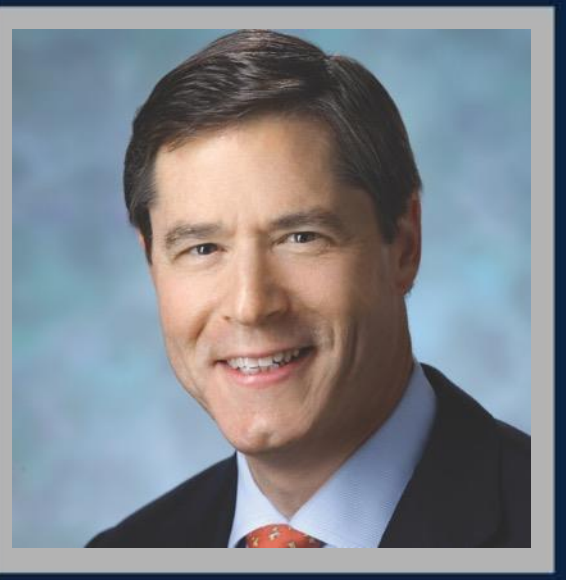
Why the Eye: Advances in Eyecare and the Impact on the Patient

Keynote Presentation



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Why the Eye:

Advances in Eyecare and the Impact on the Patient

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*** Participation by Dr. N. Bressler in this activity does not constitute or imply endorsement by the Johns Hopkins University, the Johns Hopkins Hospital, or the Johns Hopkins Health System, nor by the DRCR Network or *JAMA Ophthalmology***

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Data from IRB-approved human research is presented

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Why the Eye:

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Research

The New York Times | https://nyti.ms/2m03ki3

WELL

The Worst That Could Happen? Going Blind, People Say

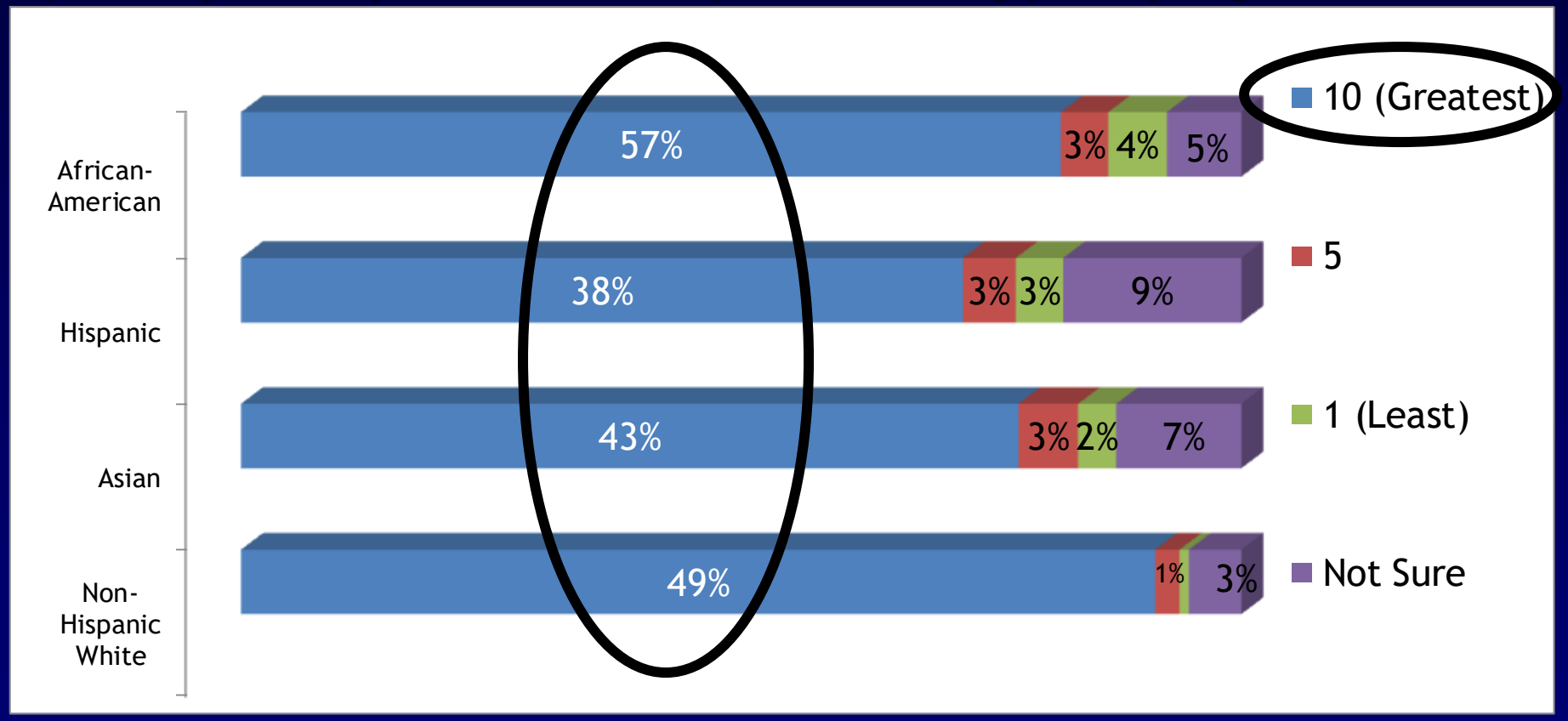
Personal Health

By JANE E. BRODY FEB. 20, 2017

"Feeling My Way Into Blindness," an essay published in The New York Times in November by Edward Hoagland, an 84-year-old nature and travel writer and novelist, expressed common fears about the effects of vision loss on quality of life.

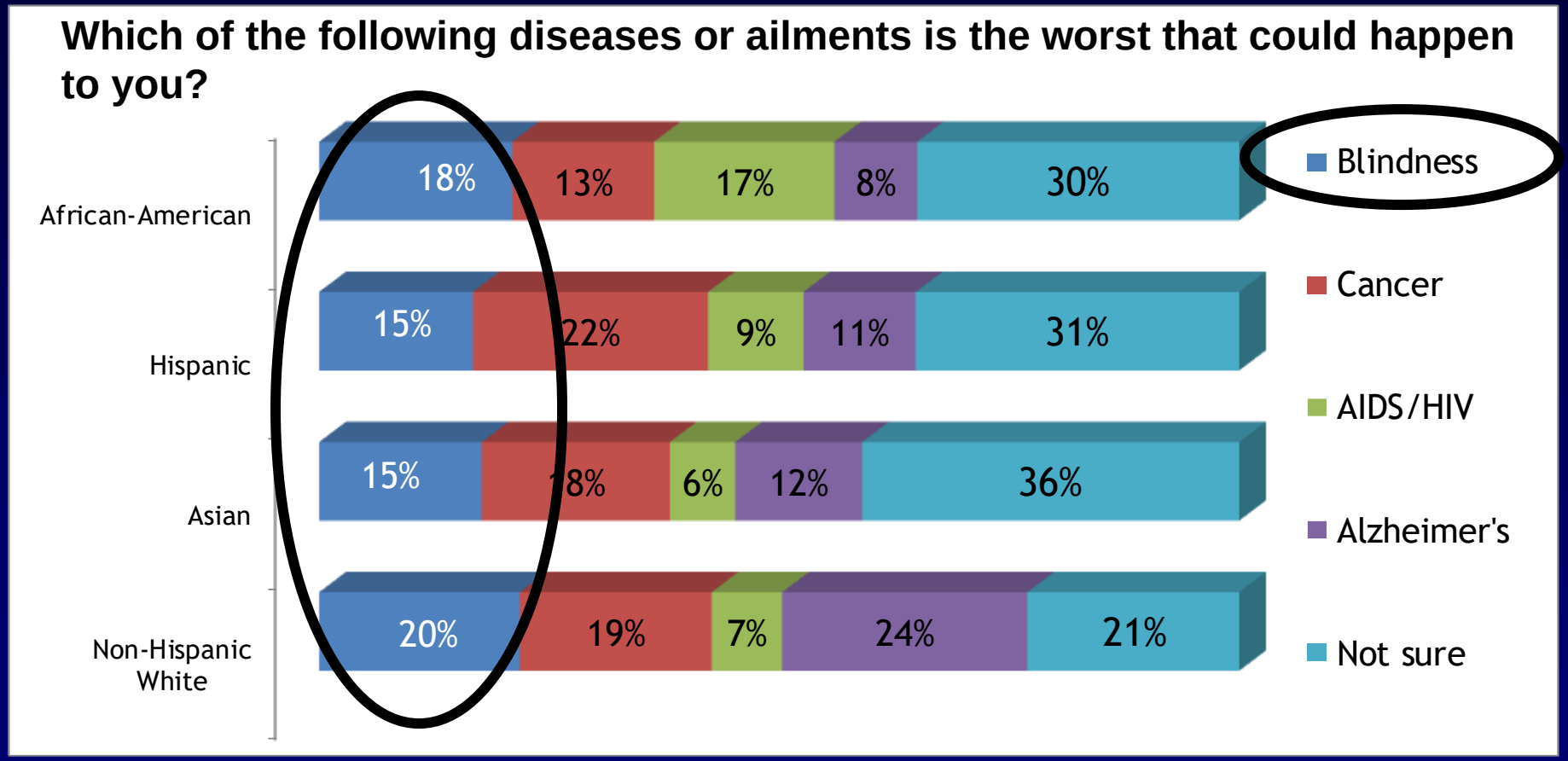
Many Americans Rate Losing Eyesight as Having Greatest Impact in Daily Life

On a scale of 1 to 10, with 1 having the least impact and 10 having the greatest impact on your daily life, how would you rate: losing your eyesight



Source: A Research!America poll of U.S. adults conducted in partnership with Zogby Analytics with support from Research to Prevent Blindness and the Alliance For Eye and Vision Research, August 2014.

Blindness Ranked High with Other Conditions Among All Groups



Source: A Research!America poll of U.S. adults conducted in partnership with Zogby Analytics with support from Research to Prevent Blindness and the Alliance For Eye and Vision Research, August 2014.

How Does Vision Loss Compare with Other Health Problems?

Ocular Disease Utility Value*		Systemic Health State Value	
Negligible visual loss (20/20-20/25)	0.88	Breast cancer, after radiotherapy Myocardial infarction	0.89 0.87
Minimal visual loss (20/30-20/50)	0.81	Colon cancer, poor prognosis AIDS	0.80 0.79
Moderate visual loss (20/60-20/100)	**0.72**	**Stroke, moderate** **Home dialysis for 8 years**	**0.73** **0.72**
Severe visual loss (20/200-No Light Perception)	0.61	Tuberculosis: hospitalized for 3 mos Ulcerative colitis, before surgery	0.60 0.58

* Based on visual acuity in the better-seeing eye.

Adapted from Brown MM, et al. *Ophthalmology.* 2003;110:1076-1081, ©2003 with permission from the *American Academy of Ophthalmology.*

How Does Vision Loss Impact Quality of Life?

- ***Mobility*, both ambulatory and driving[1]**
  - Recognition of landmarks, street signs
- ***Reading* and related close work[1]**
  - Activities of daily living (cooking, shopping, check writing, etc)
- ***Self Care Abilities*[2]**
  - Reading of medicine bottles, nutritional labels
  - Preparing insulin injections, glucose testing
- ***Social participation*[1,2]**
  - Feelings of vulnerability, emotional distress
  - Dependence on others for transportation

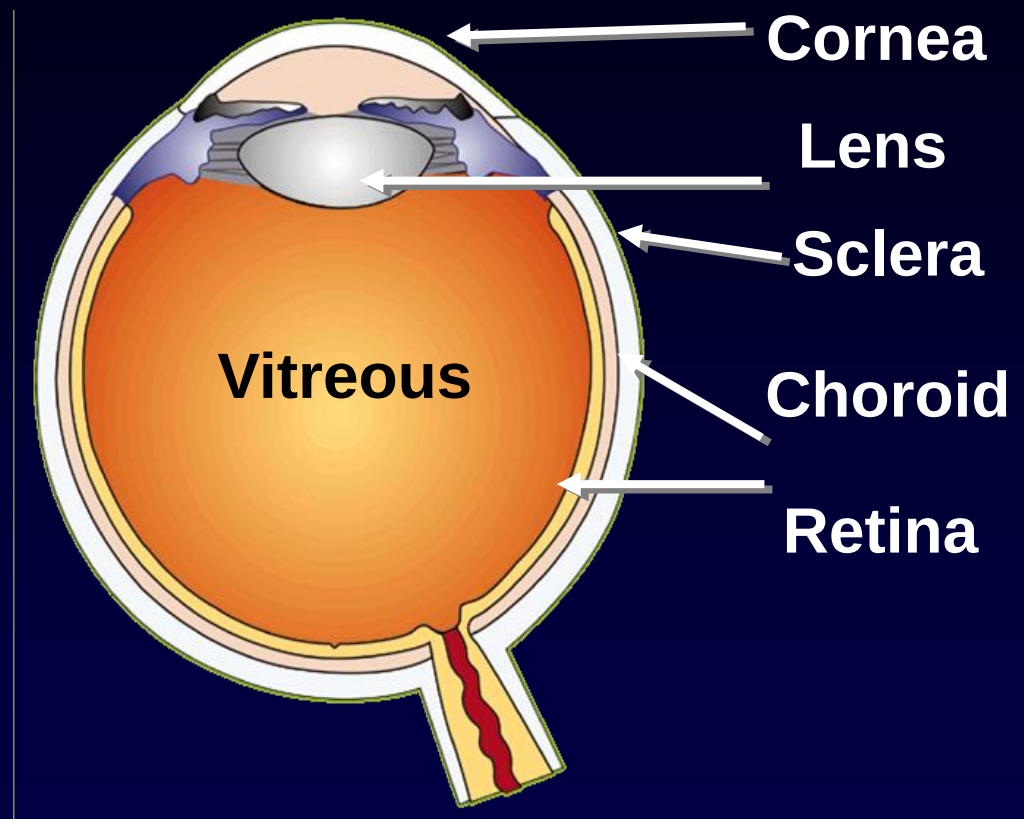
1. Lennie P, Van Hemel SB, eds. *Visual Impairments: Determining Eligibility for Social Benefits.* National Academy of Sciences. 2002.
2. Coyne KS, et al. *Family Practice*. 2004;21:447-453.

Three Leading Causes of Blindness in the United States

(and much of the Rest of the World)

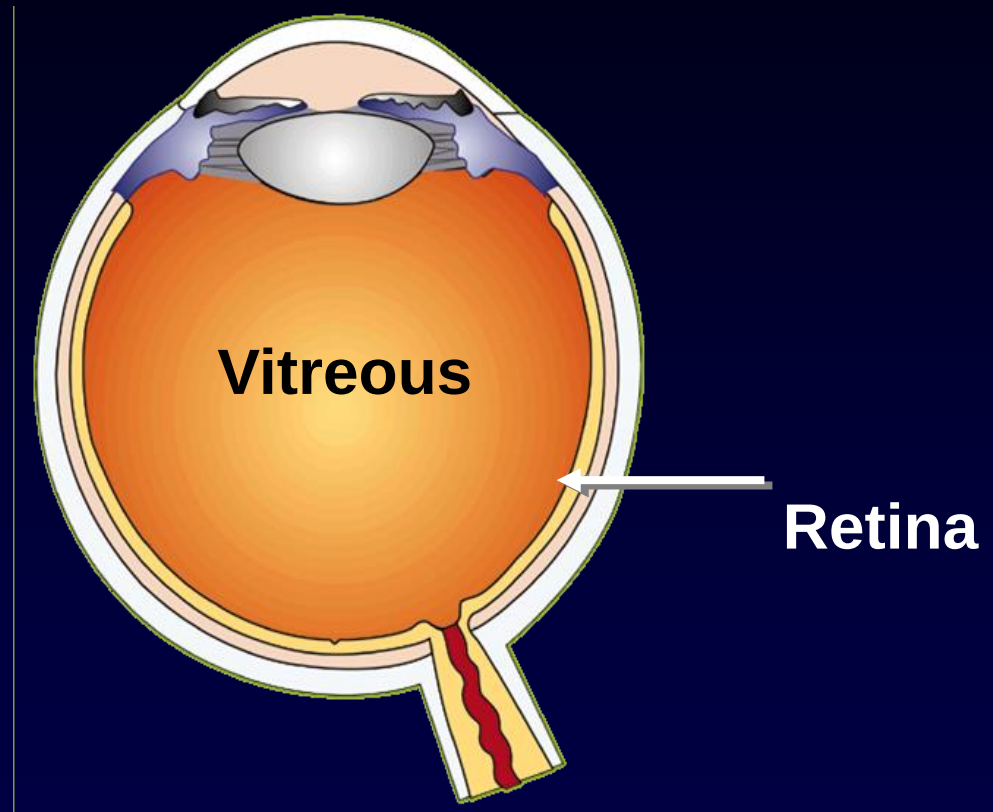
- Diabetic retinopathy
- Age-related macular degeneration
- Glaucoma

Normal Eye



Posterior Segment of Eye:

Posterior Structures—Vitreous & Retina

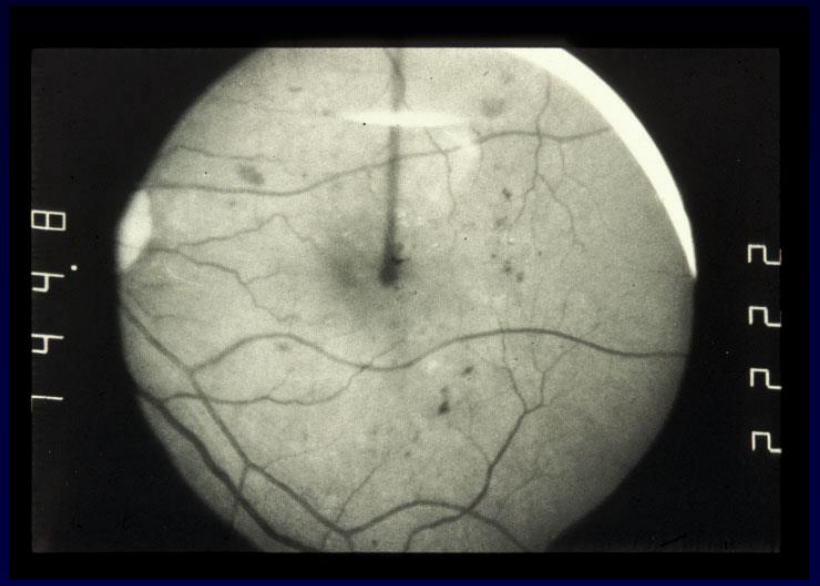


Pathogenesis of Diabetic Retinopathy

- High blood sugar levels affect inner retinal capillaries, resulting in:
  - Loss of pericytes (structural / functional support to capillary cells)
  - Thickening of basement membrane (supporting structure) of endothelial (capillary) cells
- Pathophysiologic consequences:
  - Leakage of blood vessels = diabetic macular edema
  - Closure of retinal capillaries = proliferative diabetic retinopathy

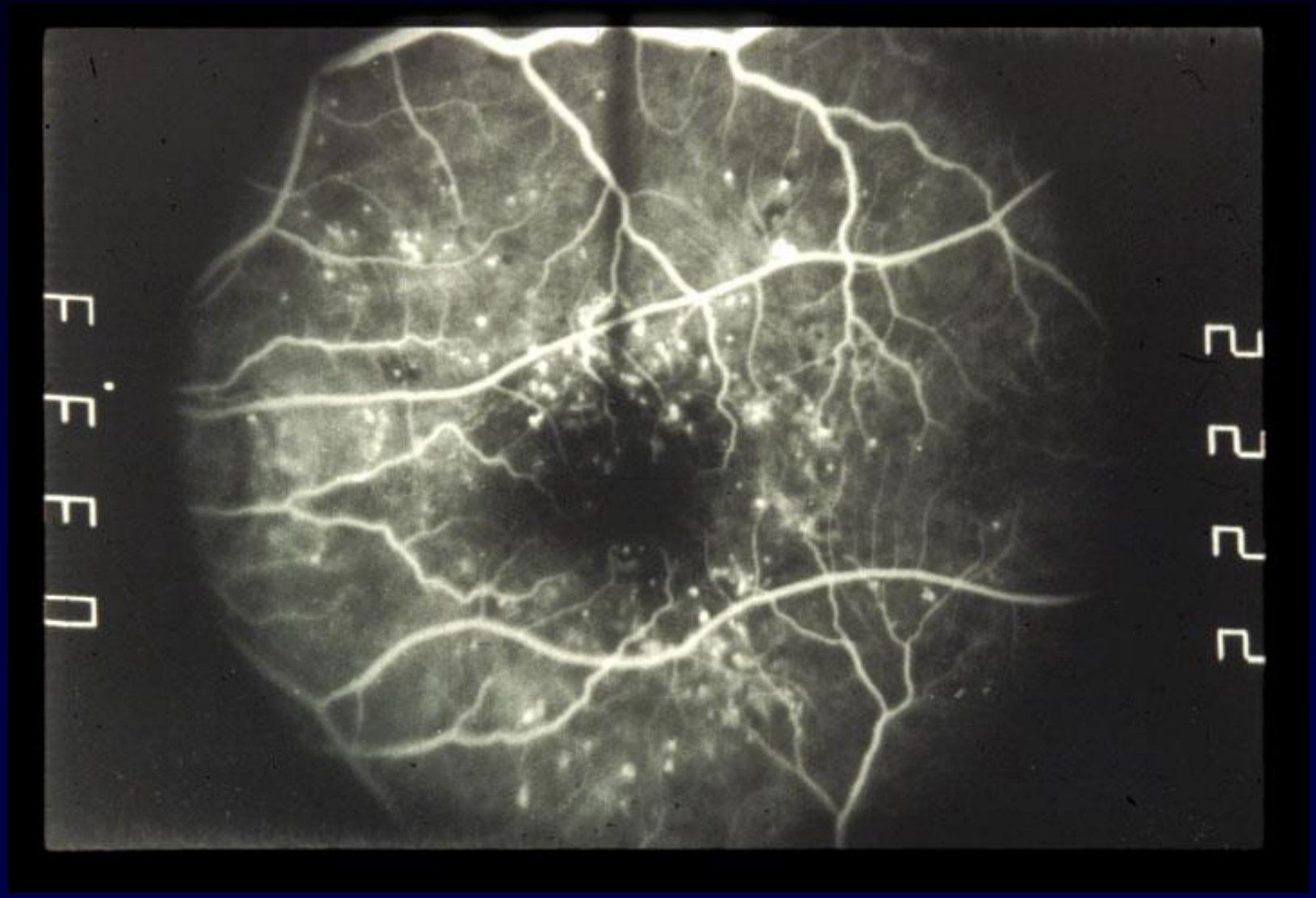
Consequences of Leakage of Capillaries: Diabetic Macular Edema

- Thickening of macula from intercellular fluid accumulation within retina
- Fluid leaks from microaneurysms and telangiectasia (dilation and toruosity of pre-existing capillaries)



Fluorescein Angiography of Diabetic Macular Edema

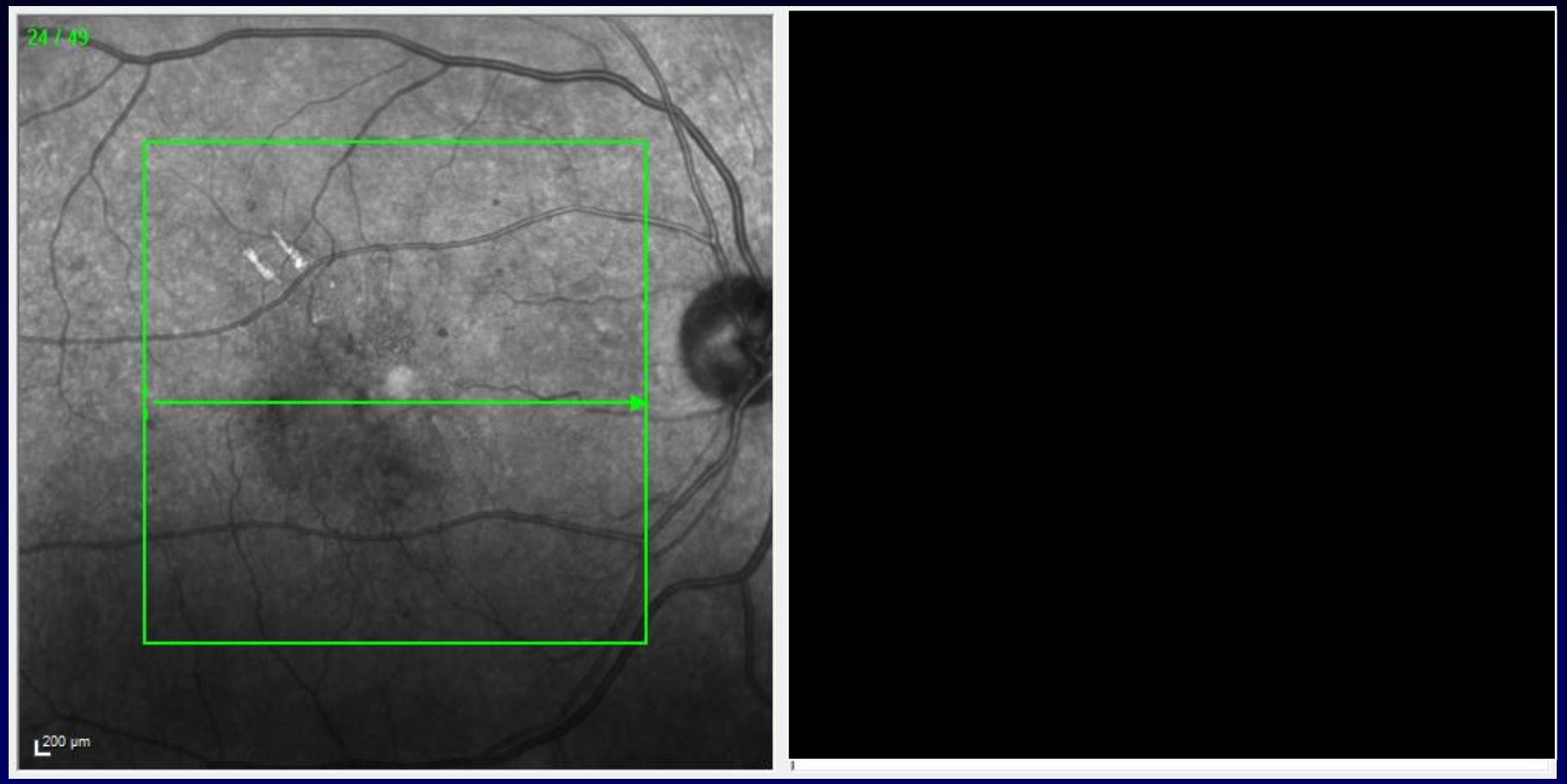
30 seconds after intravenous fluorescein injection



Fluorescein Angiography of Diabetic Macular Edema

6 minutes after intravenous fluorescein injection

Diabetic Macular Edema



Visual acuity = 20/63
Optical Coherence Tomography (OCT) Central subfield thickness = 462 microns

Magnitude of Public Health Problem from Diabetic Retinopathy, including Diabetic Macular Edema

422 million

Adults living with diabetes in 2014, globally[1]

1st challenge

Need to identify the 93 million individuals with DR, including 21 million with DME, from those without DR[2]

21 million

Number of diabetic patients worldwide with some form of DME[2]

2nd challenge

Need to identify the 21 million of individuals who develop DME before vision loss has occurred to optimize intervening with treatment before substantial vision loss has occurred

DME, diabetic macular edema; DR, diabetic retinopathy

1. Global Report of Diabetes.WHO.2016; 2. Yau JW et al. Diabetes Care. 2012 Mar;35(3):556-64.

Magnitude of Public Health Problem from Diabetic Retinopathy, including Diabetic Macular Edema

Research

JAMA Ophthalmology | Original Investigation

Prevalence of Diabetic Retinopathy in the US in 2021

Elizabeth A. Lundeen, PhD; Zeb Burke-Conte, BS; David B. Rein, PhD, MPA; John S. Wittenborn, BS; Jinan Saaddine, MD; Aaron Y. Lee, MD; Abraham D. Flaxman, PhD

IMPORTANCE Diabetic retinopathy (DR) is a common microvascular complication of diabetes and a leading cause of blindness among working-age adults in the US.

OBJECTIVE To update estimates of DR and vision-threatening diabetic retinopathy (VTDR) prevalence by demographic factors and US county and state.

Invited Commentary

Supplemental content

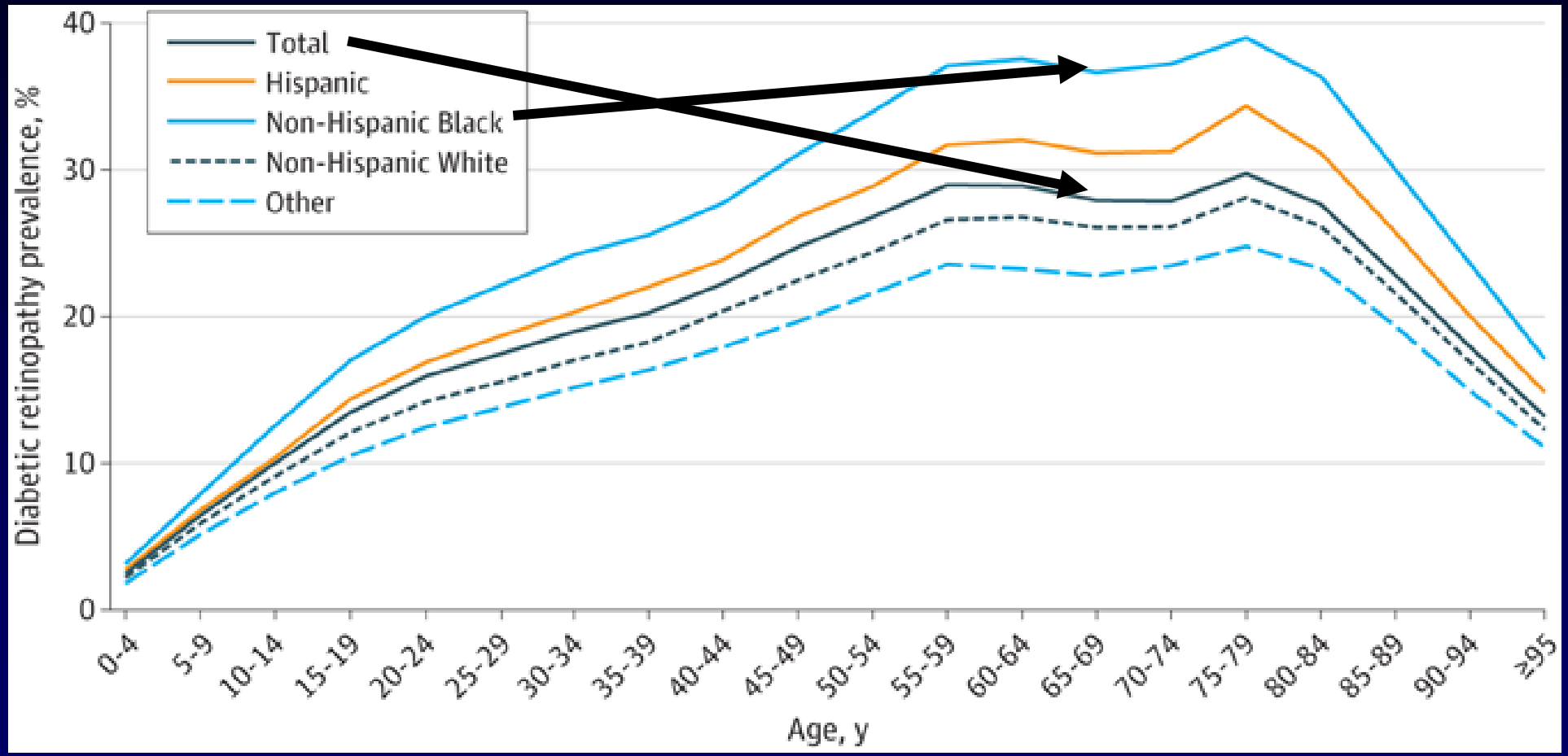
JAMA Ophthalmol. Published online June 15, 2023. doi:10.1001/jamaophthalmol.2023.2289

Magnitude of U.S. Public Health Problem from Diabetic Retinopathy, including Diabetic Macular Edema

Table. Estimated Prevalence of Diabetic Retinopathy and Vision-Threatening Diabetic Retinopathy, Stratified by Nondifferentiated Sex and Gender and Race and Ethnicity

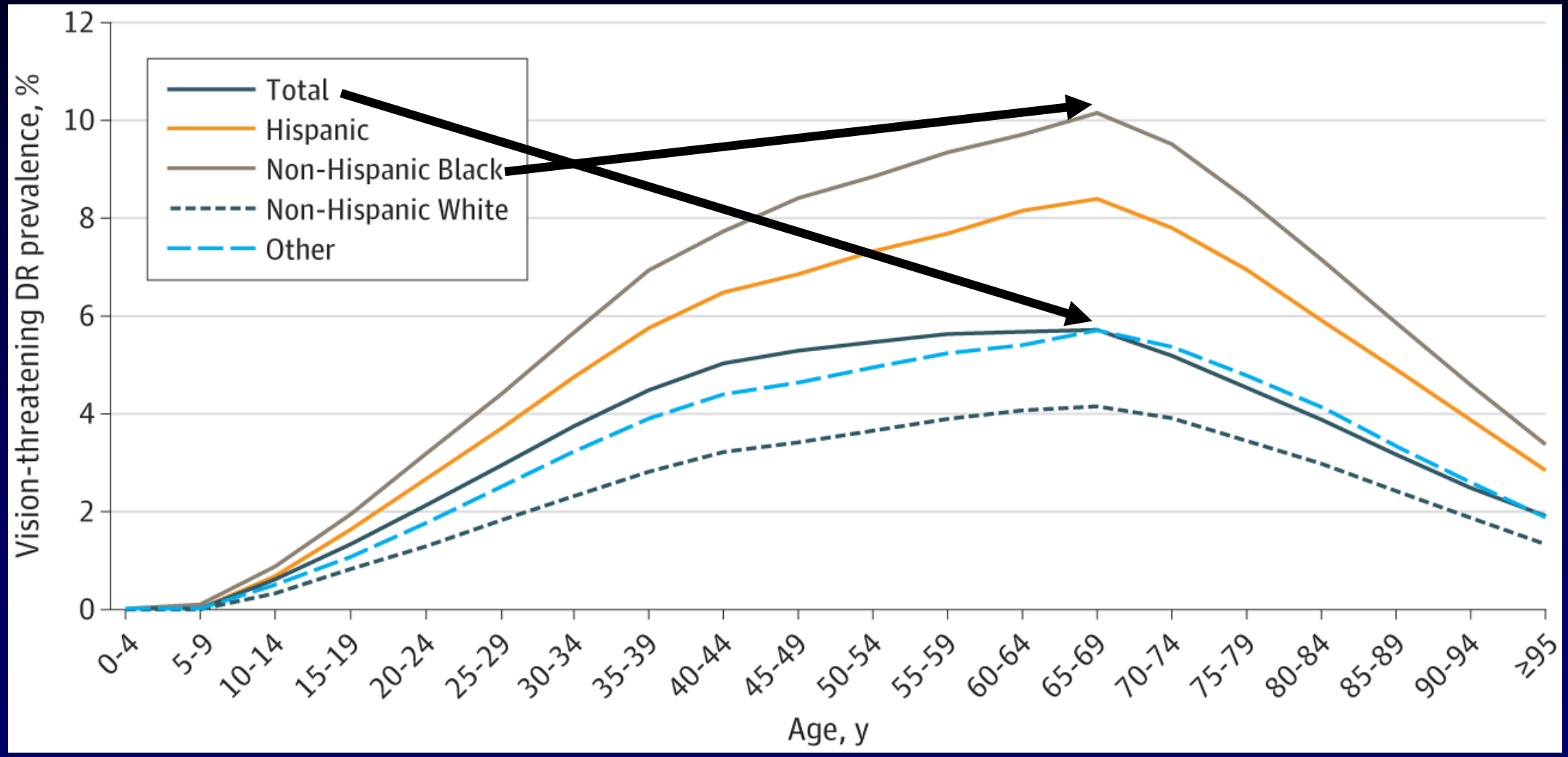
Characteristic	Prevalence count, in millions (95% UI)	Standardized prevalence rate, % (95% UI)[a]
Diabetic retinopathy		
Total	9.60 (7.90-11.55)	26.43 (21.95-31.60)

Magnitude of U.S. Public Health Problem from Diabetic Retinopathy, including Diabetic Macular Edema



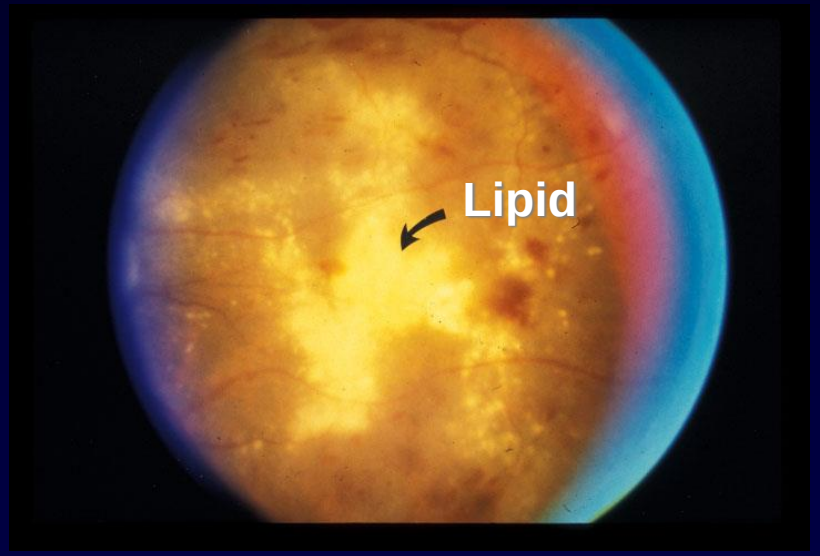
Magnitude of U.S. Public Health Problem from Vision Threatening Diabetic Retinopathy

(including Diabetic Macular Edema, Severe Non-Proliferative or Proliferative Diabetic Retinopathy)



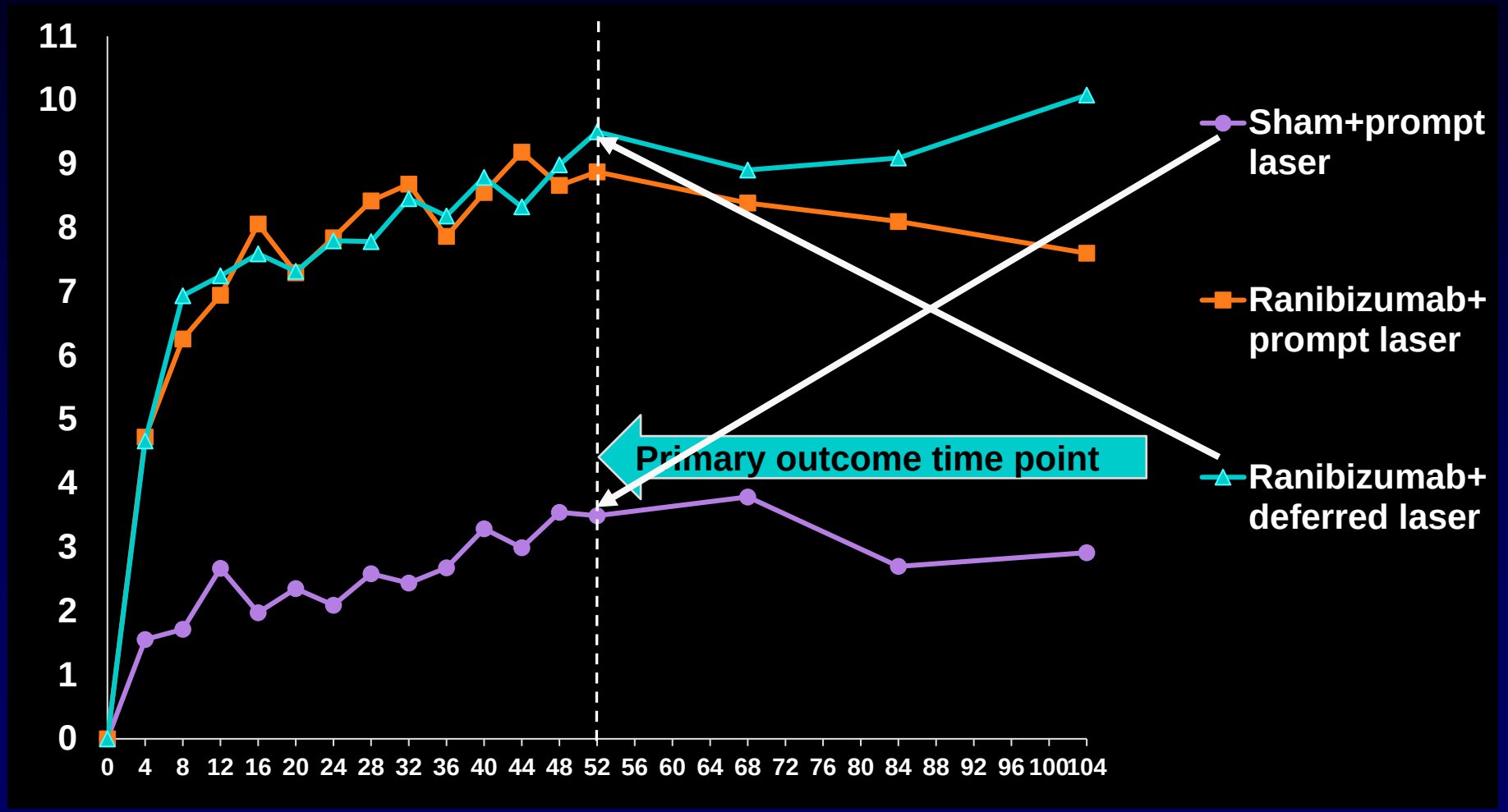
Consequences of Leakage of Capillaries: Macular Edema

- Chronic edema associated with loss of retina tissue and subsequent vision loss
- 1986: Focal/grid laser photocoagulation to thickening can reduce risk of vision loss from 30% over 3 years to 15%



2010: Periodic Injection of Anti-VEGF Agent into Middle Cavity of Eye Superior to Laser

*DRCR Retina Network Protocol I: Mean Change in Visual Acuity (Letters)**



* Values that were ±30 letters were assigned a value of 30

P-values for difference in mean change in visual acuity from sham+prompt laser at the 52-week visit: ranibizumab+prompt laser <0.001; ranibizumab+deferred laser <0.001; and triamcinolone+prompt laser=0.31.

Anti-VEGF for DME with Vision Loss (20/32 or Worse)

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 MARCH 26, 2015 VOL. 372 NO. 13

Aflibercept, Bevacizumab, or Ranibizumab for Diabetic Macular Edema

The Diabetic Retinopathy Clinical Research Network*

ABSTRACT

BACKGROUND

The relative efficacy and safety of intravitreous aflibercept, bevacizumab, and ranibizumab in the treatment of diabetic macular edema are unknown.

METHODS

The members of the writing committee (John A. Wells, M.D., Palmetto Retina Center, West Columbia, SC; Adam R. Glassman, M.S., Jaeb Center for Health Research, Tampa, FL; Allison R. Ayala, M.S., Jaeb Center for Health Research

Table S5. Detailed Distribution of Visual Acuity at 2 Years According to Baseline Visual Acuity Subgroup

Baseline Visual Acuity 20/50 or Worse (Letter Score <69)

	Aflibercept (N = 98)	Bevacizumab (N = 92)	Ranibizumab (N = 94)
~Snellen Equivalent (Letter Score)			
20/12.5 (94-98)	0	0	2(2%)
20/16 (89-93)	7 (7%)	2 (2%)	6 (6%)
20/20 (84-88)	16 (16%)	9 (10%)	12 (13%)
20/25 (79-83)	21 (21%)	19 (21%)	9 (10%)
20/32 (74-78)	16 (16%)	13 (14%)	22 (23%)
20/40 (69-73)	15 (15%)	20 (22%)	12 (13%)
20/50 (64-68)	10 (10%)	8 (9%)	9 (10%)
20/63 (59-63)	4 (4%)	5 (5%)	7 (7%)
20/80 (54-58)	2 (2%)	5 (5%)	6 (6%)
20/100 (49-53)	1 (1%)	2 (2%)	6 (6%)
20/125 (44-48)	2 (2%)	3 (3%)	1 (1%)
20/160 (39-43)	1 (1%)	1 (1%)	0
20/200 (34-38)	0	3 (3%)	0
20/250 (29-33)	1 (1%)	0	0
20/320 (24-28)	2 (2%)	0	1 (1%)
20/400 (19-23)	0	0	0
<20/400 (<19)	0	2 (2%)	1 (1%)

44% 20/25 or better

Baseline Visual Acuity 20/32-20/40 (Letter Score 78- 69)

~Snellen Equivalent (Letter Score)	Aflibercept (N = 103)	Bevacizumab (N = 93)	Ranibizumab (N = 97)
20/12.5 (94-98)	1 (1%)	3 (3%)	2 (2%)
20/16 (89-93)	14 (14%)	11 (12%)	12 (12%)
20/20 (84-88)	33 (32%)	16 (17%)	29 (30%)
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20/200 (34-38)	1 (1%)	0	0
20/250 (29-33)	0	0	0
20/320 (24-28)	0	0	0
20/400 (19-23)	0	0	0
<20/400 (<19)	0	1 (1%)	0

71% 20/25 or better

JAMA | Original Investigation

Effect of Initial Management With Aflibercept vs Laser Photocoagulation vs Observation on Vision Loss Among Patients With Diabetic Macular Edema Involving the Center of the Macula and Good Visual Acuity
A Randomized Clinical Trial

Carl W. Baker, MD; Adam R. Glassman, MS; Wesley T. Beaulieu, PhD; Andrew N. Antoszyk, MD; David J. Browning, MD; Kakarla V. Chalam, MD; Sandeep Grover, MD; Lee M. Jampol, MD; Chirag D. Jhaveri, MD; Michele Melia, ScM; Cynthia R. Stockdale, MSPH; Daniel F. Martin, MD; Jennifer K. Sun, MD, MPH; for the DRCR Retina Network

IMPORTANCE Intravitreous injections of antivascular endothelial growth factor agents are effective for treating diabetic macular edema (DME) involving the center of the macula (center-involved DME [CI-DME]) with visual acuity impairment (20/32 or worse). The best approach to treating patients with CI-DME and good visual acuity (20/25 or better) is unknown.

OBJECTIVE To compare vision loss at 2 years among eyes initially managed with aflibercept, laser photocoagulation, or observation.

DESIGN, SETTING, AND PARTICIPANTS Randomized clinical trial conducted at 91 US and Canadian sites among 702 adults with type 1 or type 2 diabetes. Participants had 1 study eye with CI-DME and visual acuity of 20/25 or better. The first participant was randomized on November 8, 2013, and the final date of follow-up was September 11, 2018.

INTERVENTIONS Eyes were randomly assigned to 2.0 mg of intravitreous aflibercept (n = 226) as frequently as every 4 weeks, focal/grid laser photocoagulation (n = 240), or observation (n = 236). Aflibercept was required for eyes in the laser photocoagulation or observation groups that had decreased visual acuity from baseline by at least 10 letters (≥ 2 lines on an eye chart) at any visit or by 5 to 9 letters (1-2 lines) at 2 consecutive visits.

MAIN OUTCOMES AND MEASURES The primary outcome was at least a 5-letter visual acuity decrease from baseline at 2 years. Antiplatelet Trialists' Collaboration adverse events (defined as myocardial infarction, stroke, or vascular or unknown death) were reported.

RESULTS Among 702 randomized participants (mean age, 59 years; 38% female [n=264]), 625 of 681 (92% excluding deaths) completed the 2-year visit. For eyes with visual acuity that decreased from baseline, aflibercept was initiated in 25% (60/240) and 34% (80/326) in the laser photocoagulation and observation groups, respectively. At 2 years, the percentage of eyes with at least a 5-letter visual acuity decrease was 16% (33/205), 17% (36/212), and 19% (39/208) in the aflibercept, laser photocoagulation, and observation groups, respectively (aflibercept vs laser photocoagulation risk difference, −2% [95% CI, −9% to 5%]; relative risk, 0.88 [95% CI, 0.57-1.35; $P = .79$]; aflibercept vs observation risk difference, −3% [95% CI, −11% to 4%]; relative risk, 0.83 [95% CI, 0.55-1.27; $P = .79$]; laser photocoagulation vs observation risk difference, −1% [95% CI, −9% to 6%]; relative risk, 0.95 [95% CI, 0.64-1.41; $P = .79$]). Antiplatelet Trialists' Collaboration vascular events occurred in 15 (7%), 13 (5%), and 8 (3%) participants in the aflibercept, laser photocoagulation, and observation groups.

CONCLUSIONS AND RELEVANCE Among eyes with CI-DME and good visual acuity, there was no significant difference in vision loss at 2 years whether eyes were initially managed with aflibercept or with laser photocoagulation or observation and given aflibercept only if visual acuity worsened. Observation without treatment unless visual acuity worsens may be a reasonable strategy for CI-DME.

TRIAL REGISTRATION ClinicalTrials.gov Identifier: NCT01909791

JAMA. doi:10.1001/jama.2019.5790
Published online April 29, 2019.

Visual Abstract
Editorial
Supplemental content
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Author Affiliations: Author affiliations are listed at the end of this article.

Group Information: The Diabetic Retinopathy Clinical Research (DRCR) Retina Network members appear at the end of this article.

Corresponding Author: Adam R. Glassman, MS, Jaeb Center for Health Research, 15310 Amberly Dr, Ste 350, Tampa, FL 33647 (drcrstat2@jaeb.org; aglassman@jaeb.org).

JAMA® Journal of the American Medical Association

CW Baker and coauthors

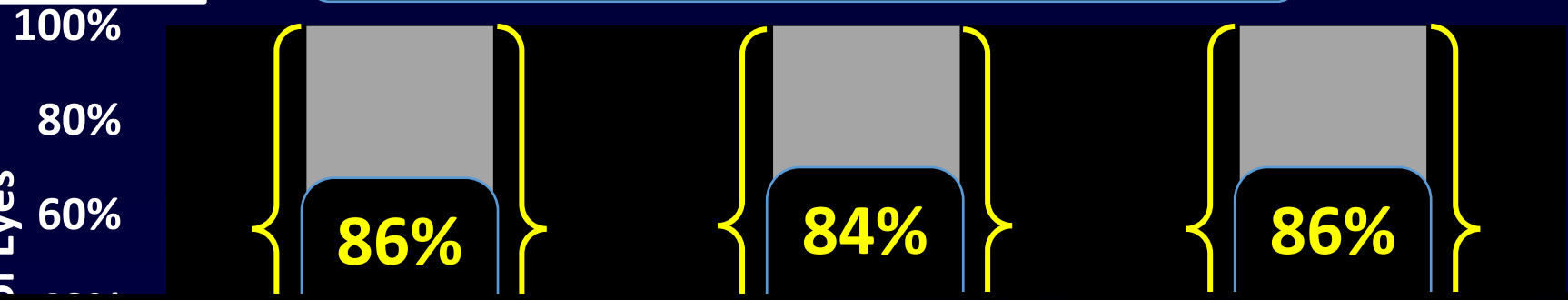
Effect of Initial Management With Aflibercept vs Laser Photocoagulation vs Observation on Vision Loss Among Patients With Diabetic Macular Edema Involving the Center of the Macula and Good Visual Acuity: A Randomized Clinical Trial

Available at jama.com and on The JAMA Network Reader at mobile.jamanetwork.com

The median number of aflibercept injections over 2 years was 8 (interquartile range, 6-11).

VA Letter Score at 2 Years

20/25 or Better



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20/12.5 (94-98)		0	0	2(2%)
20/16 (89-93)	**44% 20/25 or better**	7 (7%)	2 (2%)	6 (6%)
20/20 (84-88)		16 (16%)	9 (10%)	12 (13%)
20/25 (79-83)		21 (21%)	19 (21%)	9 (10%)
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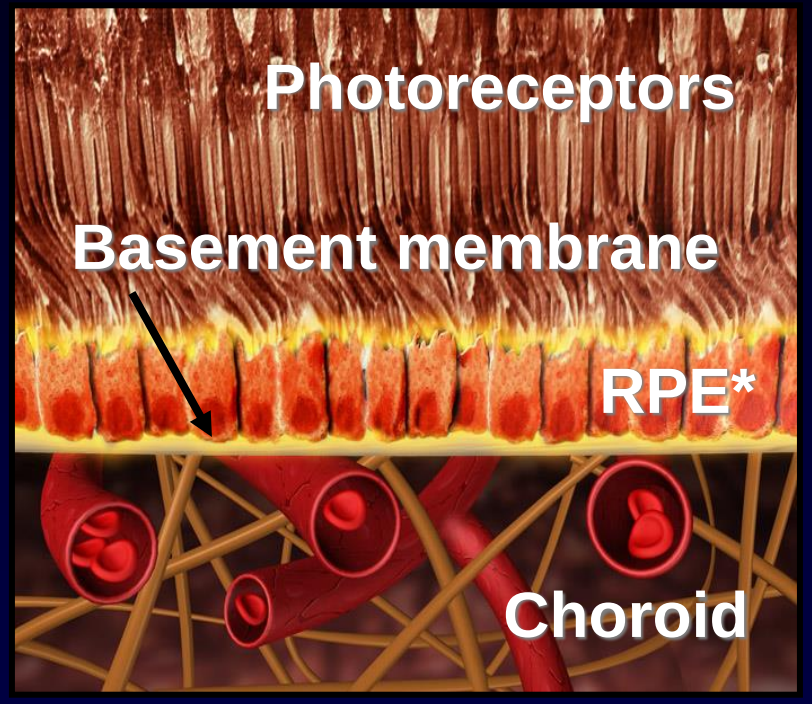
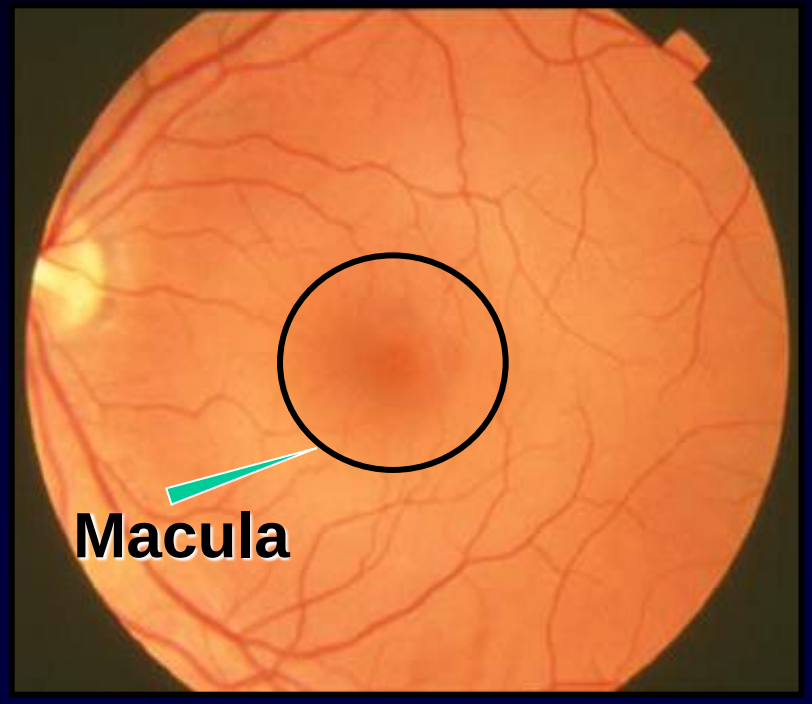
		10 (10%)	8 (9%)	9 (10%)
		4 (4%)	5 (5%)	7 (7%)
		2 (2%)	5 (5%)	6 (6%)
		1 (1%)	2 (2%)	6 (6%)
		2 (2%)	3 (3%)	1 (1%)
		1 (1%)	1 (1%)	0
		0	3 (3%)	0
		1 (1%)	0	0
		2 (2%)	0	1 (1%)
		0	0	0
		0	2 (2%)	1 (1%)

The median number of aflibercept injections over 2 years was 14 (9 in first year; 5 in second year)

Normal Retina

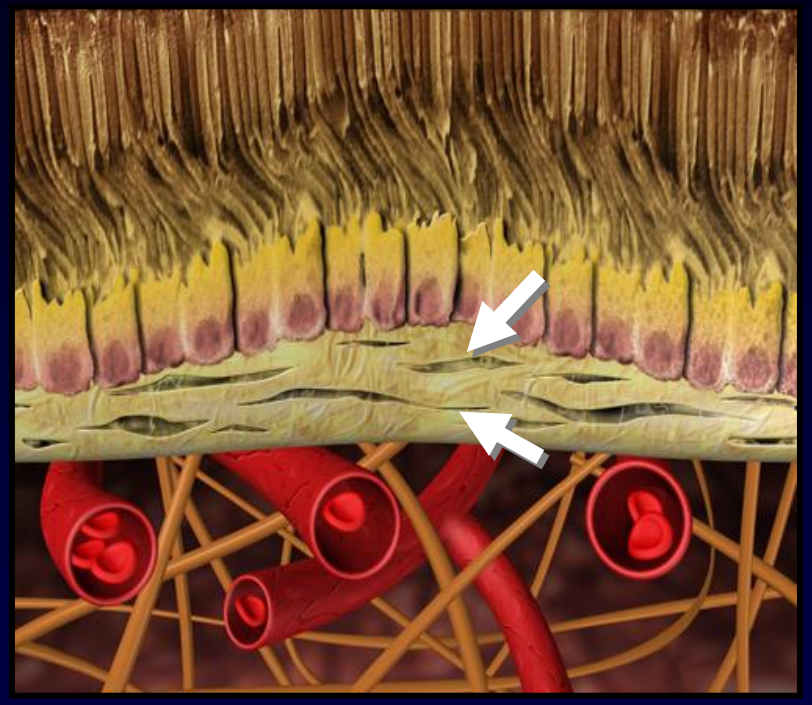


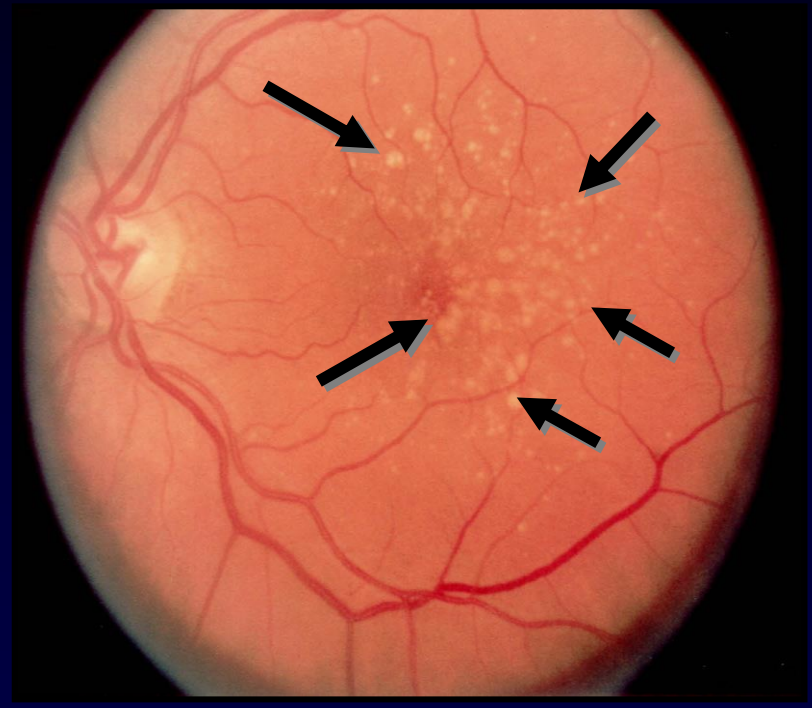


*RPE = retinal pigment epithelium

Age-related Macular Degeneration (AMD)

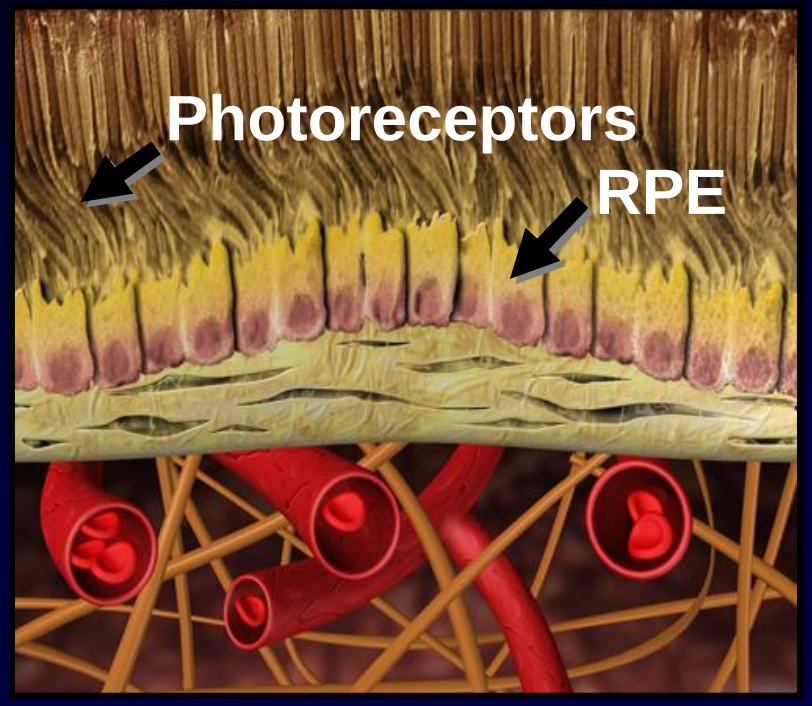
Intermediate Stage:
Extensive Medium or Large-Sized Drusen

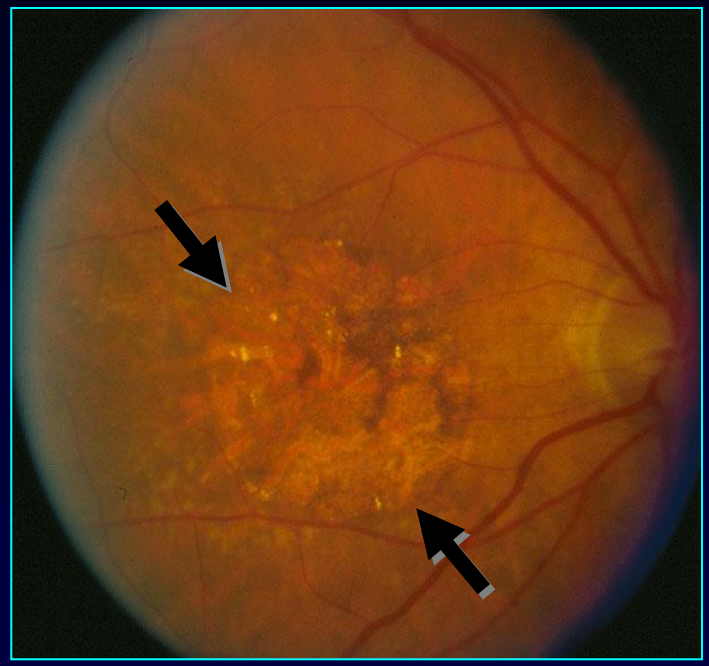




Basement membrane thickens & extensive medium or large-sized drusen become apparent

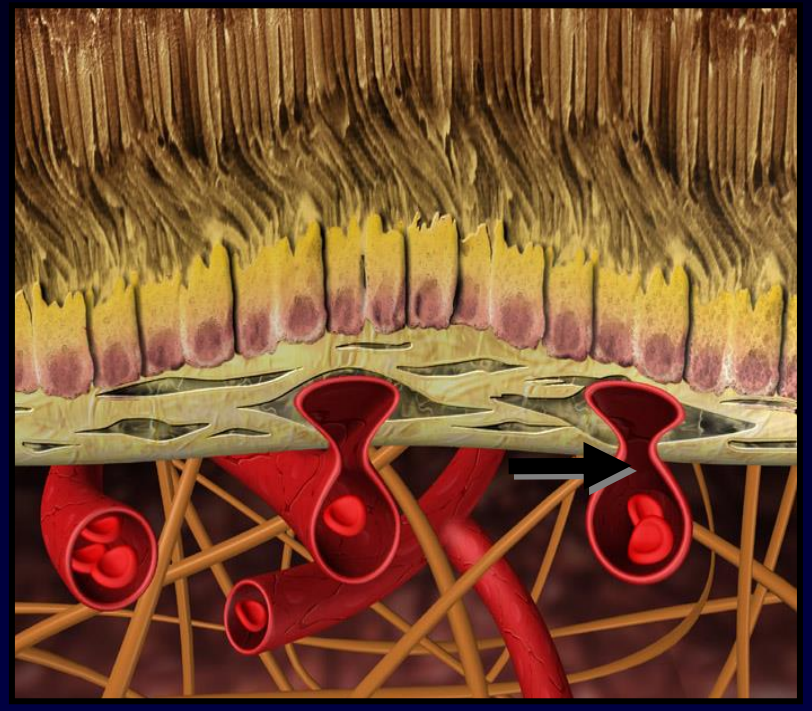
Development of Advanced AMD: Geographic Atrophy Form

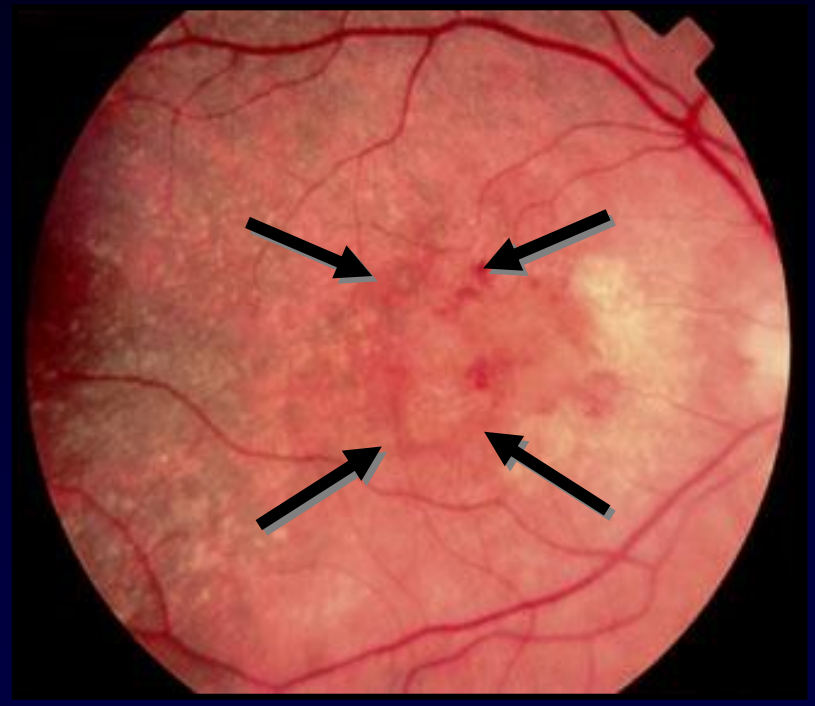




Basement membrane thickening may become associated with atrophy of retinal pigment epithelium (RPE) & loss of photoreceptors & vision

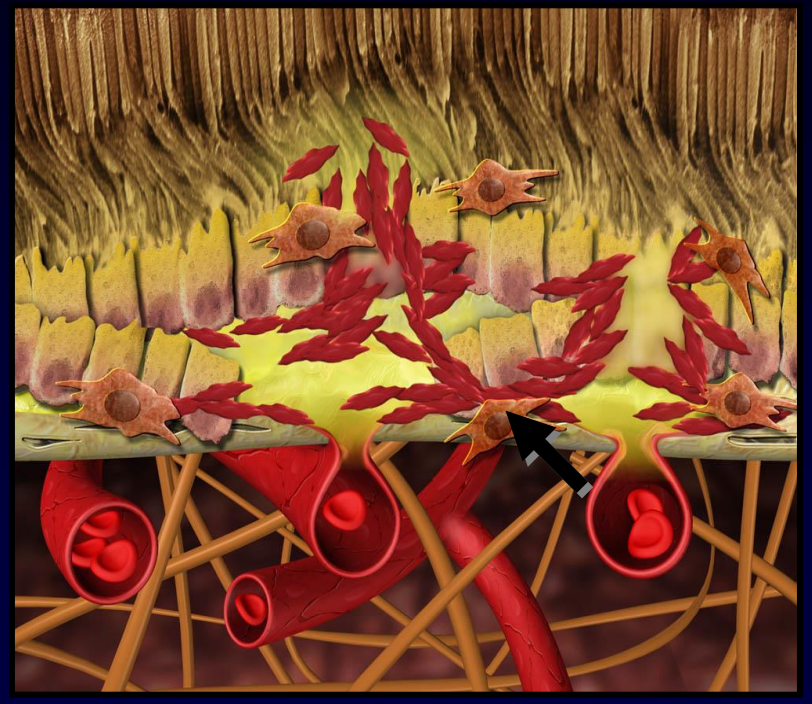
Development of Advanced AMD: Choroidal Neovascularization Form

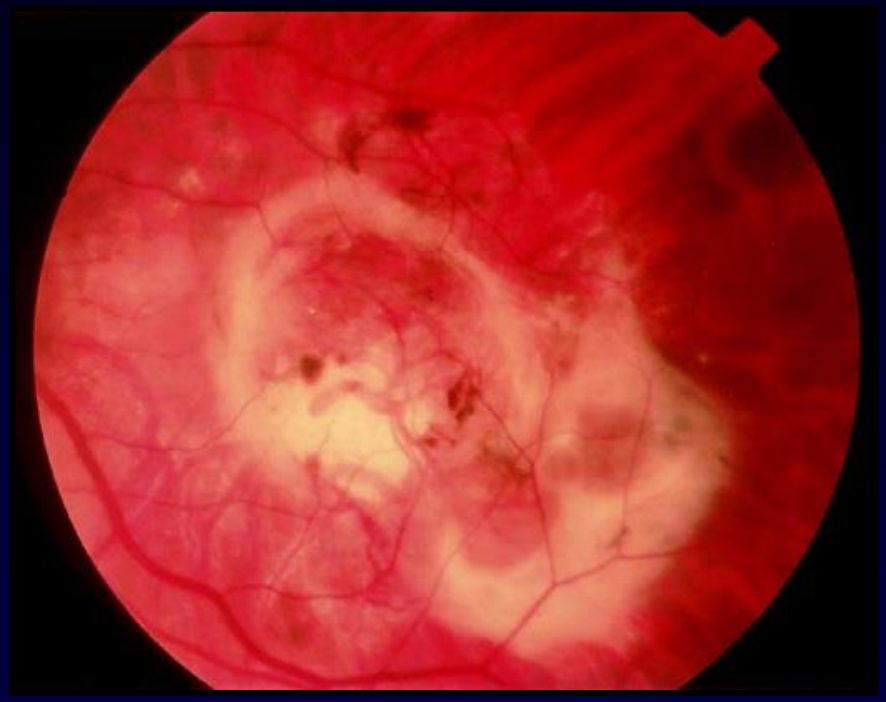




New abnormal blood vessels can proliferate and penetrate basement membrane in setting of extensive medium or large-sized drusen

Progression of Choroidal Neovascularization: Scar Formation





New blood vessels accompanied by scar tissue that replaces normal retina tissue, resulting in permanent loss of central vision

Magnitude of Public Health Problem from Age-related Macular Degeneration (40 years and older)

Research

JAMA Ophthalmology | Original Investigation

Prevalence of Age-Related Macular Degeneration in the US in 2019

David B. Rein, PhD, MPA; John S Wittenborn, BS; Zeb Burke-Conte, BS; Rohit Gulia, MS; Toshana Robalik, BS; Joshua R. Ehrlich, MD, MPH; Elizabeth A. Lundeen, PhD; Abraham D. Flaxman, PhD

Supplemental content

IMPORTANCE Age-related macular degeneration (AMD) is a leading cause of vision loss and blindness. AMD prevalence has not been estimated for the US in over a decade and early-stage AMD prevalence estimates are scarce and inconsistently measured.

OBJECTIVE To produce estimates of early- and late-stage AMD prevalence overall and by age, gender, race and ethnicity, county, and state.

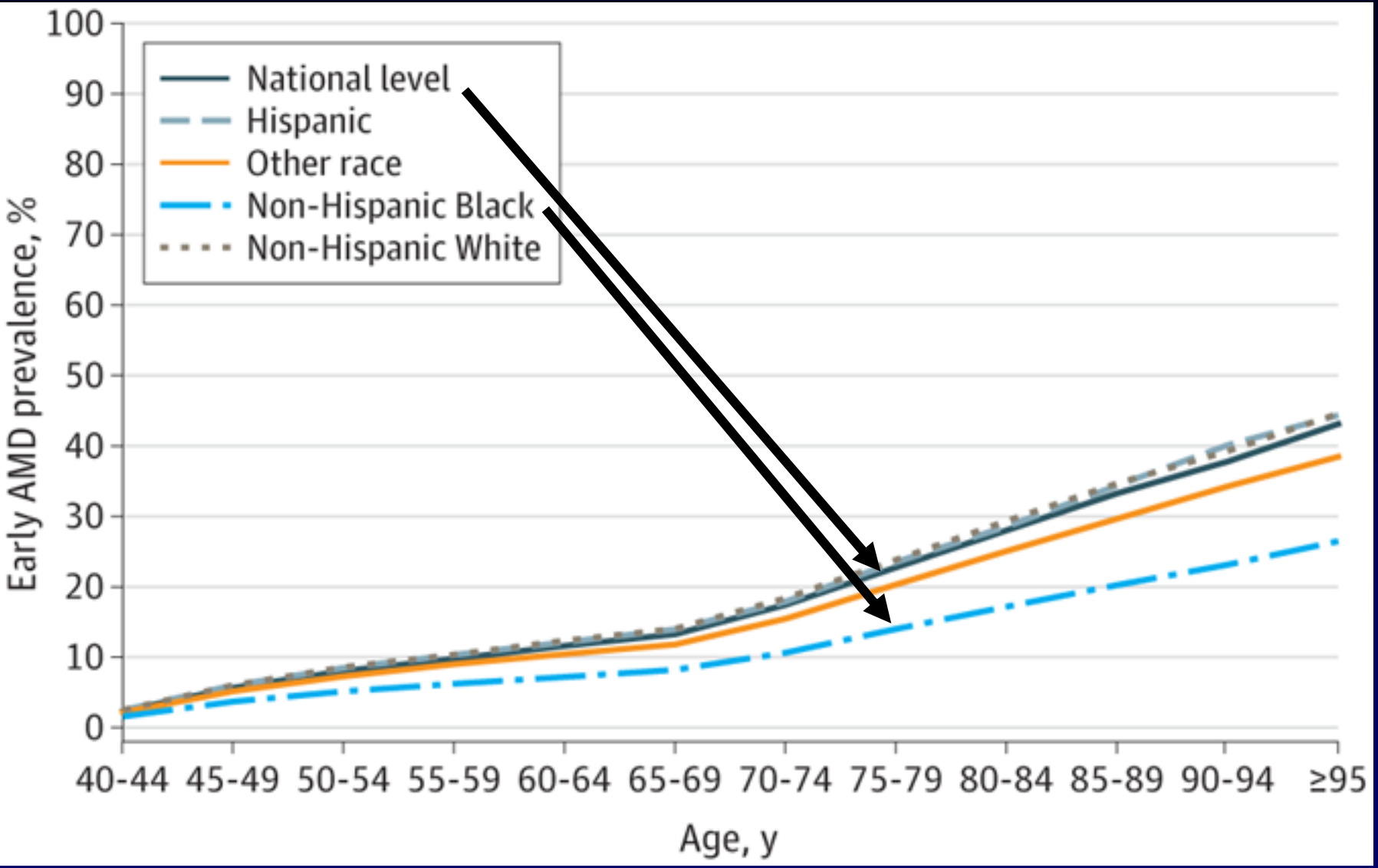
JAMA Ophthalmol. 2022;140(12):1202-1208. doi:10.1001/jamaophthalmol.2022.4401
Published online November 3, 2022.

U.S. Public Health Problem from Age-related Macular Degeneration

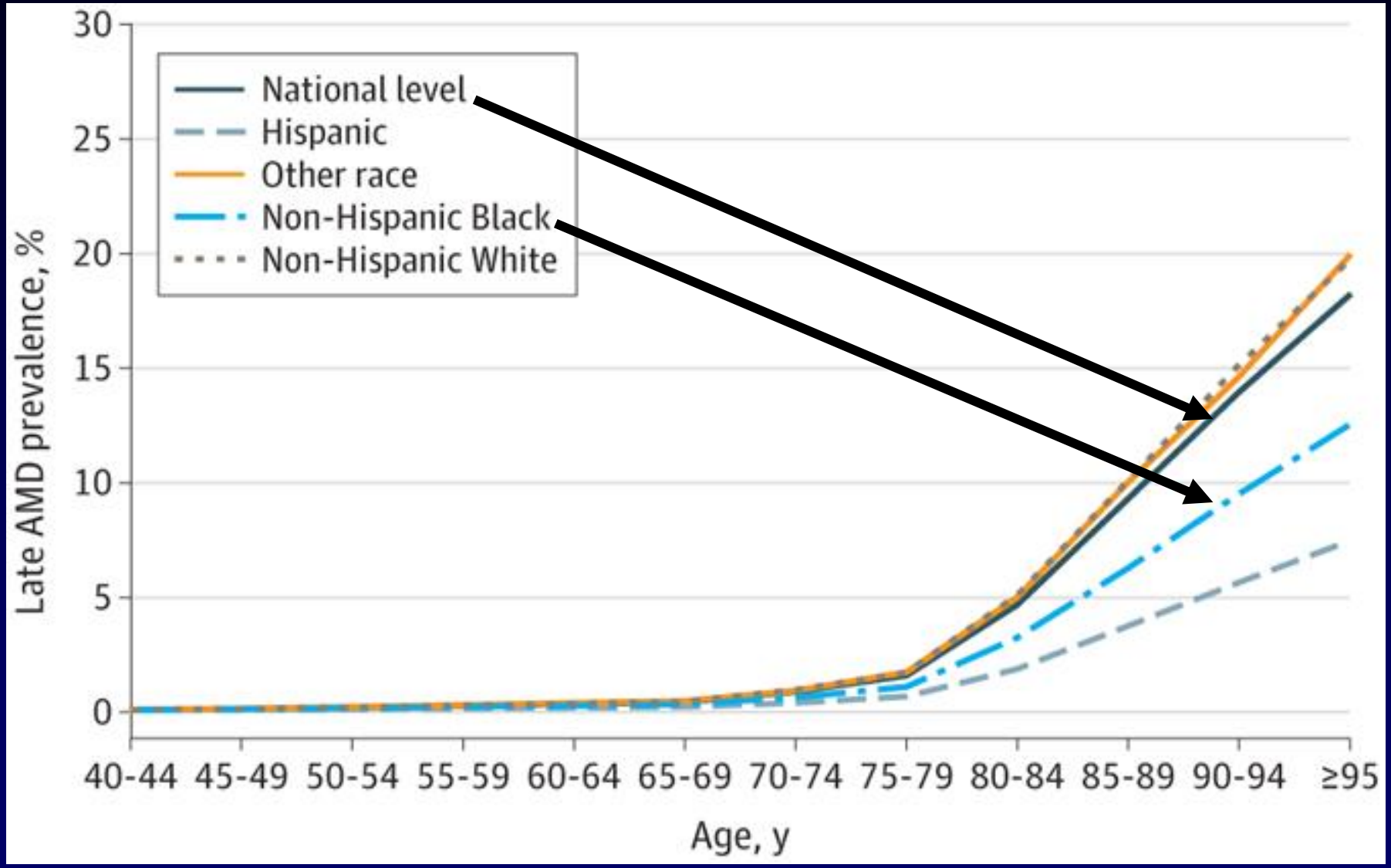
Table. Estimated Prevalence of People Living With Early and Late Age-Related Macular Degeneration (AMD), Stratified by Gender and Race and Ethnicity

Characteristic	Mean (2.5th percentile-97.5th percentile)	
	Prevalence count, in millions (95% UI)	Prevalence rate, % (95% UI)
Early-stage AMD		
Sex		
Female	9.21 (7.22-11.51)	10.73 (8.42-13.46)
Male	9.14 (7.19-11.51)	12.72 (9.96-15.99)
Total	18.34 (15.30-22.03)	11.64 (9.71-13.98)
Ethnicity[a]		
Hispanic	2.06 (1.59-2.61)	12.17 (9.44-15.63)
Non-Hispanic		
Race[a]		
Black	1.14 (0.87-1.47)	7.16 (5.44-9.24)
White	14.03 (11.14-17.65)	12.30 (9.81-15.41)
Other[b]	1.11 (0.76-1.54)	10.47 (7.23-14.64)
Late-stage AMD		
Sex		
Female	0.88 (0.53-1.35)	0.94 (0.57-1.43)
Male	0.60 (0.36-0.91)	0.95 (0.56-1.43)
Total	1.49 (0.97-2.15)	0.94 (0.62-1.36)

Magnitude of Public Health Problem from Early Stage Age-related Macular Degeneration (≥40 years)



Magnitude of Public Health Problem from Late Age-related Macular Degeneration (40 years & older)



Magnitude of Public Health Problem in Age-related Macular Degeneration

1.6 billion

Number of people over the age of 65 in 2050...[1]

1st challenge

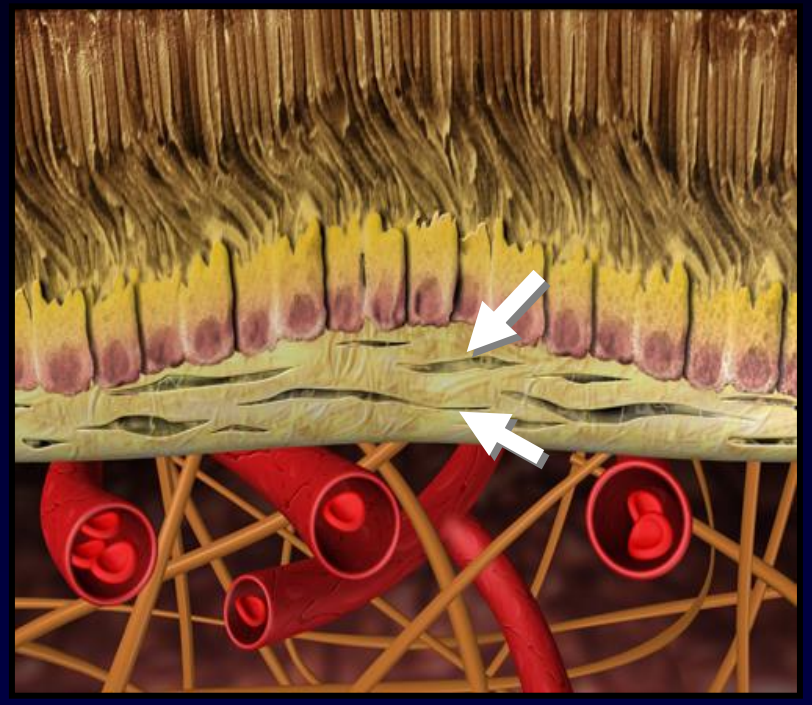
Approximately 15% (or 240 million people) have the intermediate stage of AMD, typically large drusen without symptoms – need to identify to consider dietary supplements such as that used in AREDS

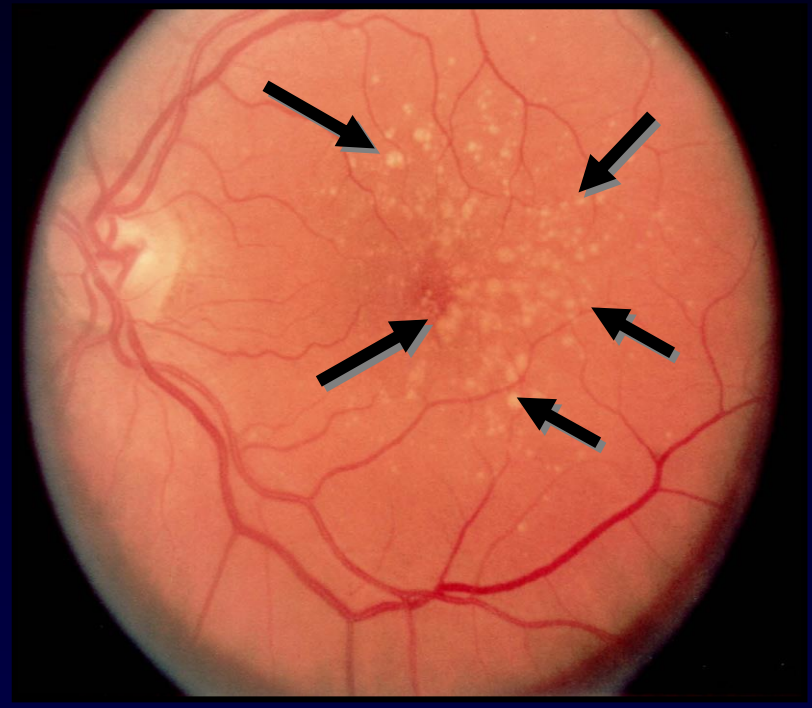
AMD, age-related macular degeneration

1. He W et al. An Aging World 2015. NIH Census Bureau. 2. Rudnicka et al. Am J Ophthalmol2015;160(1):85–93.

Age-related Macular Degeneration (AMD)

Intermediate Stage:
Extensive Medium or Large-Sized Drusen

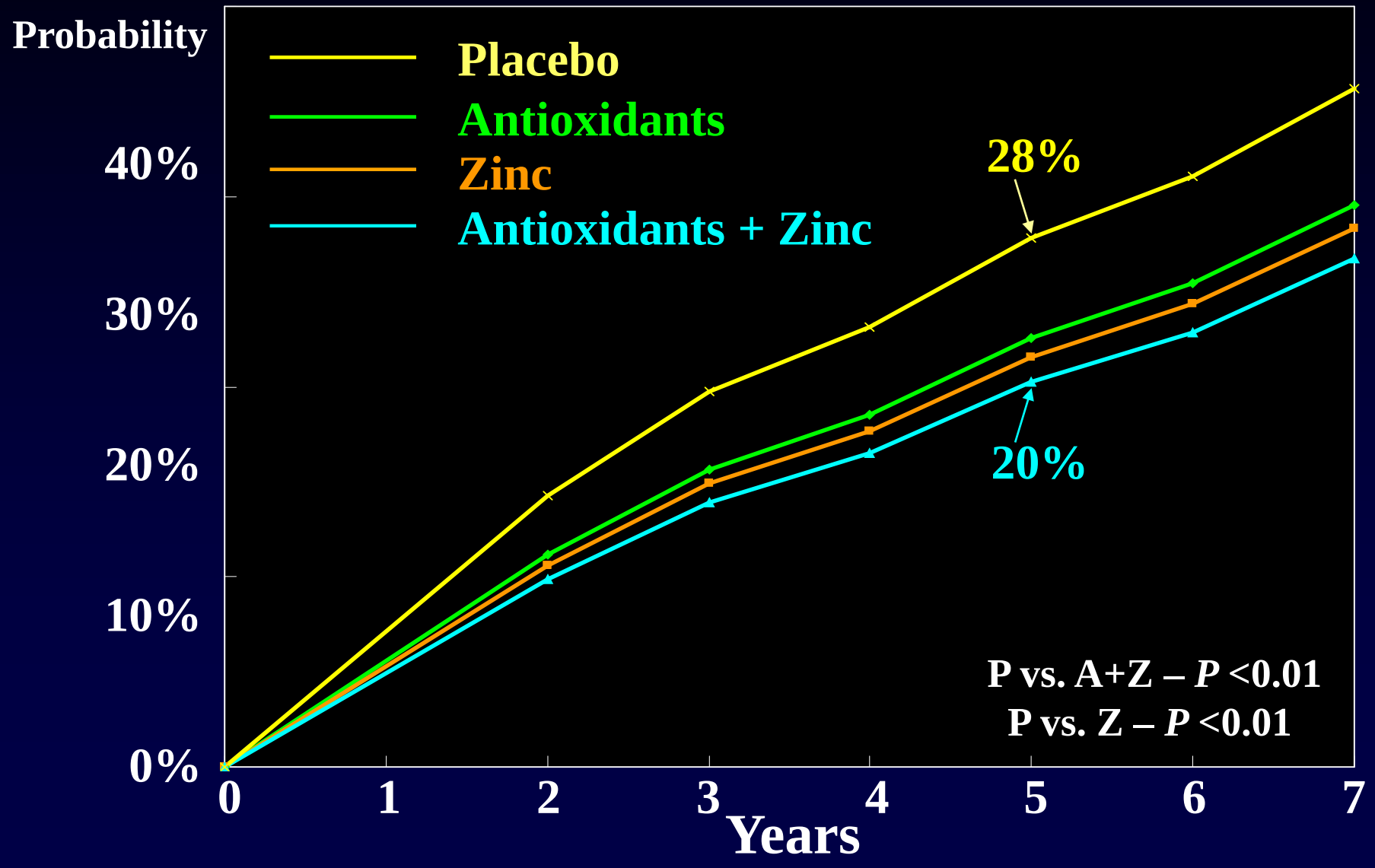




Basement membrane thickens & extensive medium or large-sized drusen become apparent

Rate to Advanced AMD

Intermediate Stage of AMD by Treatment Group



2003: Estimated # At Risk For Advanced AMD

	Number at Risk for Advanced AMD
Total Age 55 or Older (U.S.)	59,266,437 (~120 million in 2023)
A. Intermediate AMD Monocular	4,818,074
B. Intermediate AMD Binocular	2,266,247
C. Monocular Advanced AMD (NV & Central GA)	961,214
Total at Risk	8,045,535: double that in 2023

2003: Estimated Progression Rate

No Treatment (5-Year Rate):

Expected Progression to Advanced AMD:

- 6.3% of 4.8 Million (Monocular Intermediate AMD)
  and
- 26.4% of 2.3 Million (Binocular Intermediate AMD)
  and
- 43.0% of 0.96 Million (Monocular Advanced AMD)

Total Progression if No Treatment:

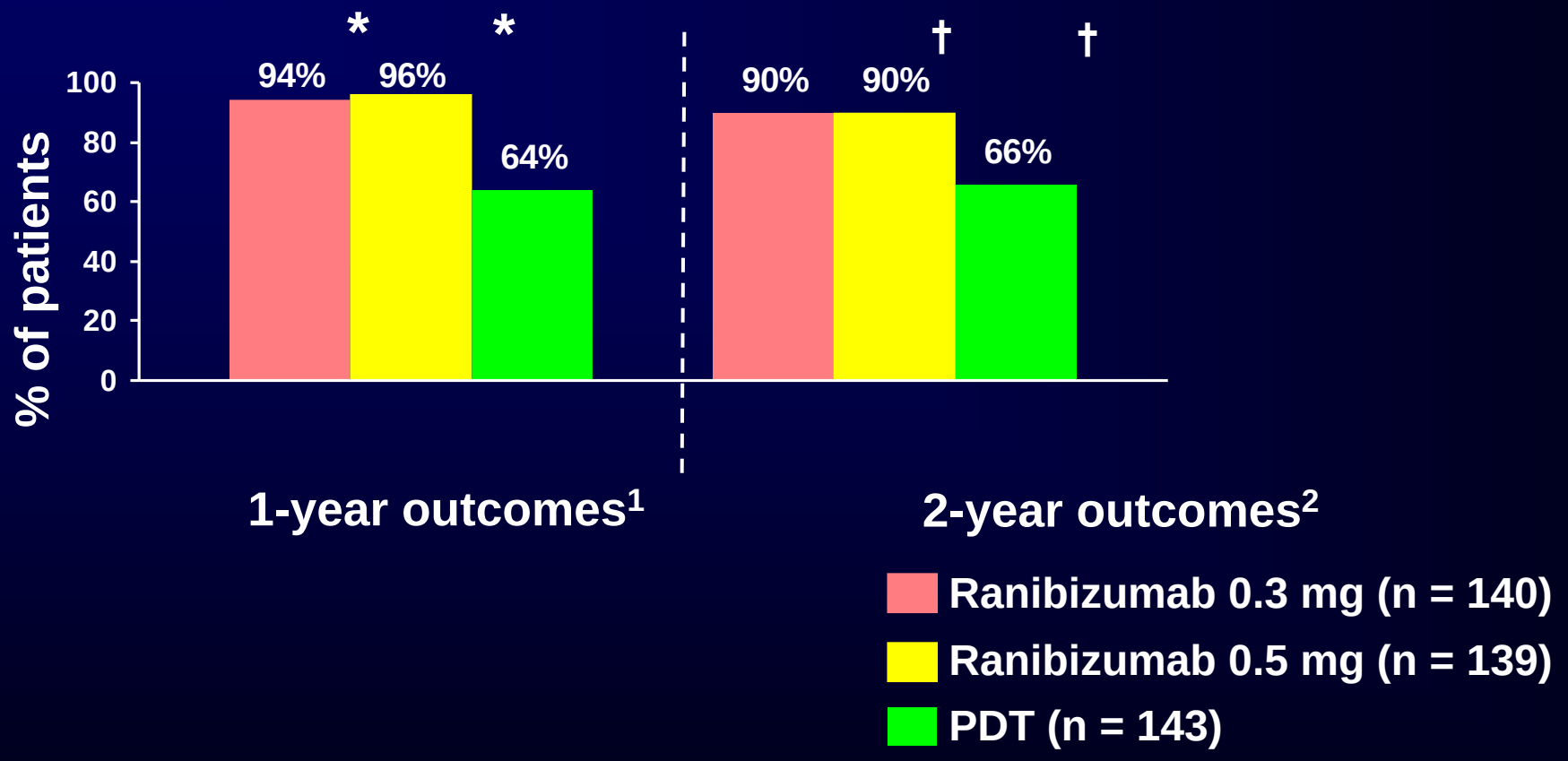
- 1,315,150 Will Develop Advanced AMD

Public Health Impact in 2003

Estimated Number Potentially Saved from Advanced AMD Assuming 25% Treatment Effect Over 5-Year Period

328,788 Persons (double that in 2023)

2005: ANCHOR: Monthly Fixed Dosing: Loss of <15 Letters From Baseline at 12 and 24 Months

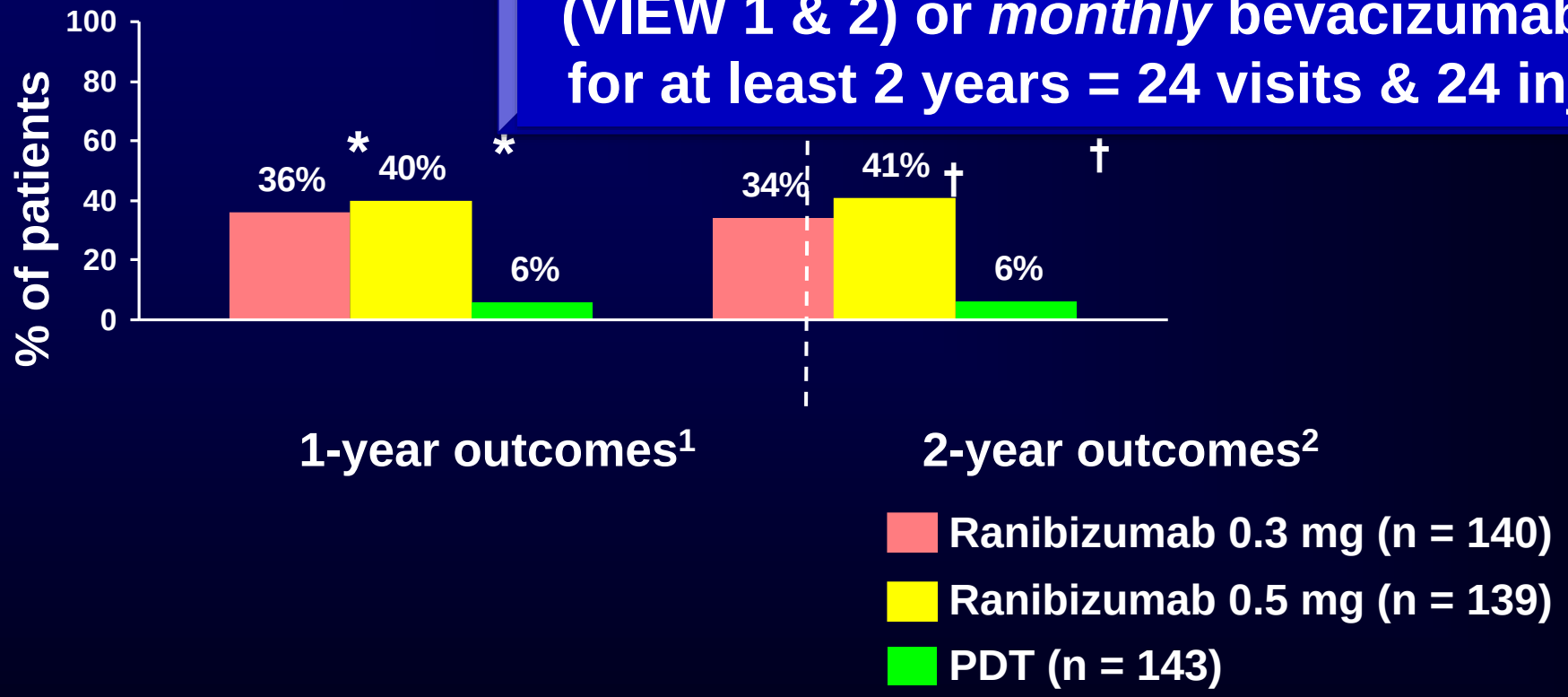


* *P*<.001 vs PDT; †*P*<.001 vs PDT

1. Brown et al. *N Engl J Med.* 2006;355:1432.
2. Brown et al. *Ophthalmology* 2009;116:57–65.

ANCHOR: Monthly Fixed Dosing: Gain of ≥15 Letters From Baseline at 12 and 24 Months

Similar outcomes with *monthly* aflibercept (VIEW 1 & 2) or *monthly* bevacizumab (CATT) for at least 2 years = 24 visits & 24 injections

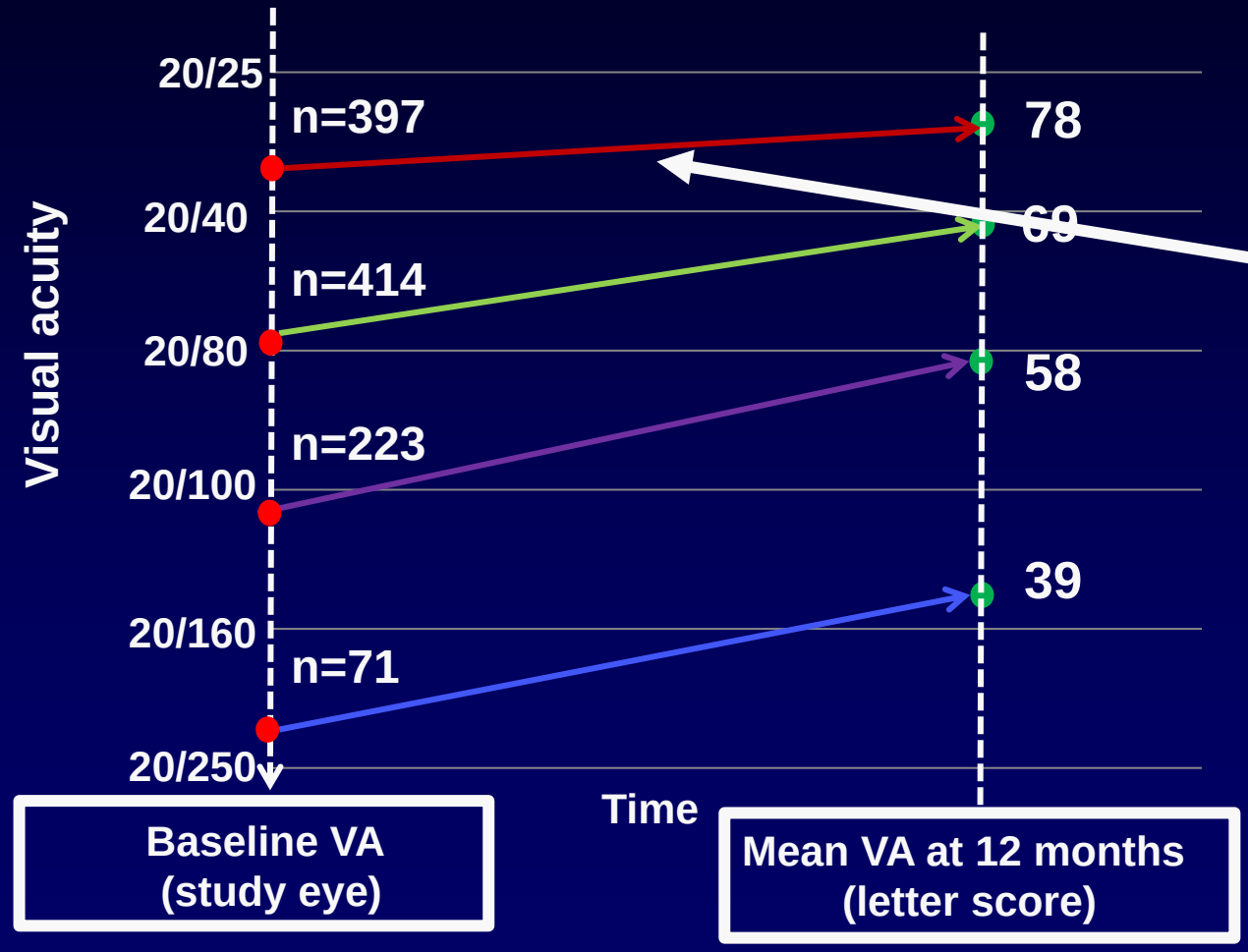


* *P*<.001 vs PDT; †*P*<.001 vs PDT

1. Brown et al. *N Engl J Med.* 2006;355:1432.
2. Brown et al. *Ophthalmology* 2009;116:57–65.

Early detection is critical to maintain visual function

Baseline VA predicts outcomes at Year 1: CATT subgroup analysis



Eyes that begin at 20/25 to 20/40 have the best mean VA at 1 year[1]

Similar stratification of response by baseline VA is also observed at 2 and 5 years[2,3]

CATT, Comparison of Age-Related Macular Degeneration Treatments Trials; VA, visual acuity.

1. Ying G-S *et al*. *Ophthalmology* 2013; 120 (1): 122–129; 2. Lee AY *et al. Br J Ophthalmology* 2015; 99: 1045–1050; 3. Gillies MC *et al. Ophthalmology* 2015; 122: 1837–1845.

Neovascular Age-related Macular Degeneration:

Potential Next Steps

- Home monitoring: Identify who over age 50 has intermediate stage of AMD
  - Consider dietary supplements such as those used in AREDS
  - Evaluate for asymptomatic progression to neovascular AMD each year – potentially supplemented with OCT exam
  - Continue home monitoring to detect neovascular AMD
- Managing neovascular AMD
  - If recent disease progression, typically initiate anti-VEGF therapy
  - Try to identify CNV when visual acuity loss first occurs
  - Frequent monitoring and frequent injections likely needed for most

Magnitude of Public Health Problem in Neovascular AMD

1.6 billion

Number of people over the age of 65 in 2050...[1]

1st challenge

Approximately 15% (or 240 million people) have the intermediate stage of AMD, typically large drusen without symptoms – need to identify to consider dietary supplements such as that used in AREDS

148,000

Number of new cases of neovascular AMD per year (US)[2]

2nd challenge

Need to identify when neovascular form begins, before substantial visual acuity loss has occurred

AMD, age-related macular degeneration

1. He W et al. An Aging World 2015. NIH Census Bureau. 2. Rudnicka et al. Am J Ophthalmol2015;160(1):85–93.

Home-based Monitoring May Provide A Solution To The Delay In Detection And Treatment

- **Monocular vision testing while reading may provide one solution**
  - **Patient can cover one eye while reading and repeat while covering the opposite eye**
- **In addition, various tests and tools, including home-based vision or perimetry or OCT testing, may become more widely available to assist patients with monitoring their vision at home including:**
  - **Smartphone-based fundus imaging[1,2]**
  - **Smartphone-based applications for:**
    - **Visual acuity testing[3,4]**
    - **Shape discrimination hyperacuity[5]**
  - **Smartphone-based visual acuity determination from fundus image[6]**

OCT, optical coherence tomography; VA, visual acuity.

1. Bolster NM *et al. J Diabetes Sci Technol* 2015; 10: 318–324; 2. Kim TN *et al. Transl Vis Sci Technol* 2018; 7 (5): 21; 3. Brady CJ *et al. JAMA* 2015; 314: 2682–2683; 4. Tofigh S *et al. Eye (Lond)* 2015; 29: 1464–1468; 5. Keane PA *et al. Clin Ophthalmol* 2015; 9: 353–366. 6. Paul W et al. *JAMA Ophthalmol* Published on line Jun 8, 2023

VISION ACADEMY
people | research | education

Managing Diabetic Retinopathy and Age-related Macular Degeneration

Can we determine the best-corrected visual acuity from AI analysis of the fundus image?
Might such AI information reduce the need for best-corrected visual acuity measurements in the clinic?
Might such AI information through home monitoring of fundus images potentially detect onset of diabetic macular edema or age-related macular degeneration for which treatment should be considered?

Research

JAMA Ophthalmology | Original Investigation

Accuracy of Artificial Intelligence in Estimating Best-Corrected Visual Acuity From Fundus Photographs in Eyes With Diabetic Macular Edema

William Paul, BS; Philippe Burlina, PhD; Rohita Mocharla, MS; Neil Joshi, BS; Zhuolin Li, MD; Sophie Gu, MD; Onnisa Nanegrungsunk, MD; Kira Lin, MD; Susan B. Bressler, MD; Cindy X. Cai, MD; Jun Kong, MD, PhD; T. Y. Alvin Liu, MD; Hadi Moini, PhD; Weiming Du, MA; Fouad Amer, MD; Karen Chu, MS; Robert Vitti, MD; Farshid Sepehrband, PhD; Neil M. Bressler, MD

IMPORTANCE Best-corrected visual acuity (BCVA) is a measure used to manage diabetic macular edema (DME), sometimes suggesting development of DME or consideration of initiating, repeating, withholding, or resuming treatment with anti-vascular endothelial growth factor. Using artificial intelligence (AI) to estimate BCVA from fundus images could help clinicians manage DME by reducing the personnel needed for refraction, the time presently required for assessing BCVA, or even the number of office visits if imaged remotely.

OBJECTIVE To evaluate the potential application of AI techniques for estimating BCVA from fundus photographs with and without ancillary information.

Invited Commentary

Supplemental content

Paul W, Burlina P, Mocharla R, et al. Accuracy of Artificial Intelligence in Estimating Best-Corrected Visual Acuity From Fundus Photographs in Eyes With Diabetic Macular Edema. *JAMA Ophthalmol.* Published online June 08, 2023.

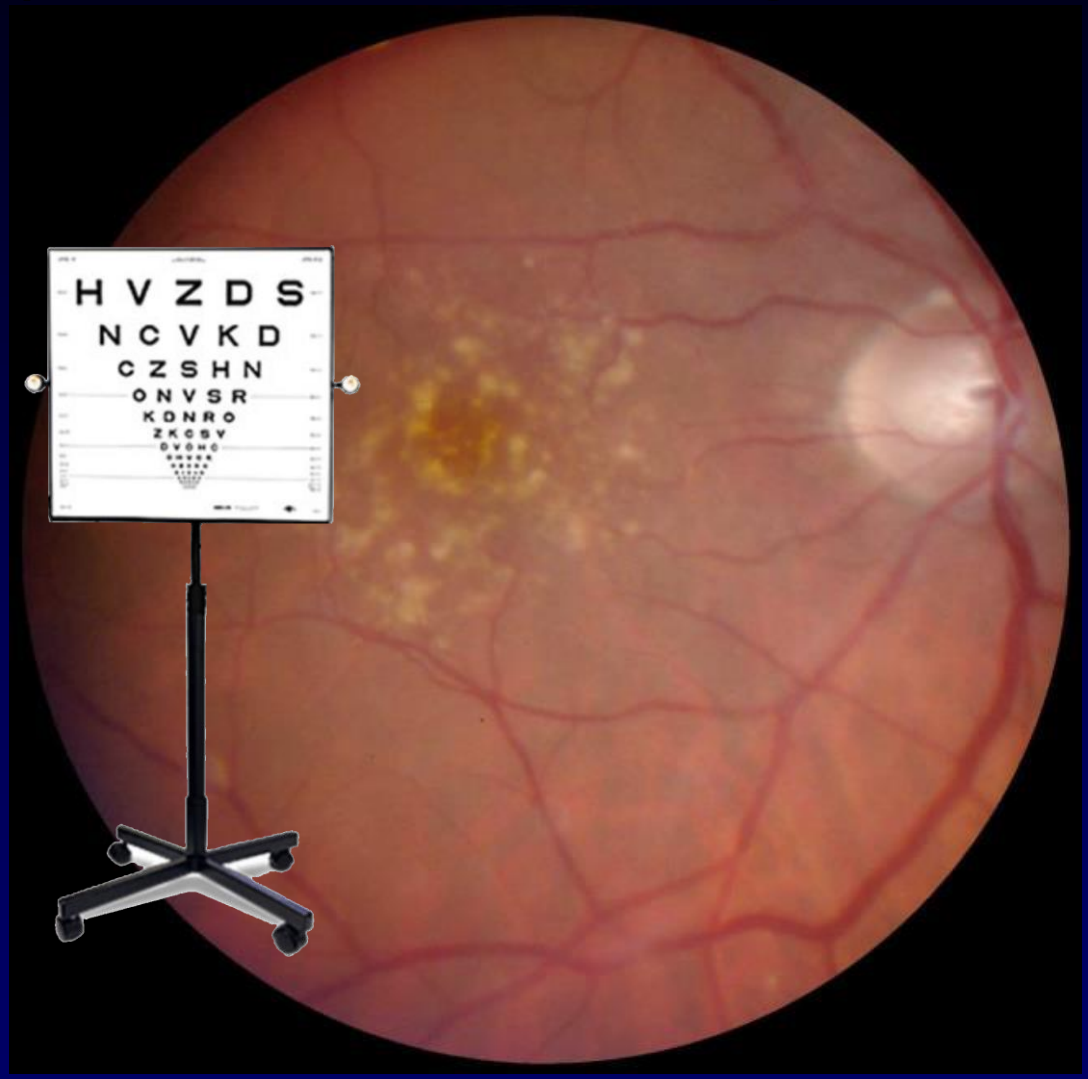
RESULTS Analysis included 7185 macular color fundus images of the study and fellow eyes from 459 participants. Overall, the mean (SD) age was 62.2 (9.8) years, and 250 (54.5%) were male. The baseline BCVA score for the study eyes ranged from 73 to 24 letters (approximate Snellen equivalent 20/40 to 20/320). Using ResNet50 architecture, the MAE for the testing set (n = 641 images) was 9.66 (95% CI, 9.05-10.28); 33% of the values (95% CI, 30%-37%) were within 0 to 5 letters and 28% (95% CI, 25%-32%) within 6 to 10 letters. For BCVA of 100 letters or less but more than 80 letters (20/10 to 20/25, n = 161) and 80 letters or less but more than 55 letters (20/32 to 20/80, n = 309), the MAE was 8.84 letters (95% CI, 7.88-9.81) and 7.91 letters (95% CI, 7.28-8.53), respectively.

CONCLUSIONS AND RELEVANCE This investigation suggests AI can estimate BCVA directly from fundus photographs in patients with DME, without refraction or subjective visual acuity measurements, often within 1 to 2 lines on an ETDRS chart, supporting this AI concept if additional improvements in estimates can be achieved.

Paul W, Burlina P, Mocharla R, et al. Accuracy of Artificial Intelligence in Estimating Best-Corrected Visual Acuity From Fundus Photographs in Eyes With Diabetic Macular Edema. *JAMA Ophthalmol.* Published online June 08, 2023.

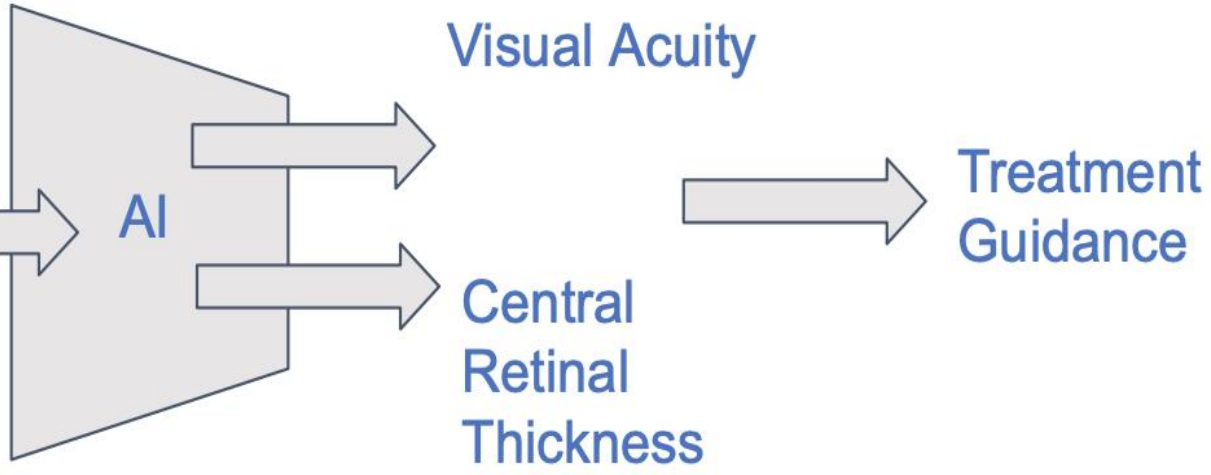
Next Steps: 2023 / 2024

(1) Macular Degeneration; (2) Clinical Practice Setting



Potential Next Steps: 2025

Image source https://labblog.uofmhealth.org/health-tech/enhancing-eye-care-a-smartphone



Why the Eye:

Advances in Eyecare and the Impact on the Patient

- Blindness is perceived as one of the worst things that can happen to us
- Major causes of blindness in U.S. and much of the world:
  - Diabetic retinopathy
  - Age-related macular degeneration
  - Open angle glaucoma
- Other causes of blindness also have a substantial affect on one's quality of life
- Access to eye care across all socioeconomic groups is critical:
  - Early detection or prevention: more likely better vision outcomes
  - Home monitoring of visual acuity or fundus images or both with AI may help address the magnitude of the problem
- Potential for improved ways of diagnosing, managing and preventing vision loss looks bright