Artificial intelligence for mass screening of diabetic retinopathy: proceeding to national level in Ukraine during 2022-2023

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BACKGROUND.
ONE YEAR AGO

• The first pilot screening project in Chernivtsi region

• The B2C format was used in collaboration with the most active diabetes patient organization – the Ukrainian Diabetes Federation

• Result: signs of diabetic retinopathy were detected in 30% of individuals with a previously diagnosed case of diabetes

93% 86%
sensitivity specificity
Screening model accuracy

– War affected regions
– CheckEye screening is implemented
Background. One year ago

The first article has been prepared for the peer-reviewed "Journal of Ophthalmology."

Presentations:
- IDF 2022,
- EURO RETINA,
- Filatov Memorial Lectures,
- EHMA 2023

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- War affected regions
- CheckEye screening is implemented
Our purpose, established for 2023-2024

- To expand AI-driven mass screening of diabetic retinopathy in Ukraine in wartime, to evaluate its accuracy
Methods:

**STUDY DESIGN**
- multicentral, prospective, open-label, observational

**TIME FRAME**
- July 2023 till March 2024

**REGIONS**
- Central, Western and South parts of Ukraine

**INCLUSION CRITERIA**
- Patients with documented DM type 1 and 2, and those in risk group

**EXCLUSION CRITERIA**
- Patients under 18 y.o.

**IMPLEMENTING MODEL**
- B2B2C, collaborating with public & private healthcare institutions

- [Map of Ukraine showing regions: War affected regions and CheckEye screening is implemented]
Methods:

- Non-mydriatic fundus camera - the field of view of 45°
- One field color photo with center in fovea for each eye
- Cloud-based Retinal-AI CheckEye©
- ROC curve analysis was performed to determine the sensitivity and specificity of the DR diagnosis method.
**Methodology**

1. Crop (remove background)
2. Resize all images
3. Use Ben Graham Color algorithm to contrast the image histogram

Uploaded photo -> Preprocessing -> Validation

Validation:
- Valid
- Invalid

DR Class (0-4)

DR Sign (1-13)

Classes:
0: Healthy
1: Early stage
4: Latest Stage
5: Invalid photo
Methodology

The first stage validation

The second stage verification
## Results

### Health care institutions\patients

<table>
<thead>
<tr>
<th></th>
<th>Number of units</th>
<th>Screened without DM</th>
<th>Screened with DM</th>
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<td>109</td>
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<tr>
<td>NGO</td>
<td>1 - Red Cross</td>
<td>14</td>
<td>18</td>
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<tr>
<td>Total</td>
<td>11</td>
<td>1734</td>
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</table>

### Mean age of patients
58 y.o.

### Mean age of patients with DM
59 y.o.

### Mean history of DM
11 y. 6 m.
Results

Diabetic patients and DR

Detecting of DR

- 35% of the diabetic patients were detected DR in at least one eye

First manifestation of DR

- 30% of persons with detected DR learned for the first time that they had diabetic retinopathy

1,612 diabetic patients
3,224 eyes

169 learned for the first time
395 knew they had DR
Results

Proportion under/over 64 y.o.

General proportion with DM

- 64 y.o. and over: 64%
- Under 64 y.o.: 46%

Presence of DR in patients with DM under 64 y.o.

- Absence of DR: 72%
- Presence of DR: 28%
Results

DR in patients under 64 y.o.

- Mild np DR: 18.50%
- Moderate np DR: 10%
- Severe np DR: 13%
- Prolif DR: 58.50%
Results

- 95% sensitivity (↑), 84% specificity (↓)
- AUC 0.97
- Adding a second neural network allowed us to achieve a combined specificity of up to 90%
Calculation Model of probable number of patients to be treated

Official data on DM in Ukraine

Non-official DM in Ukraine by UDF

People with Diabetes

1.3 million

2.3 million

Calculated number of people with Diabetic Retinopathy (28%)

364,000

644,000

23% need to be treated (severe non proliferative + proliferative stages)

83,720

148,120
Discussion

In a prospective study, Abràmoff et al. achieved 87.2% sensitivity and 90.7% specificity. Their IDx-DR (Digital Diagnostics, Corville, IA, USA) was the first US Food and Drug Administration (FDA)-approved autonomous AI device in medicine, designed to detect diabetic retinopathy and diabetic macular edema.

Abràmoff et al. reported a sensitivity of 96.8% and specificity of 87.0% with an area under the receiver operating characteristic curve (AUC) of 0.980 in the detection of referable DR.

A total of 75 137 publicly available fundus images from diabetic patients were used to train and test an artificial intelligence model to differentiate healthy fundi from those with DR. Model achieved a 0.97 AUC with a 94% and 98% sensitivity and specificity, respectively, on 5-fold cross-validation using our local data set. Testing against the independent MESSIDOR 2 and E-Ophtha databases achieved a 0.94 and 0.95 AUC score, respectively.

Ting et al. validated the application of AI in DR screening using real-world data from 10 datasets in 6 countries with an AUC of 0.936, sensitivity of 90.5% and specificity of 91.6% in detecting referable DR and an AUC of 0.958, sensitivity of 100%, and specificity of 91.1% in detecting vision-threatening DR.
Key findings

Screening has been implemented in 30% of regions free from battlefield.

Alongside the B2C format in collaboration with the most active diabetic patient organization – the Ukrainian Diabetes Federation, we are actively working in the B2B2C format, mobile format, and also initiating cooperation in the B2G format (goal for the current calendar year).

As the system processes large volumes of data, the detection results for DR remain consistent: signs of diabetic retinopathy were detected in 35% of individuals with a previously diagnosed case of diabetes.

Signs of diabetic retinopathy are detected in 28% of individuals under the age of 64 (working age) with a previously diagnosed diabetes – in contrast to the commonly accepted statistic of 10%.
The accuracy of the screening model has been improved: currently, it has 95% sensitivity and 90% specificity, with an AUC of 0.97. Our system demonstrates high accuracy, comparable to or exceeding that of humans, especially in large-scale applications and over extended periods, as AI does not tire, experience emotions, or get distracted.

During wartime, our system showed high accessibility and affordability for mass screening of DR, including due to technological accessibility and flexibility in choosing screening organization formats.

The subsequent implementation of diabetic retinopathy screening “CheckEye” will help preserve the vision of up to 150,000 residents of Ukraine, which is of immense importance for the country's survival and post-war recovery.

Further expansion of the diabetic retinopathy screening method “CheckEye” will help preserve the vision of up to 100 million people worldwide by 2050, which is of immense importance for global healthcare and wellbeing.
Ask any questions

Book an introductory meeting with CheckEye founder and team

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