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# THE ARMENIAN EXPERIENCE – THE ROLE OF ARTIFICIAL INTELLIGENCE

22 October 2021



## DISCLOSURES

Roger V. Ohanesian and Nune Yeghiazaryan  
have no relevant financial disclosures.

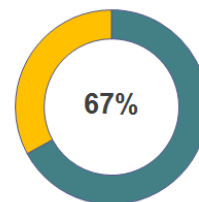
# ARMENIA BRIEF



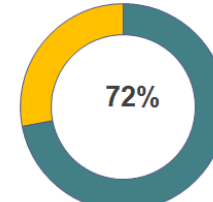
- Upper-middle income country - \$4,732 per capita GDP.
- Poverty – 26.4% (national poverty line), 43.9% (PPP 5.5 USD per day poverty line).
- Diabetes Mellitus (DM) prevalence increased 2.8 times in 1990-2019 - 4,070 per 100,000, or 96,580 people (4.6% of 20-79 y/o population).

However:

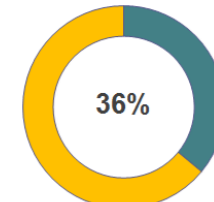
- There is no state DR and DME screening program for PwD and any data on DR and DME prevalence.
- People outside the Capital, especially rural residents have very limited access to DM care and DM related eye disease diagnosis and treatment.



Endocrinologists in the Capital



Ophthalmologists in the Capital



Population in the Capital

# Armenian EyeCare Project (AECP)

Established in 1992 by pioneer ophthalmologist Roger V. Ohanesian, MD

In partnership with the Government of Armenia and other countries, leading academic and health institutions, NGOs, Diaspora, pharmaceutical and manufacturing companies, individuals and volunteers - the AECP implements more than 20 programs in response to the needs of the country and suggestions of the Ministry of Health of Armenia.

Providing eye care services in the regions of Armenia



Regional Eye Centers

Revealing vision problems among pre-school and school children



ROP national program

Providing eye care services to people with diabetes



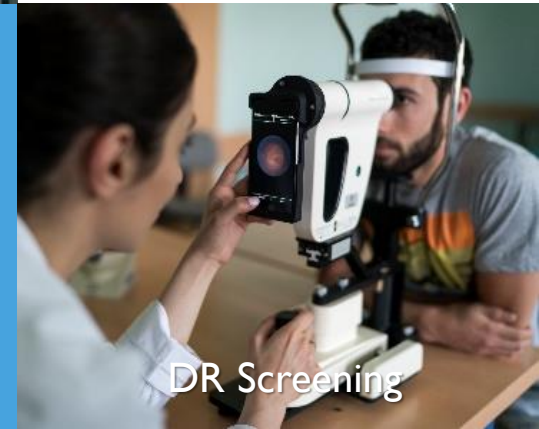
Mobile Eye Hospital

Revitalizing the regional eye care infrastructure



Massive school screening

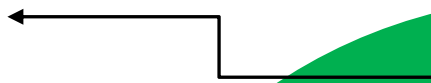
Responding to alarming increase in the number of young children who were blind or visually impaired



DR Screening

# The prevalence of the problem **will grow:**

**463 million people had diabetes**



**2018**

**162 million people had DR**



**51 million people had vision-threatening DR**



**642 million people will have diabetes**



**2040**

**224 million people will have DR**



**70 million people will have vision-threatening DR**







# Response to Diabetes and Diabetic Retinopathy

2017-2020 Project:

Preventing Blindness from Diabetic Retinopathy and other diabetes-related eye diseases in Armenia

2020-2023 Project:

Armenian National Diabetes Strategy and Diabetic Blindness Prevention



# MAIN OBJECTIVES AND COMPONENTS

- ❑ Improving geographic and financial access to diabetes-related eye-care
- ❑ Increasing the capacity of medical professionals
- ❑ Enhancing diabetes-related advocacy

Innovative screening and treatment



Professional and public education



# Methodology



*General eye screening consisted of a check-up of eye health, including visual acuity, ophthalmoscopy, tonometry and refraction (if appropriate). Those who had symptoms of diabetes were also referred for digital retinal photography.*


## Identification of screening cohorts

- Based on the PwD lists provided by endocrinologists and family medicine doctors in the communities;
- Based on the information gathered in the general eye screening using the AECPC designed data collection forms on eye screening and general health information, including the information on DM and DM risk factors.



# Methodology

## Step 1. Announcement



**Bringing Sight to Armenian Eyes**

**Free eye screening for all**  
**Free treatment for socially vulnerable**

Eye screening services will be provided free of charge, including

- General screening,
- Referral to the Mobile Eye Hospital, if needed,
- Free surgery (for socially vulnerable) and laser treatment.

For eye screening please present

- Your ID,
- Birth Certificate (for children),
- Vulnerability paperwork.

People of the following groups should pass the screening:

- People with diabetes,
- 35-68 year old people who are at risk of diabetes according to the World Bank survey,
- People who underwent eye surgery in the Mobile Eye Hospital in 2004, 2007, 2009, 2011, 2013 or 2015.

For details please contact local ophthalmologist, health and social issues department of the regional authority of Armenian EyeCare Project office (tel. 010 55 90 65)

## Step 2. General eye screening



## Step 3. Digital retinal photography with portable fundus cameras



# Methodology

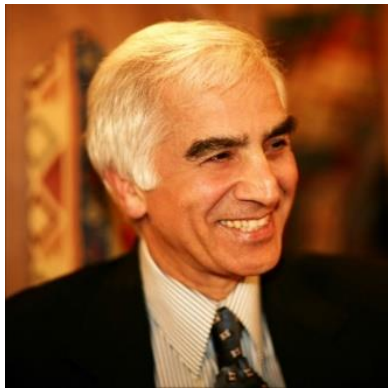
**Step 4.** DR/DME recognition, diagnosis and classification by discrete severity degrees using the EyeArt AI technology

The screenshot displays the EyeArt AI software interface. At the top, there is a navigation bar with options: management, add encounter, view encounters, view patients, my worklist, search, and my profile. Below this, there are three retinal fundus images for the Right Field 1 (2.83), Left Field 1 (2.58), and another Left Field 1 (2.66). Each image has a 'Description:' field below it. The main section is titled 'EyeArt Observations' and features the EYENUK logo. A prominent red banner states 'Positive for vDR'. To the right, a yellow box contains the text: 'Notes: Signs of Severe NPDR [3.7] with macular edema detected'. Below this, a 'CSDME Surrogate Markers' section shows 'Possibly Present' with a red bar. A 'DR Severity' scale is shown with a red bar indicating a score of 3.7. A warning message states: 'Warning: This report is automatically generated using EyeArt and only provides a Diabetic Retinopathy (DR) screening assessment. This screening does not take place of a regular eye examination for the purpose of assessing the presence of age-related macular degeneration, glaucoma, cataract, anterior segment diseases or other possible vision threatening conditions.' The EyeArt ID is 157178. The 'Consult Details' section includes a dropdown for 'Please select consult' (2020-07-03T08:11:24(Official)) and a consultant name: 'Ms. Marianne Shahsuvaryan (374-95-450503)'. The 'Image Observations' section lists findings for the Right Eye (numerous intraretinal hemorrhages and microaneurysms) and Left Eye (numerous intraretinal hemorrhages and microaneurysms). The 'Image Observation Comments' section includes 'Assessment and Recommendations: Refer to eye specialist within 3 months Return for retinal imaging within 1 year' and 'Diagnosis: Severe Nonproliferative Diabetic Retinopathy'.

**Step 5.** Patients' referral for either treatment and/or follow-up examination







# VISION, IDEAS AND IMPLEMENTATION

- Vision for Armenia
- Ideas for realization
- Connections and networking with Eyenuk



# Autonomous AI technology for DR detection

Technological progress results in developing AI systems capable of detecting diabetic retinopathy, one of which is EyeArt® AI eye screening system (the first DR diagnostic software received FDA approval).

The cooperation of the AECP and Eyenuk, the creator of the EyeArt® AI eye screening system, for DR recognition and diagnosis, and Eyepacs (data archiving system), allows collecting and keeping information on the patients with DR, their diagnosis and follow up options in one place free of charge for Armenia.



The image displays the EyeArt® AI eye screening system interface on a desktop monitor, a laptop, and a tablet. The interface shows retinal fundus images and diagnostic data. To the right of the devices are regulatory logos: FDA CLEARED, a Canadian Health Services logo, and CE 0413.



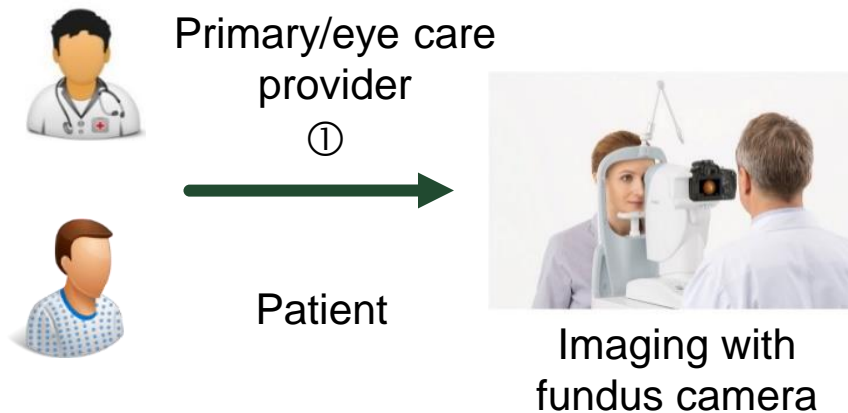
Key features of the EyeArt AI system:

- NO DILATION NEEDED (Icon: eye with a cross over a flame)
- FULLY AUTONOMOUS (Icon: gears)
- INSTANTANEOUS RESULTS (Icon: stopwatch)
- NON-INVASIVE IMAGING (Icon: syringe with a cross over it)
- NO SPECIALIST NEEDED AT POINT OF CARE (Icon: person with a question mark)
- ACTIONABLE REPORT (Icon: hand holding a document with a signal icon)

EYENUK

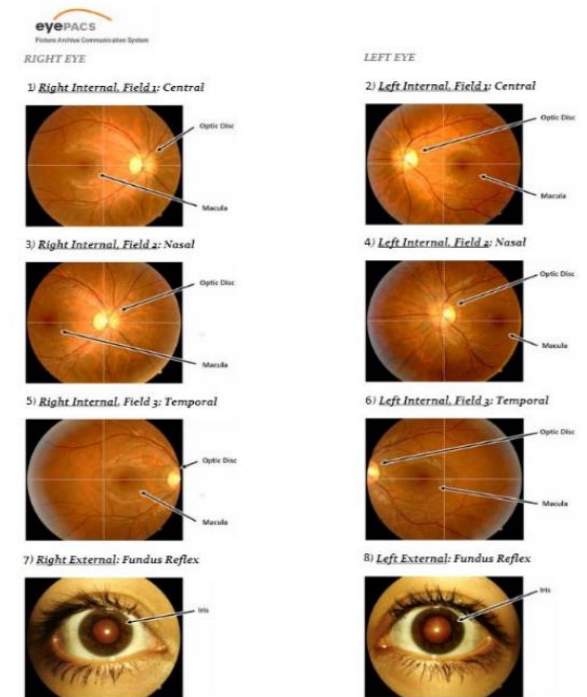


# Screening Workflow with EyeArt System



EyeArt Cloud

②



The screener/photographer took the patient's retina photo (as a baseline) and secured further steps if needed. The imaging protocol included 3 images per eye – one central with a view of the optic disk and the macula, and two images - 45 degrees, one disc centered and one macula centered image.

Lights in screening room should be off for internal images after making adjustments to table height and chin rest  
 \*\*Corner of patient's eye should line up with eye mark  
 Tap small pupil (SP) icon if dark shadows (small pupil artifacts) appear in your images  
 \*\*Wait 30-60 seconds longer between photographs

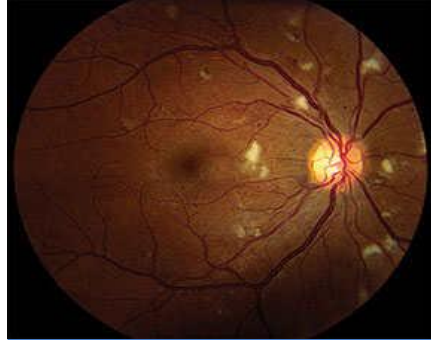
## AI and grader diagnoses



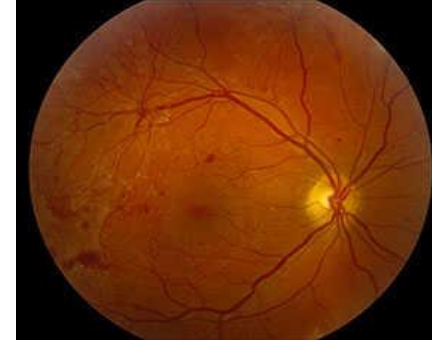
Mild  
Non-Proliferative  
DR (Mild NPDR)



Moderate  
Non-Proliferative  
DR (Moderate  
NPDR),



Severe  
Non-Proliferative  
DR (Severe  
NPDR)



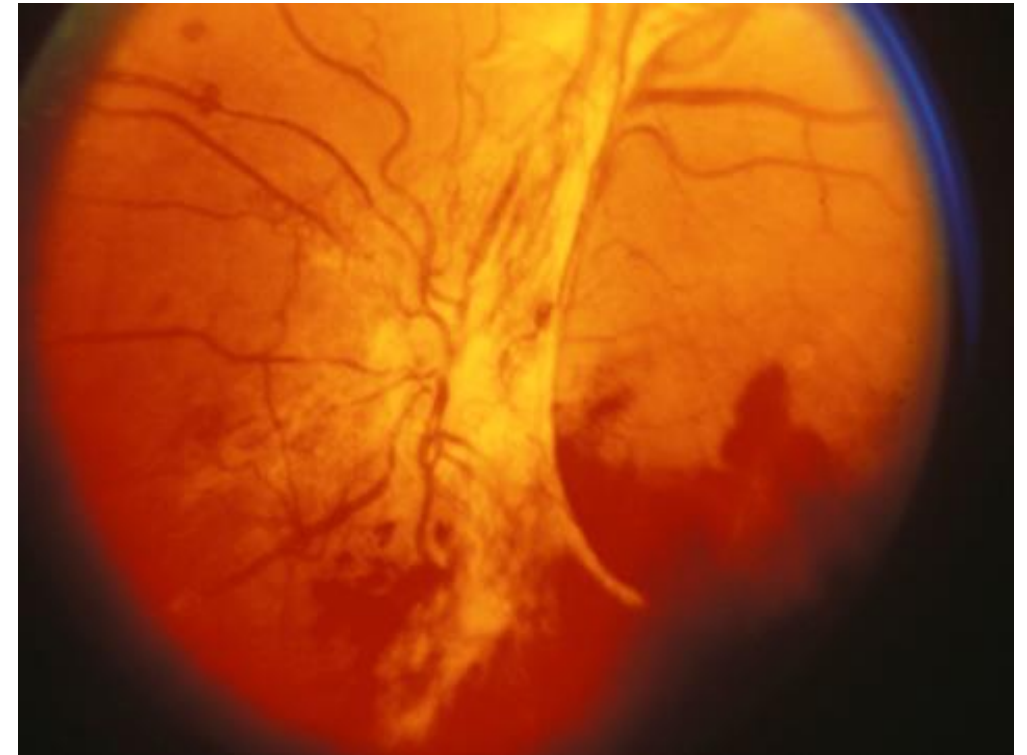
Proliferative DR  
(PDR)



Any type of DR  
with  
Clinically  
Significant  
Diabetic Macular  
Edema (CSDME)

**Referable DR** was defined as  
**Moderate NPDR or higher severity**  
**with/without**  
**Clinically Significant**  
**Diabetic Macular Edema (CSDME)**

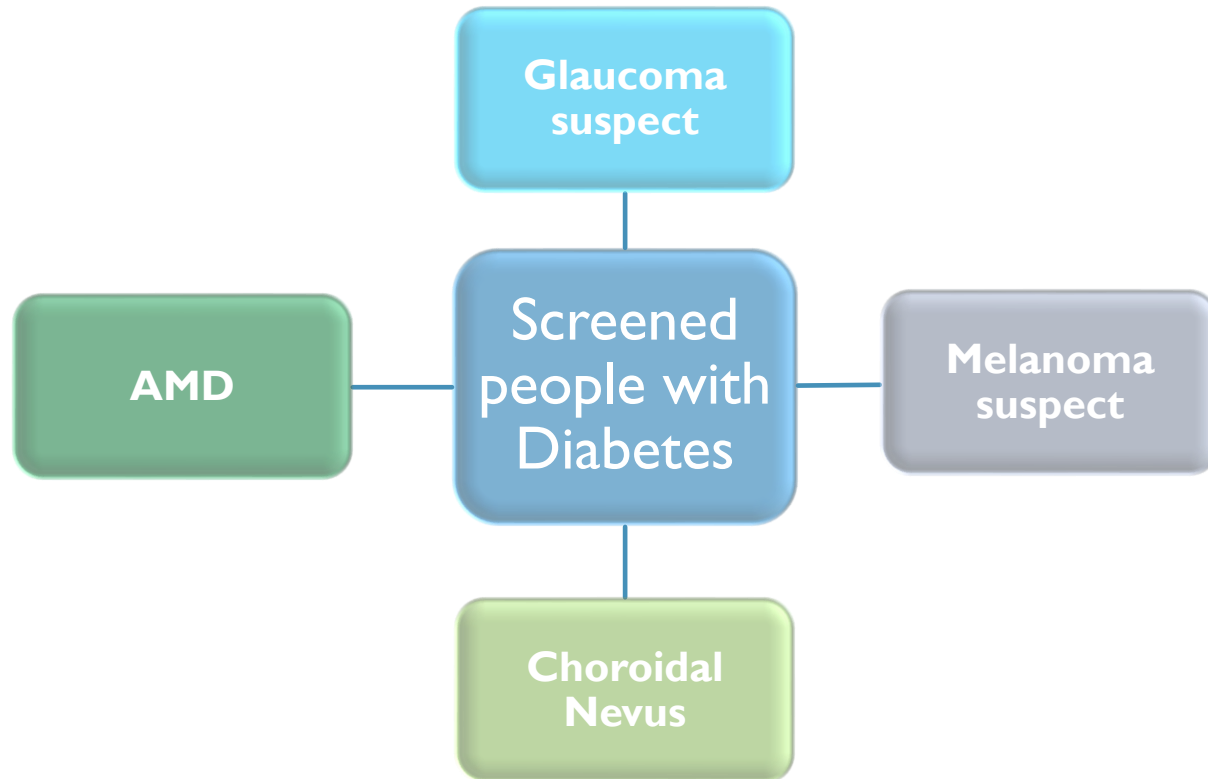
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was defined as  
**Severe NPDR or higher severity**  
**with/without Clinically Significant**  
**Diabetic Macular Edema (CSDME)**

# AI Further Development Areas

Ocular comorbidities revealed by graders include:



Eyeenuk current and future plan roadmap:

- ✓ Diabetic retinopathy (DR) - 2020
- ✓ AMD – 2021
- ✓ Glaucoma – 2021
- ✓ Cataract - 2021-2022
- ✓ Non-eye chronic diseases - TBD
  - Alzheimer's
  - CV risk, stroke & hypertension



# Professional Publications

## Ophthalmology Times

CUTTING-EDGE ADVANCEMENTS

### Sowing the seeds to develop ophthalmic care in war-torn Armenia

Eye care initiative aims to prevent, treat blindness in residents of country  
By Roger Oshanesian, MD, Special to Ophthalmology Times

As a second-generation Armenian, in 1992, when Armenia took the responsibility as the main guarantor of security for Artsakh in its conflict with Azerbaijan, the Armenian government put out a call to all Armenian-American physicians to help treat casualties of war. For me, this was a reminder of the promise I had made to my grandfather in 1912—to return to the homeland when the need arose. I had never been in a war zone before, and what I saw was shocking. Among the worst injuries were those from landmine and other explosives placed in playgrounds and schools by Azerbaijani military who had overrun the country. I treated hospitals full of soldiers who were blind or

### ARMENIA

(Continued from page 4)

—which can take up to two years—can also receive timely treatment.

**MANAGING DR**  
We have found that the best option for treating DR in patients living in rural areas is laser treatment to create one month of therapy is usually enough to stop blood vessel leakage. The typical follow-up for lasered patients occurs six months after the initial treatment, with touch-ups as required. This is a great way to prevent vision loss over the long term.

One of the most useful tools we have for the management of DR in Armenia has been the EyeART AI Eye Screening System, which was donated to us by EyeART. It enables DR screening even with limited eye care resources. This system is a cloud-based screening software that uses artificial intelligence (AI) to automatically detect DR by identifying the presence, size, position, and number of lesions within each eye.

The EyeART system provides fully automated DR screening, including image grading and reporting in a single visit, without the need for eye dilation. Less than a minute after photographing the retina, we get a report, which is used to determine whether the patient needs to be treated right away or scheduled in three, six, or 12 months. Those who require immediate treatment are sent to one of the four regional eye centers or the mobile eye hospital where laser treatment is available.

At publications, 100 patients have been screened in Armenia using the EyeART System. The EyeART AI Eye Screening System found 1,077 cases with retinopathic diabetic maculopathy or macular edema. Those with vision-threatening DR or macular edema have been referred for additional treatment.

A higher prevalence of vision-threatening diabetes is expected in a country like Armenia, where

Project is so important—until now there has been no systematic DR screening program available.

We all have something to offer the eye community, our own particular set of skills or knowledge base. My skills as an ophthalmologist can potentially further when I have the most advanced tools and equipment available to me.

Partnering with EyeART has allowed us to help numerous people keep their sight, and we will continue to screen and treat as many patients as possible.



Dr. Oshanesian examines an elderly woman with severe high blood pressure during a hip fracture in Armenia in 1992. (Photo courtesy of Roger Oshanesian, MD)



Dr. Oshanesian speaks with farmers and relatives in a remote clinic in Armenia.

Our Armenian colleagues continue to screen patients throughout the year, and just when the Armenian EyeCare Project is in town.

They are committed to eliminating preventable blindness in Armenia and teach that principle. In yearly conferences, they will teach that goal to neighboring countries and pass along what they have learned. This has been a good example of medical diplomacy, and it is working.

**ROGER OSHANESIAN, MD**  
is a physician and ophthalmologist. He has been practicing for 35 years and has worked in 100 countries.

**'We have found that the best option for treating DR in patients living in rural areas is laser treatment.'**  
— Roger Oshanesian, MD



Roger Oshanesian, MD, examines a patient in the same clinic with Anna Terlemezyan, MD, PhD, chief of the General Ocular Clinic at the Mkhitar Mikheyelian Center in Yerevan, Armenia, along with fellows and residents. (Photo courtesy of Roger Oshanesian, MD)

### TAKE-HOME

Leading experts see the need to meet eye care for rural and war-torn regions can prove to be a rewarding endeavor, offering surgeons a way to pay it forward.

### THE PROBLEM OF UNMET NEED FOR EYE CARE IN ARMENIA

Despite the heroes that I saw on those early trips, the girls were silent because dear that one after they had been

## UNITE FOR SIGHT

### Community Based eye screening by Armenian EyeCare Project, NGO

Authors: Nune Vaghazarian, PhD, MPA, Country Director of the Armenian EyeCare Project, Armenia  
Roger Oshanesian, MD, President of the Armenian EyeCare Project, US  
Nairn Jiboytanyan, PhD, MSE, Director of the Armenian EyeCare Project, Armenia

#### Background

**Basic Information on Armenia**

- Upper middle-income country - 64.73 per capita GDP
- Poverty - 26.4% (national poverty line), 43.0% (PPP U.S. USD per the poverty line)
- Diabetes Mellitus (DM) prevalence increased 2.8 times in 1990-2014 - 4.27% per 100,000

**Blinding eye disease resulting from DM include diabetic retinopathy (DR) and diabetic macular edema (DME) as well as cataract and secondary glaucoma. DR affects over 100 million people with diabetes (PwD) worldwide, however:**

- There is no data DR and DME screening program for PwD in Armenia
- People outside the Capital, especially rural residents, have very limited access to DR and DME related eye disease diagnosis and treatment.

**Objective**

- To create and test methodology of mass eye screening with the use of new technologies, and
- To evaluate effectiveness of DR in the light of community based eye screening among PwD in Armenia

#### Methodology (continued)

**Identification of People with Diabetes**

- National Diabetes (DM) registers in the communities.
- Based on the information gathered in the general eye screening, with the help of the AACP assigned data collection forms on eye screening and general health information, including DM and DM risk factors.

**Algorithm of community based eye screening**

**Step 1:** Screening and education identified in the targeted communities.

**Step 2:** Screening eye screening for cataract, including PwD (provided by the screening through the national eye clinic) in the targeted communities for the issue of cataract.

**Step 3:** These resulted in finding DM risk factors (hypertension or DM) and related eye disease (glaucoma) among people using new portable non-mydriatic fundus cameras (EyesART) based eye screening. The imaging protocol included 3 images per eye.

**Step 4:** Clinical assessment and imaging, including, when also centered and one micro centered image.

**Step 5:** Artificial intelligence (AI) algorithm (combined with ophthalmologist) evaluation used to "read" fundus images and detect the DR and DME cases. The algorithm (EyesART System) created by the EyeART and used through other screening system health care for DR and DME diagnosis and diagnosis and classified them by discrete severity degrees.

#### Results

- 10,000 people registered with DM and enrolled with DM screening in DR/DME screens in rural and urban communities, were photo-screened by EyesART and graded by AI and ophthalmologists (summarized 17% of the ultimately required PwD).

**AI grading**

- 100% High quality
- 100% Low quality
- 100% No image

**AI grading**

- 100% No DR
- 100% Mild DR
- 100% Moderate DR
- 100% Severe DR

**AI grading**

- 100% No DME
- 100% Mild DME
- 100% Moderate DME
- 100% Severe DME

**AI grading**

- 100% No DR
- 100% Mild DR
- 100% Moderate DR
- 100% Severe DR

#### Conclusion

The study suggests that DR mass screening using portable fundus cameras proved to be an effective method to increase access to cutting edge eye care and prevention of blindness due to diabetes even in the absence of an ophthalmologist, demonstrated by the large number of treated DR cases and DME cases in rural communities in the Middle East.

**Message:**

The strength of this study is the large population size that underwent systematic screening using standardized quality assurance procedures and engagement by physicians and AI grading, setting a mass screening through communities all over Armenia.

The study findings also highlighted the need for cataract screening (ophthalmologist) and further knowledge and understanding of the general health care professionals, as well as PwD, on lack of knowledge acted as a barrier to engage in screening. Eye examination using portable fundus cameras (EyesART) proved to be a viable option for DR management.

### World Health Organization

REGIONAL OFFICE FOR EUROPE

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Health topics > Noncommunicable diseases > Diabetes > Activities > World Diabetes Day 2020 > Armenia – targeted screening approach aims to prevent diabetic sight loss

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### World Diabetes Foundation

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## The project's achievements offer lessons for others working to bring diabetes eye care to under-served populations.

Diabetes as a public health threat is a Health. Working with partners, it leads various complications of the disease.

3,000 people in Armenia have a lack of resources, inadequate public health systems stand in the way of a programme across the country although ophthalmic medical professionals, some tests or treatments are unaffordable for many patients.

In progress in the last 4 years. In 2017, the Armenian Eye Care Project, in partnership with the World Diabetes Foundation, began to implement an ambitious project "Diabetic Retinopathy". Its activities were integrated with the countrywide eye-care program "Armenian Eyes".

From 2017 until 2020, were to improve geographic and financial access to diabetes-related medical professionals, and enhance diabetes-related advocacy.

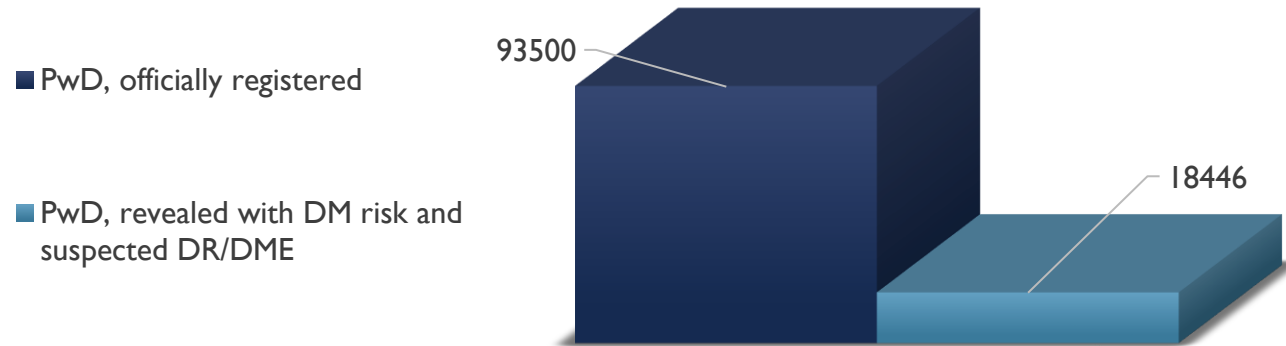
Working with the US company Eyeart, AACP introduced software that uses artificial intelligence to grade fundus photos and diagnose DR, ending the need for a physician to diagnose each patient.

Eye screening in Armenia



## Results (2017-2021)

18,466 people registered with DM and revealed with DM symptoms or DR/DME suspect in 324 rural and 43 urban communities, were photo-screened for DR/DME and graded by AI and ophthalmologists.

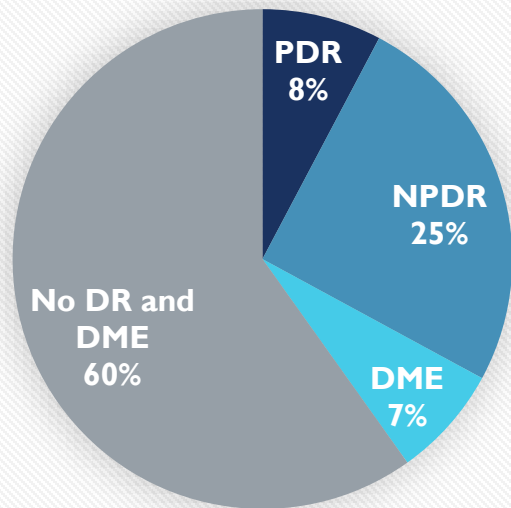


The photos were uploaded to image archiving online system, where the EyeArt AI technology identified DR and/or DME.

The final diagnosis for each patient was determined by the stage of DR of the more affected eye.

# Results (2017-2021)

## The DR diagnosis summary for 2017- September 01 2021



## The DR diagnosis summary for 2017- September 01 2021

	Cases	% of screened for DR
<b>Total screened for DR, of which diagnosed with:</b>	<b>18,466</b>	<b>100%</b>
Any DR and DME, including:	7,396	<b>40.1%</b>
PDR	1,431	7.7%
NPDR, of which:	4,626	25.1%
Severe	1,153	6.2%
Moderate	1,276	6.9%
Mild	2,197	11.9%
DME	1,339	7.3%
No DR and DME	11,070	<b>59.9%</b>

# STEPWISE APPROACH

2017-2020

2020-2023

Identifying realities in the DM system

01



Introducing systematized approach and support in the development of the National DM Strategy

01

Targeting People with Diabetes (PWD) as main group for eye screening

02



Enhancing target groups for eye screening and public awareness

02

Introducing high technologies and innovation in project design

03



Enhancing the use and dissemination of high technologies and innovations

03

Introducing professional training at various levels

04



Deepening professional training at various levels

04



# Armenia's experience and the role of AI

Telemedicine and AI linked to portable devices and automatic analysis of fundus photos

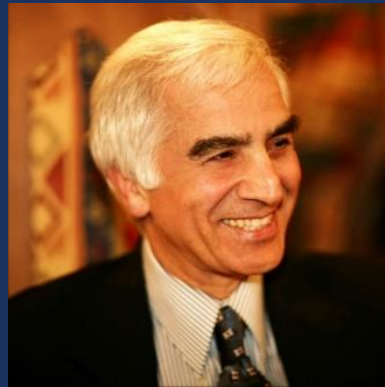
- Increase discoverability and manageability of DR
- Fill in the gap of inaccessibility to remote areas
- Enforce effective time- and cost-saving care.

The AECP's innovative approach helps practitioners who are responsible for patients' care to use AI as a valuable "helper"

- to save time
- to access more patients in remote areas
- to secure continuity of care.

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# THANK YOU FOR YOUR ATTENTION



**Roger Ohanesian, MD, FACS**  
Founder & President



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Country Director