Visual Readiness: The Importance of Comprehensive Eye Examinations with Diabetes Mellitus

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Presenter

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Disclosures

- Dr. Andrew Morgenstern has no relevant financial disclosure to anything discussed in this presentation. Dr. Morgenstern has a non-financial disclosure as the methodologist of the AOA evidence-based diabetes guideline.
- The views expressed in this presentation are those of the author and do not necessarily reflect the official policy or position of the Department of Defense, nor the U.S. Government.
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Learning Objectives

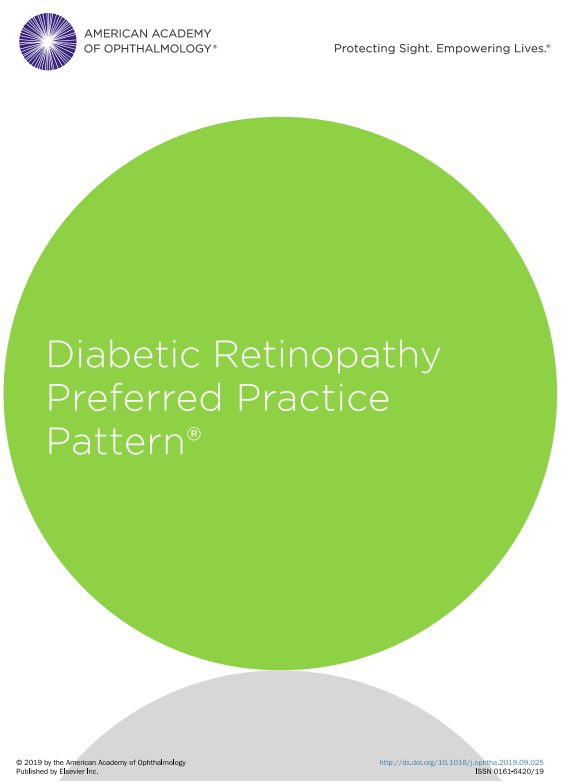
At the conclusion of this activity, participants will be able to:

1. Summarize the evidence-based information on Diabetes Mellitus (DM) and the eye .
2. Explain the reasons why comprehensive eye examinations are critical for non-diabetic and diabetic patients.
3. Discuss how DM can affect military readiness
4. Differentiate between a screening and a comprehensive eye examination for DM and Diabetic Retinopathy (DR)

Main Resources

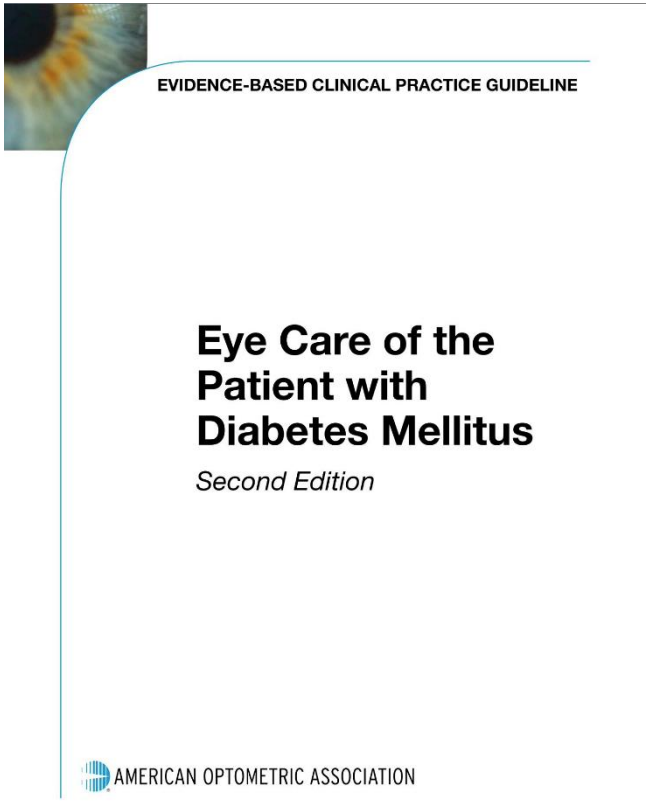
Academy of Ophthalmology

Preferred Practice Pattern (AAO PPP)



American Optometric Association

Evidence Based Clinical Practice Guideline (AOA EB-CPG)



Let's Look at the Problem

Diabetes Mellitus and Gestational Diabetes, Active and Reserve Component Service Members and Dependents, 2008–2018

Valerie F. Williams, MA, MS; Gi-Taik Oh, MS; Shauna Stahlman, PhD, MPH; Donald Shell, MD, MA

Findings and Force Readiness

WHAT ARE THE NEW FINDINGS?

During the 11-year surveillance period, annual incidence rates of type 2 DM decreased steadily among service members in the active component (57.7% decline) and reserve component (56.9%) and among MHS dependents (66.0%). Crude annual prevalence rates of gestational DM approximately doubled among women in the active and reserve component and among female MHS dependents.

WHAT IS THE IMPACT ON READINESS AND FORCE HEALTH PROTECTION?

Although the incidence rates of DM have been decreasing among service members and dependents, DM presents barriers to the ability of service members to fully participate in military operations, especially those involving deployment. Efforts to sustain the health of the force should include continued surveillance of DM incidence, ongoing research and preventive measures to reduce comorbidities and risk factors, and modification of lifestyle choices and habits to reduce the risk of developing DM.

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Incident Diagnosis and Incident Rates Active & Reserve Components 2009-2019

Defense Health Agency

TABLE 2. Incident diagnoses and incidence rates of DM, active and reserve components, U.S. Armed Forces, 2008–2018

	Active component				Reserve component			
	Type 2 DM		Any DM[a]		Type 2 DM		Any DM[a]	
	No.	Rate[b]	No.	Rate[b]	No.	Rate[c]	No.	Rate[c]
Total	10,633	71.6	12,582	84.8	6,503	63.8	7,106	69.8
Sex								
Male	9,512	75.4	11,272	89.4	5,725	69.2	6,246	75.5
Female	1,121	50.2	1,310	58.7	778	40.6	860	44.9
Age group (years)								
<20	67	6.9	167	17.1	15	1.5	38	3.8
20–24	440	9.2	1,050	22.0	88	3.7	204	8.5
25–29	741	20.9	1,219	34.4	246	12.3	364	18.2
30–34	1,182	51.1	1,452	62.8	392	27.8	478	33.9
35–39	2,466	144.7	2,733	160.5	826	72.8	890	78.5
40+	5,737	374.4	5,961	389.6	4,936	220.6	5,132	229.6
Race/ethnicity group								
Non-Hispanic white	3,960	44.5	5,139	57.7	3,298	49.1	3,698	55.0
Non-Hispanic black	3,693	154.9	4,142	173.8	1,832	117.9	1,960	126.2
Hispanic	1,315	67.2	1,494	76.4	781	69.0	836	73.8
Asian/Pacific Islander	949	169.5	983	175.6	326	103.2	333	105.4
American Indian/Alaska Native	93	59.1	108	68.6	53	64.3	57	69.2
Other/unknown	623	70.8	716	81.4	213	55.8	222	58.2
Service								
Army	5,166	91.2	5,973	105.5	4,923	72.3	5,346	78.5
Navy	3,052	86.5	3,506	99.5	485	62.6	536	69.2
Air Force	2,010	56.8	2,453	69.4	1,053	50.5	1,159	55.6
Marine Corps	405	19.1	650	30.7	42	8.1	65	12.6

[a]Type 1, type 2, or unspecified DM.
[b]per 100,000 person-years.
[c]per 100,000 persons.
DM, diabetes mellitus; No., number.

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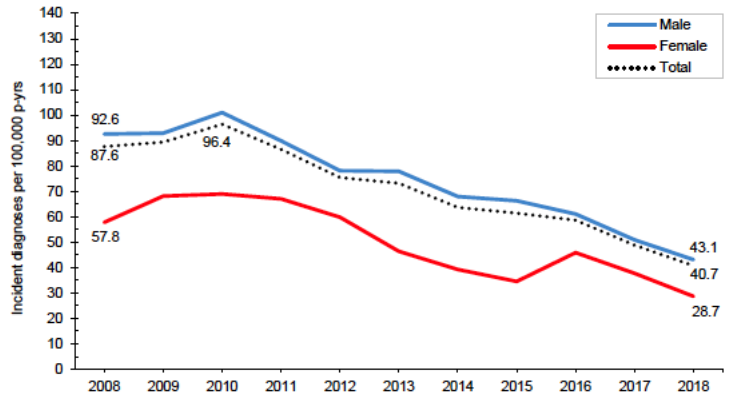
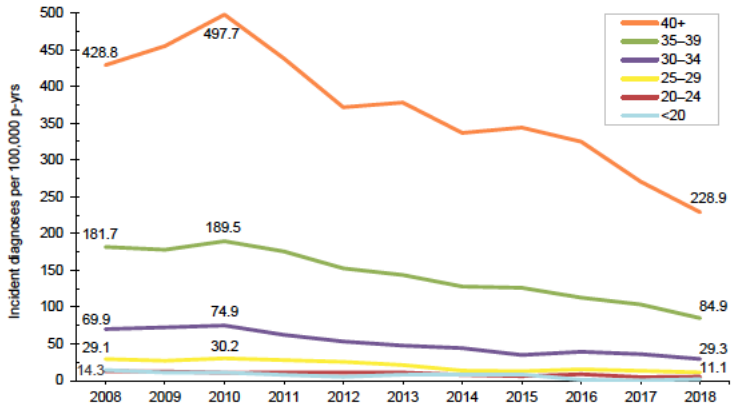
Annual Incidence Rates
T2DM, Active Component

FIGURE 1. Annual incidence rates of type 2 DM diagnoses, by sex, active component, U.S. Armed Forces, 2008–2018



DM, diabetes mellitus; p-yrs, person-years.

FIGURE 2. Annual incidence rates of type 2 DM diagnoses, by age group, active component, U.S. Armed Forces, 2008–2018



DM, diabetes mellitus; p-yrs, person-years.

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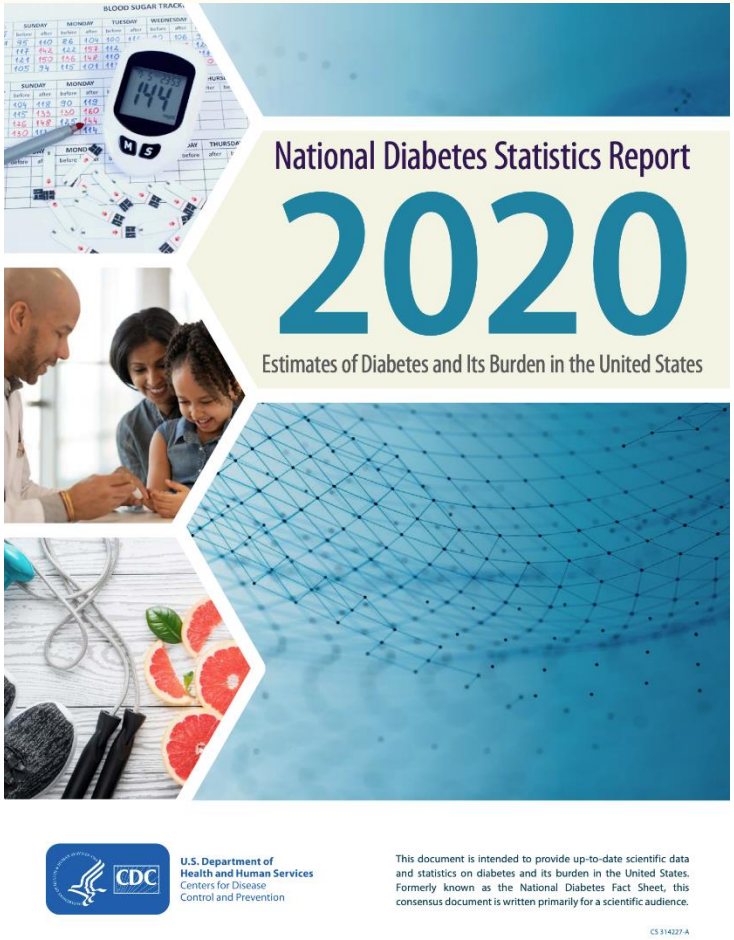
Estimates of Diabetes and Its Burden in the United States



Prevalence of Diabetes
CDC National Diabetes Statistics Report, 2020

Among the US population overall, crude estimates for 2018 were:

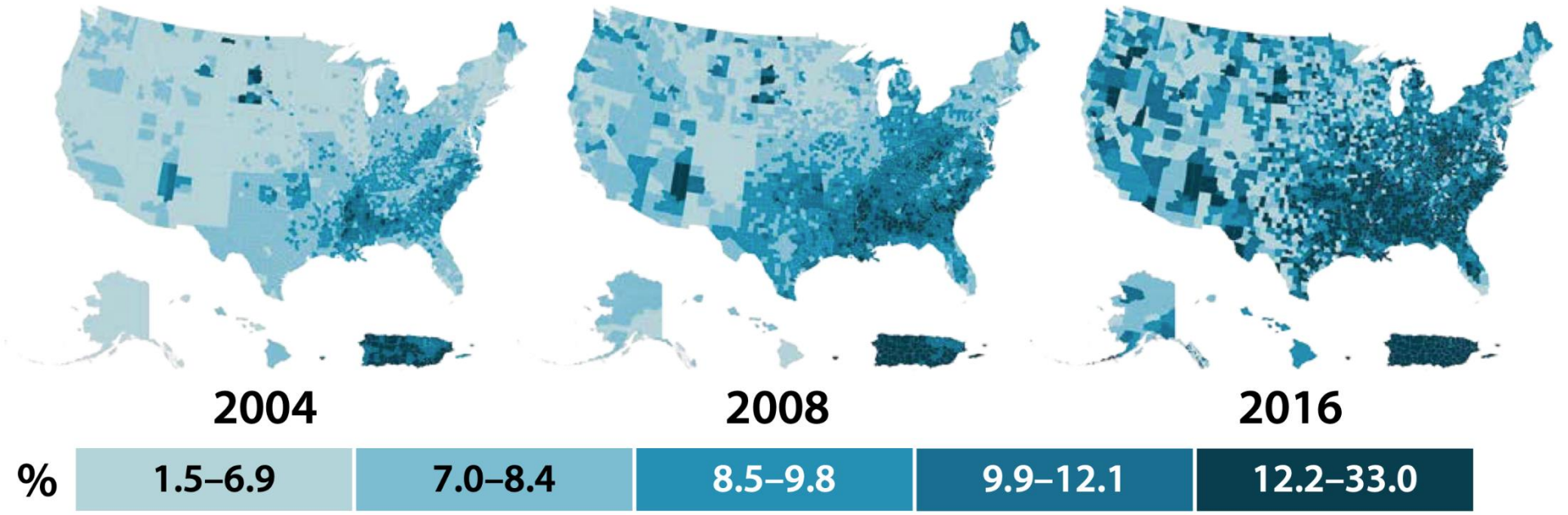
- 34.2 million people of all ages—or 10.5% of the US population—had diabetes.
- 34.1 million adults aged 18 years or older—or 13.0% of all US adults—had diabetes (Table 1a; Table 1b).
- 7.3 million adults aged 18 years or older who met laboratory criteria for diabetes were not aware of or did not report having diabetes (undiagnosed diabetes, Table 1b). This number represents 2.8% of all US adults (Table 1a) and 21.4% of all US adults with diabetes.
- The percentage of adults with diabetes increased with age, reaching 26.8% among those aged 65 years or older (Table 1a).

Estimated Crude Prevalence Diabetes Adults 18 Years Old or Older United States, 2013-2016

Characteristic	Diagnosed diabetes Percentage (95% CI)	Undiagnosed diabetes Percentage (95% CI)	Total diabetes Percentage (95% CI)
Total	**10.2 (9.3–11.2)**	**2.8 (2.4–3.3)**	**13.0 (12.0–14.1)**
Age in years			
18–44	3.0 (2.6–3.6)	1.1 (0.7–1.8)	4.2 (3.4–5.0)
45–64	13.8 (12.2–15.6)	3.6 (2.8–4.8)	17.5 (15.7–19.4)
≥65	21.4 (18.7–24.2)	5.4 (4.1–7.1)	26.8 (23.7–30.1)
Sex			
Men	11.0 (9.7–12.4)	3.1 (2.3–4.2)	14.0 (12.3–15.5)
Women	9.5 (8.5–10.6)	2.5 (2.0–3.2)	12.0 (11.0–13.2)
Race/ethnicity			
White, non-Hispanic	9.4 (8.4–10.5)	2.5 (1.9–3.3)	11.9 (10.9–13.0)
Black, non-Hispanic	13.3 (11.9–14.9)	3.0 (2.0–4.5)	16.4 (14.7–18.2)
Asian, non-Hispanic	11.2 (9.5–13.3)	4.6 (2.8–7.2)	14.9 (12.0–18.2)
Hispanic	10.3 (8.1–13.1)	3.5 (2.5–4.8)	14.7 (12.5–17.3)

CDC National Diabetes Statistics Report, 2020

Prevalence of Diagnosed Diabetes Adults 20 Years Old or Older, United States



CDC National Diabetes Statistics Report, 2020

Eye Exams in the Civilian Sector

- While advances in the management of DM and DR have reduced the risk of vision loss and blindness, more than 1/3 of persons with diabetes do not receive an annual eye examination.
- The annual rate of dilated eye examinations for adults in the United States varies by state from 49.8 percent in Indiana to 76.7 percent in Massachusetts.
- Overall, 61.6 percent of American adults with DM received a dilated eye examination from 2014-2015.
- Rates of eye examinations for elderly persons with DM also remain below recommended levels as reported in a nationally representative sample of persons with health insurance coverage.
- In addition, a significant number of individuals with diabetes are not adequately evaluated for signs and symptoms of diabetic eye disease by their primary care physician.

What is Diabetes Mellitus?

- Diabetes mellitus is a metabolic disease characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction, and failure of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels.

Types of Diabetes

- Type 1 diabetes mellitus (T1DM) is a condition where the beta-cells of the pancreas does not make or makes too little insulin. This likely occurs when the body's immune system attacks and kills these pancreatic beta-cells. (5-10% of cases)
- Type 2 diabetes mellitus (T2DM) is the most prevalent form of the disease and often goes undiagnosed for many years because high blood glucose levels develop gradually and initially are often not severe enough for a person to notice any of the symptoms of DM. (90-95% of cases)
- Gestational Diabetes (not discussed in this presentation)

Type 2 Diabetes

- With T2DM, during this undetected and asymptomatic period of disease, individuals are at risk of developing microvascular and macrovascular complications of diabetes, including visual impairment and blindness, hypertension, renal failure, heart disease, and stroke.

We Still Need to Educate on Glucose Control (AOA EB-CPG)

EVIDENCE-BASED ACTION STATEMENT: Individuals with diabetes should be educated about the long-term benefits of glucose control in reducing the risk of onset and progression of diabetic retinopathy.[11,118-121]

Evidence Quality: Grade A. Randomized Clinical Trials, Cohort-prospective Study

Level of Confidence: High

Clinical Recommendation Strength: Strong Recommendation. This recommendation should be followed unless clear and compelling rationale for an alternative approach is present.

Evidence Statements: A slowing of diabetic retinopathy by intensive treatment of glycemia was observed in persons with type 2 diabetes and cardiovascular disease or cardiovascular risk factors and hyperlipidemia in the Action to Control Cardiovascular Risk in Diabetes (ACCORD) Study.[120] (Evidence Grade: A)

Intensive glycemic control in individuals with type 1 diabetes in the Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications (DCCT/EDIC) Study was associated with a substantial reduction in long-term risk of ocular surgery.[118] (Evidence Grade: A)

Although intensive glucose control did not significantly reduce the incidence and progression of retinopathy in the Action in Diabetes and Vascular Disease: Preterax and Diamicron MR Controlled Evaluation (ADVANCE) Retinal Measurements Study of persons with type 2 diabetes, consistent trends towards a benefit were observed, with significant reductions in some lesions observed.[121] (Evidence Grade: A)

A follow-up study of individuals with type 2 diabetes in the United Kingdom Prospective Diabetes Study (UKPDS) who received intensive glucose therapy had a lower risk of microvascular complications than did those receiving conventional dietary therapy.[11] (Evidence Grade: B)

Intensive glycemic control (<6.5 A1C) with multiple insulin injection therapy was found to effectively delay the onset and progression of diabetic retinopathy in a clinical trial of Japanese patients with type 2 diabetes.[119] (Evidence Grade: B)

(AOA, 2019)

Diabetic Retinopathy

- Diabetic retinopathy, the most common microvascular complication of diabetes, is a leading cause of new cases of vision impairment (including blindness) among people 20 to 74 years of age in the United States and many developed countries.

How Do We Save Vision?

- Intensive treatment to maintain blood glucose concentrations close to the normal range has been shown to reduce the risk of development of DR and decrease the risk of its progression in persons with type 1 or type 2 DM.
- In addition, early intensive glycemic control appears to have a lasting protective effect on diabetic retinopathy progression and severity due to "metabolic memory."

What Can We Control?

Blood Pressure Control (AOA EB-CPG)

EVIDENCE-BASED ACTION STATEMENT: Persons with diabetes should be educated about the potential benefits of blood pressure control in reducing the risk for development or progression of diabetic retinopathy.[57,130,139-141]

Evidence Quality: Grade B. Systematic Review, Randomized Clinical Trial, Cohort-prospective Studies.

Level of Confidence: Medium

Clinical Recommendation Strength: Strong Recommendation. This recommendation should be followed unless clear and compelling rationale for an alternative approach is present.

Evidence Statements: In the United Kingdom Prospective Diabetes Study (UKPDS) of patients with hypertension and type 2 diabetes, tight blood pressure control (<150/85 mm/Hg) had a 34 percent reduction in risk in the proportion of patients with deterioration of retinopathy by two steps and a 47 percent reduced risk of deterioration in visual acuity by three lines of the Early Treatment of Diabetic Retinopathy Study chart.[57] (Evidence Grade: A)

The Wisconsin Epidemiologic Study of Diabetic Retinopathy showed that elevated blood pressure is directly related to the progression of diabetic retinopathy[139] (Evidence Grade: B) and the development of diabetic macular edema in persons with type 1 diabetes mellitus.[140] (Evidence Grade: B)

Among persons with type 2 diabetes, blood pressure lowering is associated with improved mortality and other clinical outcomes, including a reduced risk of retinopathy.[130] (Evidence Grade: B)

Evidence from a systematic review of 15 clinical trials supports lowering blood pressure to prevent diabetic retinopathy for up to four or five years in persons with type 1 or type 2 diabetes mellitus, but not to slow its progression.[141] (Evidence Grade: B)

(AOA, 2019)

Lipid Control (AOA EB-CPG)

EVIDENCE-BASED ACTION STATEMENT: Individuals with diabetes should be educated about the long-term benefits of optimizing lipid control in reducing the risk for progression of diabetic retinopathy.[54,125,146,147,149]

Evidence Quality: Grade B. Randomized Clinical Trials, Cohort-prospective Study, Cohort-retrospective Study

Level of Confidence: High

Clinical Recommendation Strength: Strong Recommendation. This recommendation should be followed unless clear and compelling rationale for an alternative approach is present.

Evidence Statements: Intensive treatment of dyslipidemia using a combination of simvastatin and fenofibrate, along with intensive glucose control, has been shown to slow the rate of progression of diabetic retinopathy in type 2 diabetes mellitus.[125] (Evidence Grade: A)

The Fenofibrate Intervention and Event Lowering in Diabetes (FIELD) Study reported that patients treated with fenofibrate had statistically significant reduction in the need for laser treatment for maculopathy and proliferative retinopathy.[149] (Evidence Grade: A)

In a study of Taiwanese patients with type 2 diabetes and dyslipidemia, those taking statins had a lower rate of diabetic retinopathy and the need for treatment of vision-threatening diabetic retinopathy than those not taking statins. The benefits were reported to increase as the statin intensity and patient adherence increased.[146] (Evidence Grade: B)

Observational data from the Early Treatment Diabetic Retinopathy Study (ETDRS) suggest that lipid lowering may decrease the risk of hard exudate formation and associated vision loss in patients with diabetic retinopathy.[54] (Evidence Grade: B)

Lipid-lowering therapy with statins protected against the development of diabetic macular edema and progression of diabetic retinopathy in patients with type 2 diabetes.[147] (Evidence Grade: D)

(AOA, 2019)

Diet and Physical Activity to Prevent Diabetes (AOA EB-CPG)

EVIDENCE-BASED ACTION STATEMENT: Individuals should be made aware of the effectiveness of diet and physical activity programs in delaying the onset or preventing type 2 diabetes.[110,112]
Evidence Quality: Grade A. Systematic Review, Randomized Clinical Trial **Level of Confidence:** High **Clinical Recommendation Strength:** Strong Recommendation. This recommendation should be followed unless clear and compelling rationale for an alternative approach is present.
Evidence Statements: Combined diet and physical activity programs and the use of insulin-sensitizing medications have been shown to achieve the largest diabetes risk reductions.[110] (Evidence Grade: A) The long-term reduction in diabetes development with preventative lifestyle intervention can be substantial.[112] (Evidence Grade: A)

(AOA, 2019)

Physical Exercise to Prevent the Ocular Effects of Diabetes (AOA EB-CPG)

EVIDENCE-BASED ACTION STATEMENT: Patients should be counseled about the benefits of physical exercise in delaying or reducing the ocular effects of diabetes.[157,159-161]
Evidence Quality: Grade C. Systematic Review, Cross-sectional Studies **Level of Confidence:** Low **Clinical Recommendation Strength:** Discretional. There should be an awareness of this recommendation, but a flexibility in clinical decision-making, as well as remaining alert for new information.
Evidence Statements: A meta-analysis of clinical trials on the association between walking and glycemic control found that walking decreases A1C among patients with type 2 diabetes.[159] (Evidence Grade: A) Women who engage in more physical activity have reduced odds of developing advanced diabetic retinopathy, while men demonstrate a non-significant association in the same direction.[161] (Evidence Grade: C) Increased physical activity is associated with less severe levels of diabetic retinopathy, independent of the effects of A1C or body mass index (BMI).[157] (Evidence Grade: D) Higher levels of physical activity have been associated with reduced signs of retinal microvascular disease.[160] (Evidence Grade: D)

Potential Benefits: Reduced risk of development or progression of diabetic retinopathy	**Potential Risks/Harms:** None

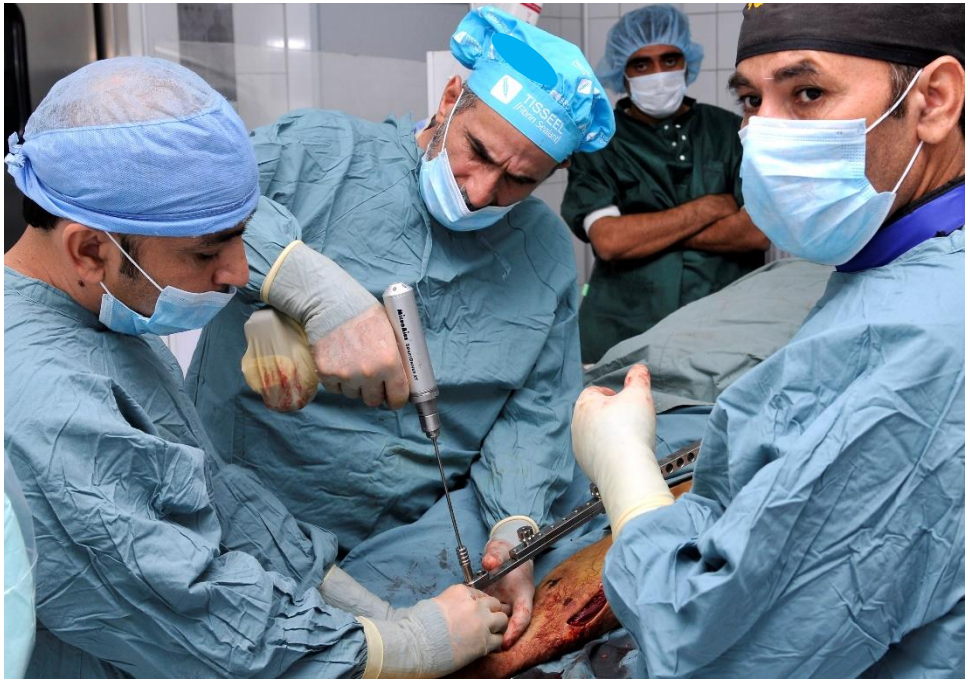
(AOA, 2019)

Why Is Diabetes Mellitus Bad for the Eyes?

Can I Make a Difference?

The Carpenter

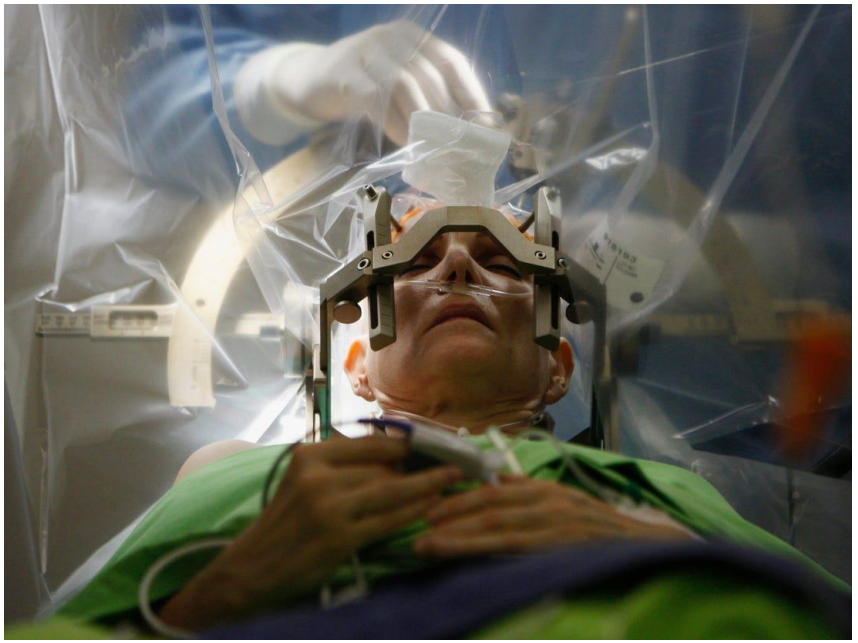
https://www.dvidshub.net/image/213549/construction



https://www.dvidshub.net/image/456307/rsc-north-others-provide-operating-room-support-ana-medical-personnel-leg-surgery

The Electrician

https://www.dvidshub.net/image/1072569/electricians-mate-em



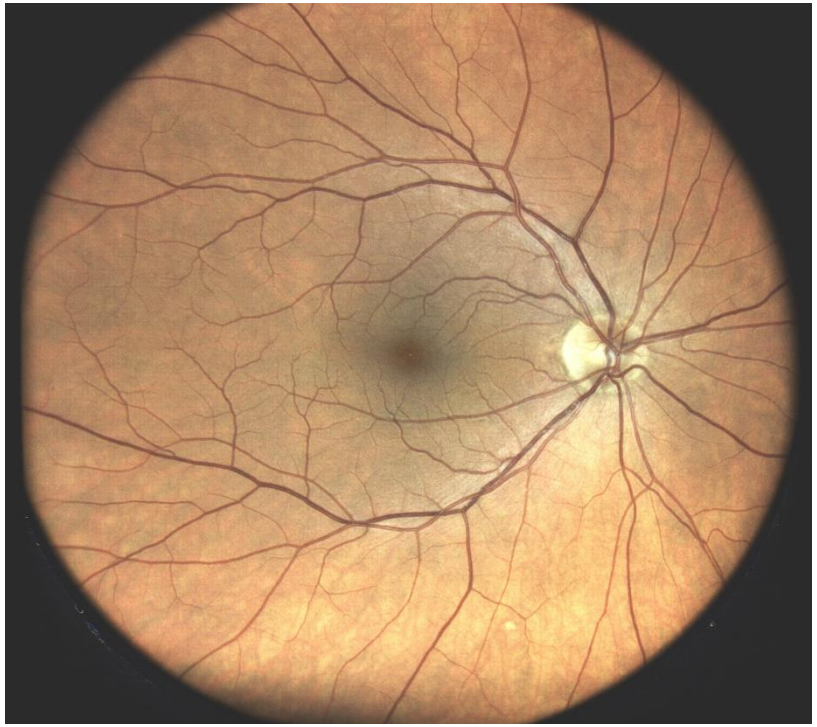
https://www.businessinsider.com/national-geographic-brain-surgery-show-2015-11

The Plumber

https://www.dvidshub.net/image/126269/did-someone-call-plumber

The Plumber and The Electrician

https://www.dvidshub.net/image/4459547/6th-mdg

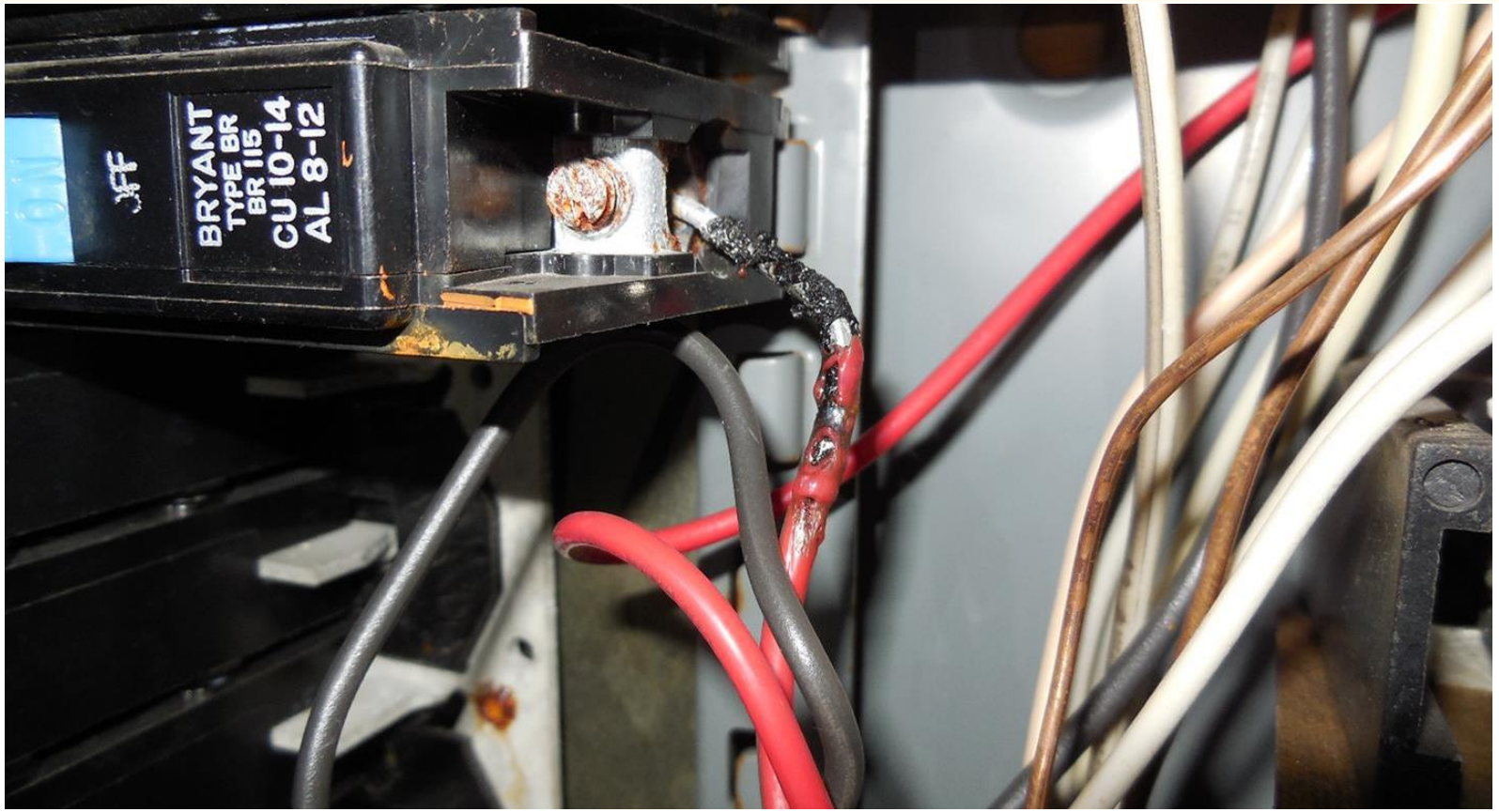


https://www.eyestore.cz/eidon-fundus-kamera

Let's Go To Submarine School

"Medically Ready Force…Ready Medical Force"

Burnt and Stripped Wires are BAD!



https://structuretech1.com/aluminum-wiring-2/

If You Have Damaged Wires, The Electricity Doesn't Get There

https://untappedcities.com/2019/07/15/watch-the-2019-nyc-blackout-in-a-time-lapse-video/

Leaky Pipes and Hoses are BAD!

https://www.dvidshub.net/image/229875/damage-control-wet-trainer

https://www.dvidshub.net/image/3870637/damage-control-training-sub-school

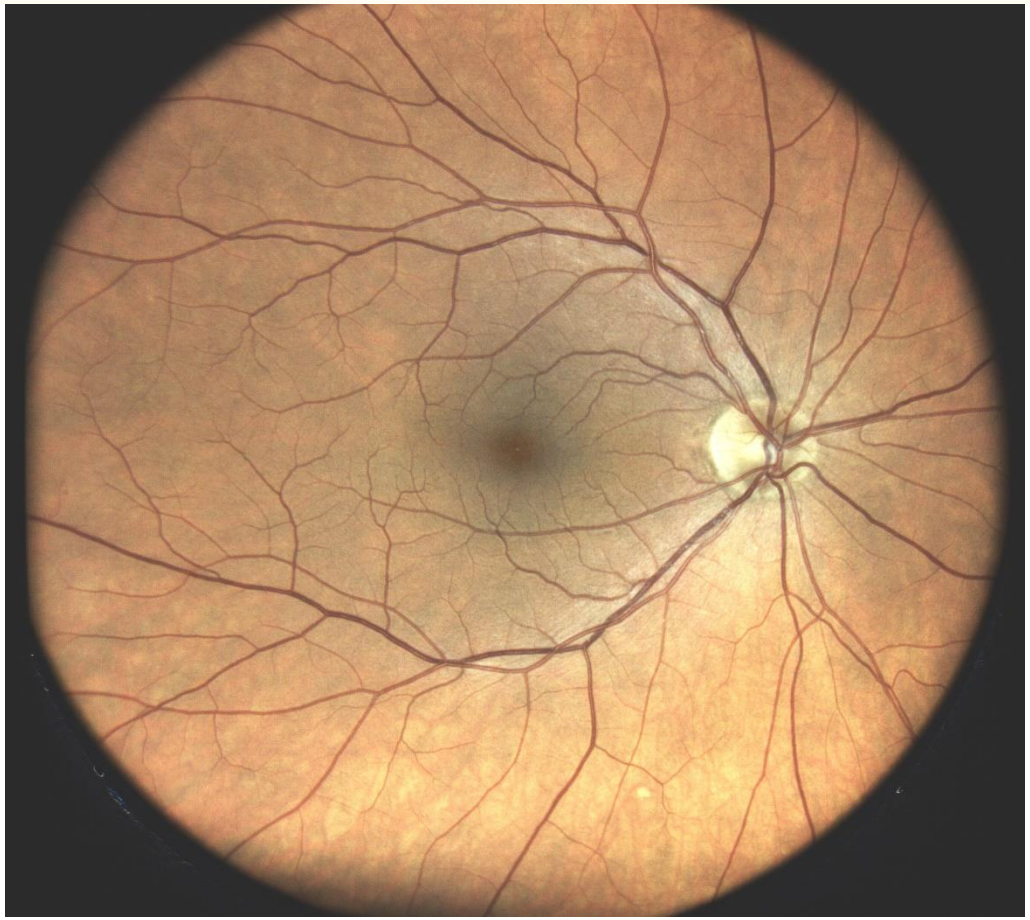
If You Have a Leaky Hose, No Water Gets to Where it Needs to Go

https://www.dvidshub.net/image/46323/firefighting-drill

What Does DM Do to the Eye?

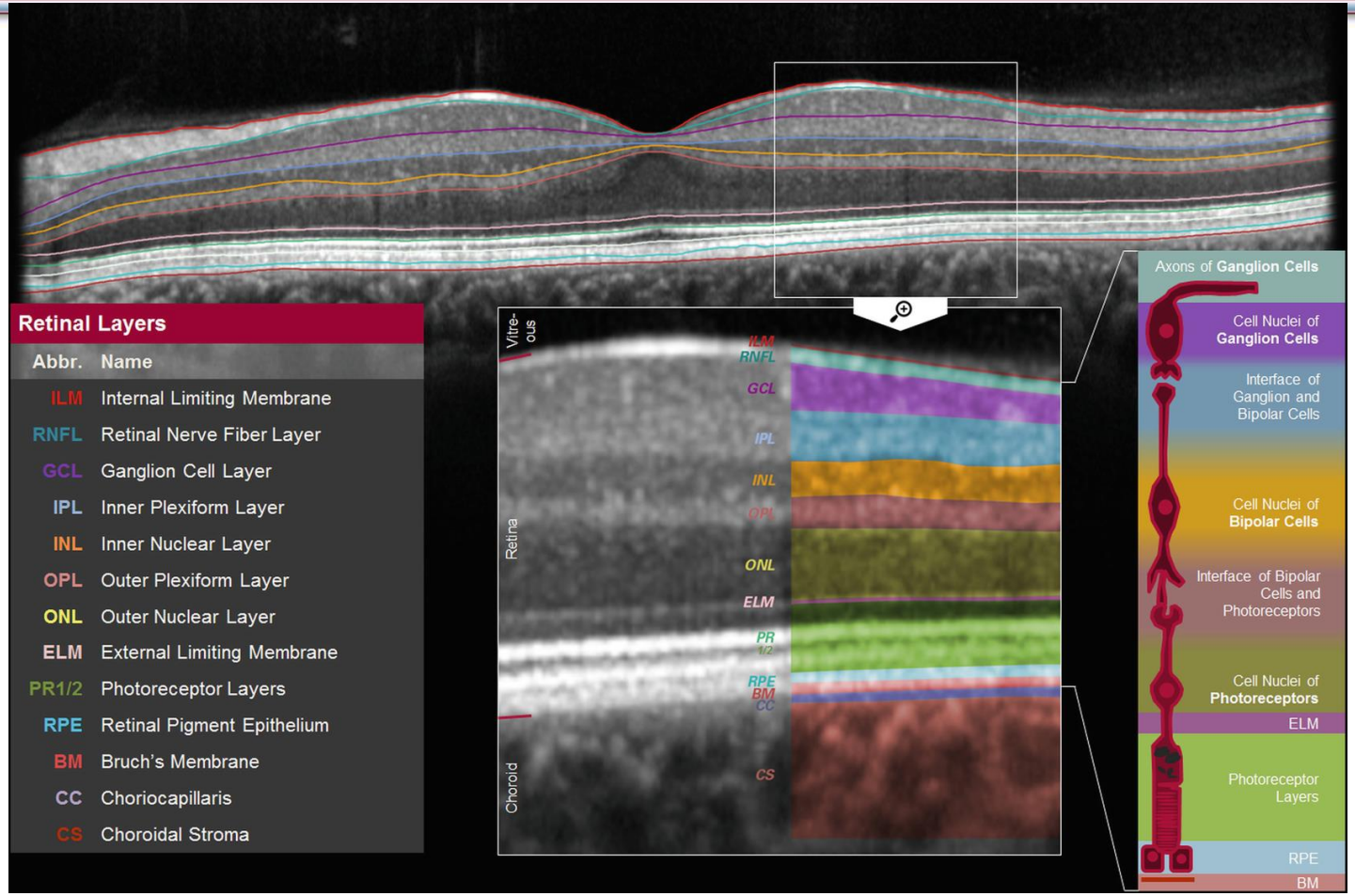
- DM is a disease that interrupts the normal flow of blood to the retinal tissue and can ultimately damage the optic nerve. The optic nerve is in charge of carrying electrical visual signals to the brain.
- If our retina is not working or the nerve is not working, we cannot see.

What Does a Normal Retina Look Like? Fundus



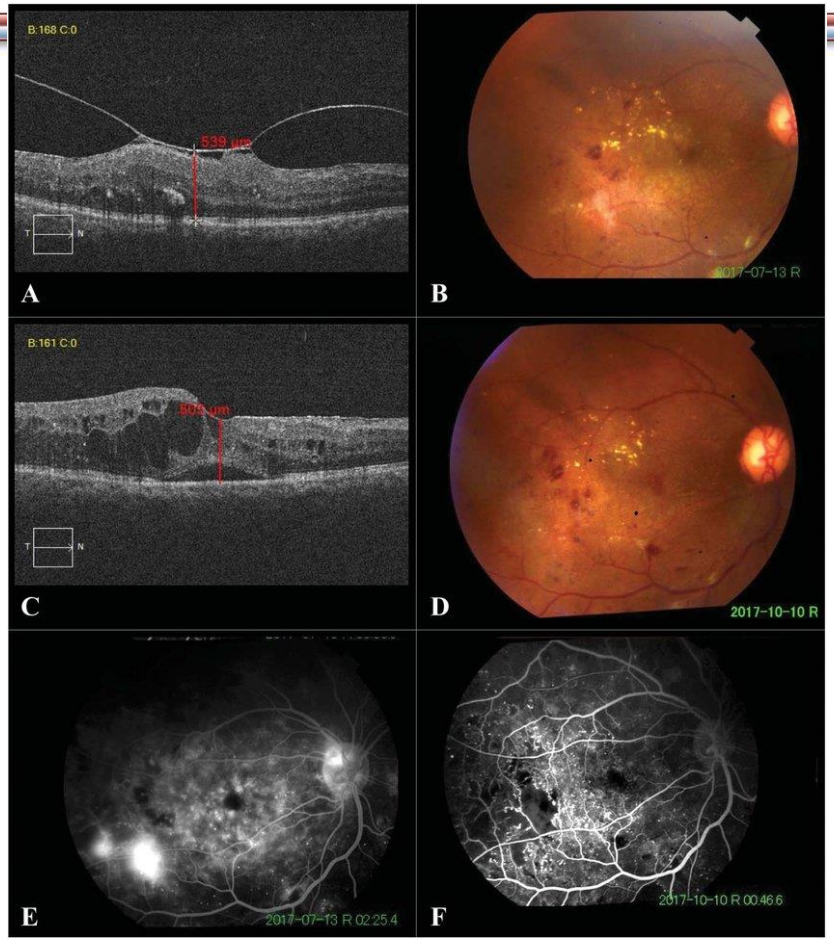
https://www.eyestore.cz/eidon-fundus-kamera

What Does a Normal Retina Look Like? Optical Coherence Tomography (OCT)



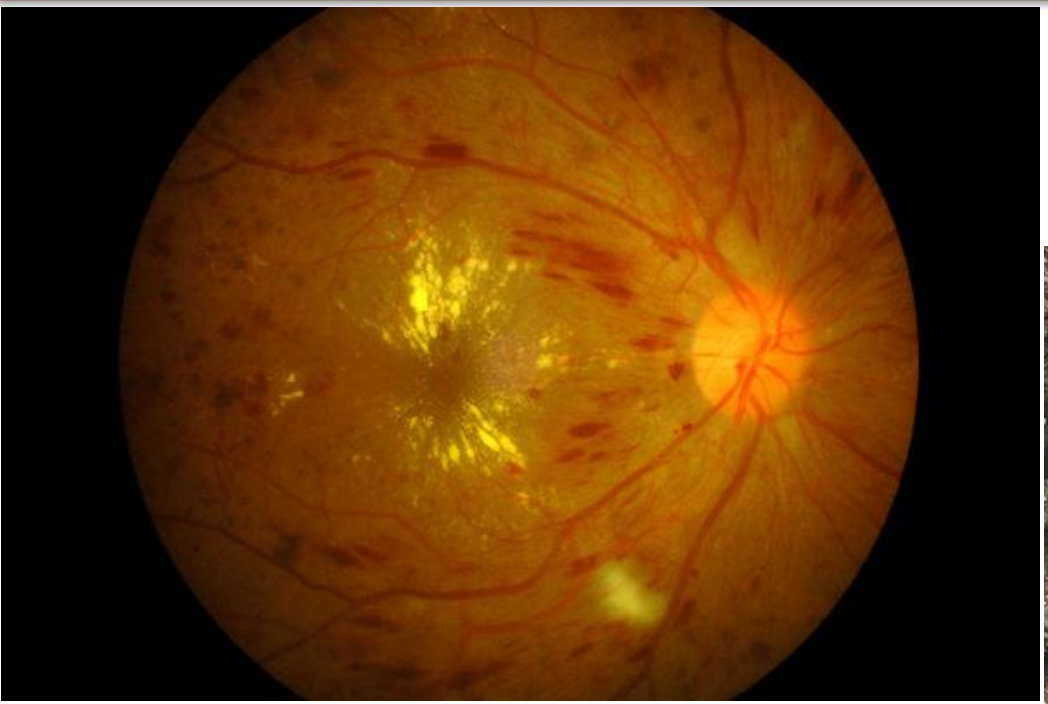
https://link.springer.com/chapter/10.1007/978-3-030-16638-0_3

Diabetic Retinopathy
Fundus and Corresponding OCT



https://www.researchgate.net/figure/Proliferative-diabetic-retinopathy-with-diabetic-macular-edema-and-vitreomacular_fig2_328534930

Diabetic Retina



https://seeclearkalamazoo.com/services/diabetic-eye-care/diabetic-retinopathy/

https://fortsaskonline.com/local/bruderheim-thankful-for-collaborative-effort-after-water-main-break

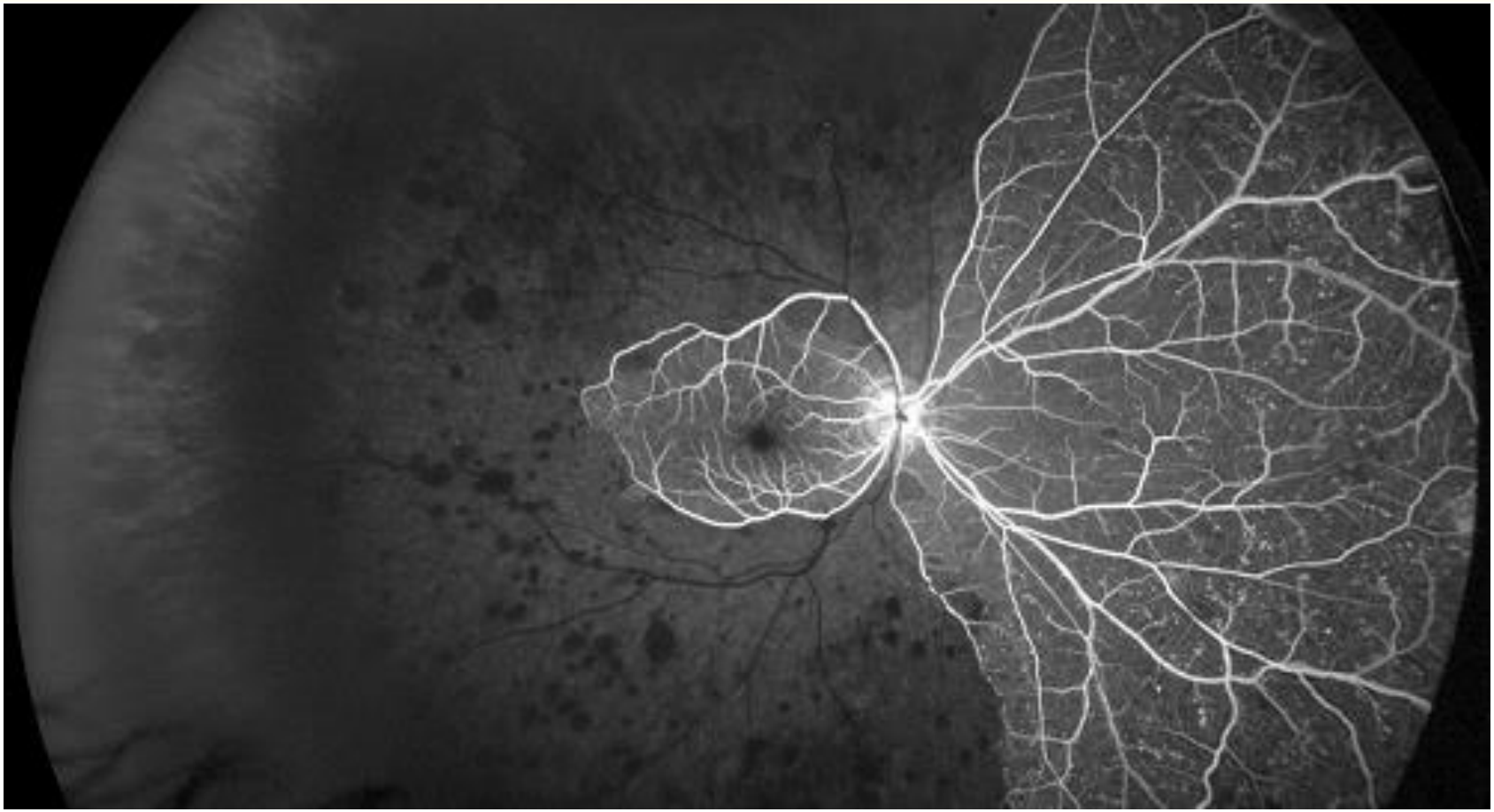
What Happens if the Water Does Not Reach the Intended Target?

https://ask.extension.org/questions/324402

What Grows In Its Place? Weeds!

https://thecultivator.net/tag/spring-weeds-2/

Non-Perfused Retinal Tissue



https://www.optos.com/image-types/fluoroscein-angiography/

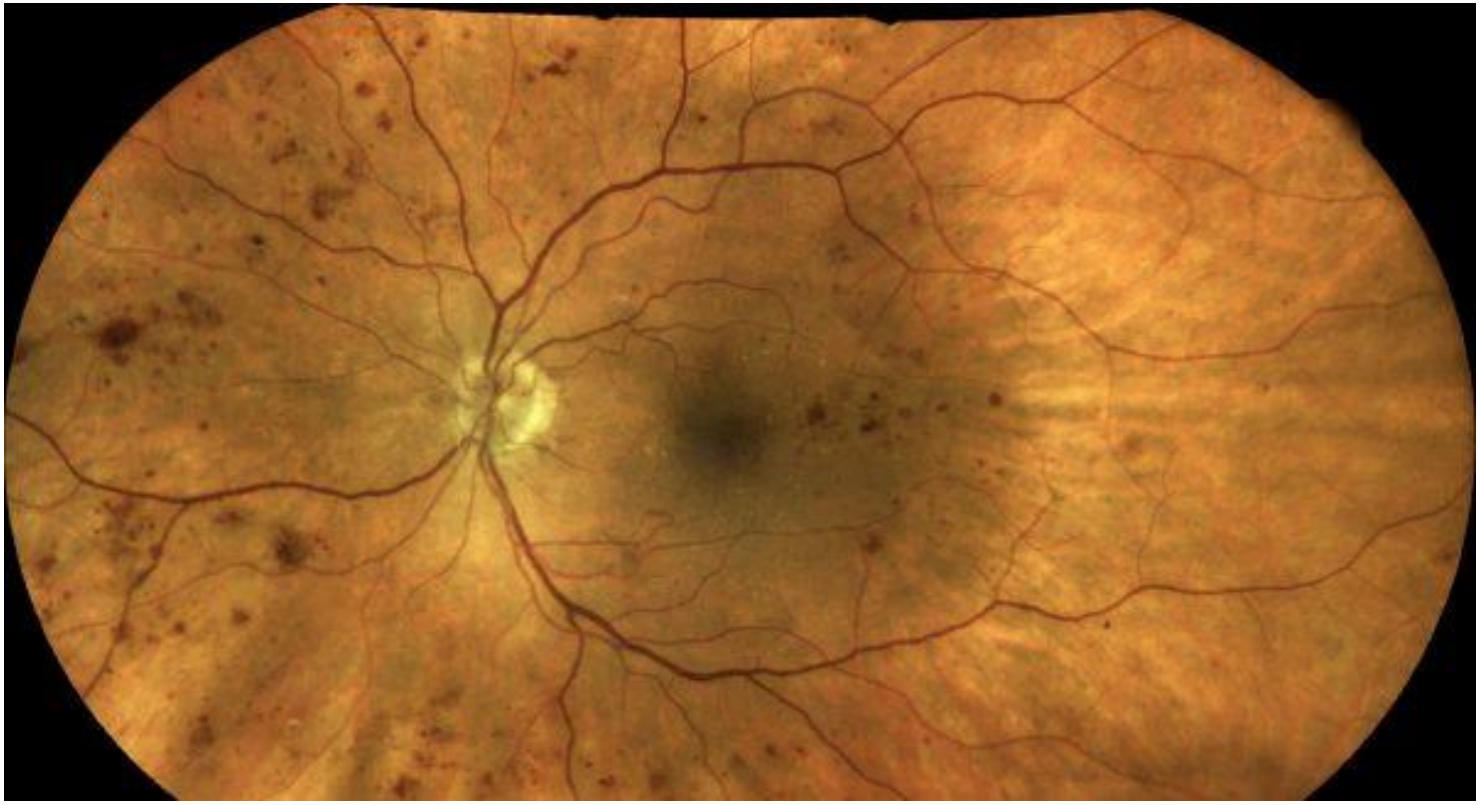
Types of Diabetic Retinopathy

- Non-Proliferative
- Proliferative

Classification and Signs of Non-Proliferative Diabetic Retinopathy

- Retinal blood flow alteration
- Saccular outpouchings of retinal capillaries aka “Microaneurysms” – loss of intramural pericytes
  - ❑ Earliest sign of DR
- Retinal hemorrhages from leaking microaneurysms
  - ❑ Pinpoint, dot or blot shape hemorrhages
- Intraretinal microvascular abnormalities (IRMA)
  - ❑ New vessel growth within the retina
  - ❑ Pre-existing vessels with endothelial cell proliferation
  - ❑ Shunts through areas of non-perfusion
  - ❑ Indicated severe ischemia
  - ❑ Neovascularization on surface of retina and/or disc in a short time

Non-Proliferative Diabetic Retinopathy



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Non-Proliferative Diabetic Retinopathy (AOA EB-CPG)

Defense Health Agency

Mild NPDR

Mild NPDR is marked by at least one retinal microaneurysm. Only H/Ma are present and the severity of H/Ma is less than that depicted in ETDRS standard photograph 2A.[32,45,47]

No other more severe retinal lesions or abnormalities associated with diabetes are present.

Moderate NPDR

Moderate NPDR is characterized by H/Ma greater than that depicted in ETDRS standard photograph 2A in one to three retinal quadrants or soft exudates, VB, and IRMAs may be present to a mild degree.[45,47]

Severe NPDR

Severe NPDR is based on the extent and severity of H/Ma, VB and IRMA, and is characterized by any one of the following lesions:

- H/Ma ≥ETDRS standard photograph 2A in **four** retinal quadrants
- Definite VB in **two** or more retinal quadrants
- Prominent IRMA (≥ETDRS standard photograph 8A) in at least **one** quadrant.[45,47]

Clinical note: *This* ***"4-2-1"*** *rule is an important clinical tool for determining the risk of progressing to PDR, as eyes with severe NPDR have a greater than 50 percent risk of developing PDR in one year.*

Very Severe NPDR

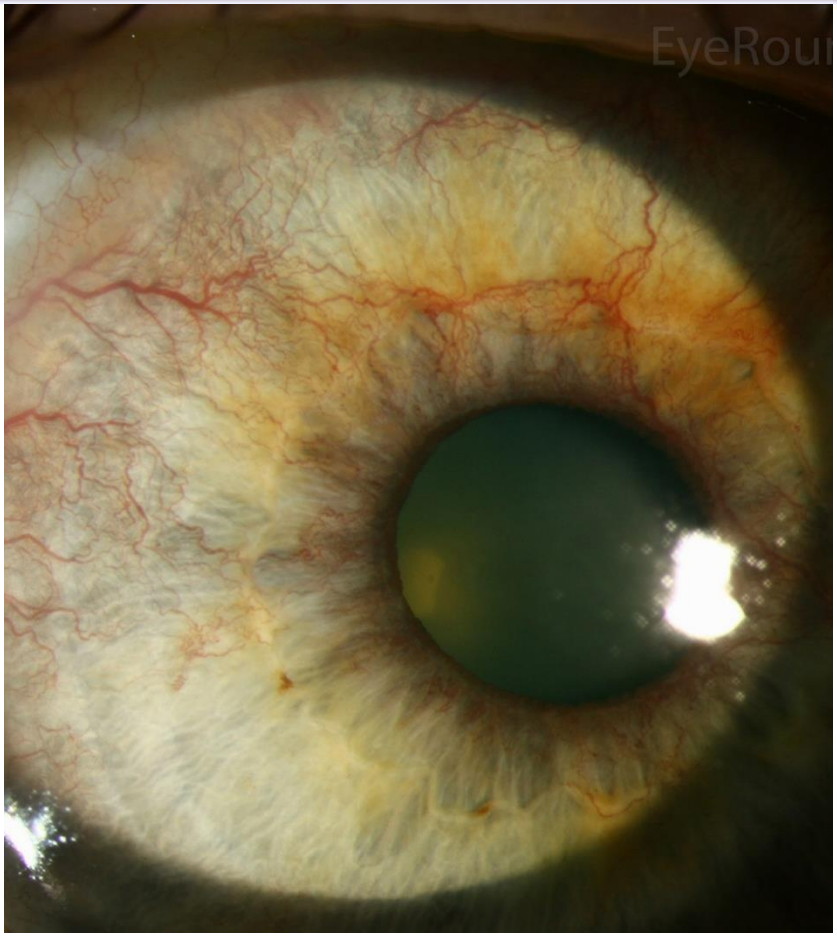
In very severe NPDR, two or more criteria for severe NPDR are met, in the absence of frank neovascularization. Eyes with very severe NPDR have an over 75 percent risk of developing PDR in one year.

(AOA, 2019)

Classification and Signs of Proliferative Diabetic Retinopathy

- Venous caliber abnormalities
  - Indicators of severe retinal hypoxia
  - Venous dilation, venous beading or loop formation
  - Substantial risk for progression to proliferative DR
- New vessels (neovascularization)
  - At or near the optic disc
  - Elsewhere in the retina
  - Increased risk of vision loss due to vitreous hemorrhage or retinal detachment

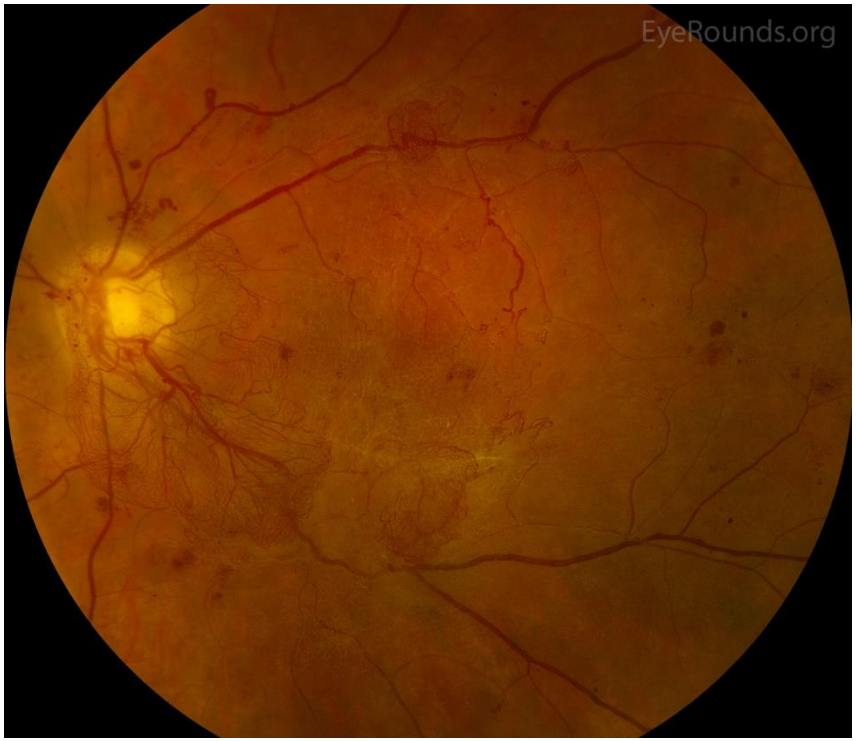
Proliferative Diabetic Retinopathy (PDR)



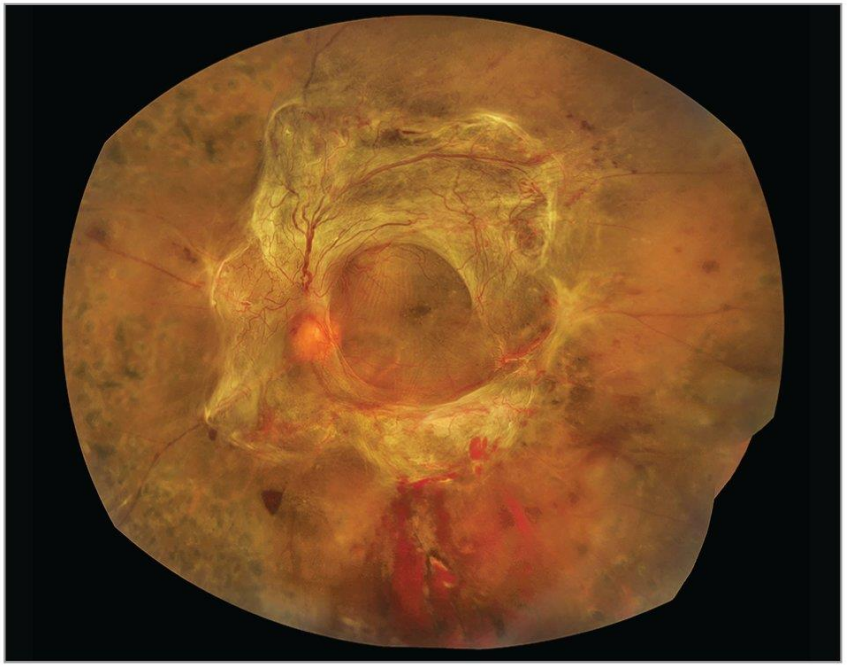
http://www.eyerounds.org/atlas/pages/NVI/index.htm

- Proliferative DR
  - Neovascularization of the disc or elsewhere
- High-Risk PDR
  - Presence of at least 3 of the 4 risk factors for severe vision loss from diabetic retinopathy
    - Presence of pre-retinal or vitreous hemorrhage
    - Presence of new vessels
    - Presence of new vessels on or near the disc
    - Presence of moderate or severe new vessels (NV ≥ standard photograph 10A or NVE ≥1/2 disc area

Proliferative Diabetic Retinopathy

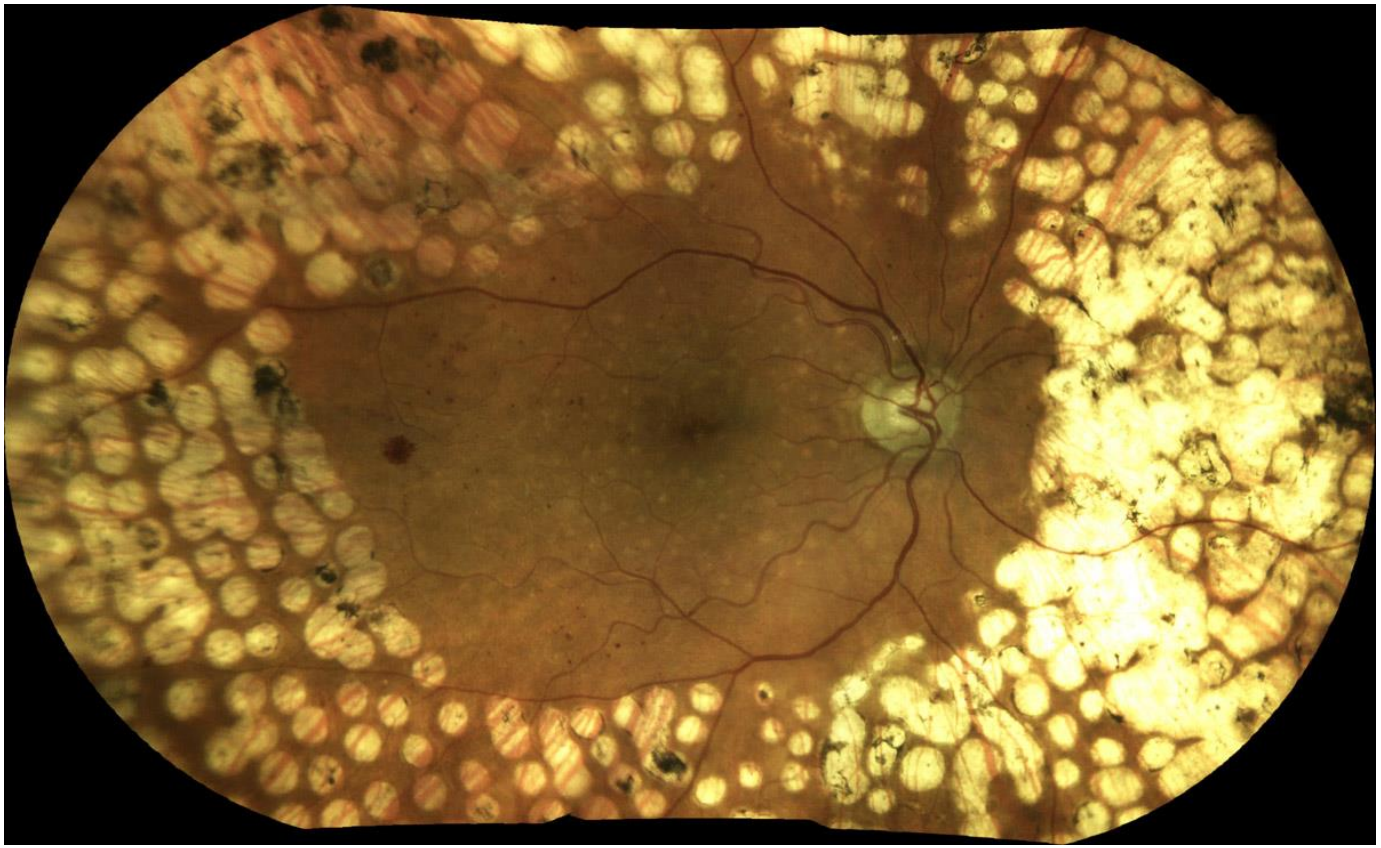


https://webeye.ophth.uiowa.edu/eyeforum/atlas/pages/proliferative-diabetic-retinopathy/index.htm



Li DQ, Choudhry N. Tractional Retinal Detachment Secondary to Diabetic Retinopathy. *JAMA Ophthalmol.*2018;136(10):e183507. doi:10.1001/jamaophthalmol.2018.3507

Laser Treatment for Diabetic Retinopathy



https://www.centervue.com/products/eidon/30-caso-11-re/

Diabetic Macular Edema (DME)

- Retinal complication in addition to DR
- Collection of intraretinal fluid in the macular area with or without lipid exudates or cystoid changes
- Affected visual acuity
- *Focal Macular Edema*
  - Circinate rings of hard exudate resulting in leakage from MA that lead to edema
- *Diffuse Macular Edema*
  - More extensive breakdown of the blood-retinal barrier with leakage from MA and retinal capillaries

Early Treatment for Diabetic Retinopathy Study (EDTRS)

- Multicenter, Randomized Controlled Clinical Trial
- Study Start Date: December 1979
  - To evaluate the effectiveness of both argon laser photocoagulation and aspirin therapy in delaying or preventing progression of early diabetic retinopathy to more severe stages of visual loss and blindness.
  - To help determine the best time to initiate photocoagulation treatment in diabetic retinopathy.
  - To monitor closely the effects of diabetes mellitus and of photocoagulation on visual function.
  - To produce natural history data that can be used to identify risk factors and test etiologic hypotheses in diabetic retinopathy.

EDTRS Clinically Significant Macular Edema (AOA EB-CPG)

The term clinically significant macular edema (CSME) was introduced in the ETDRS to signify an increased risk for moderate visual loss, defined as doubling of the visual angle (e.g., from 20/40 to 20/80).[38] To be classified as CSME, one or more of the following criteria must be present:

- Thickening of the retina ≤500 microns (1/3 DD) from the center of the macula
- Hard exudates ≤500 microns (1/3 DD) from the center of the macula with thickening of the adjacent retina
- A zone or zones of retinal thickening ≥1 disc area (DA) in size, any portion of which is ≤1 DD from the center of the macula.[41]

Diabetic macular edema can be further classified as:

- Non-central-involved – retinal thickening in the macula that does not involve the center subfield zone that is 1mm in diameter
- Central-involved – retinal thickening in the macula that does involve the central subfield zone.

(AOA, 2019)

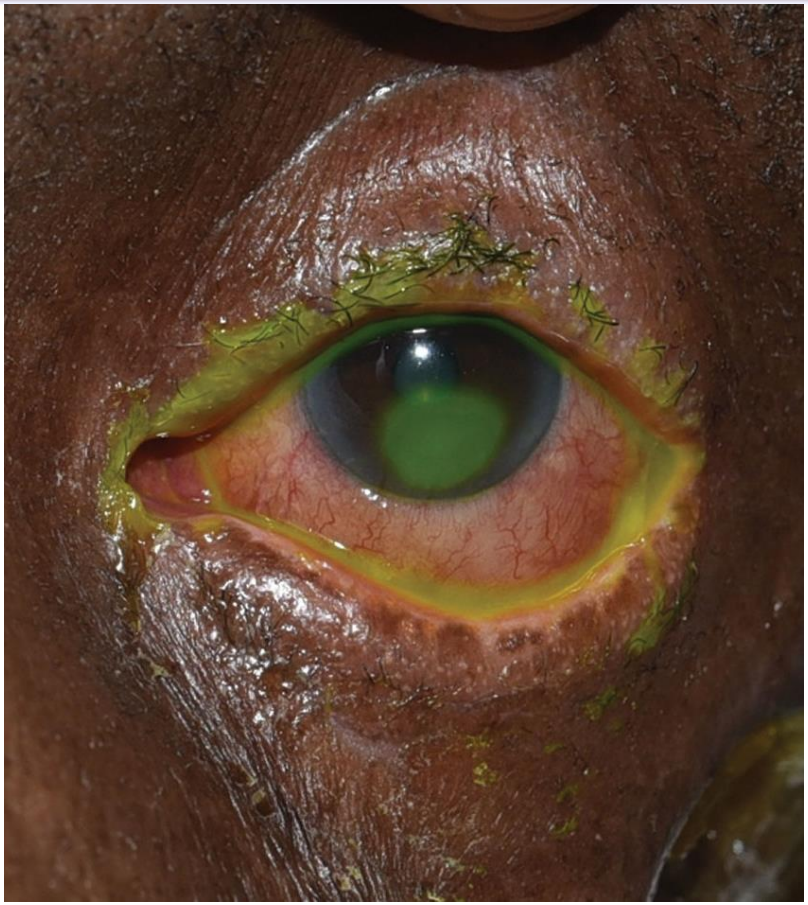
What is Leaking?

- Blood
- Exudate
- Increased vascular permeability is a hallmark of DME. In human eyes with DR, *hypoxia causes upregulation of vascular endothelial growth factor (VEGF) production*, and leads to retinal capillary hyperpermeability

Non-Retinal Ocular Complications

- Visual Function
  - ❑ Loss of visual acuity
  - ❑ Refractive error shifts
  - ❑ Changes in color vision
  - ❑ Accommodative dysfunction
  - ❑ Visual field changes
  - ❑ Contrast sensitivity loss

Non-Retinal Ocular Complications

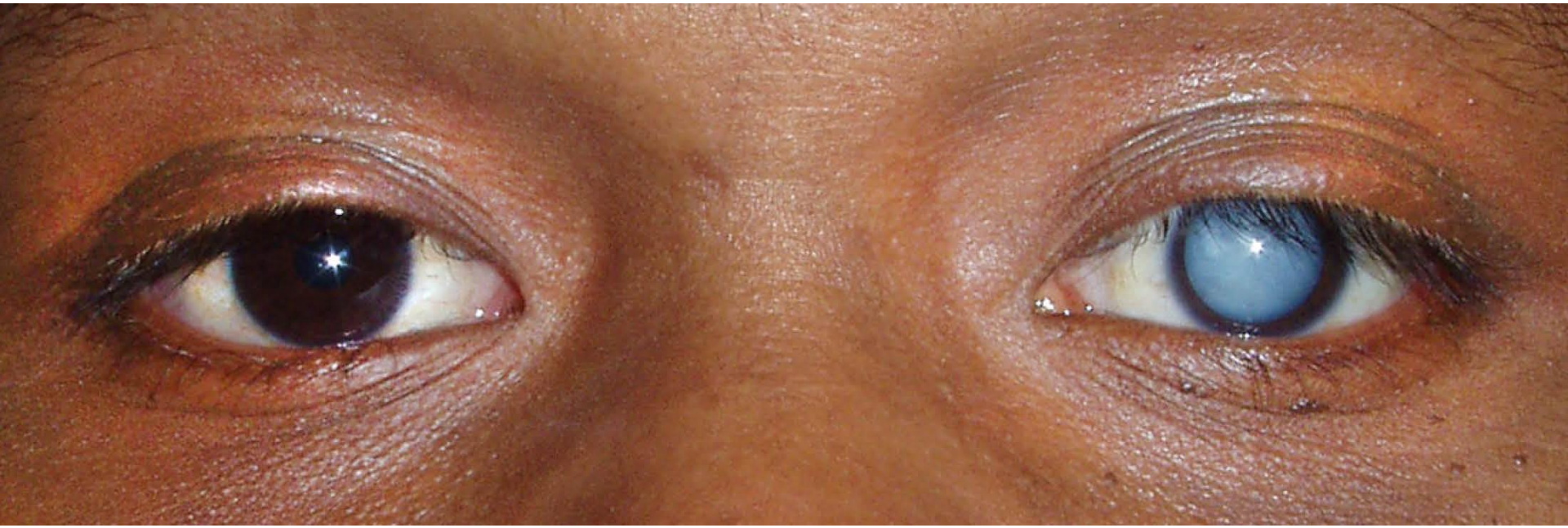


https://www.reviewofoptometry.com/article/when-corneal-wounds-wont-heal

- Ocular motility
- Pupillary reflexes
- Conjunctiva
- Tear film
- Corneal wound healing/reduced sensitivity
  - Delayed, recurrent and non-resolving erosions / neurotrophic keratitis
  - Increased risk of infection including post surgery
- Iris
  - Depigmentation
  - Neovascularization
  - Neovascular glaucoma

Cataracts

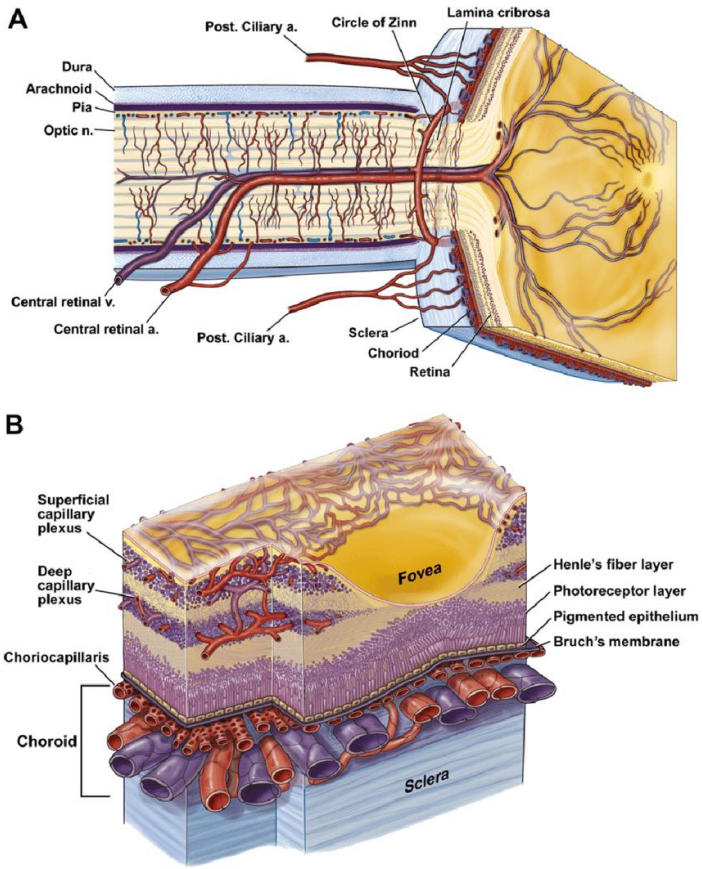
- Cataracts
  - 2-5 times more likely to develop cataracts
  - Development of cataracts at younger ages



https://www.seeintl.org/cataracts/

Glaucoma

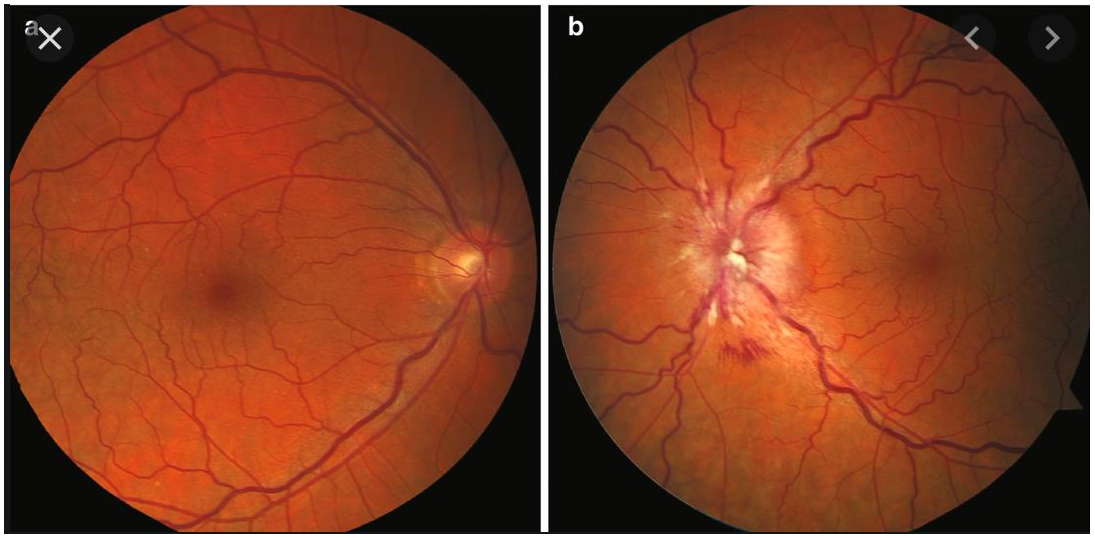
- Open Angle Glaucoma
  - Doubles the risk of developing the most common form of glaucoma



https://www.researchgate.net/figure/Anatomy-of-ocular-circulation-a-artery-b-vein-n-nerve-A-Cut-away-drawing-along-the_fig17_224949360/download

Optic Disc

- Pallor
- Papillopathy
- Ischemic optic neuropathy



https://link.springer.com/chapter/10.1007/978-3-030-10886-1_36

Referral for Advanced Treatment (AOA EB-CPG)

EVIDENCE-BASED ACTION STATEMENT: Patients with severe or very severe nonproliferative diabetic retinopathy, early proliferative diabetic retinopathy with risk of progression, or high-risk proliferative diabetic retinopathy should be referred to an ophthalmologist experienced in the management of diabetic retinal disease for possible panretinal photocoagulation (PRP)[44] or intravitreous anti-VEGF treatment.[73,76]
Evidence Quality: Grade A. Randomized Clinical Trials **Level of Confidence:** High **Clinical Recommendation Strength:** Strong Recommendation. This recommendation should be followed unless clear and compelling rationale for an alternative approach is present.
Evidence Statements: When high-risk proliferative diabetic retinopathy is present, panretinal (scatter) photocoagulation[44] (Evidence Grade: A) or intravitreous anti-VEGF agents[73,76] should be considered and should not be delayed.

Potential Benefits: Preservation of vision	**Potential Risks/Harms:** Complications from laser treatment or intravitreous injections
Benefit and Harm Assessment: Benefits significantly outweigh harms	

(AOA, 2019)

Laser Treatments

- Laser Photogoagulation
  - Panretinal (scatter Photocoagulation)
  - Regression of retinal neovascularization
- Pattern Scan Laser (Pascal)
  - More targeted retinal laser photocoagulation
  - Spares better perfused tissue
- Subthreshold diode micropulse
  - Minimizes negative thermal effects
  - Confined energy

DME and VEGF/anti-VEGF

- Increased vascular permeability is a hallmark of DME.
- In human eyes with DR, hypoxia causes upregulation of vascular endothelial growth factor (VEGF) production, and leads to retinal capillary hyperpermeability

Kulkarni AD, Ip MS. Diabetic macular edema: therapeutic options. *Diabetes Ther*. 2012;3(1):1-14. doi:10.1007/s13300-012-0002-y

Anti-VEGF Treatments (AOA EB-CPG)

EVIDENCE-BASED ACTION STATEMENT: Anti-vascular endothelial growth factor (anti-VEGF) agents should be considered as a treatment alternative or adjunct to panretinal photocoagulation (PRP) in the management of proliferative diabetic retinopathy (PDR), with or without diabetic macular edema (DME).[73,76,78,79,308-310]

Evidence Quality: Grade A. Randomized Clinical Trials

Level of Confidence: High

Clinical Recommendation Strength: Strong Recommendation. This recommendation should be followed unless clear and compelling rationale for an alternative approach is present.

EVIDENCE-BASED ACTION STATEMENT: Patients with central-involved diabetic macular edema (DME) should be referred to an ophthalmologist experienced in the management of diabetic retinal disease for treatment with anti-VEGF agents and/or subsequent or deferred focal/grid macular laser therapy.[65,69,71,72,74,75,77,82,298,300,311,313-317,319-324,327,329]

Evidence Quality: Grade A. Randomized Clinical Trials, Systematic Reviews, Cohort-prospective Studies, Cohort-retrospective Study, Case Series

Level of Confidence: High

Clinical Recommendation Strength: Strong Recommendation. This recommendation should be followed unless clear and compelling rationale for an alternative approach is present.

(AOA, 2019)

Injectable and Intraocular Treatments

- Intravitreous steroids and Intraocular sustained release corticosteroid
- Intravitreous anti-VEGF (Vascular Endothelial Growth Factor)
  - Standard of care in patients with central involved DME especially if visual acuity is reduced
  - Repeat injections required

The most commonly used anti-VEGF agents for DME are:

- Ranibizumab (Lucentis®) is FDA approved for treatment of wet age-related macular degeneration, retinal vein occlusion, and diabetic retinopathy with or without DME.
- Aflibercept (Eylea®) is FDA approved for the treatment of wet age-related macular degeneration, central retinal vein occlusion, and DME.
- Bevacizumab (Avastin®) is FDA approved for treatment of cancer and its systemic use is known to be associated with an increased risk of stroke. It is unknown if a substantially smaller dose, when used intravitreally, has any significant systemic toxicity.[299] It has been used off-label for the treatment of DME.

Repeated intravitreous administration of anti-VEGF agents has been shown to be more effective than conventional focal/grid laser alone in the treatment of central-involved DME. The full benefit of intravitreous injections with prompt or deferred macular laser treatment may not manifest until the second year of treatment.[300] (Evidence Grade: A)

Anti-VEGF Studies (AOA EB-CPG)

TABLE 4
Clinical Studies of Anti-VEGF Agents

Study name / study type	Evidence grade	Background	Results
RESOLVE Study[216] RCT	A	Evaluated the use of RBZ versus a placebo over twelve months for the treatment of central-involved DME.	RBZ led to significant and continuous improvement in both BCVA and central retinal thickness compared with sham treatment in patients with visual impairment due to DME.
READ-2 Study[217,318] RCT	A	Compared the use of RBZ alone to laser therapy alone or RBZ plus laser over two years.	Patients treated with intraocular RBZ and PRP, if needed, and/or a combination of both showed a mean improvement in visual acuity of 7.4 ETDRS letters. A follow-up study using more aggressive treatment with RBZ during year three found continued improvement in best corrected visual acuity with RBZ, but many patients required frequent injections to optimally control edema and maximize vision.
RESTORE Study[219] RCT	A	Conducted a twelve-month randomized trial of RBZ plus macular laser photocoagulation.	Demonstrated the superiority of RBZ monotherapy over standard macular laser photocoagulation in patients with visual impairment due to DME and found no additional benefit of RBZ therapy combined with macular laser therapy.
RESTORE Extension Study[220] Cohort-prospective Study	A	Evaluated the long-term (3 year) efficacy and safety of RBZ treatment in persons with DME.	Reported RBZ was effective in improving and maintaining BCVA and central retinal subfield thickness outcomes and was generally well tolerated, with a progressively declining number of injections over three years of individualized dosing.
RISE and RIDE Studies[321-323] RCT, Cohort-prospective Study	A	Conducted two parallel, identical studies on the efficacy and safety of RBZ in patients with DME.	Showed that RBZ monotherapy provided rapid and sustained results in improving macular edema and BCVA in persons with DME, which was maintained over three years. Initial, intensive therapy with RBZ, followed by observation and maintenance therapy when indicated, was shown to maintain visual and anatomic gains for patients with DME. In addition, patients treated with RBZ experienced fewer complications, such as vitreous hemorrhage, and fewer developed PDR or underwent PRP.
REVEAL Study[324] RCT	A	Evaluated whether the use of RBZ alone or combined with laser was superior to laser therapy alone based on mean change in best corrected visual acuity.	Showed RBZ monotherapy or RBZ combined with laser provided superior BCVA improvements over laser treatment alone in Asian patients with visual impairment resulting from DME.
RETAIN Study[325] RCT	A	Conducted to determine the non-inferiority of RBZ treat-and-extend (incremental increase in treatment intervals for a given patient based on disease progression) with/without laser to RBZ pro re nata (PRN) for best corrected visual acuity in patients with DME.	Concluded that treat-and-extend is a feasible treatment option for patients with DME, with a potential to reduce treatment burden.
BOLT Study[300] RCT	A	Compared intravitreous BVZ to laser therapy alone.	Found mean BCVA to be significantly better in the BVZ group versus laser therapy alone. For persistent central-involved CSME, improvements in central macular thickness were seen with BVZ at one year and were maintained over the second year with a mean of four injections.

Table Continued on next page

(AOA, 2019)

Anti-VEGF Studies (AOA EB-CPG)

TABLE 4 *(Continued)*
Clinical Studies of Anti-VEGF Agents

Study name / study type	Evidence grade	Background	Results
BOLT Study[326,327] RCT	B	Provided a post hoc analysis of patients to assess the factors that may determine the injection frequency at 12 and 24 months.	Good long-term response from treatment with BVZ was predicted based on resolution of macular edema by four months; however, approximately 20 percent of patients with persistent edema at 12 months achieved a dry macula and 50 percent gained more than 15 letters at 24 months with sustained treatment, suggesting that edema at 4 or 12 months should not be used as a stopping criterion for treatment. The overall outcomes of mean change in BCVA and central macular thickness in participants treated with BVZ were comparable to those reported in association with RBZ at 12 and 24 months.
Bevordex Study[328] RCT	B	Evaluated the use of intravitreous BVZ versus intravitreous dexamethasone for central-involved DME.	Twelve-month results found the dexamethasone implant achieved similar rates of visual acuity improvement compared with BVZ for DME, with superior anatomic outcomes and fewer injections. Both treatments were associated with improvement in visual quality-of-life scores; however, more dexamethasone implant-treated eyes lost vision, mainly because of cataract.
DAVINCI Study[329,330] RCT	B	Compared five different aflibercept regimens to laser therapy to determine whether different doses and dosing regimens of intravitreous VEGF Trap-Eye (aflibercept) are superior to focal/grid photocoagulation in eyes with DME.	Intravitreous aflibercept produced a statistically significant and clinically relevant improvement in visual acuity when compared with macular laser photocoagulation in patients with DME. Eyes receiving aflibercept experienced improvements in BCVA compared with laser treatment at 6 months and results were maintained or improved through 12 months.
VISTA and VIVID Studies[331] RCT	A	Assessed the efficacy and safety of aflibercept in treating DME when comparing two dosing regimens of intravitreous aflibercept with macular laser photocoagulation for DME.	Intravitreous aflibercept was associated with significant BCVA gains from baseline over 100 weeks compared with laser treatment. This study indicated the potential for a therapeutic option with a longer injection interval and subsequently a reduced number of injections and monitoring visits.

BCVA – best corrected visual acuity
CSME – clinically significant macular edema
ETDRS – Early Treatment Diabetic Retinopathy Study
PRP – panretinal photocoagulation
RCT – randomized clinical trial
BVZ – bevacizumab
DME – diabetic macular edema
PDR – proliferative diabetic retinopathy
RBZ – ranibizumab

(AOA, 2019)

Surgical Treatment

- Vitrectomy
- Retinal Detachment Repair
- Glaucoma Filtering Surgery

Side Effects and Complications of the Treatment for Diabetic Retinopathy (AAO PPP)

TABLE 6 Side Effects and Complications of Treatment for Diabetic Retinopathy

Treatment	Side Effect/Complication
Focal laser photocoagulation surgery for DME	• Possible transient initial decrease in central vision • Paracentral scotomas if laser burns have been placed close to the fovea, especially large or confluent burns[236] • Permanent central scotoma from inadvertent foveal burns • Expansion of laser scar area (over many years) • Choroidal neovascularization and subretinal fibrosis
Panretinal photocoagulation (scatter) for severe NPDR or PDR	• Transient central vision loss from macular edema[132] • Peripheral visual field constriction with delayed dark adaptation • Vitreous hemorrhage if neovascularization is present • Reduced or compromised accommodation[237] • Pupillary dilation (mydriasis)
Vitrectomy	• Vitreous hemorrhage[238,239] • Retinal tear or detachment[240] • Vision loss[240,241] • Infectious endophthalmitis[242] • Cataract[243]
Intravitreal injections	• Ocular hemorrhage • Elevated IOP (i.e., corticosteroids)[244,245] • Infectious endophthalmitis • Noninfectious inflammatory reactions • Possible systemic effect from intravitreal medication[211] • Increased retinal traction • Cataract[244,245]

DME = diabetic macular edema; IOP = intraocular pressure; NPDR = nonproliferative diabetic retinopathy; PDR = proliferative diabetic retinopathy

(AAO, 2019)

Course of Progression (AOA EB-CPG)

Table 2A
Frequency and Composition of Evaluation and Management Visits for Retinal Complications of Diabetes Mellitus

Severity of Condition	Natural Course Rate of Progression to		Frequency of follow-up	Components of Follow-up Evaluations		
	PDR (1 year)	High-risk category (5 years)		Fundus Photography	Fluorescein Angiography	OCT
No diabetic retinopathy			12 months	No	No	No
Mild NPDR	5%	15%				
No macular edema			12 months	No	No	No
Macular edema (not CSME)			4-6 months	Yes	Based on clinical judgment	Based on clinical judgment
CSME or central-involved DME			1-4 months*	Yes	Based on clinical judgment	Yes
Moderate NPDR	12-27%	33%				
No macular edema			6-9 months	Yes	No	No
Macular edema (not CSME)			4-6 months	Yes	Based on clinical judgment	Based on clinical judgment
CSME or central-involved DME			1-4 months*	Yes	Based on clinical judgment	Yes
Severe or Very Severe NPDR	52-75%	60-75%				
No macular edema			3-4 months	Yes	Based on clinical judgment	No
Macular edema (not CSME)			2-3 months	Yes	Based on clinical judgment	Based on clinical judgment
CSME or central-involved DME			1-4 months*	Yes	Based on clinical judgment	Yes
Non-high-risk PDR		75%				
No macular edema			3-4 months	Yes	Based on clinical judgment	No
Macular edema (not CSME)			2-3 months	Yes	Based on clinical judgment	Based on clinical judgment
CSME or central-involved DME			1-4 months*	Yes	Based on clinical judgment	Yes

Table Continued on next page

(AAO, 2019)

Course of Progression (cont)

Table 2A *(Continued)*
Frequency and Composition of Evaluation and Management Visits for Retinal Complications of Diabetes Mellitus

Severity of Condition	Natural Course Rate of Progression to		Frequency of follow-up	Components of Follow-up Evaluations		
	PDR (1 year)	High-risk category (5 years)		Fundus Photography	Fluorescein Angiography	OCT
High-risk PDR						
No macular edema			2-3 months	Yes	Based on clinical judgment	No
Macular edema (not CSME)			2-3 months	Yes	Based on clinical judgment	Based on clinical judgment
CSME or central-involved DME			1-4 months*	Yes	Based on clinical judgment	Yes

*Intravitreous anti-VEGF therapy for central-involved DME requires monthly injections until the DME resolves or vision reaches 20/20 or better, until additional treatment is unlikely to be beneficial, or if edema worsens or remains unaffected by treatment. The monthly follow-up time could be doubled if edema does not recur or worsen, and could be doubled again (up to 16 weeks) if edema continues not to recur or worsen.[289]

(AAO, 2019)

Management Plan (AOA EB-CPG)

Table 2B
Frequency and Composition of Evaluation and Management Visits for Retinal Complications of Diabetes Mellitus

Severity of Condition	Management Plan*			
	Referral for Consultation and/or Treatment	Panretinal Laser Treatment	Focal Laser Treatment	Intravitreal Anti-VEGF Injections
No diabetic retinopathy	Communicate with patient's physician	No	No	No
Mild NPDR				
No macular edema	Communicate with patient's physician	No	No	No
Macular edema (not CSME)	Obtain retinal consult in 2-4 weeks	No	No	No
CSME or central-involved DME	Obtain retinal consult in 2-4 weeks	No	Based on clinical judgment	Yes, if vision impaired*
Moderate NPDR				
No macular edema	Communicate with patient's physician	No	No	No
Macular edema (not CSME)	Obtain retinal consult in 2-4 weeks	No	No	No
CSME or central-involved DME	Obtain retinal consult in 2-4 weeks	No	Based on clinical judgment	Yes, if vision impaired*

Table Continued on next page

(AOA, 2019)

Management Plan (cont)

Table 2B *(Continued)*
Frequency and Composition of Evaluation and Management Visits for Retinal Complications of Diabetes Mellitus

Severity of Condition	Management Plan*			
	Referral for Consultation and/or Treatment	Panretinal Laser Treatment	Focal Laser Treatment	Intravitreal Anti-VEGF Injections
Severe or Very Severe NPDR				
No macular edema	Obtain retinal consult in 2-4 weeks	Sometimes**	No	Alternative, Sometimes**
Macular edema (not CSME)	Obtain retinal consult in 2-4 weeks	Sometimes**	No	Alternative, Sometimes**
CSME or central-involved DME	Obtain retinal consult in 2-4 weeks	Sometimes**	Based on clinical judgment	Yes, if vision impaired*
Non-high-risk PDR				
No macular edema	Obtain retinal consult in 2-4 weeks	Sometimes**	No	Alternative, Sometimes**
Macular edema (not CSME)	Obtain retinal consult in 2-4 weeks	Sometimes**	No	Alternative, Sometimes**
CSME or central-involved DME	Obtain retinal consult in 2-4 weeks	Sometimes**	Based on clinical judgment	Yes, if vision impaired*
High-risk PDR				
No macular edema	Obtain retinal consult in 24-48 hours	Yes	No	Alternative
Macular edema (not CSME)	Obtain retinal consult in 24-48 hours	Yes	No	Usually
CSME or central-involved DME	Obtain retinal consult in 24-48 hours	Yes	Based on clinical judgment	Usually

* At the present time, anti-VEGF therapy is the initial treatment choice for center-involving macular edema with vision impairment (20/32 or worse), with possible subsequent or deferred focal laser treatment.

** Consider scatter laser treatment (PRP), especially if very severe NPDR (see levels of diabetic retinopathy), significant medical complication, or type 2 diabetes mellitus. The alternative use of anti-VEGF injections may be considered in eyes with severe NPDR in settings where PRP would be considered.

*** Consider scatter laser treatment (PRP) or anti-VEGF injections, especially if moderate PDR (see levels of diabetic retinopathy), significant medical complication, or type 2 diabetes mellitus.

(AOA, 2019)

Comprehensive Eye Exam Soon After Diagnosis (AOA EB-CPG)

EVIDENCE-BASED ACTION STATEMENT: As diabetes may go undetected for many years, any individual with type 2 diabetes mellitus should have a comprehensive eye and vision examination soon after the diagnosis of the condition, with follow-up examination as directed by their eye doctor.[17]

Evidence Quality: Grade B. Randomized Clinical Trial

Level of Confidence: High

Clinical Recommendation Strength: Strong Recommendation. This recommendation should be followed unless clear and compelling rationale for an alternative approach is present.

(AOA, 2019)

Follow Up Schedules (AOA EB-CPG)

No Diabetic Retinopathy/Mild NPDR

An annual dilated eye examination is generally recommended for monitoring the patient with no retinopathy or mild NPDR, as long as there is neither DME nor coincident medical risk factors such as hypertension, renal disease, or pregnancy that may predispose patients to progression.

If DME or medical risk factors are present, reexamination should occur every 4 to 6 months. When CSME is present, follow-up every 1 to 3 months is recommended.

Moderate NPDR

For patients with moderate NPDR, reexamination in 6 to 9 months is appropriate in the absence of DME or complicating medical risk factors.

If DME is present, but does not meet criteria for CSME, follow up every 4 to 6 months. When CSME is present, follow-up every 1 to 3 months is advisable.

Severe or Very Severe NPDR

Follow-up every 3 to 4 months in consultation with an ophthalmologist experienced in the management of diabetic retinal disease is advisable for patients with severe or very severe NPDR. When macular edema, including CSME, is present, follow-up every 1 to 3 months may be considered. Laser treatment or injection of anti-VEGF agents may be strongly considered.

PDR

Consultation with an ophthalmologist experienced in the management of diabetic retinal disease is indicated if PDR or DME is suspected or if there is an unexplained loss of visual acuity. Follow-up every 3 to 4 months is recommended for non-high-risk PDR without DME. Laser treatment or injection of anti-VEGF agents may be strongly considered.

High-Risk PDR

With or without DME, patients with high-risk PDR should receive laser treatment and/or injection of anti-VEGF agents with follow-up every 2 to 3 months, or as determined by the treating ophthalmologist.

(AOA, 2019)

Inform Primary Care Physician Results of Diabetic Eye Exam (AOA EB-CPG)

EVIDENCE-BASED ACTION STATEMENT: The patient's primary care physician should be informed of eye examination results following each examination, even when retinopathy is minimal or not present.[274]

Evidence Quality: Grade B. Cohort-retrospective Study

Level of Confidence: High

Clinical Recommendation Strength: Strong Recommendation. This recommendation should be followed unless clear and compelling rationale for an alternative approach is present.

(AOA, 2019)

Make Sure the Patients are Dilated! (AOA EB-CPG)

CONSENSUS-BASED ACTION STATEMENT: Retinal examinations for diabetic retinopathy should be performed through a dilated pupil.
Evidence Quality: There is a lack of published research to support or refute the use of this recommendation.
Benefit and Harm Assessment: Implementation of this recommendation is likely to provide more thorough examination for diabetes-related retinal disease. The benefits of this recommendation were established by expert consensus opinion.

(AOA, 2019)

WHEN IT COMES TO COVID-19
PEOPLE HAVE DIFFERENT RISKS

If you're over 65 or have a serious underlying condition like

Chronic lung disease

Serious heart conditions

Diabetes

You may be at higher risk of getting very sick from this disease

CS 316032-A March 25, 2020 10:17 AM

cdc.gov/CORONAVIRUS

Key Takeaways

- Diabetic Retinopathy is a leading cause of blindness
- Individuals with diabetes should receive at least annual dilated eye examinations
- More frequent examination may be necessary due to stage of disease
- Individuals with diabetes should modify their lifestyles
- Individuals with diabetes should be educated about the ocular signs and symptoms of diabetic retinopathy and eye examinations and care
- Diabetes is a military readiness issue
- Individuals with Diabetes may be at higher risk of getting very sick from COVID-19

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Questions?

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