SEEING WHAT'S NEXT: APPLYING AI TO DETECT AND DIAGNOSE CHRONIC DISEASES

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NCAFCC Annual Conference

Charlotte, NC - October 24-25, 2024

AFFILIATIONS AND FUNDING

SCHOOL OF BUSINESS

SCHOOL OF MEDICINE

CENTER FOR
HEALTHCARE INNOVATION

WAKE FOREST CLINICAL &
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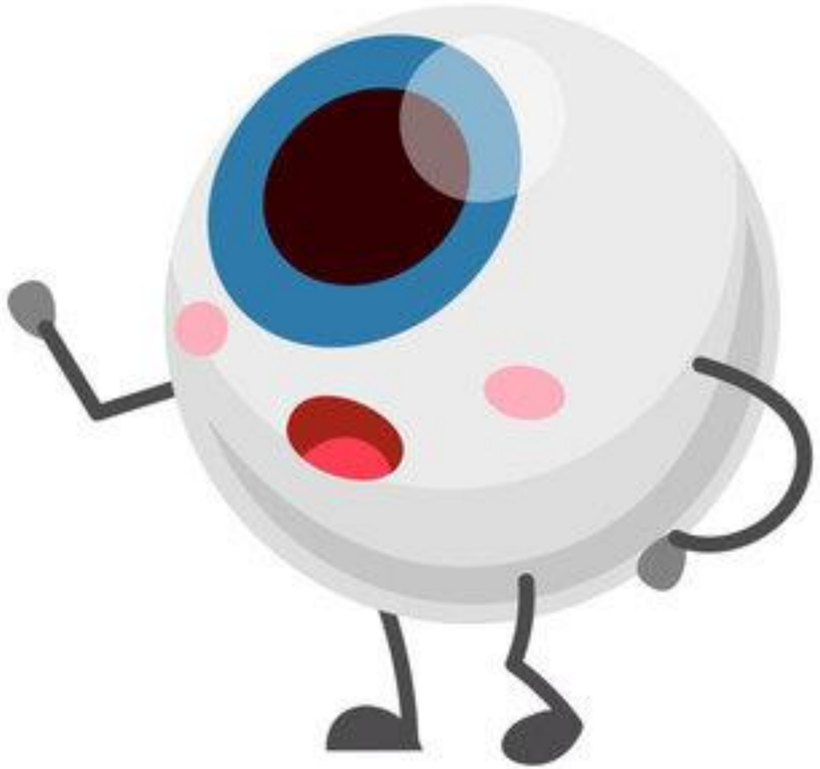
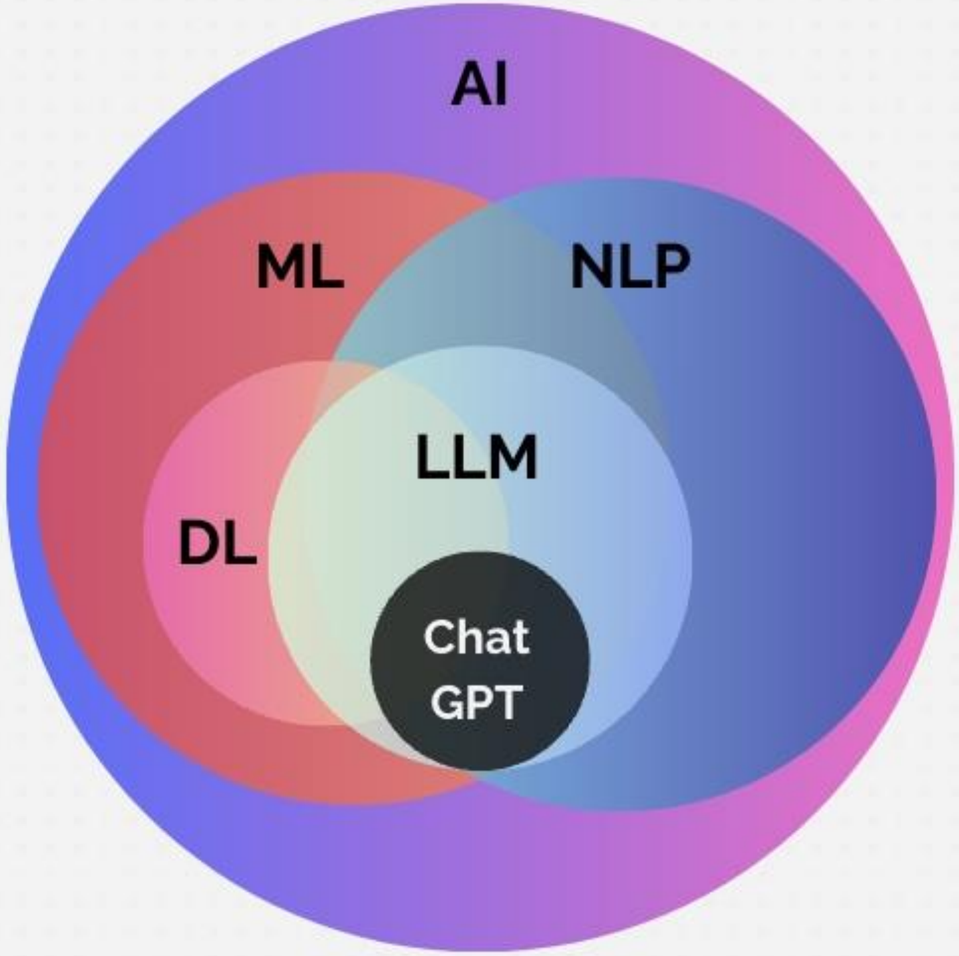
“IT’S ALL IN THE EYES”




THE EYES
ARE THE WINDOW
TO YOUR SOUL


THE EYES
ARE A WINDOW
TO OUR HEALTH

AI Landscape: Terms and Relationships



Artificial Intelligence

Machine Learning

Natural Language Processing

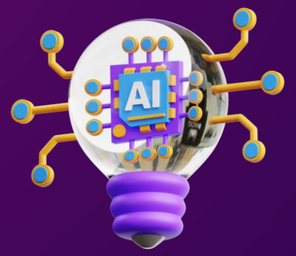
Deep Learning

Large Language Models

ChatGPT

Source: [Wonda VR]

WHAT IS AI?



WHAT ARE THE TYPES OF AI AVAILABLE?

Defining Generative AI

To understand generative artificial intelligence (GenAI), we first need to understand how the technology builds from each of the AI subcategories listed below.

Expert System AI

Programmers teach AI exactly how to solve specific problems by providing precise instructions and steps.

Artificial Intelligence

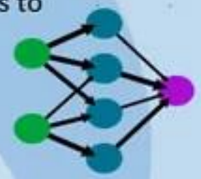
The theory and methods to build machines that think and act like humans.

Machine Learning

The ability for computers to learn from experience or data without human programming.

Deep Learning

Mimics the human brain using artificial neural networks such as **transformers** to allow computers to perform complex tasks.



Generative AI

Generates new text, audio, images, video or code based on content it has been **pre-trained** on.

AI for Education

aiforeducation.io

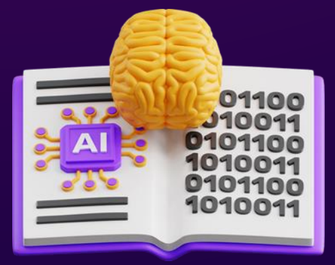
HOW IS AI USED IN HEALTHCARE?

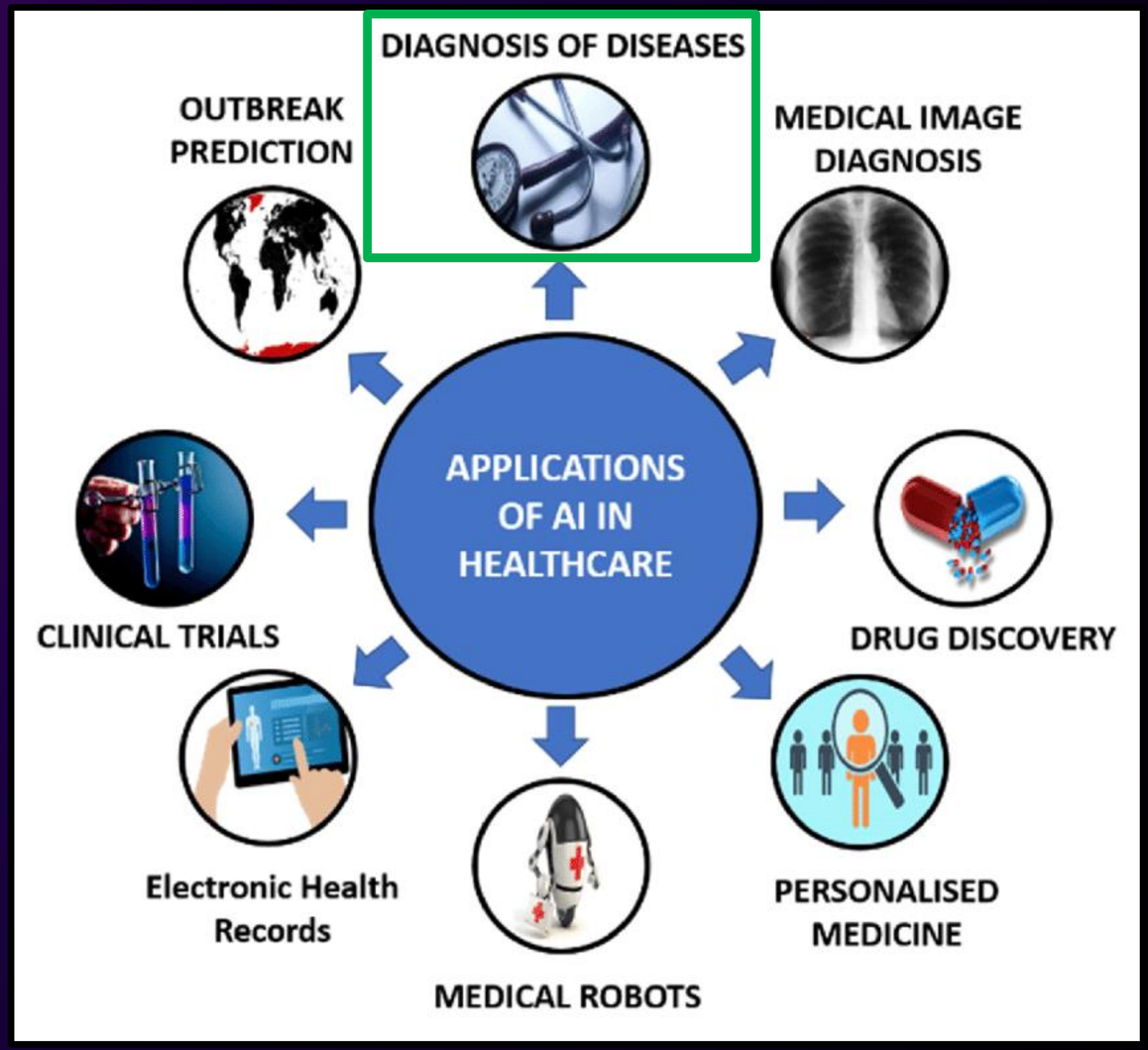
Managerial

Operational

Financial

Clinical





'A study of the recent trends of immunology: Key challenges, domains, applications, datasets, and future directions," *Sensors* 21.23 7786 (Pandya, S., et al. 2021).

1. HUMAN-CENTERED AI

2. CASE STUDY

3. LESSONS LEARNED

HUMAN-CENTERED AI:

"focuses on amplifying, augmenting, and enhancing human performance in ways that make systems reliable, safe, and trustworthy."

FEAR VS. HOPE

- Both are powerful motivators, either away from or towards something
- Felt when experiencing negative or positive outcomes from meaningful events
- Evoke anticipatory physiological responses, whether desirable or not
- Affect thinking ability, especially when situational control is limited

FEAR:

WILL AI TAKE MY JOB?

HOPE:

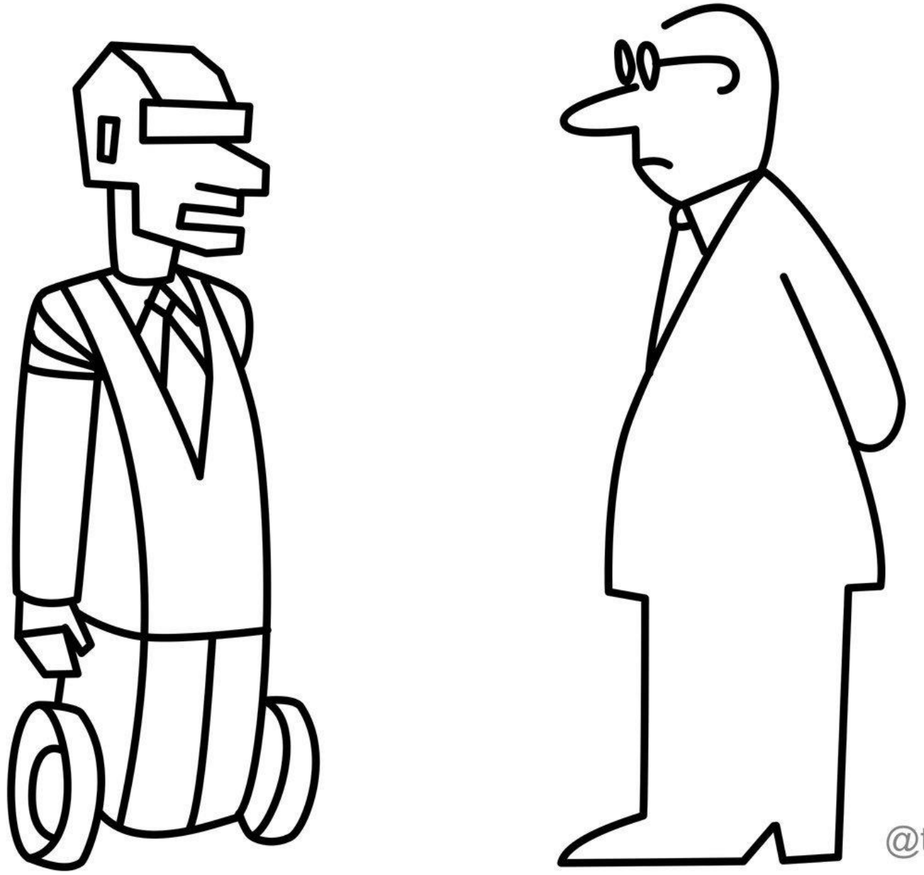
WILL AI TAKE MY JOB TO THE NEXT LEVEL?

WHY, HOW, AND WHEN WILL AI TAKE MY JOB TO THE NEXT LEVEL?

DRIVERS OF FEAR

FEAR:

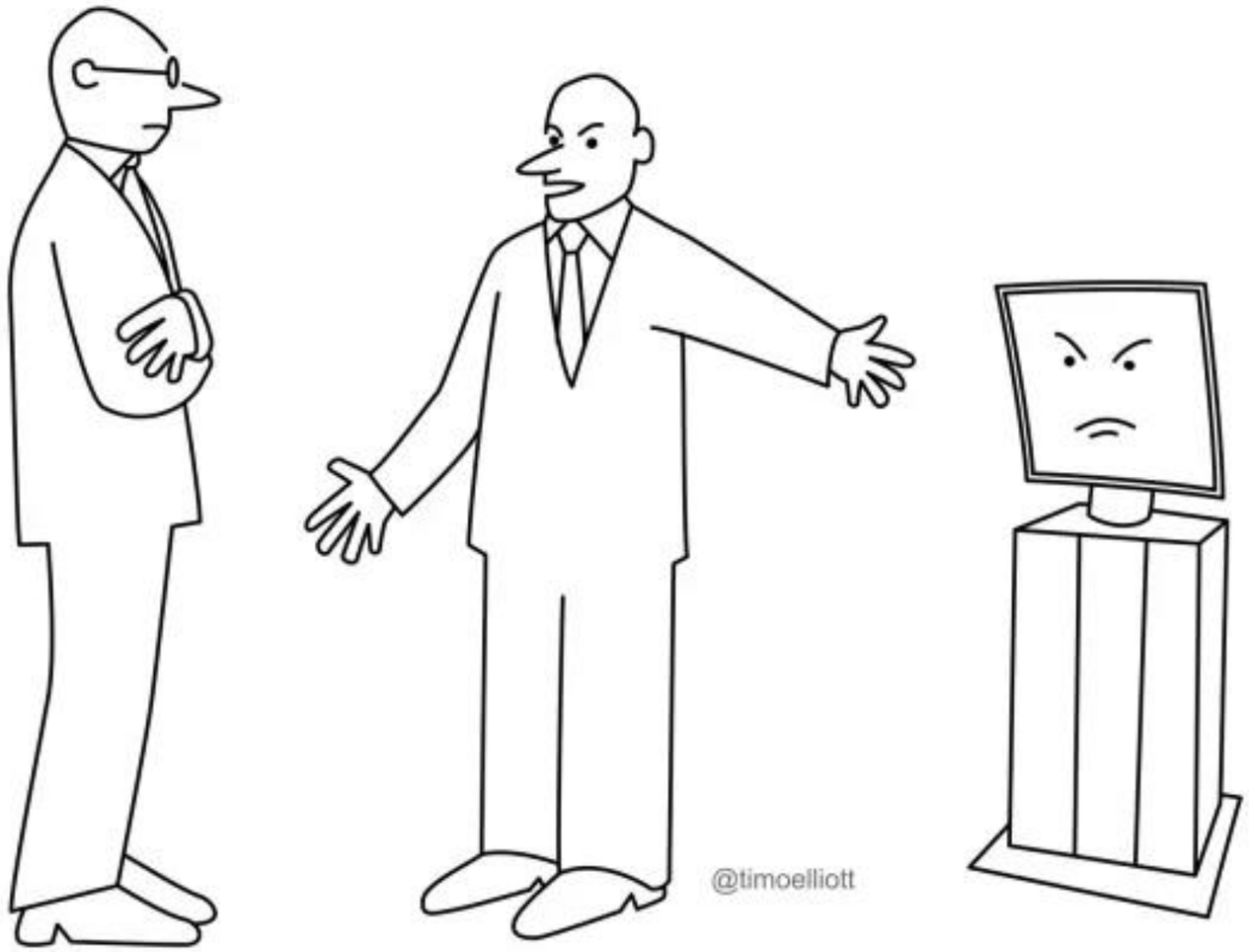
GOOD NEWS IS ACTUALLY BAD NEWS



"The good news is I have discovered inefficiencies. The bad news is that you're one of them."

FEAR:

ENABLING FASTER DECISIONS



His decisions aren't any better than yours — but they're WAY faster...

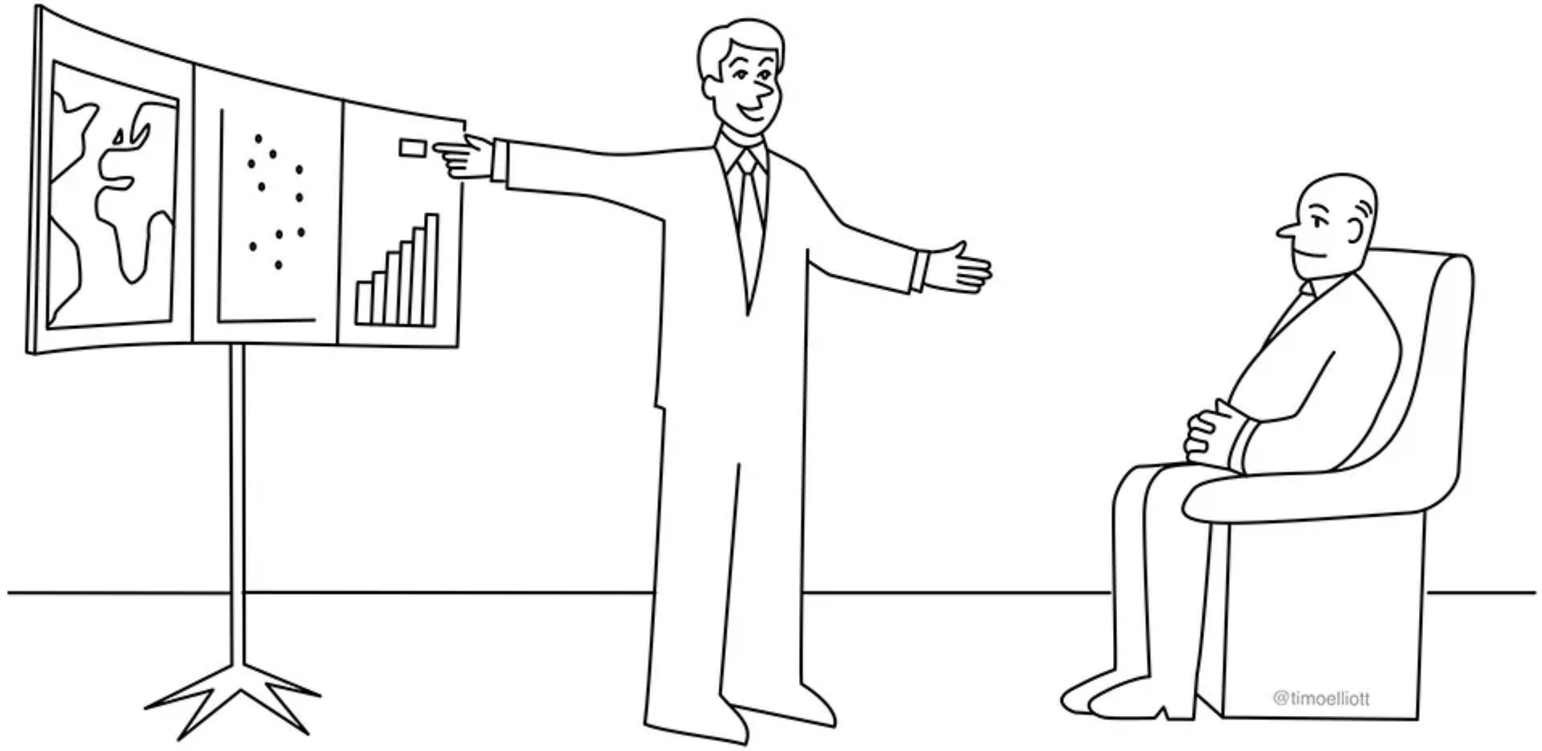
FEAR:

MAKING WORSE DECISIONS

"We're outsourcing all our critical business decisions to a flawed algorithm with insufficient data — what could possibly go wrong?!"

FEAR:

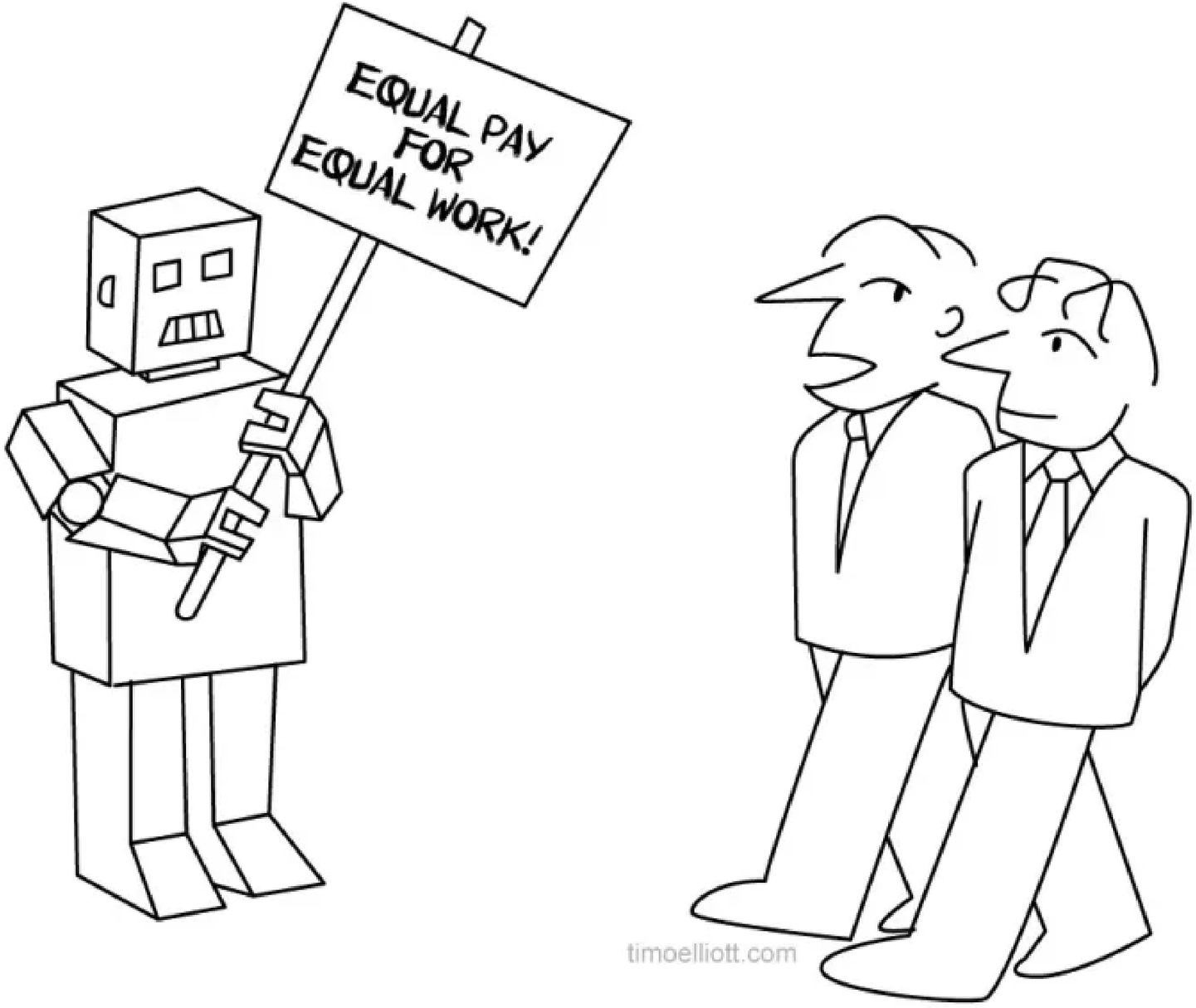
CREATING FALSE CONFIDENCE



"And our unique JustifyIt™ feature uses deep learning to find data that agrees with your point of view!"

FEAR:

BECOMING SMARTER THAN US



"I guess they really are getting smarter!..."

HUMAN-CENTERED AI SYSTEMS:

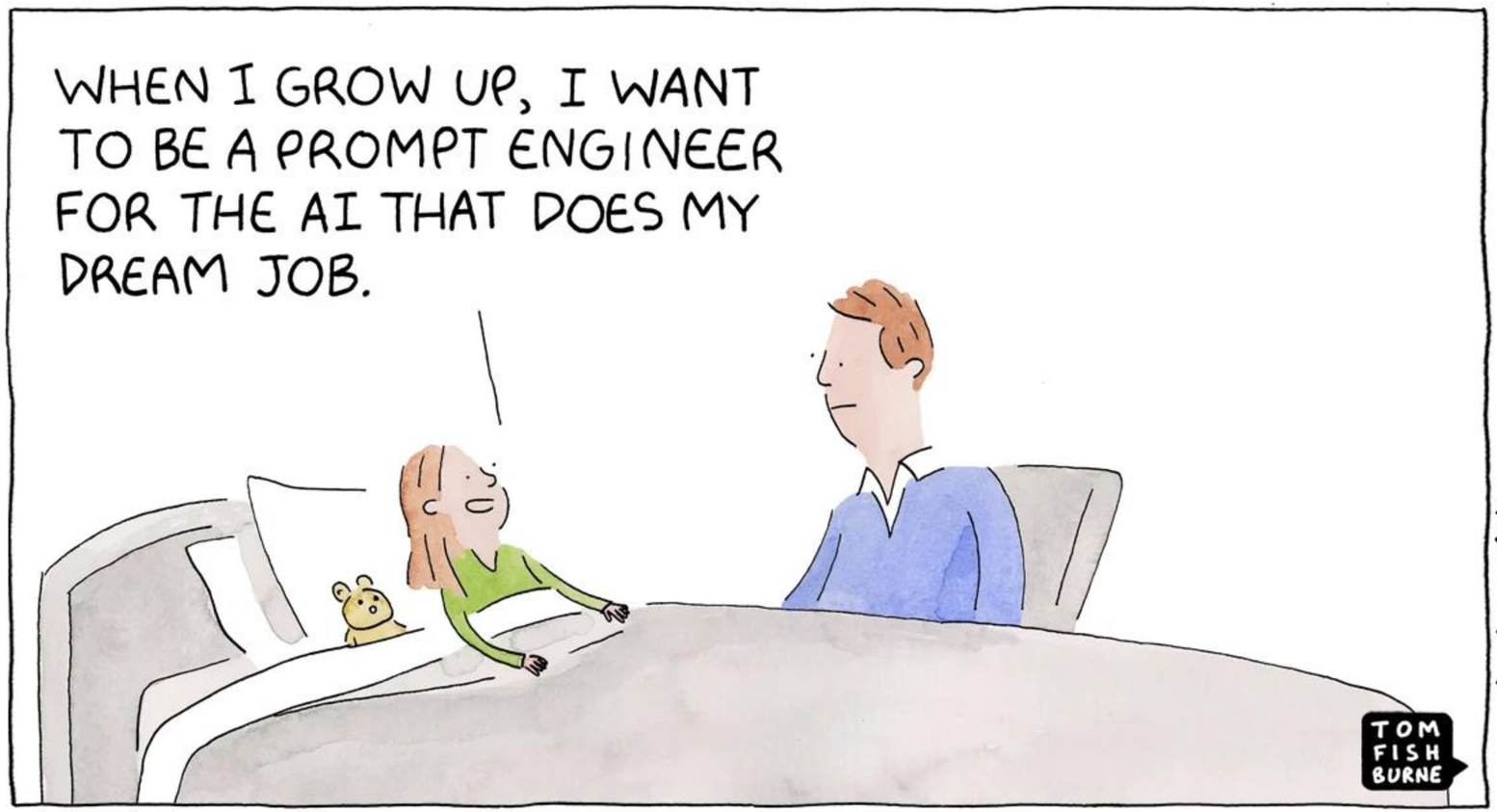
“amplify and augment human abilities while preserving human control and ensuring ethically aligned design.”

‘AI/Human augmentation: a study on chatbot–human agent handovers,’
Vassilakopolu & Pappas (2022)

REASONS FOR HOPE

HOPE:

DESIGNING OUR JOBS



Source: Marketoonist

HOPE:

FREEING UP OUR TIME

Source: Marketoonist

HOPE:

SOLVING BIGGER PROBLEMS

Source: Marketoonist

HOPE:

MAKING PRODUCTIVE GAINS

Source: Marketoonist

HOPE:

BECOMING THOUGHT LEADERS

Source: Marketoonist

HUMAN-CENTERED AI SYSTEMS:

“enhance human capacities and improve human experiences rather than replacing them through automation.”

‘Commentary: human-centered AI: the new zeitgeist,’
Rogers (2022)

CASE STUDY

A STRATEGIST,
A PHYSICIAN, AND
AN ECONOMIST
WALK INTO A HOSPITAL ...

Eyes: The Windows to Your Health

National Geographic

THE EYES ARE A WINDOW TO OUR HEALTH

NUTRITION DEFICIENCY

Poor nutrition can cause a variety of problems — including dry, irritated eyes and **blurry vision**. Ask your eye doctor if dietary changes or supplements will help.

ALLERGIES

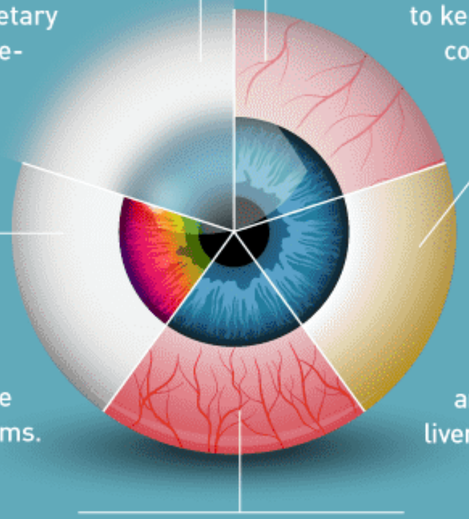
Don't suffer from **red, itchy, watery eyes** caused by allergies. Your eye doctor can prescribe treatments to keep your eyes comfortable year-round.

COLOR VISION CHANGES

Do **colors look faded**? Changes in your color vision may be a sign of early cataracts or other eye health problems.

LIVER PROBLEMS

Yellow eyes could be a sign of liver problems. See your eye doctor and general physician to make sure your eyes are healthy and your liver is functioning normally.



AUTOIMMUNE DISEASE

Autoimmune disease is when your body's defense mechanism against disease-causing microbes starts attacking normal, healthy cells. **Dry eyes and dry mouth** can be the warning signs of an autoimmune disease called Sjögren's syndrome, which damages glands that produce tears and saliva.

CANCER

Your eye doctor can check for sun damage that can cause cancer of the eyelids and front of the eye. Remember to wear shades outdoors in daylight to shield your eyes from UV.

DEMENTIA

Amyloid protein that builds up in the brain in Alzheimer's disease may appear in the retina as an early marker of the condition. Detection requires a special test called SD-OCT.

HIGH BLOOD PRESSURE

Early signs of damage from high blood pressure can be detected in a routine eye exam so potentially life-saving treatment can be initiated and adjusted as needed.

DIABETES

Both type 1 and type 2 diabetes can cause serious vision problems and even blindness. Routine dilated eye exams are essential to monitor control of the disease.

STROKE

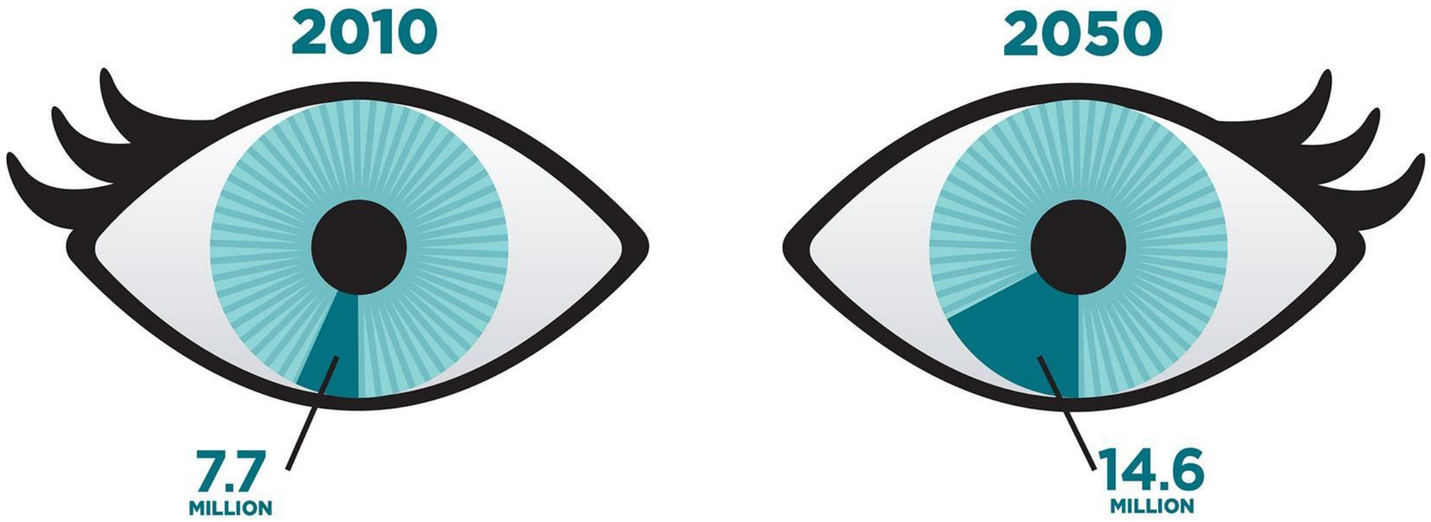
During a dilated eye exam, your eye doctor can examine the health of blood vessels in the retina and detect signs of increased risk of carotid artery disease and stroke.

Source: Vision Art Eye Care

LOOKING AHEAD AT THE IMPACT

Diabetic Retinopathy: NEI Looks Ahead

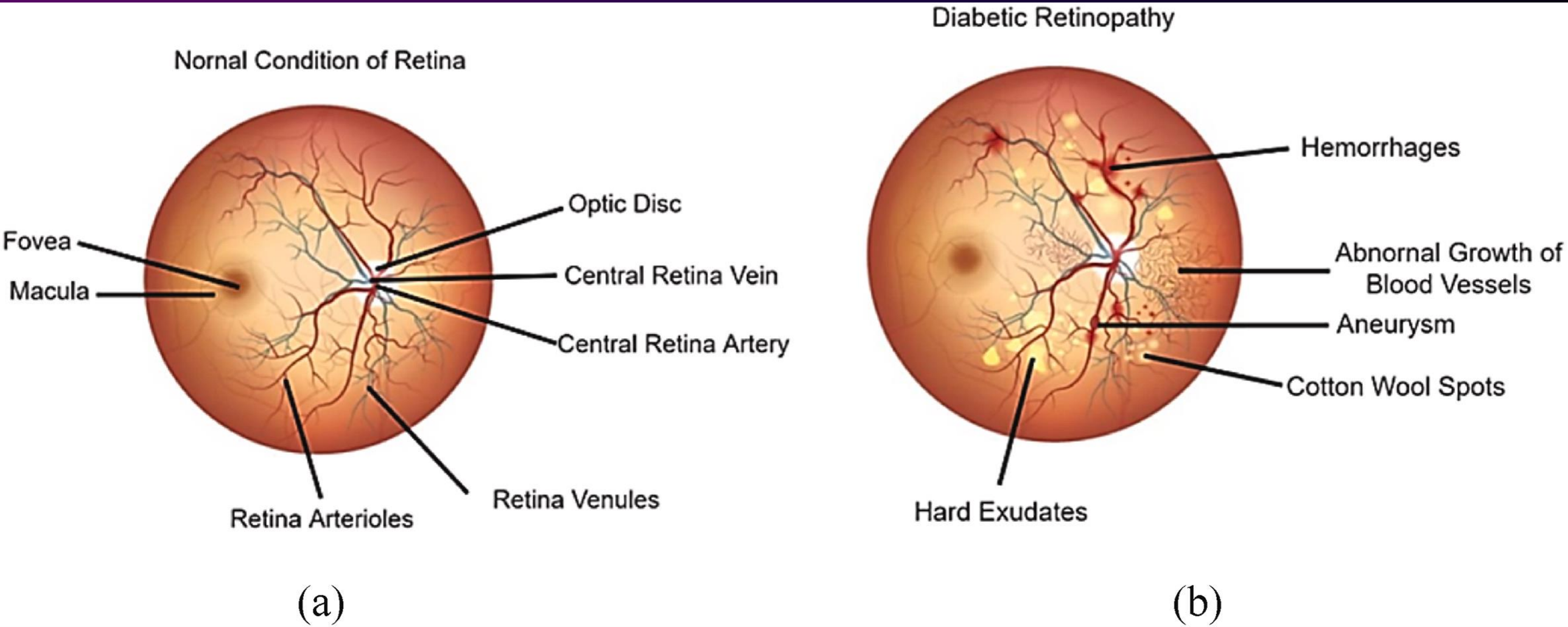
Between 2010 and 2050, the estimated number of people who have diabetic retinopathy will nearly double from 7.7 million to 14.6 million.



Each eye represents a total of 80 million people, the estimated number of Americans who will be 65 and older in 2050, the population most affected by common eye diseases.

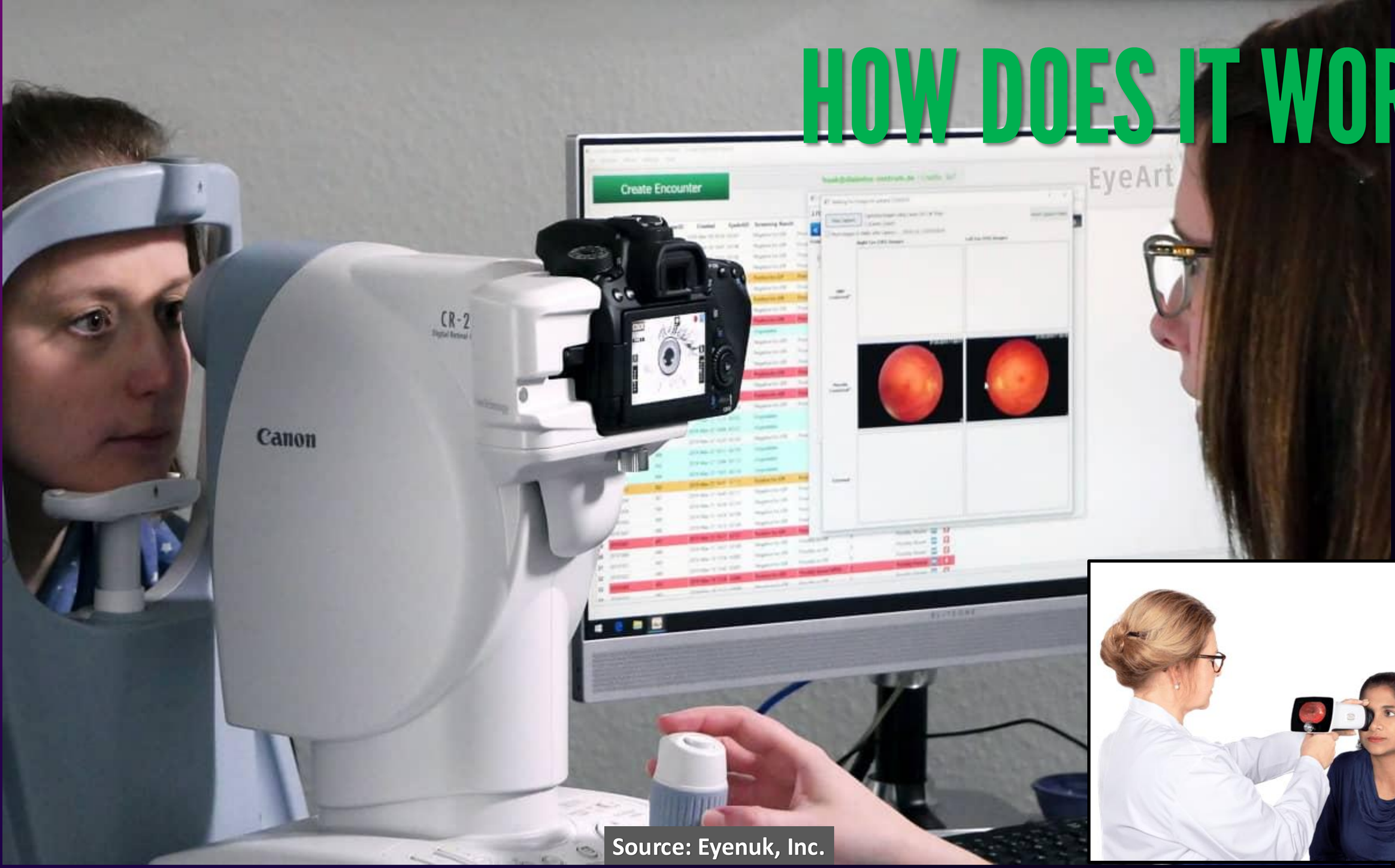
Source: NIH, National Eye Institute

HOW IS DIABETIC RETINOPATHY DETECTED?



‘Artificial intelligence for diabetic retinopathy detection: a systematic review." *Informatics in Medicine Unlocked* (Senapati et al., 2024)

HOW DOES IT WORK?



Source: Eyenuk, Inc.

HOW DOES IT WORK?

STEP 1: Capture color retinal fundus image of patient's eyes

STEP 2: Submit images to the cloud for analysis

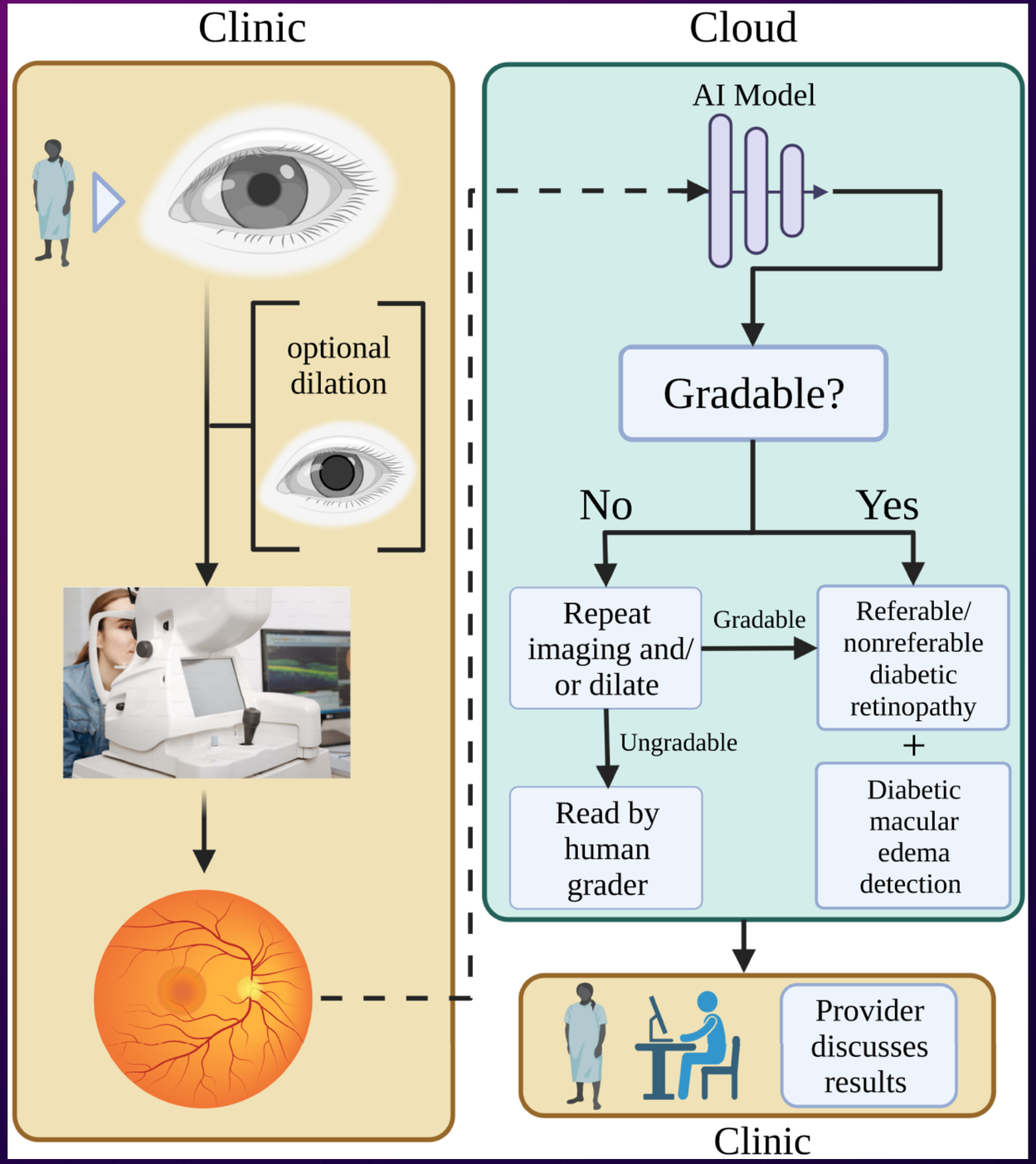
STEP 3: Download DR screening results and export PDF report

EyeArt®

FDA CLEARED

HEALTH CANADA APPROVED

Source: Eyenuk, Inc.



VALUE:

QUICK results < 1 min

SIMPLE – no dilation

SECURE – data safely stored locally

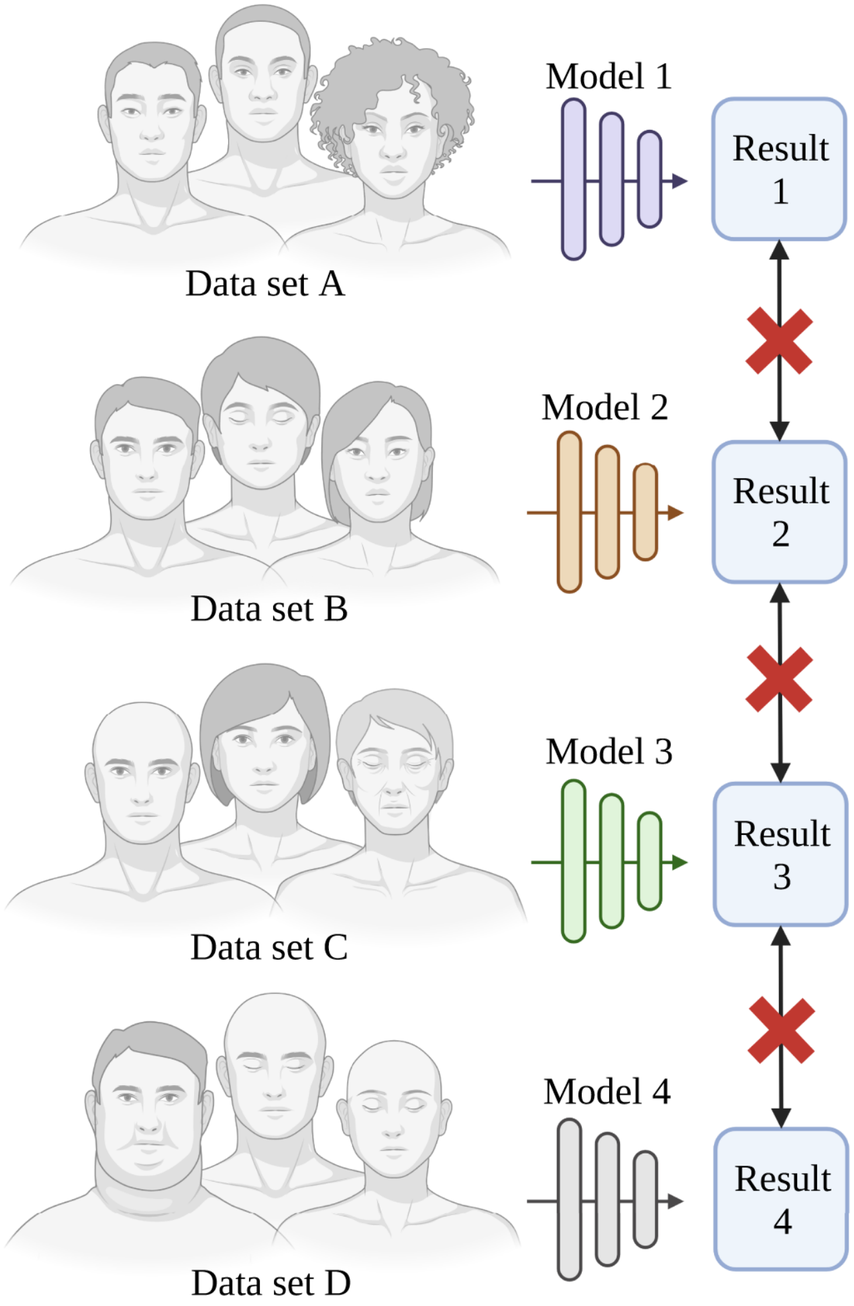
COST-EFFECTIVE – Reimbursable by Medicare and private payors:

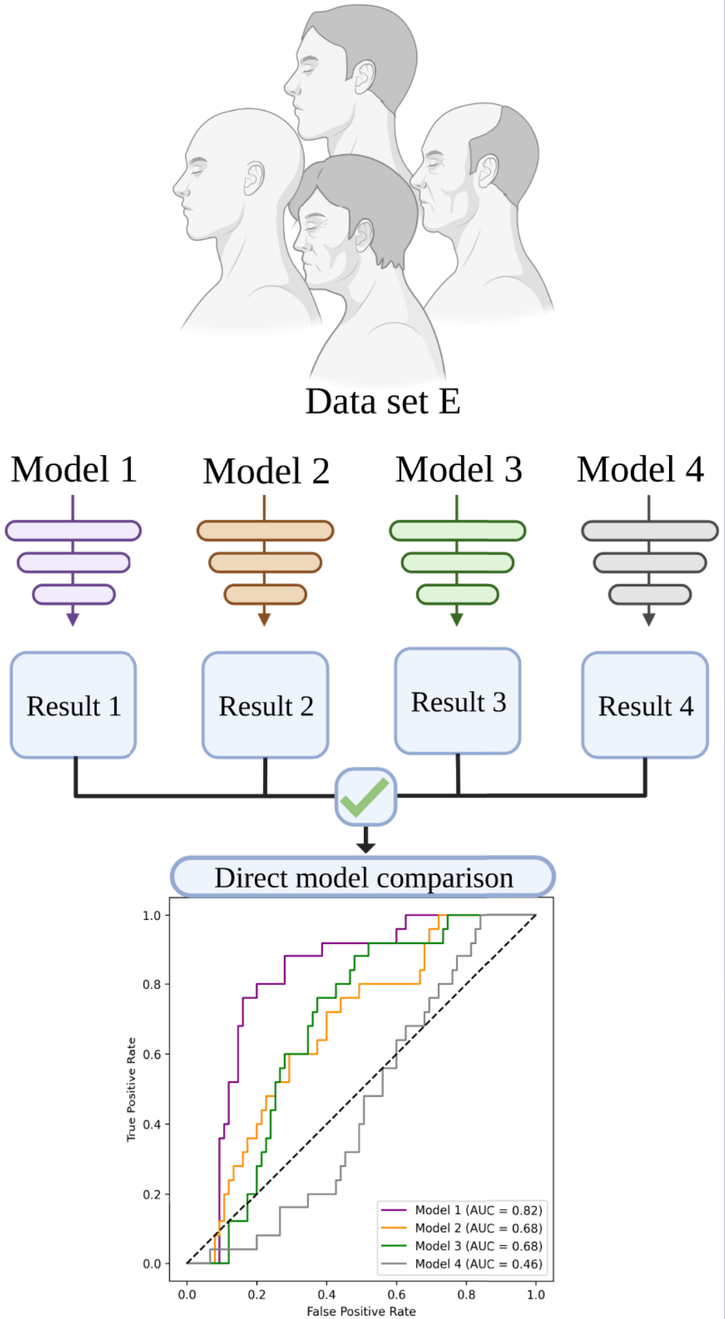
CPT Code 92229

Physician Fee AVG: $45.75, MAX: $62.93

For non-US data, see: 'A pilot cost-analysis study comparing AI-based EyeArt® and ophthalmologist assessment of diabetic retinopathy in minority women in Oslo, Norway,' *Int J Retina Vitreous*, (Karabeg et al., 2024)

'Artificial Intelligence and Diabetic Retinopathy: AI Framework, Prospective Studies, Head-to-head Validation, and Cost-effectiveness,' *Diabetes Care,* (Rajesh et al., 2023)





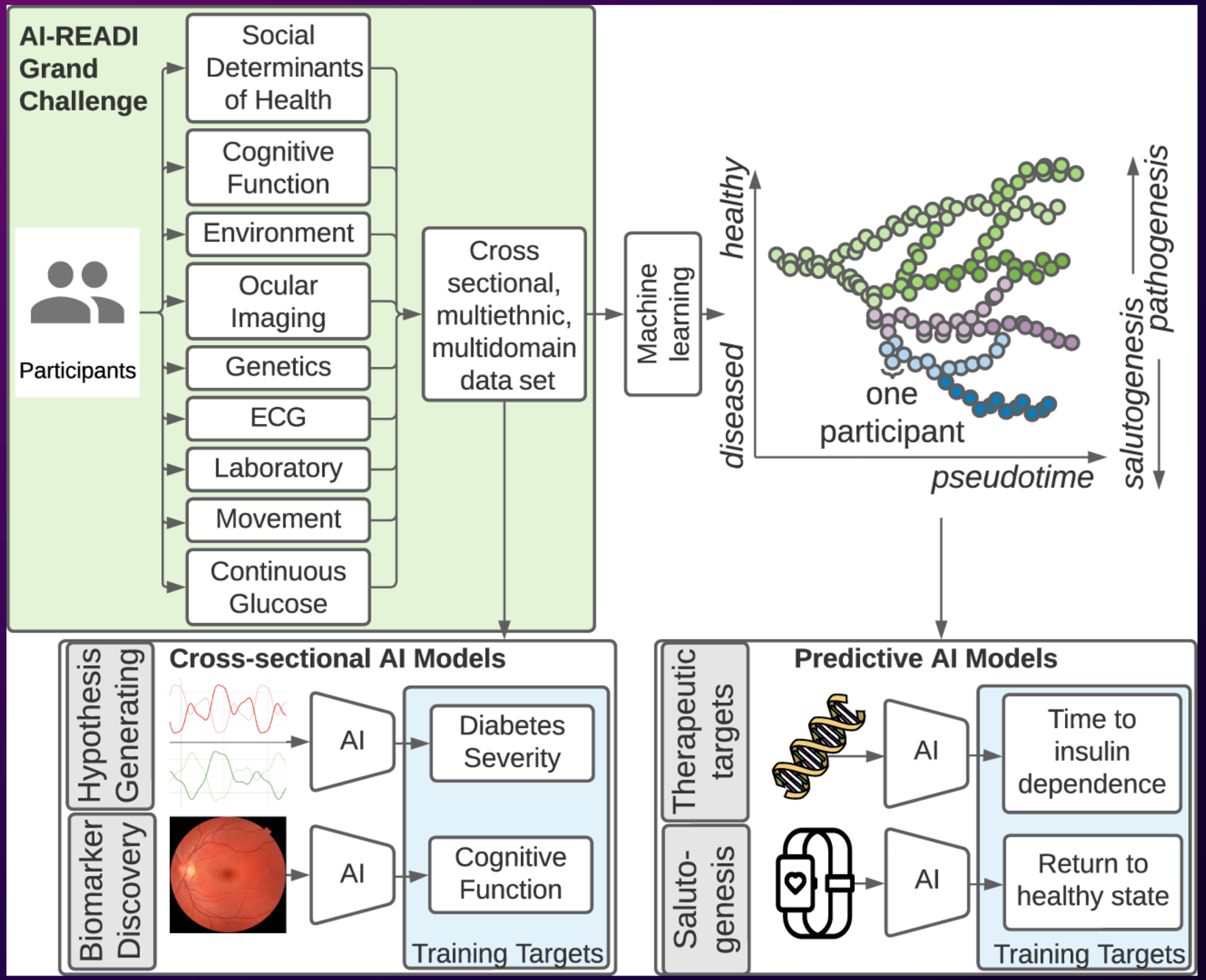
VALIDITY:

Direct comparison on common dataset, with large, diverse patient population

Results independently checked by human experts

93.3-95.5% agreement with AI analysis

‘Artificial Intelligence and Diabetic Retinopathy: AI Framework, Prospective Studies, Head-to-head Validation, and Cost-effectiveness,’ *Diabetes Care,* (Rajesh et al., 2023)



QUALITY:

AI System Performance

SENSITIVITY: 96%

SPECIFICITY: 88%

GRADABILITY:

87.4% - no dilation

97.4% - with dilation

Training set: 375K images,

Validation set: 250K images

'Artificial Intelligence Detection of Diabetic Retinopathy,' *Ophthalmology Science*, (Lim et al., 2023)

'Artificial Intelligence and Diabetic Retinopathy: AI Framework, Prospective Studies, Head-to-head Validation, and Cost-effectiveness,' *Diabetes Care,* (Rajesh et al., 2023)

Original Article

Five-Year Cost-Effectiveness Modeling of Primary Care-Based, Nonmydriatic Automated Retinal Image Analysis Screening Among Low-Income Patients With Diabetes

Journal of Diabetes Science and Technology
2022, Vol. 16(2) 415–427

DOI: 10.1177/1932296820967011
journals.sagepub.com/home/dst
SAGE

Spencer D. Fuller, MD, MPH[1], Jenny Hu, MD, MAS[2], James C. Liu, MD[1], Ella Gibson, BA[1], Martin Gregory, MD[3], Jessica Kuo, BS[1], and Rithwick Rajagopal, MD, PhD[1]

Abstract

Background: Artificial intelligence-based technology systems offer an alternative solution for diabetic retinopathy (DR) screening compared with standard, in-office dilated eye examinations. We performed a cost-effectiveness analysis of Automated Retinal Image Analysis System (ARIAS)-based DR screening in a primary care medicine clinic that serves a low-income patient population.

Methods: A model-based, cost-effectiveness analysis of two DR screening systems was created utilizing data from a recent study comparing adherence rates to follow-up eye care among adults ages 18 or older with a clinical diagnosis of diabetes. In the study, the patients were prescreened with an ARIAS-based, nonmydriatic (undilated), point-of-care tool in the primary care setting and were compared with patients with diabetes who were referred for dilated retinal screening without prescreening, as is the current standard of care. Using a Markov model with microsimulation resulting in a total of 600 000 simulated patient experiences, we calculated the incremental cost-utility ratio (ICUR) of the two screening approaches, with regard to five-year cost-effectiveness of DR screening and treatment of vision-threatening DR.

Results: At five years, ARIAS-based screening showed similar utility as the standard of care screening systems. However, ARIAS reduced costs by 23.3%, with an ICUR of $258 721.81 comparing the current practice to ARIAS.

Conclusions: Primary care-based ARIAS DR screening is cost-effective when compared with standard of care screening methods.

Keywords

artificial intelligence, cost-effectiveness analysis, diabetic retinopathy, healthcare economics, machine learning technology, public health

EQUITY:

Over 5 years, primary care-based AI screening among low-income patients with diabetes is **23.3% less costly and equally effective** as referring all patients for annual dilated eye examination.

Cost savings come from **increased adherence to follow-up** ophthalmic care recommendations and **reduced severity** of complications.

WHAT ARE THE COSTS AND FUNDING?

Item	Cost	Estimated Cost Per Patient
Camera Equipment	$16,000 (one-time)	$5.33
Camera Maintenance	$ 1,000 (annual)	$0.33
Software Subscription	$ 5,000 (annual)	$1.67

Estimated Total Cost Per Patient is $31.02, based on screening 3000 Patients/Year. No eye dilation required = faster exam time.

University of Chicago Illinois deployment funded by NIH/NEI grants, Health Equity Pilot Project and Cless Family Foundation.

‘Five-Year Cost-Effectiveness Modeling of Primary Care-Based, Nonmydriatic Automated Retinal Image Analysis Screening Among Low-Income Patients With Diabetes,’ *Journal of Diabetes Science and Technology*, (Fuller et al., 2022)

‘Planning an artificial intelligence diabetic retinopathy screening program: a human-centered design approach,’ *Frontiers in Medicine,* (Scanzera et al., 2023)

LESSONS LEARNED

WHEN APPLYING AI, FOLLOW A HUMAN-CENTERED APPROACH

HUMAN-CENTERED AI SYSTEMS:

“AI will not replace medical professionals. However, those medical professionals that use AI will replace those that don’t.”

Dr. Bertalan Mesko,

‘The Future of Radiology And Artificial Intelligence’, The Medical Futurist (2022)

1. CLEARLY EXPLAIN “WHY”

2. FLEXIBLY ADAPT “HOW”

3. FIRMLY COMMIT “WHEN”

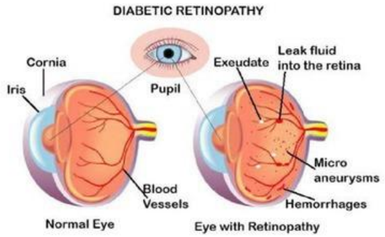
A

UI Health

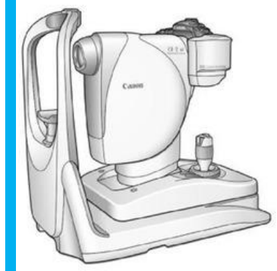
AI-Driven Diabetic Retinopathy Screening at Family & Community Medicine

What is Diabetic Retinopathy?

Diabetic retinopathy (DR) is an eye condition that could cause bleeding in the eye and possibly vision loss in people who have diabetes. DR causes 12,000-24,000 new cases of blindness annually, and is one of the leading causes of blindness in the U.S.



Early detection and treatment can prevent vision threatening problems



Why Get Screened Today?

The new **AI technology** can autonomously detect DR with a high level of accuracy. It is also:

- **Quick** – results back in < 1 min.
- **Simple** – no dilation required
- **Secure** – data safely stored locally

Result from screening could determine how soon you will be seen and put you in front of the line to receive **personalized care** and **timely treatment** from your ophthalmology referral (in < 1 month).

Why Comprehensive Eye Exam?

"Getting your screening result back is a great start but far from the end"—as patients with diabetes are recommended to have a dilated fundus examination or posterior pole image screening **annually**, regardless of your result, it is critical that you follow up with a **Comprehensive eye exam** for more in-depth assessments.

Referral appointment scheduled before the end of your visit

We at Family & Community Medicine and the Department of Ophthalmology aim to help and assist you as much as we can as you go on this valuable journey. **Please scan the QR code shown to learn more about this process.**

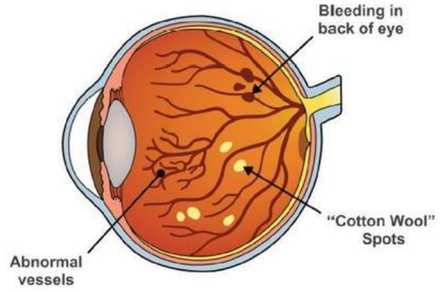
B

Diabetes Eye Care
at UI Health

Why is eye care important?

- Diabetes is the *leading cause* of vision loss in people 18-64 years old.
- Many eye problems do not have obvious symptoms at first.

Annual eye exams can prevent 95% of vision loss caused by diabetes.



Normal Vision

Diabetic Retinopathy with Vision Loss

Why get an eye screening today?

- Diabetic retinopathy is a common eye condition that can cause vision loss.
- Family Medicine can screen you for diabetic retinopathy today and connect you with an eye specialist sooner.

Your next steps:

1 Get eye screening today at Family Medicine clinic.

2 Schedule a comprehensive eye exam. We can help!

3 Attend eye exam and any follow-up eye care visits.

Have questions? Ask your doctor or scan the QR code to learn more about diabetes eye care.

UI Health

Photos adapted from ©NEI Media Library.

'Planning an artificial intelligence diabetic retinopathy screening program: a human-centered design approach,' *Frontiers in Medicine,* (Scanzera et al., 2023)

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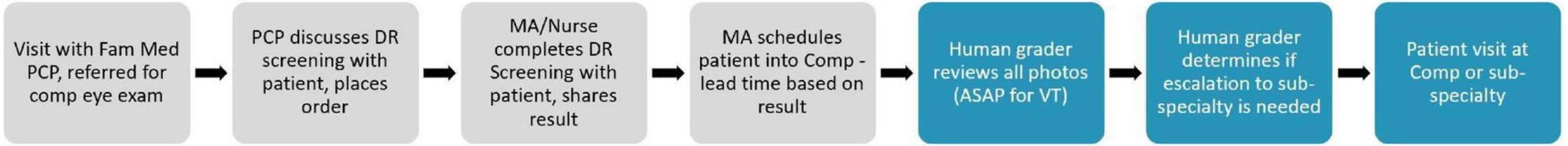

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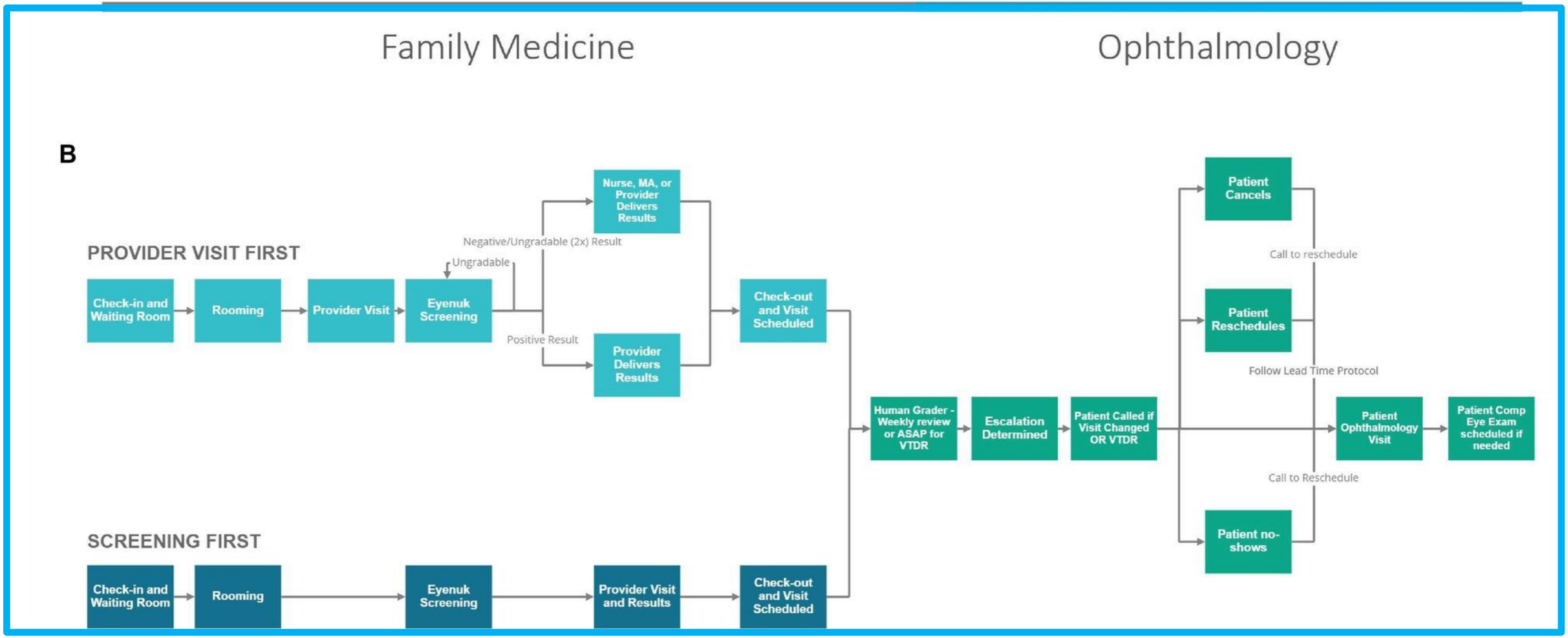
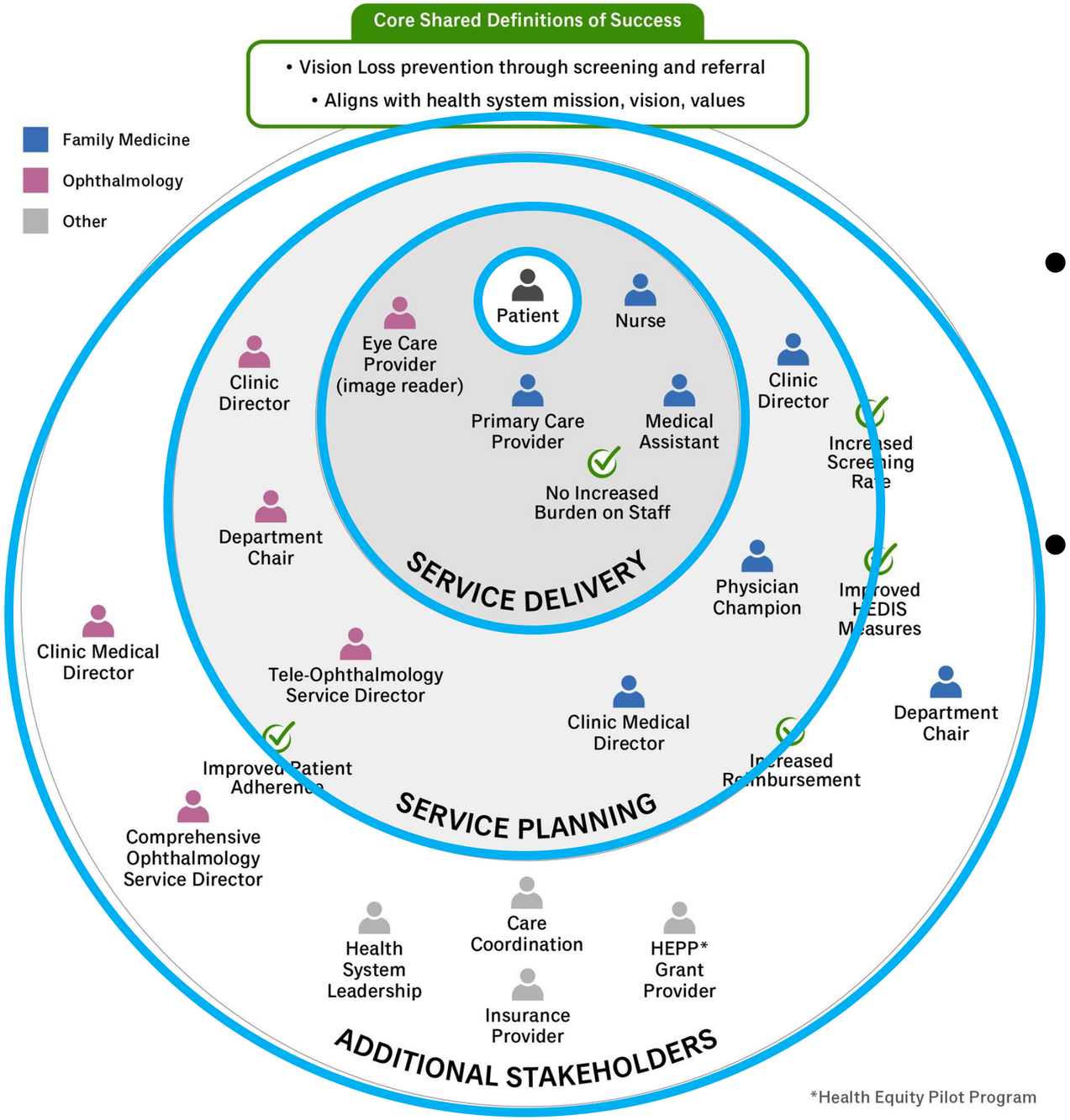


'Planning an artificial intelligence diabetic retinopathy screening program: a human-centered design approach,' *Frontiers in Medicine,* (Scanzera et al., 2023)



BEST PRACTICES:

- Start with core shared definition of success, aligned with:
  - Mission, Vision, and Values
- Sustain via active involvement of key stakeholders, to drive:
  - Optimized staffing
  - Increased screening rate
  - Improved patient adherence
  - Improved quality measures

‘Planning an artificial intelligence diabetic retinopathy screening program: a human-centered design approach,’ *Frontiers in Medicine,* (Scanzera et al., 2023)

MANAGE FEAR AND HOPE,
ASK WHY, HOW, AND WHEN
WILL AI TAKE MY JOB
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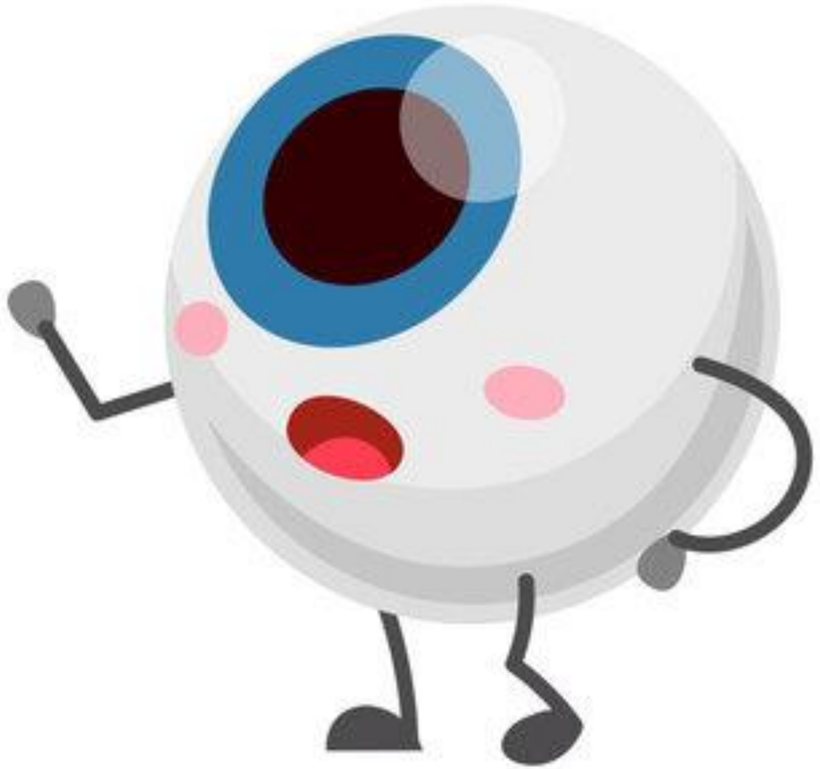
“IT’S ALL IN THE EYES”



THANK YOU!

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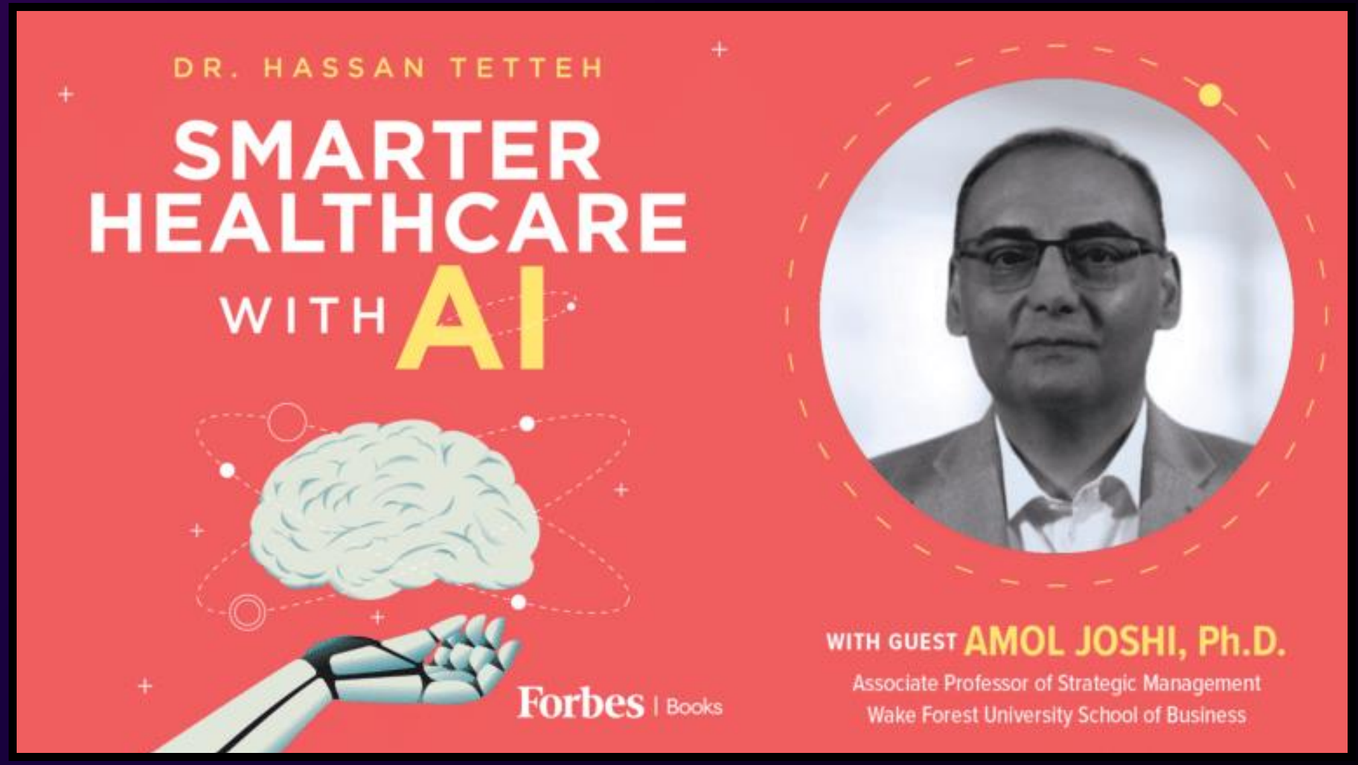

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PART 1 | PART 2