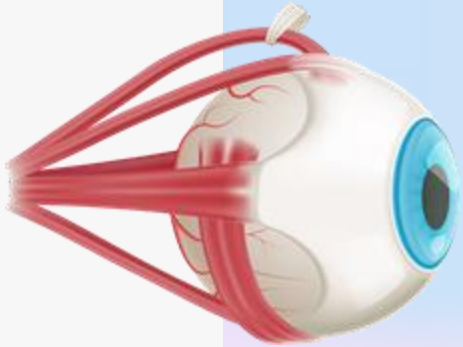
DR-AI: AI in Diabetic Retinopathy Screening



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11/29/2023

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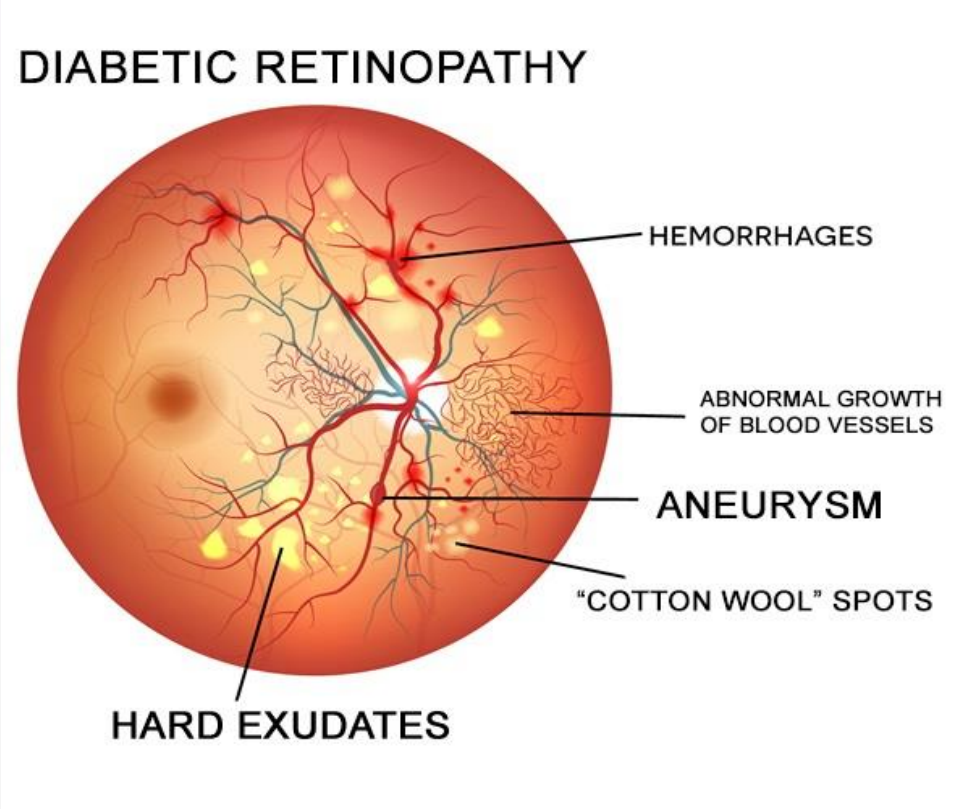
Introduction

What is a Diabetic Retinopathy?



Introduction and Background

Diabetic retinopathy affects 34.6% of diabetic patients, with early-stage cases often asymptomatic. Screening is vital, but global initiatives face challenges like healthcare professional shortages, infrastructure limitations, and costs (Rêgo et al., 2022).

The World Health Organization emphasizes the screening of all diabetes patients, particularly crucial as diabetes diagnoses rise and global life expectancy increases, necessitating swift adaptations in healthcare services to ensure widespread screenings (Rêgo et al., 2022).

02

Business Case

Traditional methods Vs. AI-driven CDSS

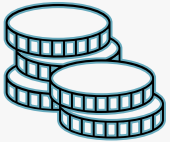
Current DR screening System

- Limited accessibility due to limited trained staff
- Cost-related issues
- Increased burden on healthcare resources
- Patient non-compliance
- Accurate screening methods

AI-driven CDSS – DR-AI

- Improved accessibility
- Cost-effective
- Reduce need for specialist visits.
- Patient compliance.
- Improved accuracy of screening

Risks and Mitigation Strategies:



Costs:

Risks: initial setup expenses, staff training, system development

Mitigation strategy: develop clear financial plan to save costs.

Technical Risks:

Risks: not maintaining efficient/updated AI system

Mitigation strategy: Perform regular maintenance and software updates, hiring IT development team.

Integration challenges:

Risks: problems with implementing the AI-CDSS withing the existing healthcare system, training of the medical staff, patient acceptance.

Mitigation strategy: train medical staff on the new system and educating patients through a comprehensive educational plan and highlighting the benefits and AI-driven screening

03

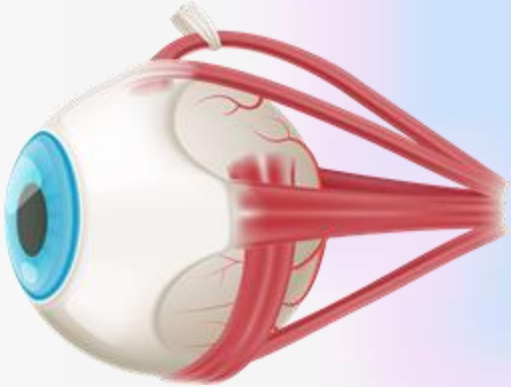
Current State

CURRENT STATE/ GAP ANALYSIS

1. Performed by specialized care (optometrists and ophthalmologists)

2. Costly and time consuming

3. Long waiting times for screening



FLOW CHART: CURRENT STATE EXAMPLE

Actors involved:

- Patient
- Primary care physician
- Optometrist
- Ophthalmologist

Issues:

1. Specialized care
2. Waiting time for screening

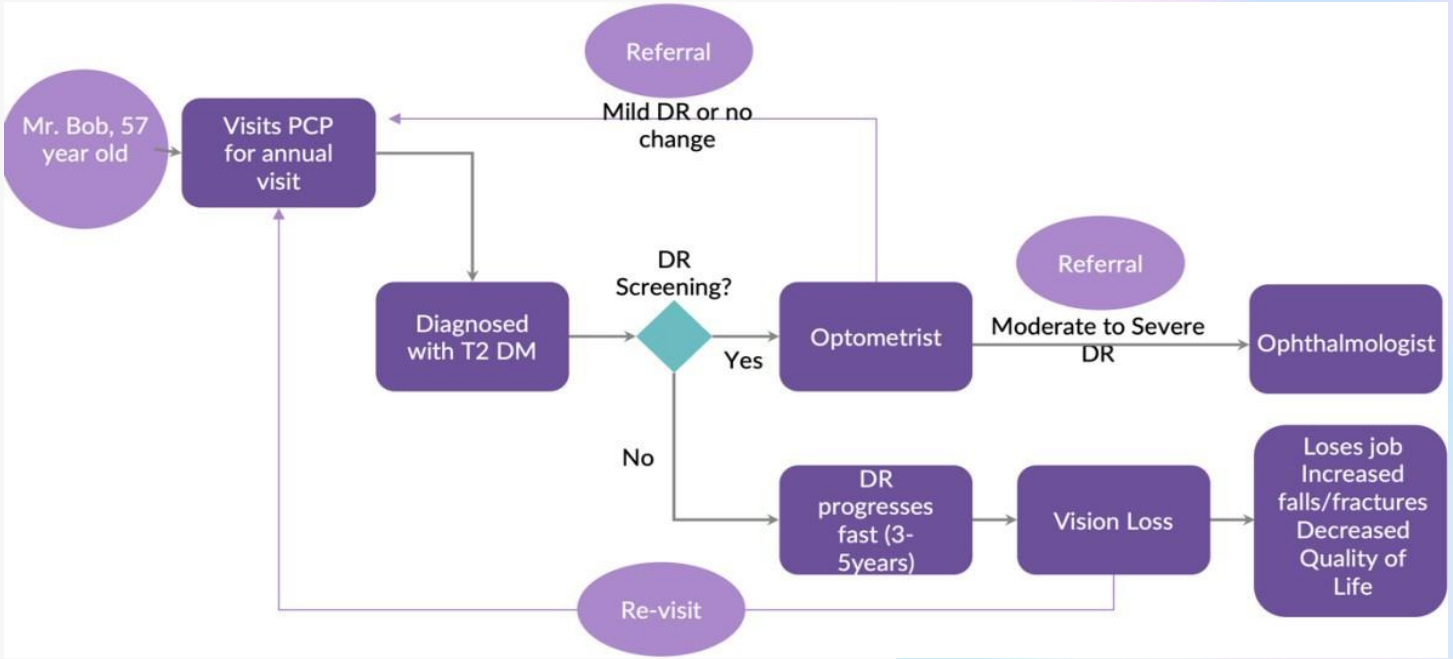
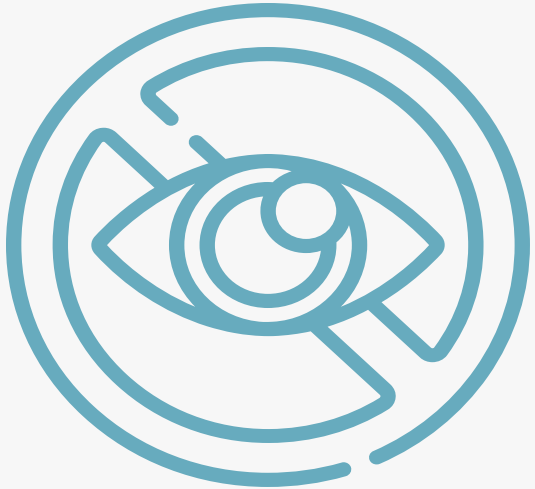
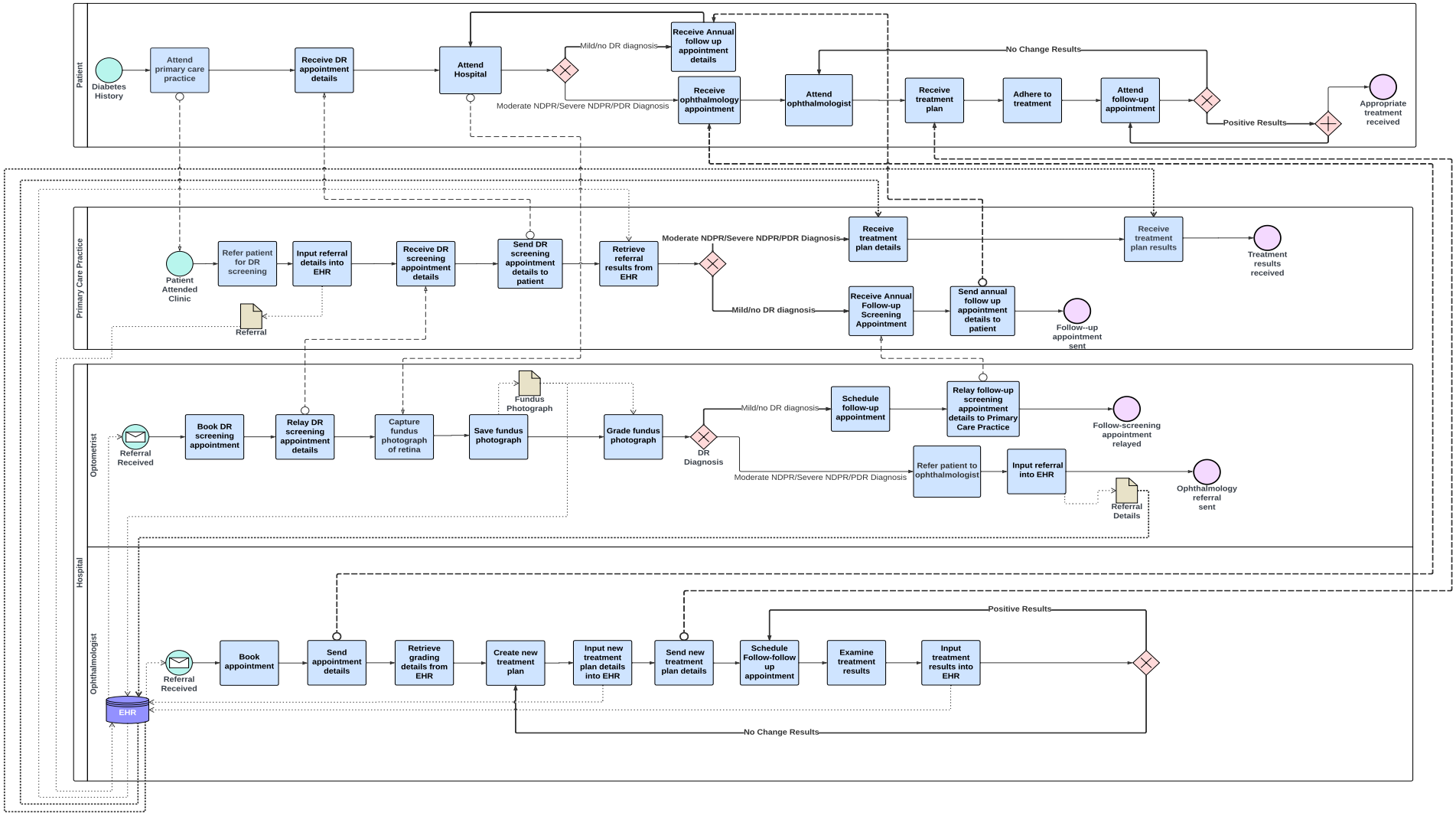


Figure of: https://healthydebate.ca/2023/02/topic/blind-spot-care-diabetes/

(Marcus, 2023)

CURRENT STATE WORKFLOW




Patient
Diabetes History
Attend primary care practice
Receive DR appointment details
Attend Hospital
Mild/no DR diagnosis
Receive Annual follow up appointment details
Moderate NDPR/Severe NDPR/PDR Diagnosis
Receive ophthalmology appointment
Attend ophthalmologist
Receive treatment plan
Adhere to treatment
Attend follow-up appointment
No Change Results
Positive Results
Appropriate treatment received
Primary Care Practice
Patient Attended Clinic
Refer patient for DR screening
Input referral details into EHR
Receive DR screening appointment details
Send DR screening appointment details to patient
Retrieve referral results from EHR
Referral
Moderate NDPR/Severe NDPR/PDR Diagnosis
Receive treatment plan details
Receive treatment plan results
Treatment results received
Mild/no DR diagnosis
Receive Annual Follow-up Screening Appointment
Send annual follow up appointment details to patient
Follow--up appointment sent
Optometrist
Referral Received
Book DR screening appointment
Relay DR screening appointment details
Capture fundus photograph of retina
Fundus Photograph
Save fundus photograph
Grade fundus photograph
DR Diagnosis
Mild/no DR diagnosis
Schedule follow-up appointment
Relay follow-up screening appointment details to Primary Care Practice
Follow-screening appointment relayed
Moderate NDPR/Severe NDPR/PDR Diagnosis
Refer patient to ophthalmologist
Input referral into EHR
Referral Details
Ophthalmology referral sent
Hospital
Ophthalmologist
Referral Received
EHR
Book appointment
Send appointment details
Retrieve grading details from EHR
Create new treatment plan
Input new treatment plan details into EHR
Send new treatment plan details
Schedule Follow-follow up appointment
Examine treatment results
Input treatment results into EHR
Positive Results
No Change Results

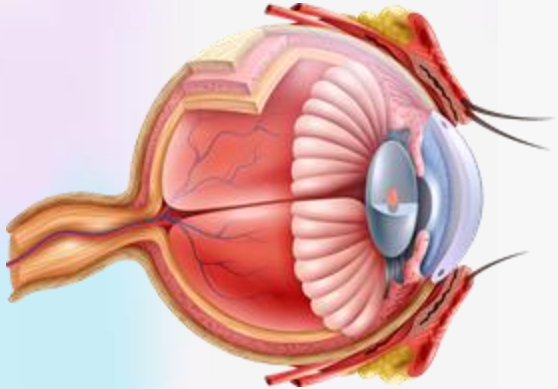
POTENTIAL SOLUTION

CDSS – ARTIFICIAL INTELLIGENCE FOR SCREENING DR

- Artificial intelligence (AI) systems using digital fundus photography
- This can reduce the burden on the health system in detecting DR and offer timely detection of the stage of the disease to avoid blindness.

(Padhy et al., 2019)

INFOGRAPHIC



DR-AI: Diabetic Retinopathy Artificial Intelligence

Screening using mobile devices

Early detection can reduce the risk of severe vision loss by 95%

Diabetes affects 8.9% or over 3 million Canadians

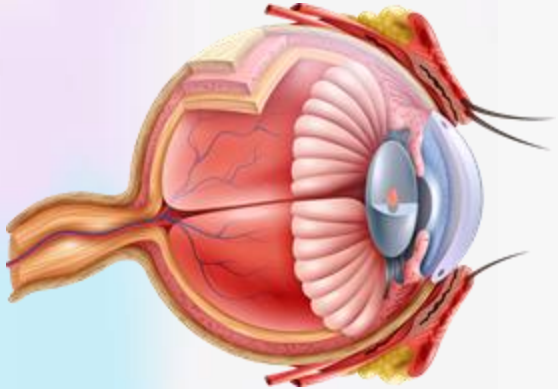
What is DR?

Diabetic retinopathy is a disease caused by high blood sugar levels that damage the small vessels in the eye, in people with type 1 or 2 diabetes. It is the main cause of blindness worldwide.

Barriers to DR screening

- **Need for specialised care ophthalmologist or physician**
- **Long waiting times for screening**
- **Current process is costly and time-consuming**

INFOGRAPHIC



HOW DOES DR-AI (CDSS) HELP?

1.Increasing the number of cases detected

2. Immediate referral of patients who require treatment

3. Deliver a more reliable and quick DR grading using convolution neural networks

4. Eliminate the necessity of attending hospital

5. Provide a more accurate prediction of DR development

HOW DOES DRAI WORK?

1. Patient diagnosed with type 1 or 2 diabetes

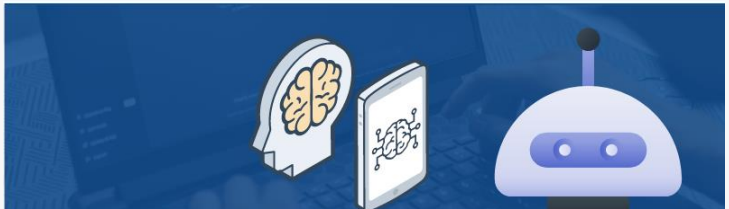
2. Go to Primary Care Center

3. Attended by a General Practitioner

4. Fundus photos are taken using AI through a mobile phone

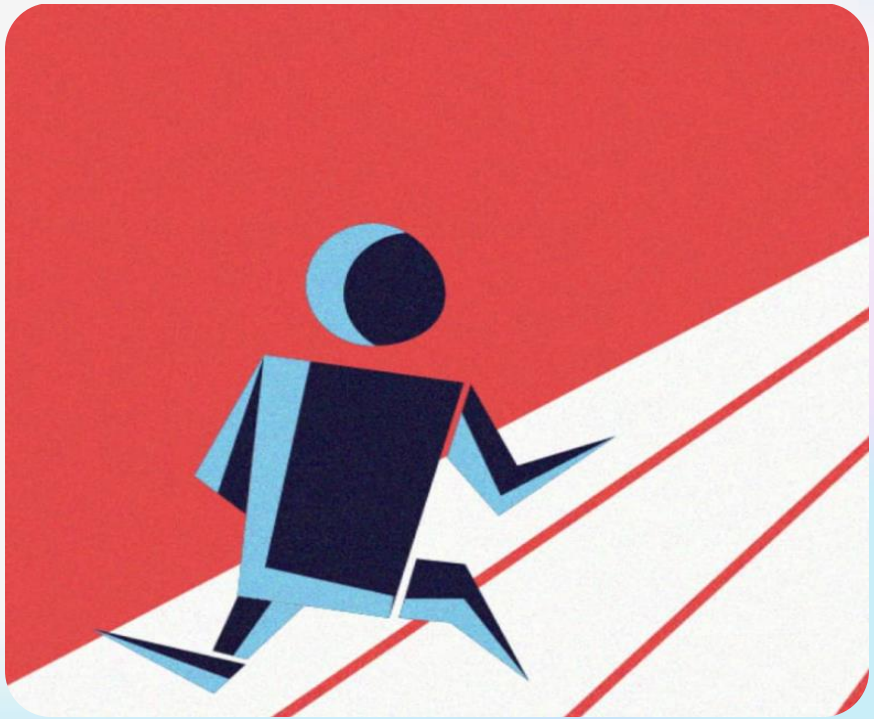
5. DR grading System

6. Moderate to severe degree: the patient is referred to an ophthalmologist

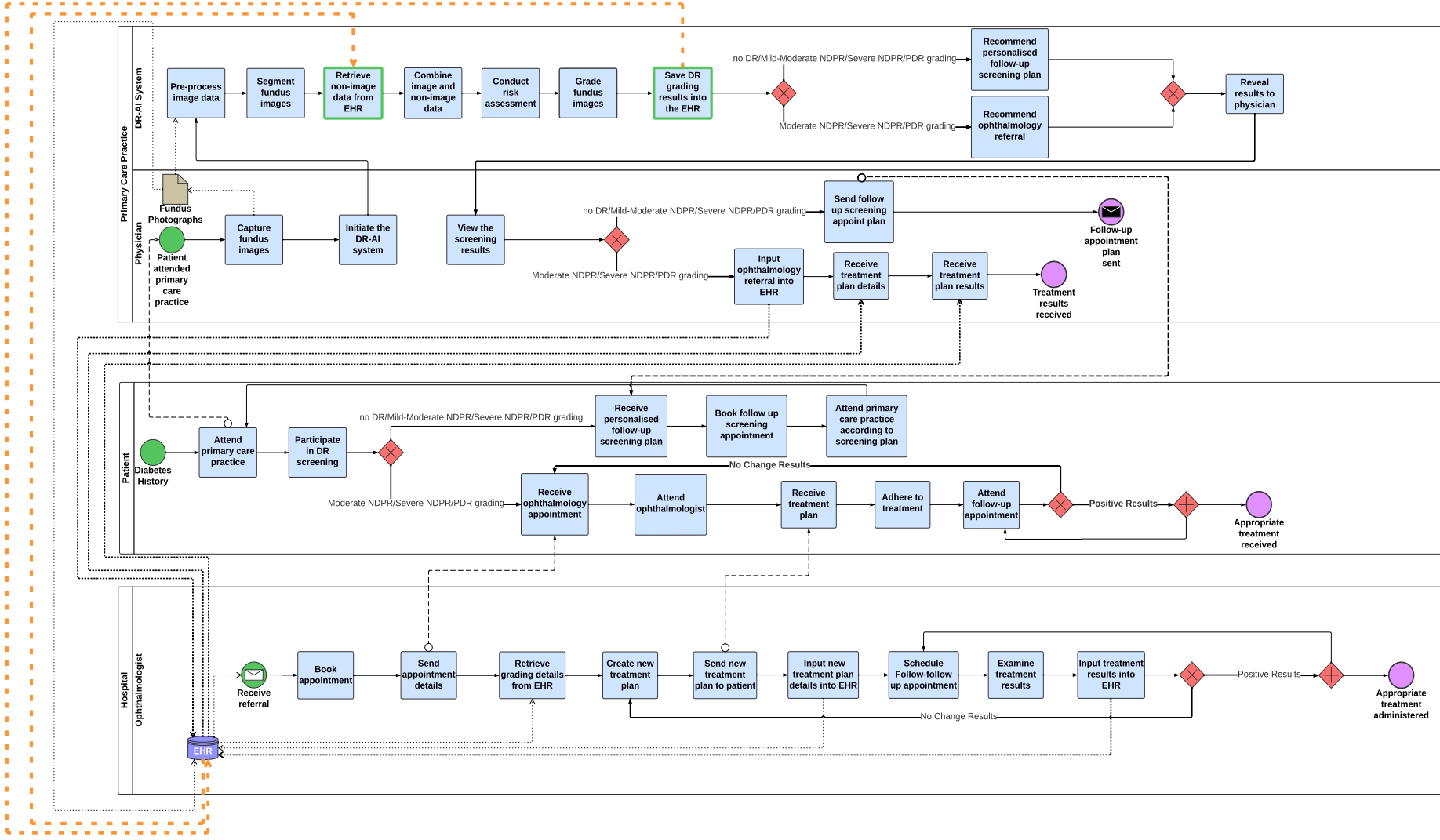


04

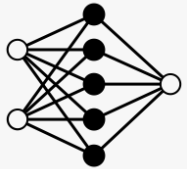
Future State



Future State Map


Primary Care Practice
DR-AI System
Pre-process image data
Segment fundus images
Retrieve non-image data from EHR
Combine image and non-image data
Conduct risk assessment
Grade fundus images
Save DR grading results into the EHR
no DR/Mild-Moderate NDPR/Severe NDPR/PDR grading
Moderate NDPR/Severe NDPR/PDR grading
Recommend personalised follow-up screening plan
Recommend ophthalmology referral
Reveal results to physician
Physician
Fundus Photographs
Patient attended primary care practice
Capture fundus images
Initiate the DR-AI system
View the screening results
no DR/Mild-Moderate NDPR/Severe NDPR/PDR grading
Moderate NDPR/Severe NDPR/PDR grading
Send follow up screening appoint plan
Follow-up appointment plan sent
Input ophthalmology referral into EHR
Receive treatment plan details
Receive treatment plan results
Treatment results received
Patient
Diabetes History
Attend primary care practice
Participate in DR screening
no DR/Mild-Moderate NDPR/Severe NDPR/PDR grading
Moderate NDPR/Severe NDPR/PDR grading
Receive personalised follow-up screening plan
Book follow up screening appointment
Attend primary care practice according to screening plan
No Change Results
Receive ophthalmology appointment
Attend ophthalmologist
Receive treatment plan
Adhere to treatment
Attend follow-up appointment
Positive Results
Appropriate treatment received
Hospital Ophthalmologist
Receive referral
Book appointment
Send appointment details
Retrieve grading details from EHR
Create new treatment plan
Send new treatment plan to patient
Input new treatment plan details into EHR
Schedule Follow-follow up appointment
Examine treatment results
Input treatment results into EHR
Positive Results
No Change Results
Appropriate treatment administered
EHR

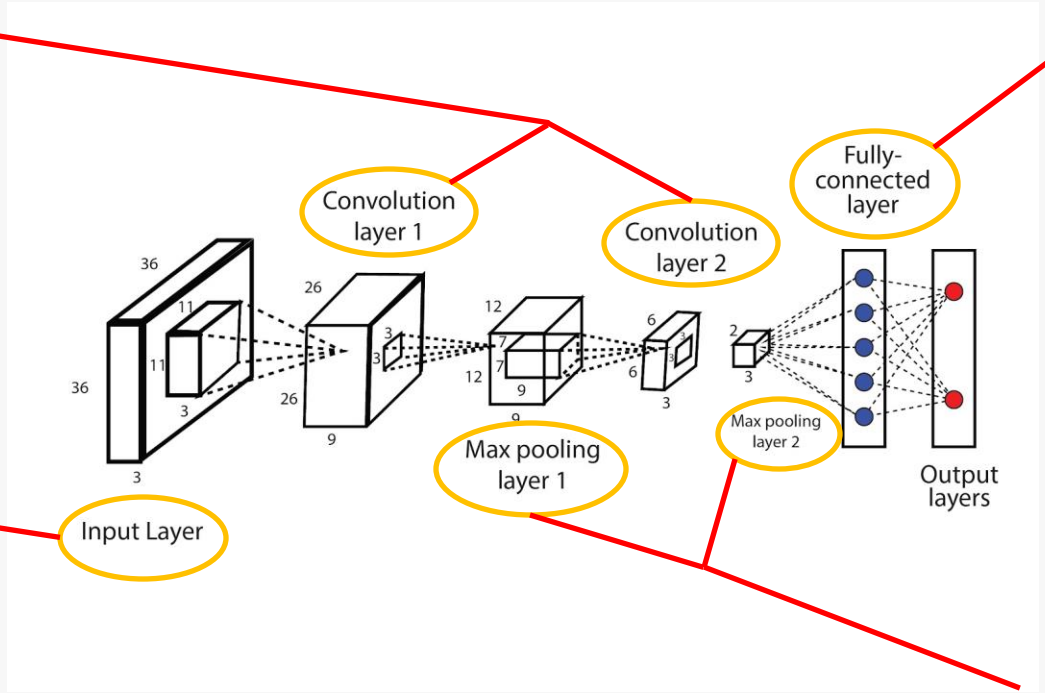
Convolutional Neural Networks



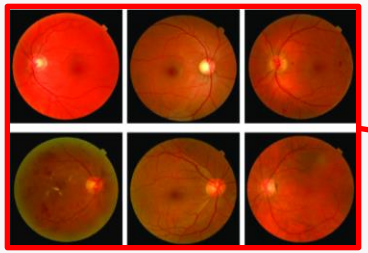
CNN has made uncomplicated automated retinal image analysis possible

Produce (feature) maps with high-level feature

Uses features to classify input images based on the training set



Source: (Kim et al., 2022)



Retinal Images

Source: (Balodi, 2019)

Summarises features in the feature map created by convolution layer

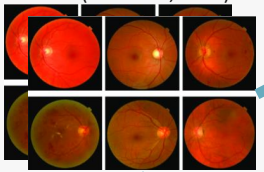
Explanatory (X) AI and Transfer Learning

Source: (Madala, Suvarna, & Pranathi Jalapally, 2022)

Input Images

Preprocessing

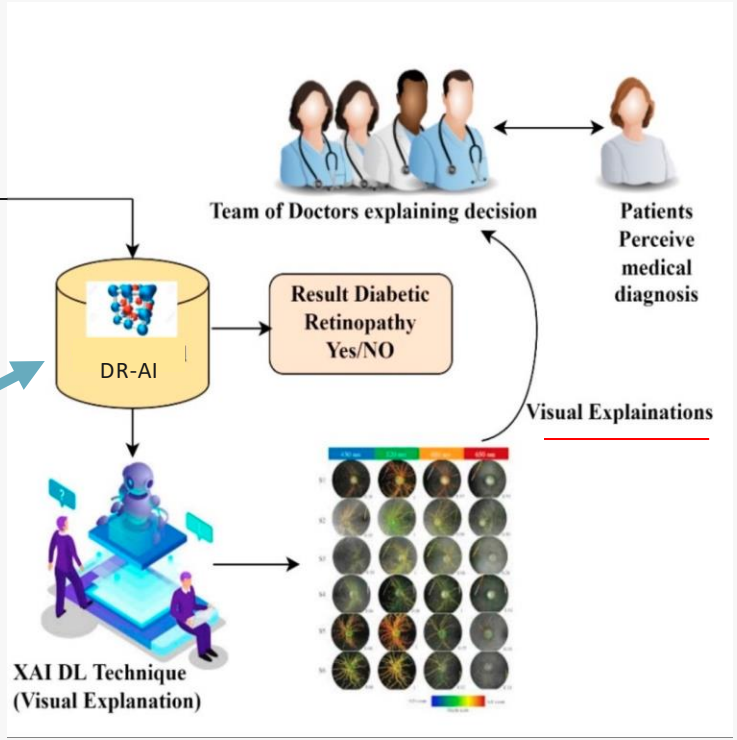
Source: (Kim et al., 2022)



Smaller Dataset

Existing CNN Model

Transfer Trained Weights



Source: (Bidwai, Gite, Pahuja, & Kotecha, 2022)

Electronic Health Record Integration

Source: (Remidio, n.d.)

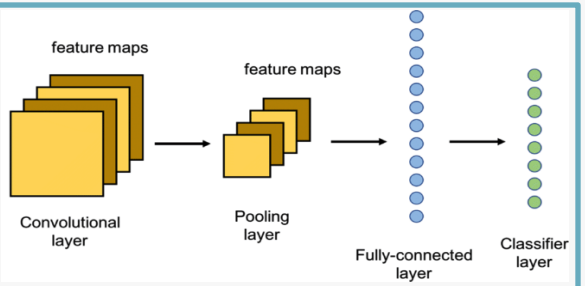
Fundus camera-equipped Smartphone

Source: (Madala, Suvarna, & Pranathi Jalapally, 2022)

Input Images

Preprocessing

DR-AI



Source: (Hatice Öncel Çekim, Hatice Nur Karakavak, Gamze Özel, & Tekin, 2023)

Medical History

DR screening/referral guidelines

Combine non-image data

XAI

Risk assessment, classification results and visuals, and recommendation

EHR

Input images, classification results and visuals automatically Saved into EHR

DR Screening and Referral Guidelines

Table 1: ICO/ADA 2018 DR Screening and Referral Guidelines for High Resource Settings

Source: (Lee, 2023)

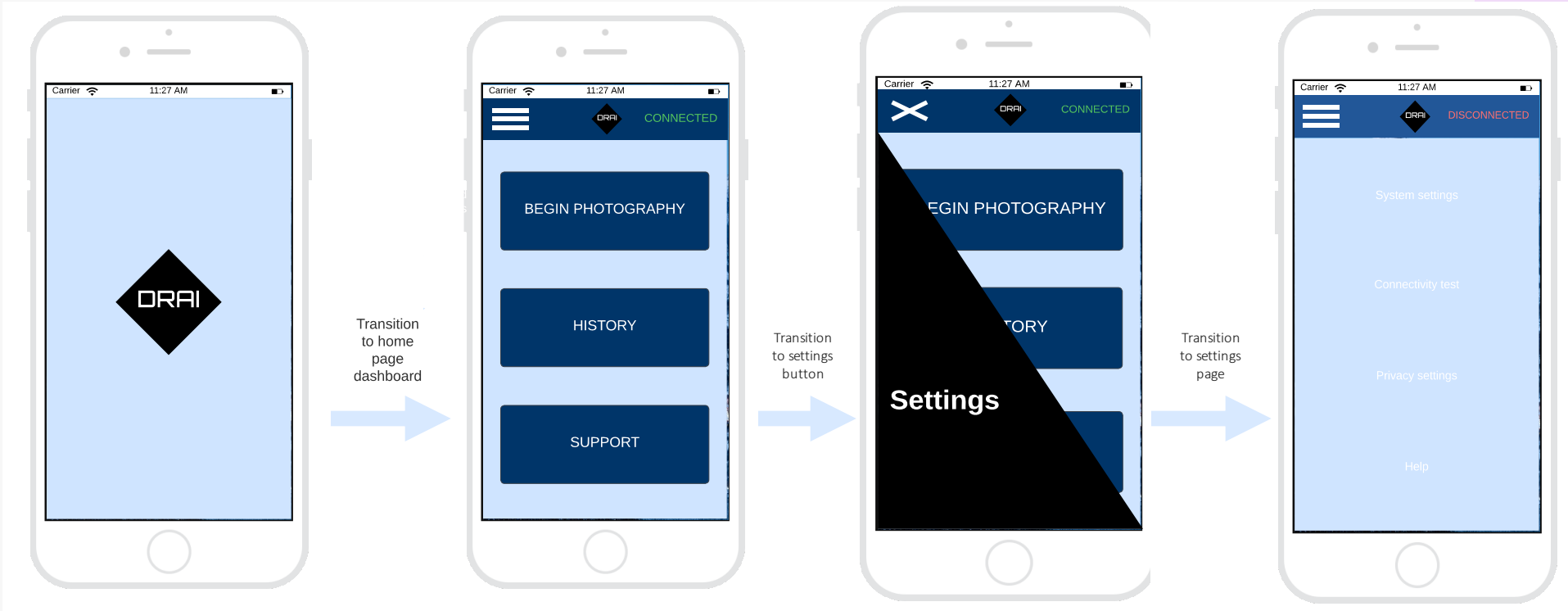
Classification	Re-examination or Next Screening Schedule	Referral to Ophthalmologist
Diabetic Retinopathy (DR)		
No apparent DR, mild nonproliferative DR, and no DME	Re-examination in 1–2 yrs	Referral not required
Mild nonproliferative DR	6–12 mos	Referral not required
Moderate nonproliferative DR	3–6 mos	Referral required
Severe nonproliferative DR	<3 mos	Referral required
Proliferative DR	<1 mo	Referral required
Diabetic Macular Edema (DME)		
Non–center-involving DME	3 mos	Referral required
Center-involving DME	1 mo	Referral required

Table 2: ICO/ADA 2018 DR Screening Follow-up Guidelines for Low-Intermediate Resource Settings

Source: (Lee, 2023)

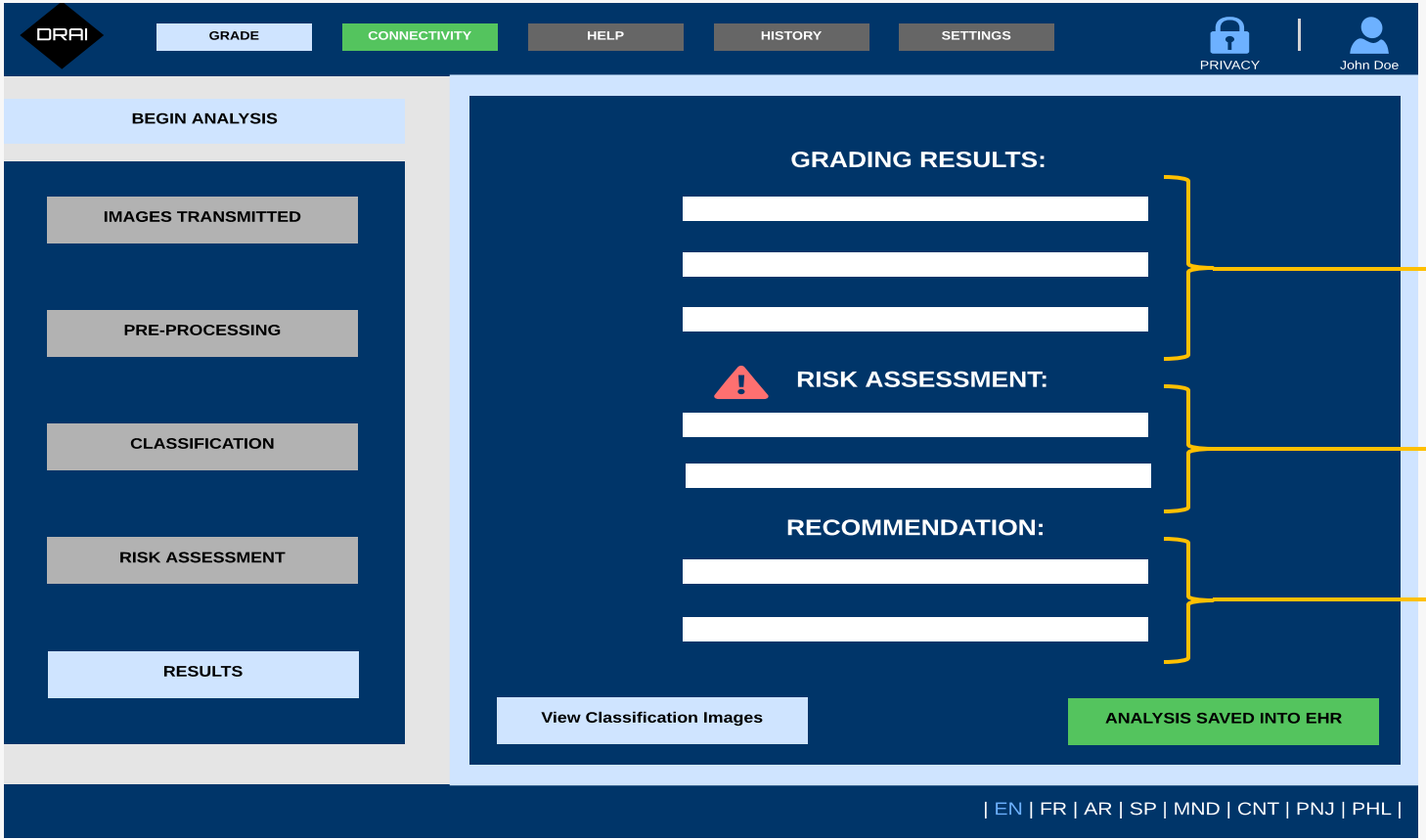
Classification	Re-examination or Next Screening Schedule	Referral to Ophthalmologist
Diabetic Retinopathy (DR)		
No apparent DR, mild nonproliferative DR, and no DME	Re-examination in 1–2 yrs	Referral not required
Mild nonproliferative DR	1—2 yrs	Referral not required
Moderate nonproliferative DR	6-12 mos	Referral required
Severe nonproliferative DR	<3 mos	Referral required
Proliferative DR	<1 mo	Referral required
Diabetic Macular Edema (DME)		
Non–center-involving DME	3 mos	Referral not required (referral recommended if laser sources available)
Center-involving DME	1 mo	Referral required

DR-AI Mobile App



Made with lucid.app

DR-AI Website



No/Mild/Moderate /Severe Non-proliferative DR, Proliferative DR

Low/Moderate/High Risk Based on Medical Records

Personalised Screening Plan Based on Risk Assessment and Guidelines, and/or Ophthalmology referral

Made with lucid.app

05

Stakeholders

Stakeholder Engagement

1- Patients

2- Primary Care Practice

3-Ophthalmologists/Optometrists/Hospitals

4- AI Developers

5- Regulatory Authorities

6- Research Organizations

7- Health Informaticians

8- EMR Vendors

9- WHO

10- Other CDSS system vendors

(IST Project Management Office, 2023)

Inform

Consult

Engage

Collaborate

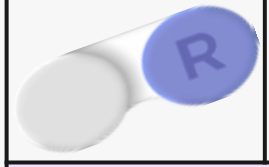
06

Conclusion

Next steps/Conclusion

AI-driven CDSS for DR screening Implementation

- Enhance the screening process for eye diseases
  - •Primary care clinics
  - •Diabetes centers
  - •Ophthalmology clinics
- Pharmacies accessing healthcare professionals
- Health insurance companies
- Companies can include DR-AI



Future of AI-driven CDSS for DR screening (DR-AI)

AI algorithms and CDSS systems(DR-AI)

- Better detecting invisible signs of DR
- Integrating CDSS into healthcare systems
- Combining the tool with telemedicine platforms.
- Technology affordable and portable
  - •Smaller clinics
  - • Rural areas
  - • Developing countries
- Addressing privacy and ethical concerns
- Test for a broader range of eye illnesses and diseases
- DR-AI mobile health apps-self-assessments

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Thank You

Do you have any questions?