Neil Bressler, MD
Editor-in-Chief
JAMA Ophthalmology
Professor of Ophthalmology
Johns Hopkins School of Medicine
Neil M. Bressler, MD*

The James P. Gills Professor of Ophthalmology
Retina Division (Chief: 2005-2018) – Wilmer Eye Institute
Johns Hopkins University School of Medicine & Hospital – Baltimore, MD
Editor in Chief, JAMA Ophthalmology

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

* 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 DCRN Network or JAMA Ophthalmology
I have the following financial interests or relationships to disclose:

<table>
<thead>
<tr>
<th>Disclosure</th>
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<tr>
<td>AMA – <em>JAMA Ophthalmology</em> Editor-in-Chief</td>
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<td>Bayer Healthcare Pharmaceuticals Inc.</td>
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<td>FDA: Chair, Ophthalmic Devices Panel</td>
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<td>Genentech (Roche)</td>
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<td>Regeneron</td>
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<td>Samsung Bioepis</td>
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<td>EMMES Company, LLC – Chair: Data and Safety Monitoring Committee for The National Eye Institute Intramural Program</td>
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**AMA = American Medical Association; FDA = Food and Drug Administration; JHU = Johns Hopkins University School of Medicine

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The Worst That Could Happen? Going Blind, People Say

Personal Health

By JANE E. BRODY  FEB. 20, 2017

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

<table>
<thead>
<tr>
<th>Group</th>
<th>10 (Greatest)</th>
<th>5</th>
<th>1 (Least)</th>
<th>Not Sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>African-American</td>
<td>57%</td>
<td>3%</td>
<td>4%</td>
<td>5%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>38%</td>
<td>3%</td>
<td>3%</td>
<td>9%</td>
</tr>
<tr>
<td>Asian</td>
<td>43%</td>
<td>3%</td>
<td>2%</td>
<td>7%</td>
</tr>
<tr>
<td>Non-Hispanic White</td>
<td>49%</td>
<td>1%</td>
<td>3%</td>
<td>3%</td>
</tr>
</tbody>
</table>

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

Which of the following diseases or ailments is the worst that could happen to you?

- African-American: 18% Blindness, 13% Cancer, 17% AIDS/HIV, 8% Alzheimer's, 30% Not sure
- Hispanic: 15% Blindness, 22% Cancer, 9% AIDS/HIV, 11% Alzheimer's, 31% Not sure
- Asian: 15% Blindness, 18% Cancer, 6% AIDS/HIV, 12% Alzheimer's, 36% Not sure
- Non-Hispanic White: 20% Blindness, 19% Cancer, 7% AIDS/HIV, 24% Alzheimer's, 21% Not sure

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?

<table>
<thead>
<tr>
<th>Ocular Disease Utility Value*</th>
<th>Systemic Health State Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Negligible visual loss</strong></td>
<td>Breast cancer, after radiotherapy</td>
</tr>
<tr>
<td>(20/20-20/25)</td>
<td>Myocardial infarction</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Colon cancer, poor prognosis</td>
</tr>
<tr>
<td></td>
<td>AIDS</td>
</tr>
<tr>
<td></td>
<td>Stroke, moderate</td>
</tr>
<tr>
<td></td>
<td>Home dialysis for 8 years</td>
</tr>
<tr>
<td><strong>Moderate visual loss</strong></td>
<td>Tuberculosis: hospitalized for 3 mos</td>
</tr>
<tr>
<td>(20/60-20/100)</td>
<td>Ulcerative colitis, before surgery</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

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

---

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

Cornea
Lens
Sclera
Choroid
Vitreous
Retina
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

1st challenge
Need to identify the 93 million individuals with DR, including 21 million with DME, from those without DR

21 million
Number of diabetic patients worldwide with some form of DME

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

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; Jnan 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.

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

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Prevalence count, in millions (95% UI)</th>
<th>Standardized prevalence rate, % (95% UI)Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetic retinopathy</td>
<td>9.60 (7.90-11.55)</td>
<td>26.43 (21.95-31.60)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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%

![Lipid](image)
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

MARCH 26, 2015

Aflibercept, Bevacizumab, or Ranibizumab for Diabetic Macular Edema

The Diabetic Retinopathy Clinical Research Network®

ABSTRACT

BACKGROUND
The relative efficacy and safety of intravitreal aflibercept, bevacizumab, and ranibizumab in the treatment of diabetic macular edema are unknown.
<table>
<thead>
<tr>
<th>~Snellen Equivalent (Letter Score)</th>
<th>Aflibercept (N = 98)</th>
<th>Bevacizumab (N = 92)</th>
<th>Ranibizumab (N = 94)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20/12.5 (94-98)</td>
<td>0</td>
<td>0</td>
<td>2 (2%)</td>
</tr>
<tr>
<td>20/16 (89-93)</td>
<td>7 (7%)</td>
<td>2 (2%)</td>
<td>6 (6%)</td>
</tr>
<tr>
<td>20/20 (84-88)</td>
<td>16 (16%)</td>
<td>9 (10%)</td>
<td>12 (13%)</td>
</tr>
<tr>
<td>20/25 (79-83)</td>
<td>21 (21%)</td>
<td>19 (21%)</td>
<td>9 (10%)</td>
</tr>
<tr>
<td>20/32 (74-78)</td>
<td>15 (16%)</td>
<td>13 (14%)</td>
<td>22 (23%)</td>
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<tr>
<td>20/40 (69-73)</td>
<td>10 (10%)</td>
<td>8 (9%)</td>
<td>9 (10%)</td>
</tr>
<tr>
<td>20/50 (64-68)</td>
<td>4 (4%)</td>
<td>5 (5%)</td>
<td>7 (7%)</td>
</tr>
<tr>
<td>20/63 (59-63)</td>
<td>2 (2%)</td>
<td>5 (5%)</td>
<td>6 (6%)</td>
</tr>
<tr>
<td>20/80 (54-58)</td>
<td>1 (1%)</td>
<td>2 (2%)</td>
<td>6 (6%)</td>
</tr>
<tr>
<td>20/100 (49-53)</td>
<td>2 (2%)</td>
<td>3 (3%)</td>
<td>1 (1%)</td>
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<tr>
<td>20/125 (44-48)</td>
<td>1 (1%)</td>
<td>1 (1%)</td>
<td>0</td>
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<tr>
<td>20/160 (39-43)</td>
<td>0</td>
<td>3 (3%)</td>
<td>0</td>
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<tr>
<td>20/200 (34-38)</td>
<td>1 (1%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>20/250 (29-33)</td>
<td>2 (2%)</td>
<td>0</td>
<td>1 (1%)</td>
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<tr>
<td>20/320 (24-28)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>20/400 (19-23)</td>
<td>0</td>
<td>2 (2%)</td>
<td>1 (1%)</td>
</tr>
<tr>
<td>&lt;20/400 (&lt;19)</td>
<td>0</td>
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### Baseline Visual Acuity 20/32-20/40 (Letter Score 78-69)

<table>
<thead>
<tr>
<th>Snellen Equivalent (Letter Score)</th>
<th>Aflibercept (N = 103)</th>
<th>Bevacizumab (N = 93)</th>
<th>Ranibizumab (N = 97)</th>
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<tr>
<td>20/125 (44-48)</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>20/160 (39-43)</td>
<td>0</td>
<td>0</td>
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<td>1 (1%)</td>
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<tr>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>&lt;20/400 (&lt;19)</td>
<td>0</td>
<td>1 (1%)</td>
<td>0</td>
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</table>

71% 20/25 or better
**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**

**CW Baker and coauthors**

**Abstract**

Purpose: To compare vision loss at 2 years among patients randomly assigned to aflibercept, laser photocoagulation, or observation for diabetic macular edema involving the center of the macula.

Methods: This was a randomized clinical trial with 1:1:1 allocation of 1256 eyes (510 aflibercept, 495 laser photocoagulation, and 271 observation). Eyes were randomly assigned to aflibercept on an as-needed basis or monthly for 2 years after enrollment. The primary outcome was visual acuity at 2 years.

Results: One thousand two hundred fifty-six eyes (827 patients) were randomized; 1254 eyes (826 patients) were evaluable for the primary outcome. The primary outcome was worse vision in the aflibercept group compared with the observation group. Vision was better in the laser photocoagulation group than in the aflibercept group.

Conclusions: Among patients with diabetic macular edema involving the center of the macula, aflibercept reduced vision loss compared with observation, but vision loss was similar between aflibercept and laser photocoagulation.


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).

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)

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

**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.
## 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

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

Age-related Macular Degeneration (AMD)

Intermediate Stage:
Extensive Medium or Large-Sized Drusen

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

Intermediate Stage of AMD by Treatment Group

- Placebo
- Antioxidants
- Zinc
- Antioxidants + Zinc

Projected probability at 20% and 28% for different treatment groups.

- P vs. A+Z: \( P < 0.01 \)
- P vs. Z: \( P < 0.01 \)
2003: Estimated # At Risk For Advanced AMD

Total Age 55 or Older (U.S.) 59,266,437 (~120 million in 2023)

Number at Risk for Advanced AMD

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)

% of patients

1-year outcomes¹

2-year outcomes²

Ranibizumab 0.3 mg (n = 140)
Ranibizumab 0.5 mg (n = 139)
PDT (n = 143)

* P<.001 vs PDT; † P<.001 vs PDT

**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

1-year outcomes

- **Ranibizumab 0.3 mg (n = 140)**: 36%
- **Ranibizumab 0.5 mg (n = 139)**: 40%
- **PDT (n = 143)**: 6%

2-year outcomes

- **Ranibizumab 0.3 mg (n = 140)**: 34%
- **Ranibizumab 0.5 mg (n = 139)**: 41%
- **PDT (n = 143)**: 6%

* *P* < .001 vs PDT; † *P* < .001 vs PDT

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

Similar stratification of response by baseline VA is also observed at 2 and 5 years

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

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

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

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

AMD, age-related macular degeneration
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 imaging¹,²
  • Smartphone-based applications for:
    o Visual acuity testing³,⁴
    o Shape discrimination hyperacuity⁵
  • Smartphone-based visual acuity determination from fundus image⁶

OCT, optical coherence tomography; VA, visual acuity.

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?
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 Nanegrunugsunk, 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.

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.
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
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.