighty-eight patients were recruited from retina and general ophthalmology practices from a tertiary referral center and excluded only if they did not have all three modalities tested, had a diagnosis of macular telangiectasia (MacTel) or Stargardt disease, or had poor AFI image quality. Skin, macular, and serum carotenoid levels were measured by RRS, AFI, and HPLC, respectively.

Results. Skin RRS measurements and serum zeaxanthin concentrations correlated most strongly with AFI macular pigment volume under the curve (MPVUC) measurements up to 9° eccentricity relative to MPVUC or rotationally averaged macular pigment optical density (MPOD) measurements at smaller eccentricities. These measurements were reproducible and not significantly affected by cataracts. We also found that these techniques could readily identify subjects taking oral carotenoid-containing supplements.

Conclusions. Larger macular pigment volume AFI and skin RRS measurements are noninvasive, objective, and reliable methods to assess ocular and systemic carotenoid levels. They are an attractive alternative to psychophysical and optical methods that measure MPOD at a limited number of eccentricities. Consequently, skin RRS and MPVUC at 9° are both reasonable biomarkers of macular carotenoid status that could be readily adapted to research and clinical settings.

Keywords: macular pigment, carotenoids, macula

Carotenoid Levels

NIH National Institutes of Health
Turning Discovery Into Health

- Quick Test (approx. 30 sec)
- Portable
- Cost Effective
- Remeasure in 60 days
- Reassurance to you and patient

Raman Spectroscopy

478nm PHOTONS ARE EMITTED FROM THE SCANNER

AS 478nm PHOTONS STRIKE CAROTENOIDS IN THE SKIN, THEY ARE REFLECTED BACK AS 518nm PHOTONS

Resonance Raman spectroscopic evaluation of skin carotenoids as a biomarker of carotenoid status for human studies

Susan T. Mayne [a,*], Brenda Cartmel [a], Stephanie Scarmo [a,b], Lisa Jahns [c], Igor V. Ermakov [d], Werner Gellermann [d]

[a] Yale School of Public Health and Yale Cancer Center, 60 [illegible] 8034, Ne [illegible] SA
[b] Center for Science in the Public Interest, 1220 L Street [illegible] ite 300, [illegible] ton, D [illegible] USA
[c] USDA/ARS Grand Forks Human Nutrition Research Ce [illegible] 0 2nd Ave [illegible] h, G [illegible] s, ND 58
[d] Department of Physics and Astronomy, University of [illegible] t Lake City [illegible] 2,

ARTICLE INFO

Article history:
Available online xxxx

Keywords:
Carotenoids
Skin
Resonance Raman spectroscopy
Beta-carotene
Biomarker

ABSTRA

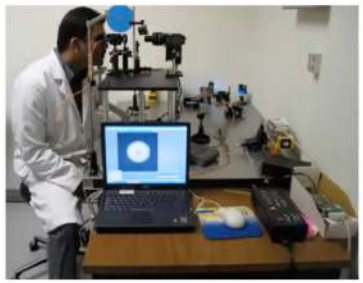
[illegible] spectrosc [illegible] nvasive method that has been developed to assess carot- [illegible] human tissues [illegible] an skin *in vivo*. Skin carotenoid status has been suggested as a promising biomarker for human studies. This [illegible] ript describes research done relevant to the development of this biomarker, including its rep [illegible] ibility, [illegible] lidity, feasibility for use in field settings, and factors that affect the biomark [illegible] s [illegible] ch a [illegible] t, [illegible] mok [illegible] and adiposity. Recent studies have evaluated the response of the b [illegible] ar [illegible] r to [illegible] ntroll [illegible] c [illegible] otenoid interventions, both supplement-based and dietary [e.g., provision [illegible] of a hi [illegible] h-ca [illegible] ter [illegible] id [illegible] uit and vegetable (F/V)-enriched diet], demonstrating consistent response to interv [illegible] tio [illegible] The totality of evidence supports the use of skin carotenoid status as an objective biomarker [illegible] f F/V intake, although in the cross-sectional setting, diet explains only some of the variation in this biomarker. However, this limitation is also a strength in that skin carotenoids may effectively serve as an integrated biomarker of health, with higher status reflecting greater F/V intake, lack of smoking, and lack of adiposity. Thus, this biomarker holds promise as both a health biomarker and an objective indicator of F/V intake, supporting its further development and utilization for medical and public health purposes.

90 STUDIES

*Arch Biochem Biophys. PMC 2014 Nov 15.

An Evening with Dr. Paul Bernstein

Measurement of Macular Pigment



- **HPLC**
- **Psychophysical**
  - Heterochromatic flicker photometry (HFP)
  - Minimum motion photometry
- **Image Based**
  - Autofluorescence attenuation
  - Reflectometry
  - Resonance Raman spectroscopy (skin and eye)

High Performance Liquid Chronography

ARVO STUDY

Interrelationships between Macula, Skin and Serum Carotenoids- Paul Bernstein, Werner Gellerman et al ARVO May 2016

Conclusions:

"Our results emphasize the importance of measuring the total amount of carotenoids in the macula region using an objective image based modality such as AFI w Spectralis rather than subjective MPOD."

Skin resonance Raman Spectroscopy of skin carotenoids is a reasonable biomarker of macula carotenoid status. and correlates better than than subjective MPOD tests.

The objective hand scanner is better than the subjective Macuscope, QuantifEYE, and Densitometer for estimating macula pigment.

An Evening with Dr. Paul Bernstein

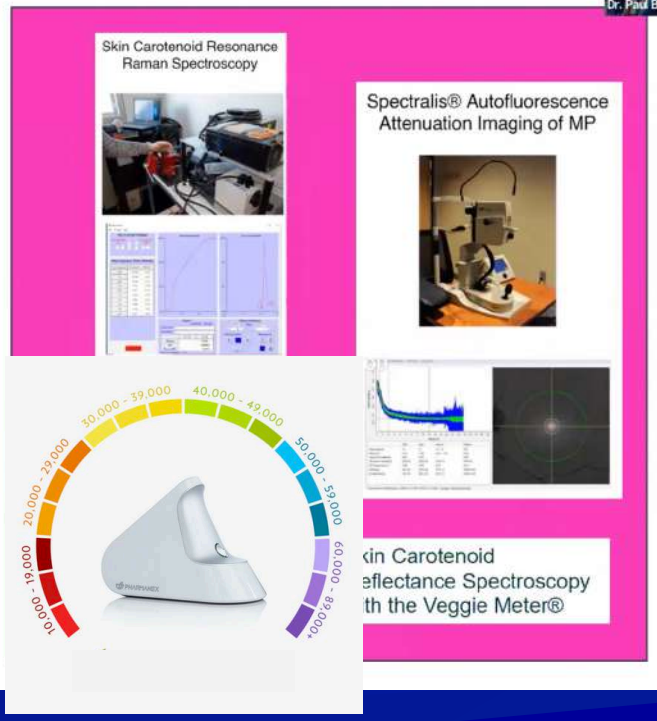
The Lutein and Zeaxanthin in Pregnancy Study: The L-ZIP Study

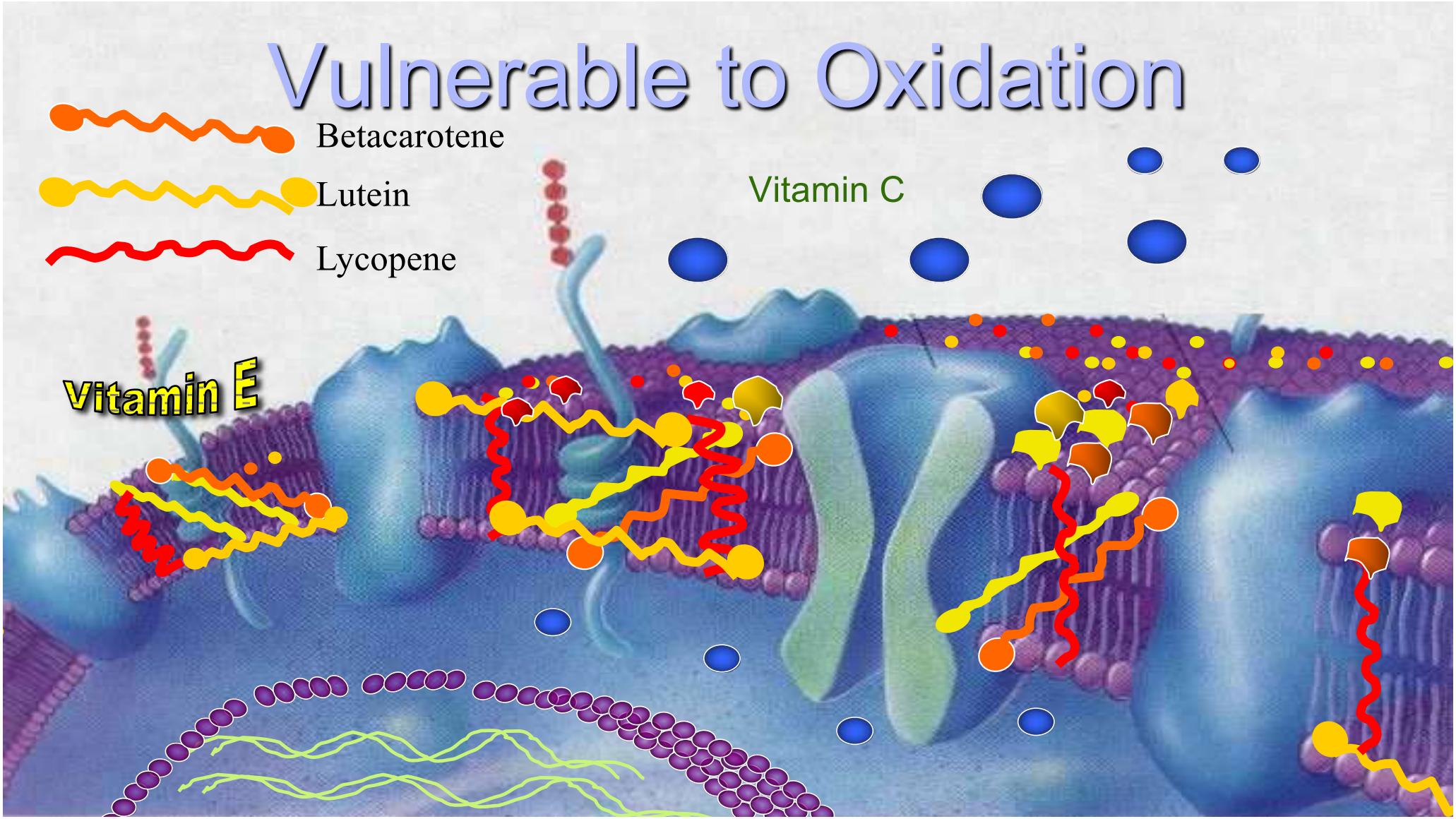
- Will addition of L and Z to standard-of-care prenatal vitamins combat maternal carotenoid depletion and improve maternal and infant ocular health?
- Randomized, controlled trial of 10 mg/d L and 2 mg/d Z v no L/Z
- Low-risk pregnancies
- Outcomes
  - Skin carotenoids by RRS in mother and infant
  - Maternal macular pigment by Spectralis AFI
  - Infant macular pigment and foveal structure by RetCam and Bioptigen OCT
- Fully enrolled
- NEI funded

An Evening with Dr. Paul Bernstein

The Moran AMD Genetic Testing Assessment Study: The Magenta Study

- Will knowledge of AMD genetic risk lead to quantifiable, sustained healthy changes in lifestyle?
- Randomized, controlled trial of pre-symptomatic genetic risk testing and counseling
  - immediate versus deferred disclosure
- 18-64 years-old w/o AMD
- Outcomes
  - Skin carotenoids by RRS and RS
  - Macular pigment by Spectralis AFI
  - Lifestyle surveys
- Awaiting NEI funding




Vulnerable to Oxidation
Betacarotene
Lutein
Lycopene
Vitamin C
Vitamin E

53-year-old man

- Family history of AMD
  - Dad with 43 injections for AMD
- Pre-diabetic with borderline HbA1c
- Vision 20/20 OU
- DFE- retina clear
- OCT normal
- Passes dark adaptation

CONGRATULATIONS ON TAKING THE FIRST STEPS TOWARDS OPTIMIZING YOUR SCS

Dear [redacted]

Recently, on 12/15/2020, you met with me and I scanned the palm of your hand with the [redacted] BioPhotonic Scanner. Your scan returned a Skin Carotenoid Score (SCS) of 26000.

This score represents the current carotenoid level of your skin. The higher the score, the more carotenoids your body is receiving.

Ingredients

Ingredients	Amount	% Daily Value
Serving Size: 1 Packet		
Vitamin A (83% as Beta Carotene (1875 mcg RAE) from *Blakeslea trispora*, and Vitamin A palmitate) (375 mcg RAE)	2250 mcg RAE	250%
Vitamin C (as Calcium Ascorbate)	200 mg	222%
Vitamin D (as Cholecalciferol)	5 mcg (200 IU)	25%
Vitamin E (as D-Alpha-Tocopheryl Acetate, D-Alpha Tocopherol, Tocotrienols)	50.3 mg	335%
Vitamin K (as Phytonadione)	20 mcg	17%
Thiamin (as Thiamine Mononitrate)	3.75 mg	313%
Riboflavin (as Riboflavin)	4.25 mg	327%
Niacin (as Niacinamide)	17.5 mg NE	109%
Vitamin B6 (as Pyridoxine Hydrochloride)	5 mg	294%
Folate	500 mcg DFE (300 mcg folic acid)	125%
Vitamin B12 (as Cyanocobalamin)	15 mcg	625%
Biotin (as Biotin)	75 mcg	250%
Pantothenic Acid (as D-Calcium Pantothenate)	15 mg	300%
Calcium (as Calcium Carbonate, Di-Calcium Malate, Calcium Ascorbate)	250 mg	19%
Calcium (as Calcium Carbonate, Di-Calcium Malate, Calcium Ascorbate)	250 mg	19%
Iodine (as Potassium Iodide)	50 mcg	33%
Magnesium (as Magnesium Glycinate, Magnesium Oxide)	125 mg	30%
Zinc (as Zinc Bisglycinate)	7.5 mg	68%
Selenium (as L-Selenomethionine, Sodium Selenite)	70 mcg	127%
Copper (as Copper Bisglycinate)	0.5 mg	56%
Manganese (as Manganese Bisglycinate)	1 mg	43%
Chromium (as Chromium Nicotinate Glycinate)	100mcg	286%
Molybdenum (as Molybdenum Bisglycinate)	37.5 mcg	83%
Polyphenol and Flavonoid Blend	97.5 mg	*
Catechins (from *Camellia sinensis* Leaf Extract)	(45 mg)	*
Quercetin	(25 mg)	*
Grape Seed Extract (min. 95% Polyphenols)	(12.5 mg)	*
Citrus Bioflavonoids (from Citrus Fruits)	12.5 mg)	*
Resveratrol (from *Polygonum cuspidatum* root extract)	(2.5 mg)	*
Mixed Tovopherols (Gamma, Delta & Beta Tocopherols)	53 mg	*
Alpha-Lipoic Acid	15 mg	*
Inositol (as Inositol)	5 mg	*
Carotenoid Blend	3.5 mg	*
Lycopene (as Lycopene)	(2.5 mg)	*
Lutein (from Marigold Flower Extract)	(1 mg)	*
Boron (as Boron Citrate)	1.5 mg	*
Vanadium (as Vanadyl Sulfate)	10 mcg	*

OTHER INGREDIENTS: Gelatin, Microcrystalline Cellulose, Crosmarmellose Sodium, Stearic Acid, Magnesium Stearate, Silicon Dioxide, Titanium Dioxide.

CONTAINS: Fish (Cod, Pollack, Haddock, Hake, Cusk, Redfish, Sole, Flounder).

SUPPLEMENT FACTS

Supplement Facts

Serving Size 2 Softgels — Servings Per Container 60

Amount Per Serving		% DV
Total Calories	15	
Total Fat	1 g	1%*
Saturated Fat	0 g	0%*
Trans Fat	0 g	
Vitamin D_3 (as cholecalciferol)	12.5 mcg (500 IU)	63%
Vitamin K_2 (as menaquinone-7)	20 mcg	17%
Ultra-pure fish oil concentrate:	1055 mg	**
EPA (Eicosapentaenoic acid)	300 mg	**
DHA (Docosahexaenoic acid)	200 mg	**
Citrus Bioflavonoids (including hesperidin and naringin)	100 mg	**
Purple corn (*Zea mays L.*) cob extract including anthocyanins	66.67 mg	**
Alpha Lipoic Acid	50 mg	**
Quercetin (from *Dimorphandra mollis* fruit extract)	37.5 mg	**
D-Limonene (from *Citrus sinensis* peel)	25 mg	**
Rosemary (*Rosmarinus officinalis L.*) leaf extract including carnosic acid	18.75 mg	**
Resveratrol (from *Polygonum cuspidatum* root)	15 mg	**
Coenzyme Q10	15 mg	**
Lycopene	2.5 mg	**
Lutein (from marigold flower (*Targetes erecta*))	2 mg	**
Astaxanthin (from *Haematococcus pluvialis* algae)	0.5 mg	**

* Percent Daily Values are based on a 2,000 Calorie Diet.
** Daily Value (DV) not established.

OTHER INGREDIENTS: Gelatin, Glycerin, Beeswax, Sunflower Lecithin, Vanillin.

CONTAINS: Fish (anchovies, sardines, mackerel).

53-year-old man

CONGRATULATIONS ON TAKING THE FIRST STEPS TOWARDS OPTIMIZING YOUR SCS

Dear [redacted]

Recently, on 12/27/2020, you met with me and I scanned the palm of your hand with the [redacted] BioPhotonic Scanner. Your scan returned a Skin Carotenoid Score (SCS) of 33000.

This score represents the current carotenoid level of your skin. The higher the score, the more carotenoids your body is receiving.

33000

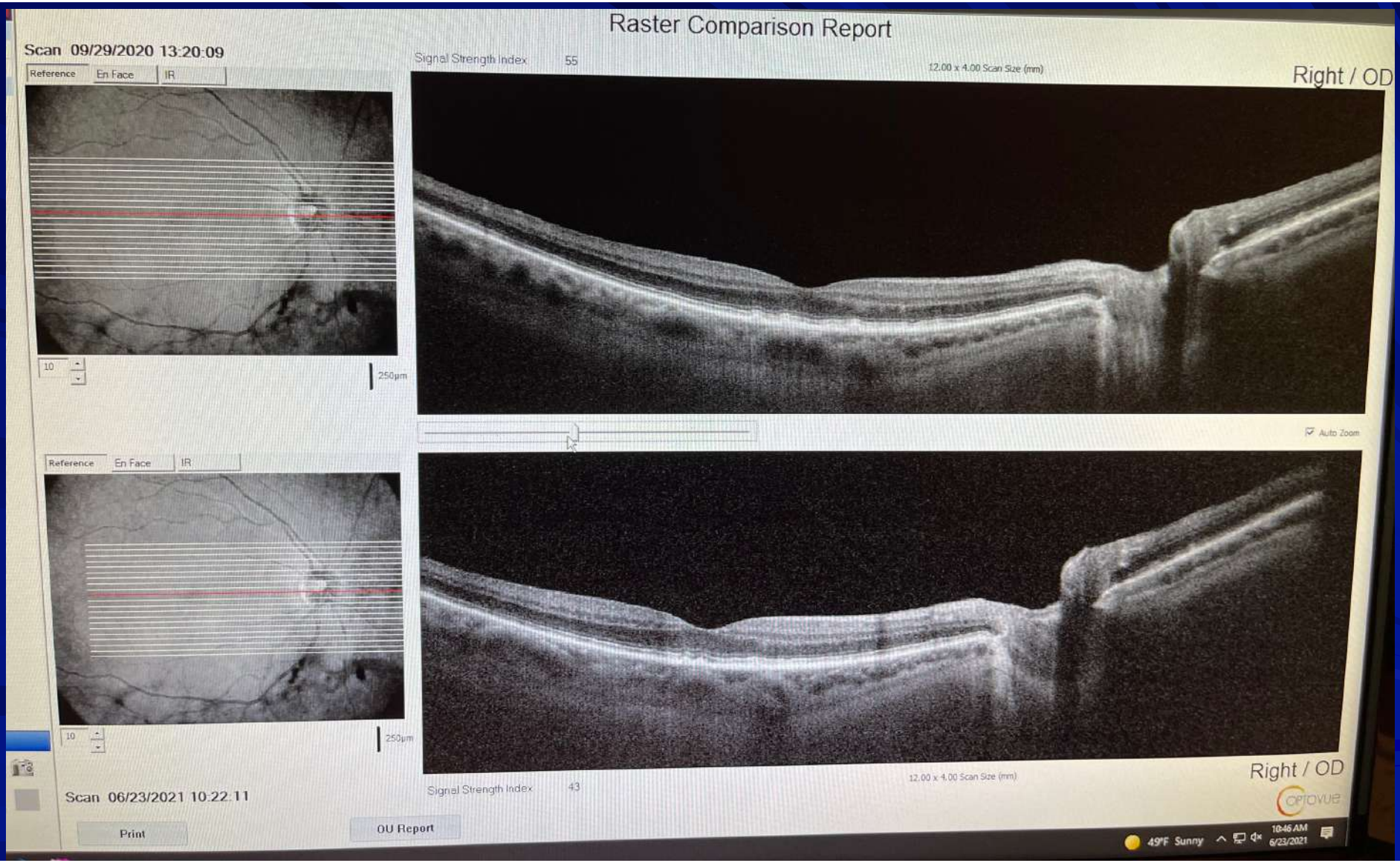
CONGRATULATIONS ON TAKING THE FIRST STEPS TOWARDS OPTIMIZING YOUR SCS

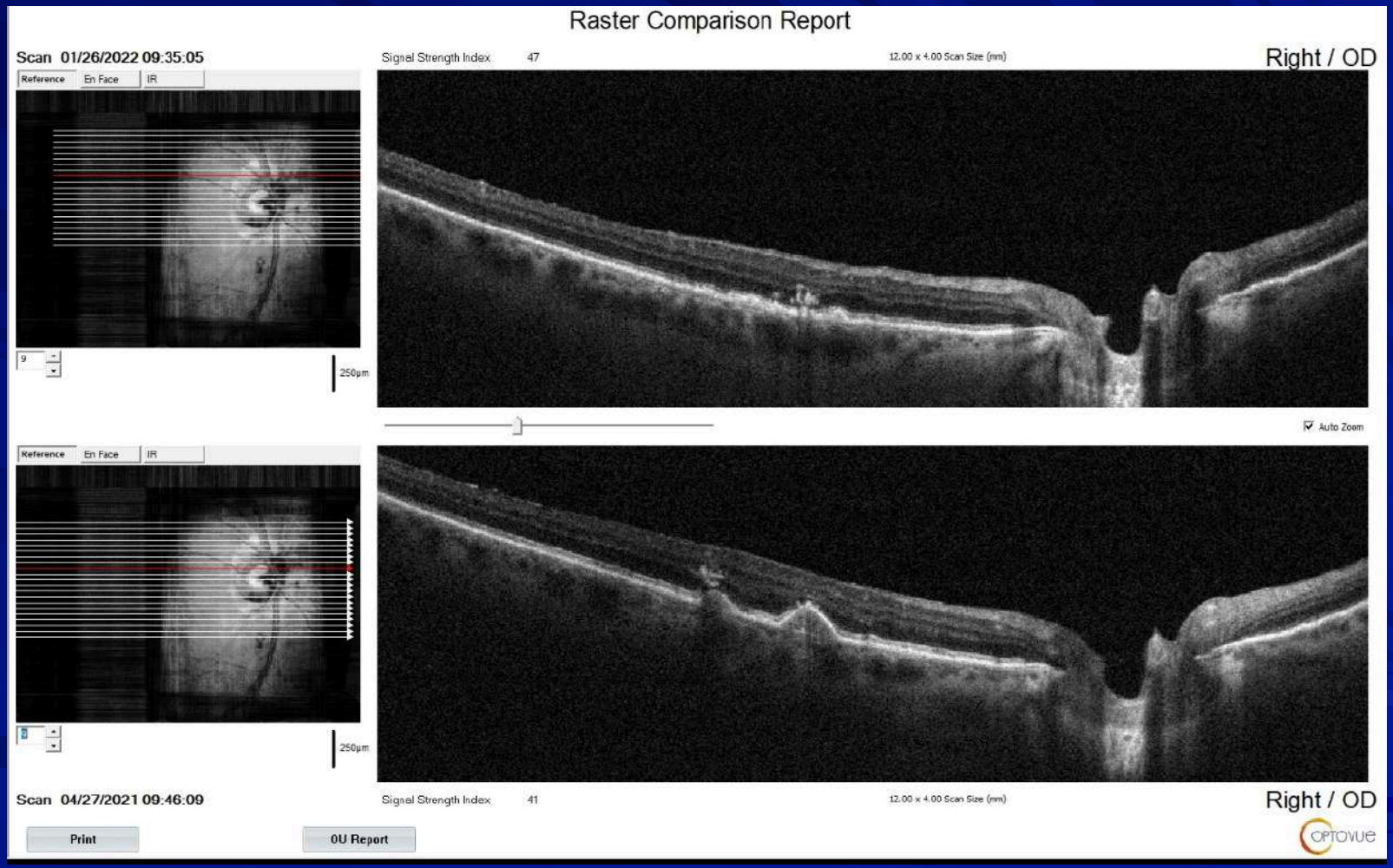
Dear [redacted]

Recently, on 01/23/2021, you met with me and I scanned the palm of your hand with the [redacted] BioPhotonic Scanner. Your scan returned a Skin Carotenoid Score (SCS) of 47000.

This score represents the current carotenoid level of your skin. The higher the score, the more carotenoids your body is receiving.

47000


Raster Comparison Report
Scan 09/29/2020 13:20:09
Reference
En Face
IR
Signal Strength Index 55
12.00 x 4.00 Scan Size (mm)
Right / OD
10
250µm
Auto Zoom
Reference
En Face
IR
10
250µm
Scan 06/23/2021 10:22:11
Signal Strength Index 43
12.00 x 4.00 Scan Size (mm)
Right / OD
OPTOVUE
Print
OU Report
49°F Sunny
10:46 AM
6/23/2021


Raster Comparison Report
Scan 01/26/2022 09:35:05
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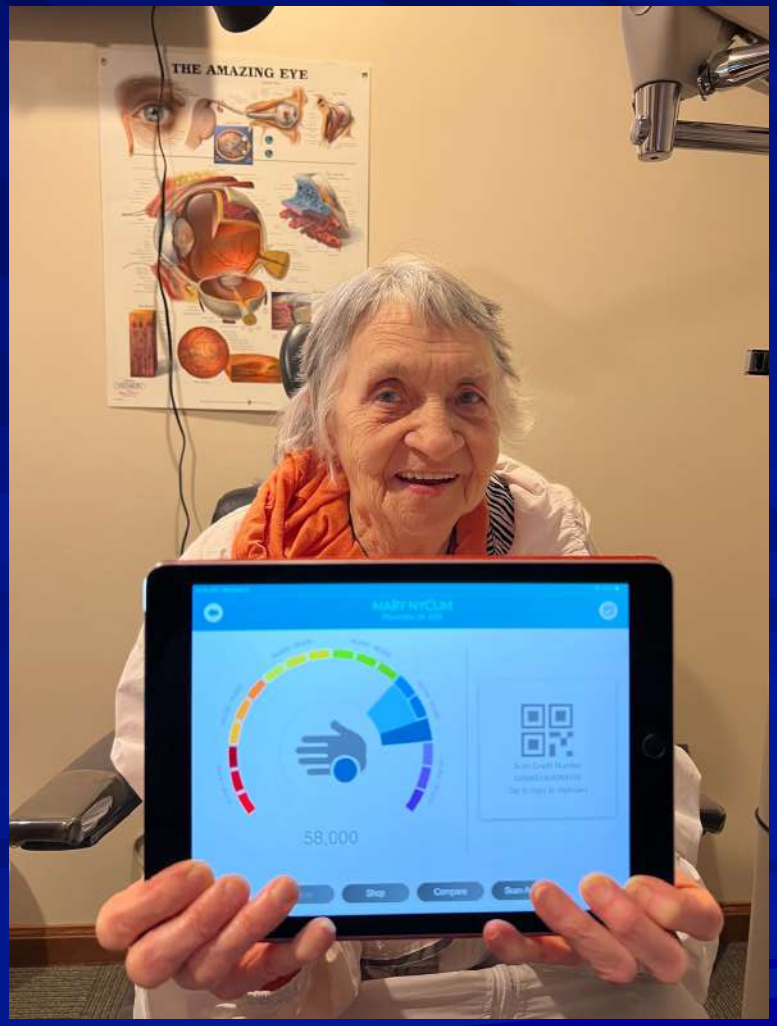
12.00 x 4.00 Scan Size (mm)
Right / OD
Reference
En Face
IR
250µm
Auto Zoom
Scan 04/27/2021 09:46:09
Signal Strength Index 41
12.00 x 4.00 Scan Size (mm)
Right / OD
Print
OU Report
OPTOVUE


THE AMAZING EYE
58,000

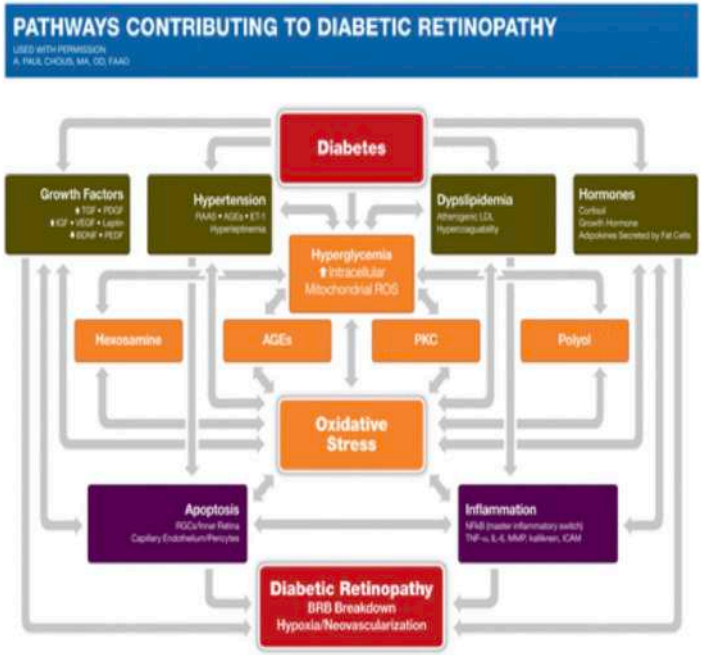
Randomized Controlled Trial > Br J Ophthalmol. 2016 Feb;100(2):227-34.
doi: 10.1136/bjophthalmol-2014-306534. Epub 2015 Jun 18.

The Diabetes Visual Function Supplement Study (DiVFuSS)

A Paul Chous [1], Stuart P Richer [2], Jeffry D Gerson [3], Renu A Kowluru [4]

Affiliations + expand

PMID: 26089210 PMCID: PMC4752618 DOI: 10.1136/bjophthalmol-2014-306534
Free PMC article



DiVFuSS Constituents	Mitigates DR in animal models	Blocks capillary cell apoptosis	Improves retinal capillary fragility	Reduces VEGF	Reduces oxidative stress	Reduces AGE activity	Reduces Polyol activity	Reduces PKC activity	Reduces NF-Kβ
Alpha-Lipoic Acid	•		•	•	•				•
Benfotiamine	•	•				•	•	•	
Vitamins C/E	•				•		•		•
Curcumin	•			•	•	•			•
Vitamin D3	•			•					
DHA/EPA	•	•			•				
Grape Seed Extract		•			•	•			
Resveratrol	•	•			•				
Green Tea Extract				•					
N-Acetyl Cysteine	•			•	•				
CoQ10					•				
Zinc	• (in ARDS)								
Pycnogenol	•		•		•				•
Lutein/Zeaxanthin	•			•	•				•

DiVFuSS Constituents	Improves visual function in humans	Reduces retinal edema in humans	Improves endothelial dysfunction in humans	Improves retinal blood flow in humans	Reduces HbA1c in humans	Improves Dyslipidemia in humans	Reduces blood pressure in humans	Reduces DPN symptoms in humans
Alpha-Lipoic Acid			•	•				•
Benfotiamine			•			•		•
Vitamins C/E			•	•		•		
Curcumin	•	•		•				
Vitamin D3					•	•		
DHA/EPA			•			•	•	
Grape Seed Extract								
Resveratrol			•		•			
Green Tea Extract			•			•	•	
N-Acetyl Cysteine								
CoQ10			•					
Zinc						•		
Pycnogenol	•	•		•	•	•	•	
Lutein/Zeaxanthin	•	•						

Note: Suggested improvements marked by • include published evidence in animal and/or cell models, except as specifically noted, but do not reflect grading of that evidence.

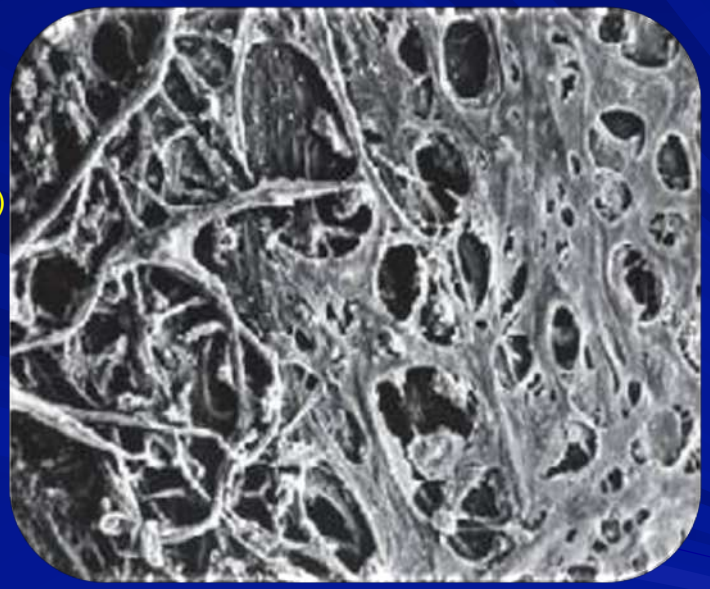
Download figure

Disease at the TM is responsible for elevated IOP in glaucoma[1,2]

Healthy TM
Normal IOP

Cellular Damage
(eg, Oxidative Stress)

POAG TM Stiffness
Elevated IOP



Scanning electron microscopy (2000x) was used to examine human TM under physiological conditions and in patients with POAG.[2]
POAG, primary open-angle glaucoma; TM, trabecular meshwork.

1. He et al. *Invest Ophthalmol Vis Sci*. 2008;49:1447.
2. Saccà et al. *J Cell Physiol.* 2015;230:510.

Glaucoma

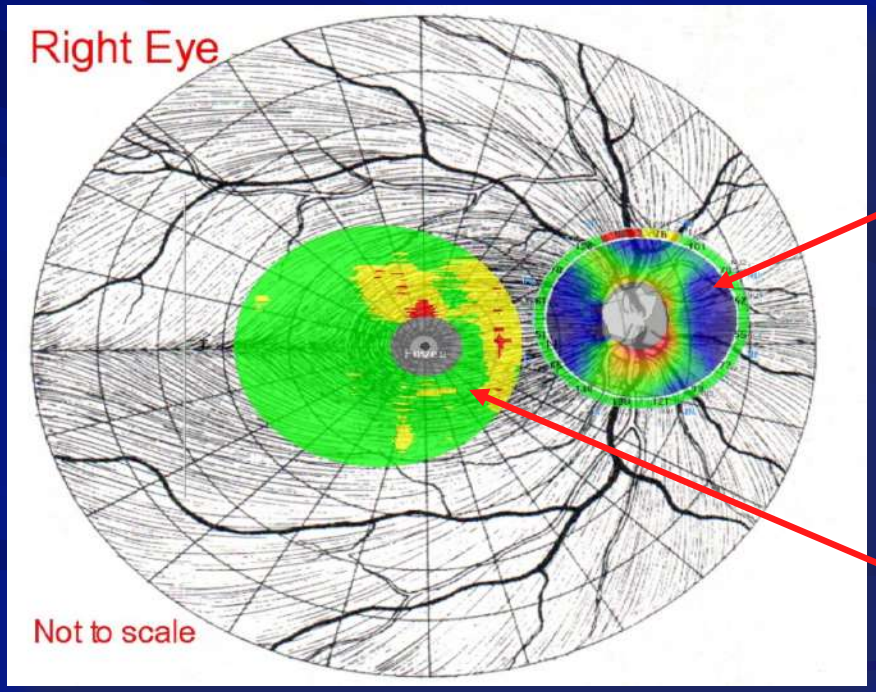
PERSPECTIVES ON GLAUCOMA

Antioxidants enhance ocular perfusion in Open Angle Glaucoma

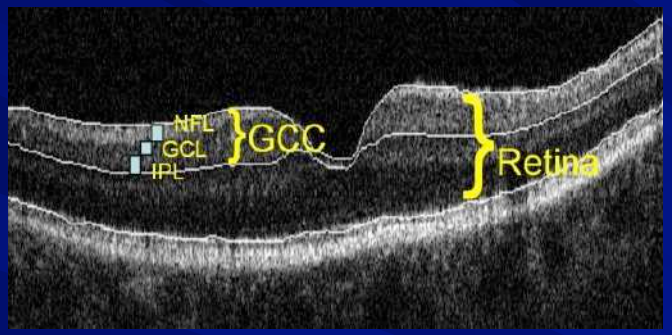
Harris A, et al. Acta Ophthalmol. 2018;doi:10.1111/aos.13530.

"In agreement with previous findings, our results indicate that the supplementation of certain antioxidants may increase blood supply to the orbit and within retinal capillary beds following 4 weeks administration," the authors wrote. "Our data suggest oral antioxidant supplementation may decrease vascular resistance over a longer period of time than previous trials investigated."

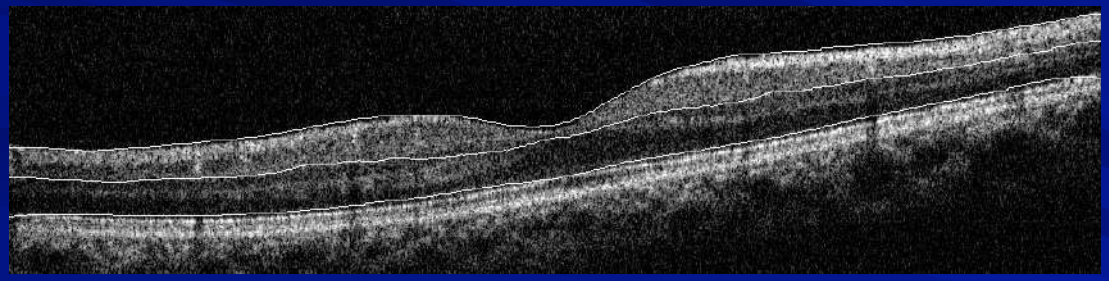
Overlay of the RNFL and GCC



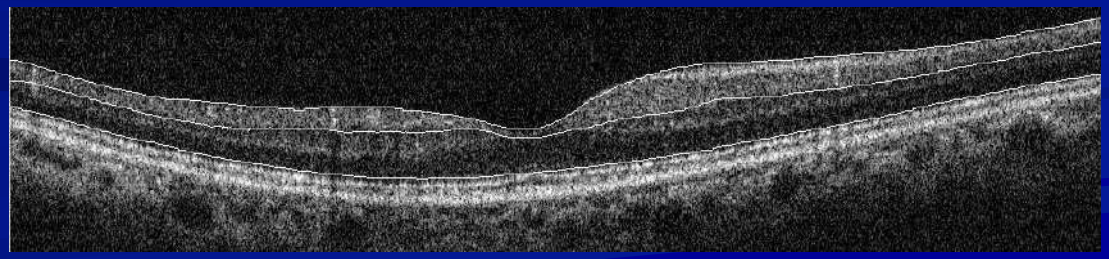
GCC Thinning in Glaucoma

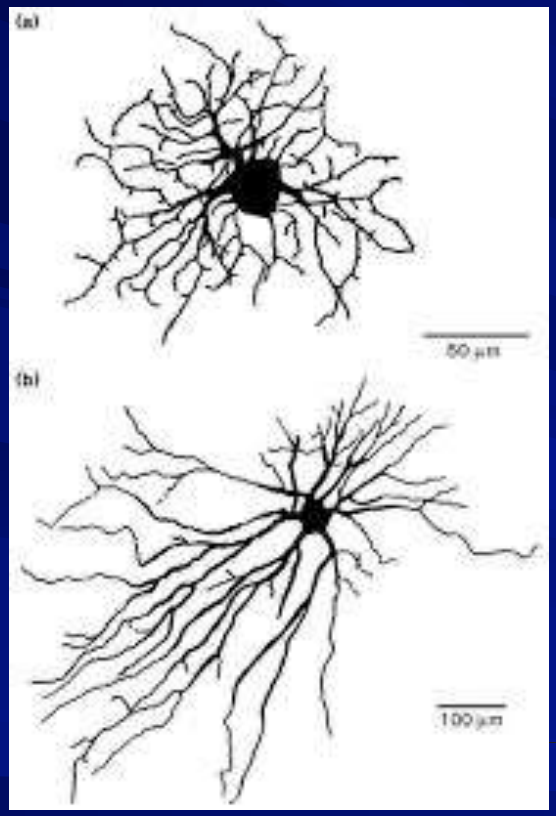


Normal

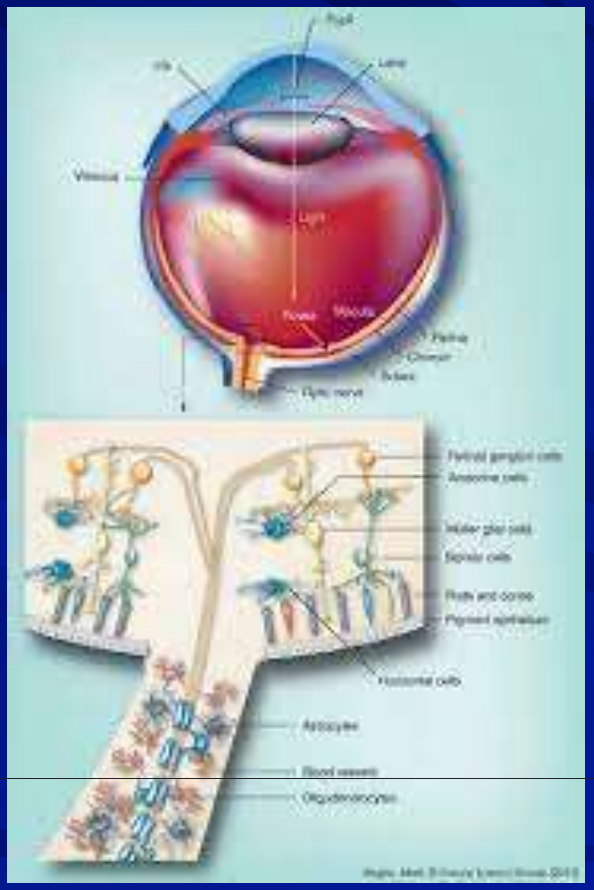


Glaucoma with thinner GCC

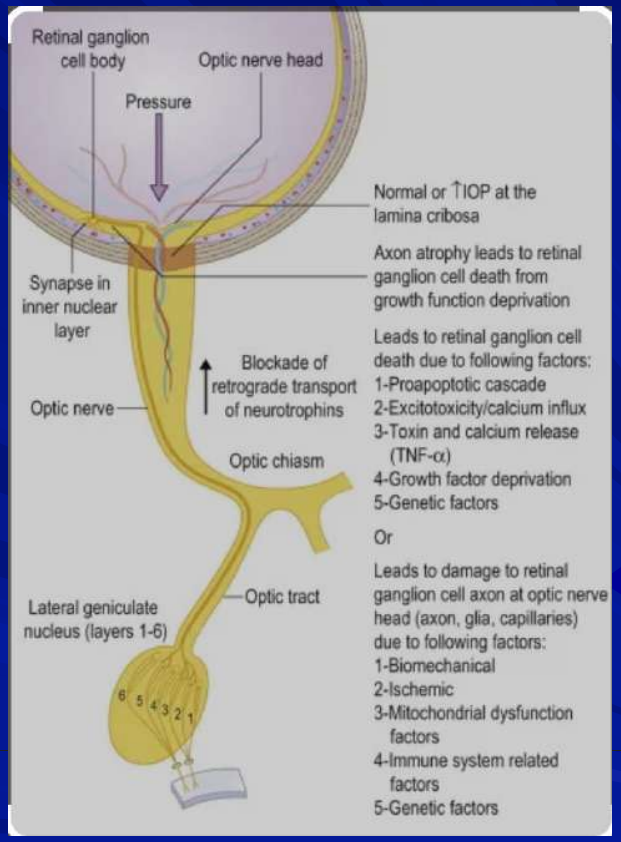




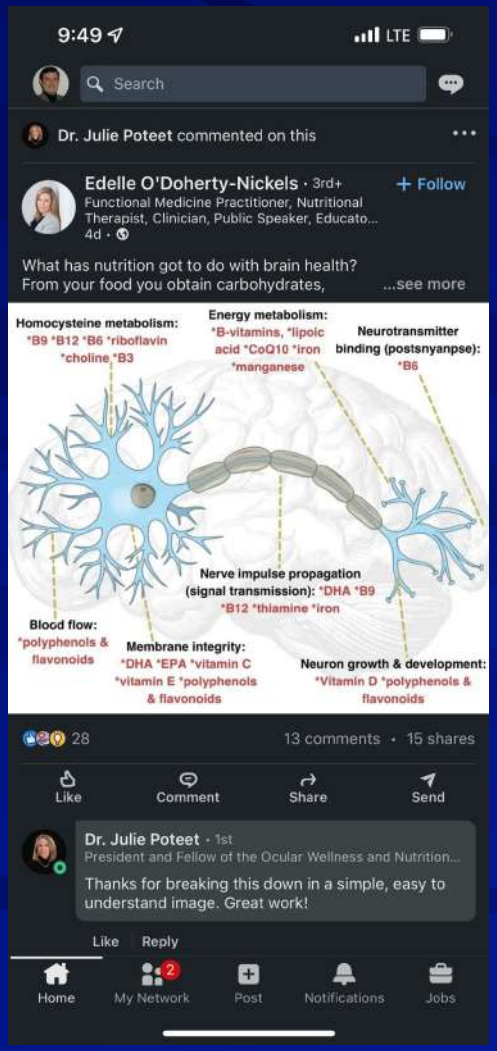
alpha and beta retinal ganglion cells ... cell.com



retinal ganglion cell regeneration ...futuremedicine.com



Pu Eble Rino
Retinal Ganglion Cells Optic Nerve


9:49
LTE
Search
Dr. Julie Poteet commented on this
Edelle O'Doherty-Nickels · 3rd+
Functional Medicine Practitioner, Nutritional Therapist, Clinician, Public Speaker, Educato...
4d ·
+ Follow
What has nutrition got to do with brain health?
From your food you obtain carbohydrates,
...see more
Homocysteine metabolism: *B9 *B12 *B6 *riboflavin *choline *B3
Energy metabolism: *B-vitamins, *lipoic acid *CoQ10 *iron *manganese
Neurotransmitter binding (postsnyanpse): *B6
Nerve impulse propagation (signal transmission): *DHA *B9 *B12 *thiamine *iron
Blood flow: *polyphenols & flavonoids
Membrane integrity: *DHA *EPA *vitamin C *vitamin E *polyphenols & flavonoids
Neuron growth & development: *Vitamin D *polyphenols & flavonoids
28
13 comments • 15 shares
Like
Comment
Share
Send
Dr. Julie Poteet · 1st
President and Fellow of the Ocular Wellness and Nutrition...
Thanks for breaking this down in a simple, easy to understand image. Great work!
Like
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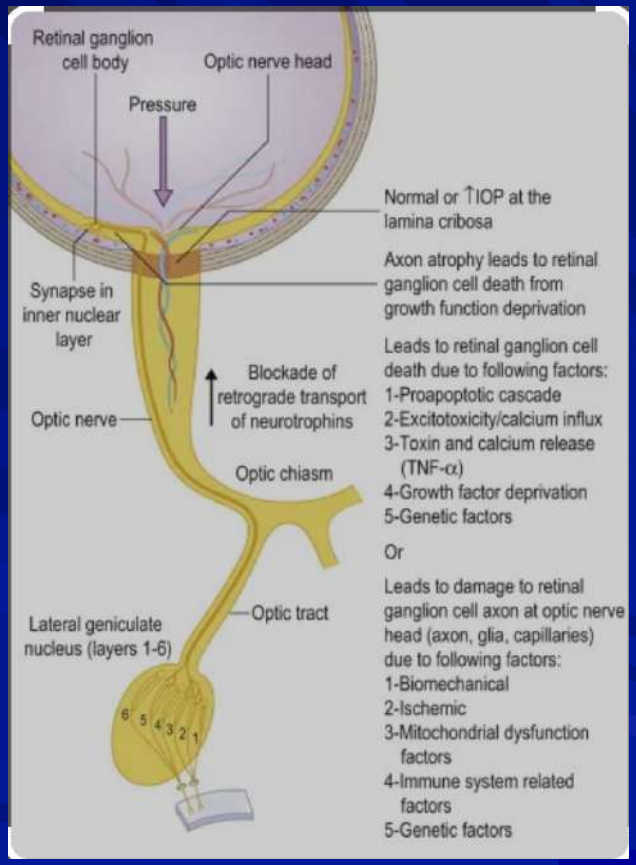
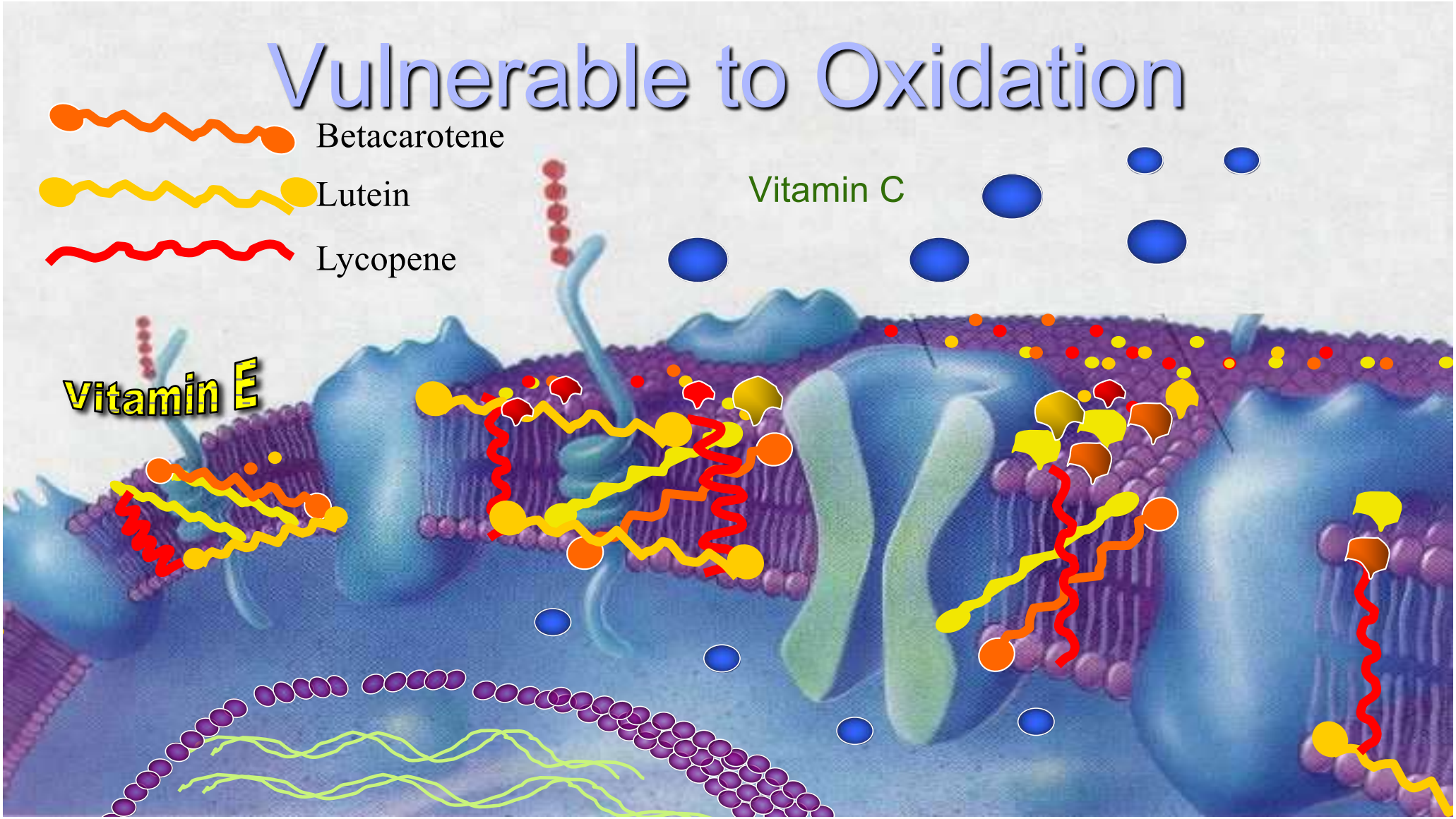
Home
My Network
Post
Notifications
Jobs


Retinal ganglion cell body
Optic nerve head
Pressure
Normal or ↑IOP at the lamina cribosa
Axon atrophy leads to retinal ganglion cell death from growth function deprivation
Synapse in inner nuclear layer
Leads to retinal ganglion cell death due to following factors:
1-Proapoptotic cascade
2-Excitotoxicity/calcium influx
3-Toxin and calcium release (TNF-α)
4-Growth factor deprivation
5-Genetic factors
Blockade of retrograde transport of neurotrophins
Optic nerve
Optic chiasm
Or
Leads to damage to retinal ganglion cell axon at optic nerve head (axon, glia, capillaries) due to following factors:
1-Biomechanical
2-Ischemic
3-Mitochondrial dysfunction factors
4-Immune system related factors
5-Genetic factors
Optic tract
Lateral geniculate nucleus (layers 1-6)
6 5 4 3 2 1

Who Here Prescribe Fatty Acids?

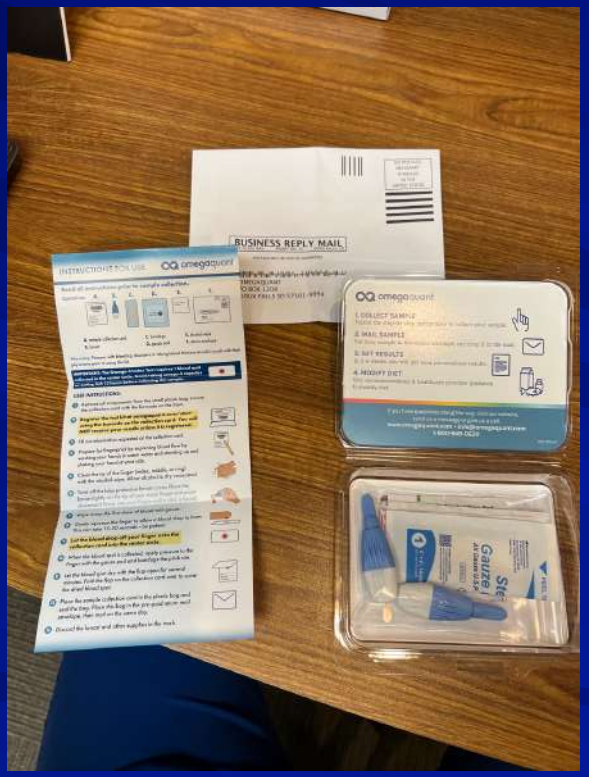
EPA/DHA

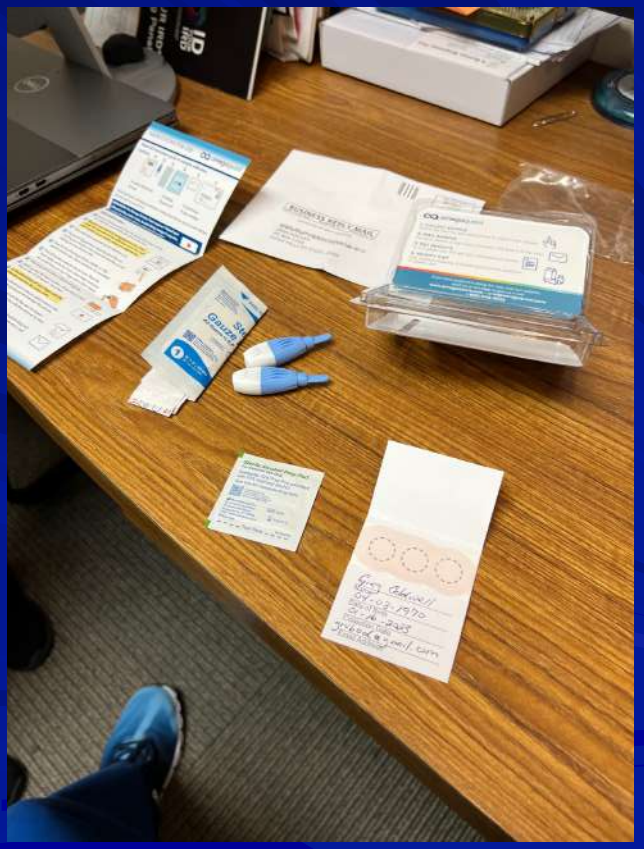
EPA/DHA


Vulnerable to Oxidation
Betacarotene
Lutein
Lycopene
Vitamin C
Vitamin E

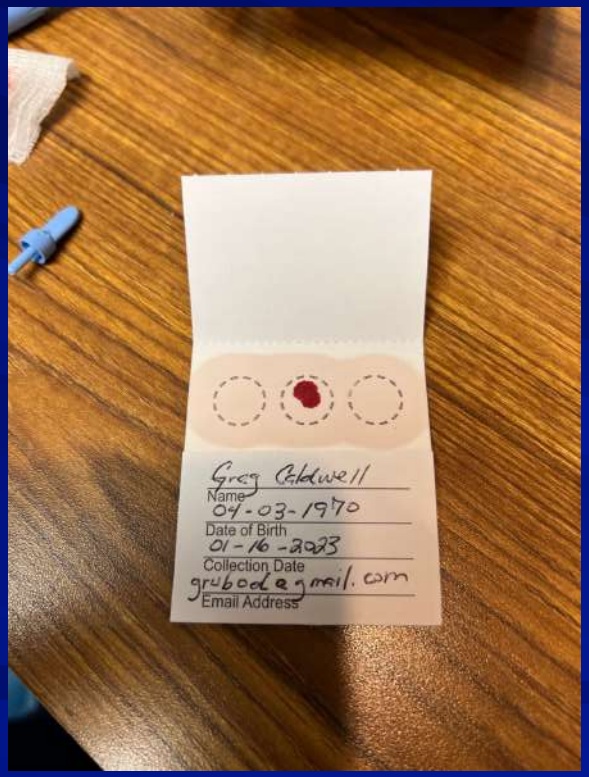
Omega Quant


omegaquant
Omega-3
Index
Plus Test
Dried Blood Spot Collection Kit


BUSINESS REPLY MAIL
omegaquant



Omega Quant


Greg Caldwell
Name
04-03-1970
Date of Birth
01-16-2023
Collection Date
grubodeg mail. com
Email Address


Sample Collection Card
USAF532022
Name
Date of Birth
Collection Date
Email Address

omegaquant

OmegaQuant Analytics
5009 W. 12th St, Suite 7
Sioux Falls, SD 57106
omegaquant.com

Omega-3 Index Plus Report

NAME: Greg Caldwell
DOB: 04/03/1970
PATIENT ID: GCaldwell
SAMPLE ID: USAF532022

COLLECTION DATE: 01/16/2023
RESULT DATE: 01/27/2023
PROVIDER:
ACCOUNT: Consumer

Your Omega-3 Index

Reference Range*: 3.00% - 14.10%

* Reference Ranges encompass about 99% of fatty acids levels measured in US adults. Visit our FAQ section for more information on ranges.

The Omega-3 Index is the proportion of long-chain omega-3s, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), of all fatty acids in your red blood cell membranes. It reflects the omega-3 status of your body over the last 4 months, similar to how hemoglobin A1C reflects long-term glucose blood levels. As a part of an overall healthy lifestyle, an Omega-3 Index in the 8-12% range may help to maintain heart, brain, eye and joint health. To increase your Omega-3 Index, eat foods rich in EPA and DHA, especially "oily" fish such as those in the accompanying table. They can also be obtained from dietary supplements (fish, krill, cod liver, algal oils) and functional foods (omega-3 enriched milk, eggs, etc.).

The amount of EPA and DHA needed to raise the Omega-3 Index into the desirable range is different for everybody. Many factors – age, sex, weight, diet, genetics, smoking habits, medications, and other medical conditions – can all influence the body's response to EPA and DHA. Still, we can provide an estimate, based on our own research, of how much EPA and DHA you may need to raise your level to the desirable range given your current Omega-3 Index level. Visit our Omega-3 Index Calculator on OmegaQuant.com to find out your personalized EPA and DHA recommendation.

The other main dietary omega-3 fatty acid, alpha-linolenic acid (ALA), is found in walnuts, flax and chia seeds. ALA can be converted to EPA and DHA in the body, but this happens at a very low rate in most people. An increase in ALA intake will have little to no effect on the Omega-3 Index.

Please consult with your healthcare provider before making any dietary changes. If you increase your intake of EPA and DHA, your Omega-3 Index will begin to slowly go up within a few days but will continue to change for 3-4 months. We recommend that you re-measure your Omega-3 Index in 3-4 months until you reach the desirable range. Once you reach the desirable range for Omega-3 Index, we recommend that you re-test every 6 months. Answers to commonly asked questions about your results can be found in the FAQ section on our website.

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OmegaQuant Analytics
5009 W. 12th St, Suite 7
Sioux Falls, SD 57106
omegaquant.com

Omega Ratios Report

NAME: Greg Caldwell
DOB: 04/03/1970
PATIENT ID: GCaldwell
SAMPLE ID: USAF532022

COLLECTION DATE: 01/16/2023
RESULT DATE: 01/27/2023
PROVIDER:
ACCOUNT: Consumer

Omega-6:Omega-3

Reference Range*: 2.1:1 - 13.6:1

AA:EPA

Reference Range*: 1.3:1 - 59.9:1

* Reference Ranges encompass about 99% of fatty acids levels measured in US adults. Visit our FAQ section for more information on ranges.

Omega-6:Omega-3 (n6:n3) ratio is calculated by dividing the sum of seven omega-6 fatty acids by the sum of four omega-3 fatty acids in whole blood. Only one omega-6 fatty acid, arachidonic acid (AA), and one omega-3 fatty acid, eicosapentaenoic acid (EPA), make up the AA:EPA ratio. The desirable range for the Omega-6:Omega-3 ratio is 3:1 to 5:1, and the desirable range for the AA:EPA ratio is 2.5:1 – 11:1. The desirable ranges for the ratios were calculated to correspond to the desirable range for the Omega-3 Index due to the strong relationship among these metrics.

Higher omega-3 blood levels are strongly related to improved health and longevity. Similarly, higher - not lower - blood levels of the main omega-6 fatty acid, linoleic acid, have been associated with better heart and metabolic health. AA blood levels alone are a poor predictor of health outcomes. However, there is considerable controversy regarding omega-6s in the diet and health, which is beyond the scope of this report.

Please consult with your healthcare provider before making any dietary changes. The most efficient way to lower both the Omega-6:Omega-3 and the AA:EPA ratios is to consume more omega-3 EPA and DHA from fish or supplements (see attached table). Omega-6 blood levels are less responsive to dietary changes than omega-3 blood levels. Therefore, lowering dietary omega-6s as a strategy to correct these ratios is typically less effective than raising intake of EPA and DHA. It will take 3-4 months for these ratios to reach their new levels and we recommend re-testing at that time.

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OmegaQuant Analytics
5009 W. 12th St, Suite 7
Sioux Falls, SD 57106
omegaquant.com

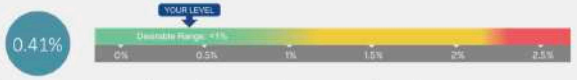
Trans Fat Index Report

NAME: Greg Caldwell
DOB: 04/03/1970
PATIENT ID: GCaldwell
SAMPLE ID: USAFS32022

COLLECTION DATE: 01/16/2023
RESULT DATE: 01/27/2023
PROVIDER:
ACCOUNT: Consumer

Your Trans Fat Index

Reference Range*: 0.30% - 1.70%



* Reference Ranges encompass about 99% of fatty acids levels measured in US adults. Visit our FAQ section for more information on ranges.

The Trans Fat Index is the percent of 18:1 and 18:2 trans fatty acids of total fatty acids in red blood cell membranes, and the desirable range is **<1%**. *Trans* fatty acids (or *trans* fats) in our blood come only from the food we eat because our bodies cannot make them. *Trans* fats in the diet come from two sources: 1) industrial production by the "partial hydrogenation" of vegetable oils, in which liquid oils are converted into solid fats to be used in processed foods, and 2) meat and milk products of ruminant animals, like cows and goats. The fatty acids that make up the Trans Fat Index were chosen because they were typically found in processed foods, but a small amount may come from ruminant sources.

Higher intakes of *trans* fats from processed foods have led to higher Trans Fat index levels. High*trans* fat blood levels and intake have been strongly related to heart disease. As such, the World Health Organization (WHO) has called on all countries to remove*trans* fats from their food supplies by 2023, and many countries have already achieved this. The relationship between ruminant*trans* fats and heart disease is not as clear. The amount of ruminant trans fats typically present in meat and dairy are very low, so normal intakes of these foods probably will not result in a high Trans Fat Index.

Traditionally, *trans* fats were abundant in processed foods, like baked goods, chips, and microwave popcorn. As*trans* fats have been removed from the food supply, however, eating processed foods has become less connected to blood*trans* fat levels. For example, since 2009, the average Trans Fat Index measured at OmegaQuant has decreased by half (from 1.7% to 0.8%), and in 2017 more than half of the samples submitted to OmegaQuant have a Trans Fat Index of <1%. Still, if you ate a lot of processed food in the past, your Trans Fat Index may be elevated.

Please consult with your healthcare provider before making any dietary changes. If your Trans Fat Level is <1%, there is no need to change your diet. If your Trans Fat Level is >1%, you may still be releasing stored*trans* fats that have built up over the years. Eating less processed food ensures you will not be eating any "hidden" *trans* fats that may still be in the food supply. We recommend you re-test every 6 months until your levels are <1%.

omegaquant

Amount of EPA and DHA in Seafood and Supplements

Fish and Seafood (3 oz or 85 g)	EPA (mg)	DHA (mg)	EPA + DHA (mg)
Pacific Herring	1056	751	1807
Atlantic Herring	773	939	1712
Atlantic Salmon (wild)	349	1215	1564
Bluefin Tuna	309	970	1279
Atlantic Salmon (farmed)*	510-587	680-1238	1190-1825
Pink Salmon (wild)	456	638	1094
Coho Salmon (farmed)	347	740	1087
Mackerel (canned)	369	677	1046
Sockeye Salmon (wild)	451	595	1046
Chum Salmon (canned)	402	597	999
Rainbow Trout (farmed)	284	697	981
Coho Salmon (wild)	341	559	900
Sardines (canned)	402	433	835
Albacore (or white) Tuna (canned)	198	535	733
Shark (raw)	267	444	711
Swordfish	117	579	696
Sea Bass	175	473	648
Pollock	77	383	460
Flat Fish (Flounder/Sole)	207	219	426
Blue Crab	207	196	403
Halibut	77	318	395
Oysters (farmed)	195	179	374
King Crab	251	100	351
King Mackerel	148	193	341
Walleye	93	245	338
Dungeness Crab	239	96	335
Scallops	141	169	310
Skipjack Tuna	77	201	278
Mixed Shrimp	145	122	267
Clams	117	124	241
Yellowfin Tuna	40	197	237
Light Chunk Tuna	40	190	230
Catfish (wild)	85	116	201
Catfish (farmed)	42	109	151
Cod	3	131	134
Mahi-Mahi (dolphin fish)	22	96	118
Tilapia	4	111	115
Orange Roughy	5	21	26
Dietary Supplements - Amount (mg) per capsule or per teaspoon			
Standard Fish Oil Capsules	180	120	300
Fish Oil Concentrates (many varieties)	100-400	100-400	300-700
Cod Liver Oil (teaspoon)	300	500	800
Krill Oil	100-300	50-150	150-450
Algal Oil	50-150	100-300	150-450

Table adapted from Harris et al. Current Atherosclerosis Reports 2008;10:503-509. Values based on USDA Nutrient Data Lab values and are for fish cooked with dry heat unless otherwise noted.

*Farmed Salmon can have a range of EPA and DHA based on the fish feed. Sprague M, et al. Scientific Reports, 2016; 6:21892.

Optometric Education Consultants

Thank You! Questions?

Ocular Disease

Interpretation and Utilization of New and Old Technologies

Greg Caldwell, OD, FAAO

Pittsburgh Primary Eye Care Conference
Saturday, February 18, 2023