

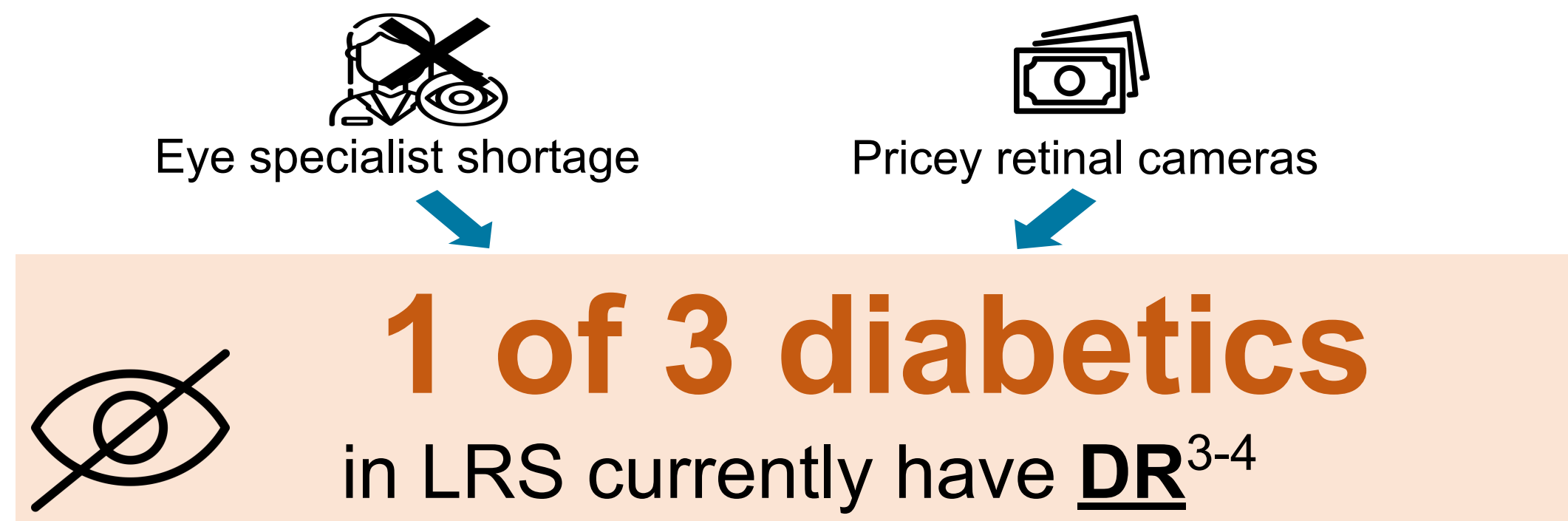
Introducing a Low-Cost Tele-Retinal Camera for Diabetes-Related Retinopathy Screening in Resource-Constrained Settings

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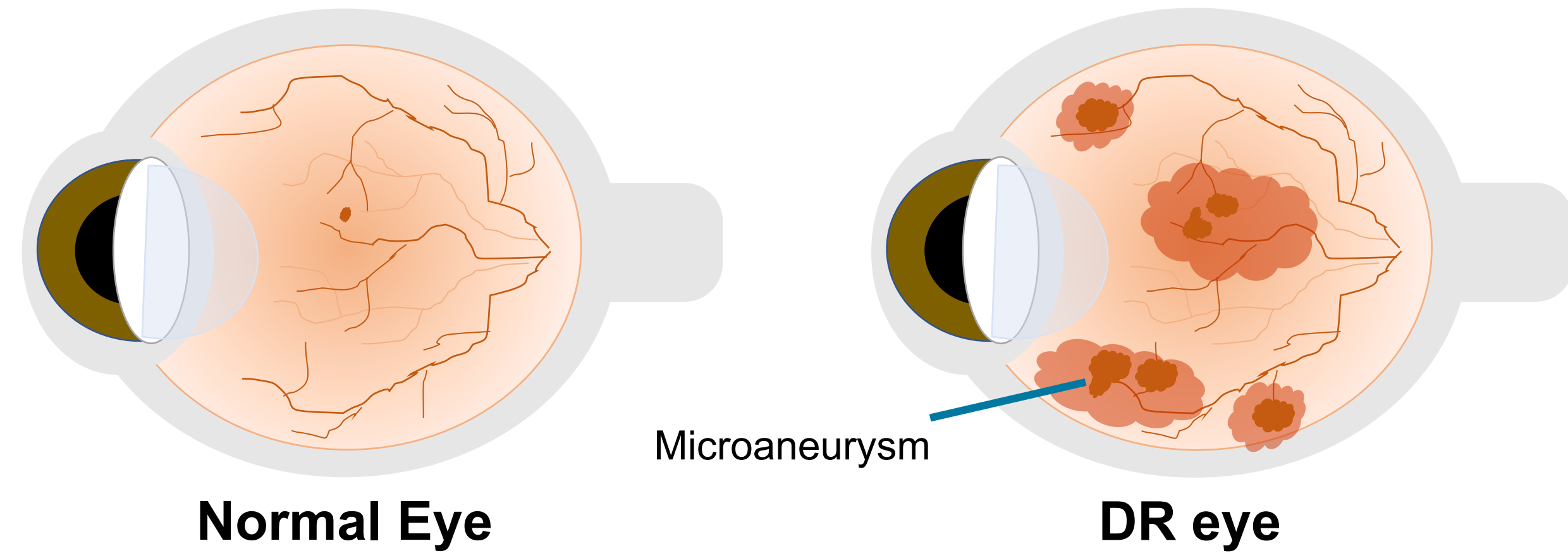
Clinical Motivation: Low-Resource Clinics Need Affordable Retinal Cameras

- Diabetic retinopathy (DR) is **preventable** with early eye screenings¹
- However, **80%** of diabetics in low-resource settings (LRS)² remain **unscreened** due to:



Proposed Technological Solution

Design a **low-cost retinal camera** for accessible, early screening of **diabetic retinopathy (DR)**, to **reduce** the prevalence of **blindness** in diabetics in low-resource settings (LRS).



Methods and Key Design Objectives

- Interviewed **20+** physicians and optical experts
- Created 19 design inputs
- Used **ISO 13485** and **ISO 10940** to guide testing protocols
- Performed **usability testing** with **primary care providers (PCPs)** in outpatient clinic

IMAGE QUALITY^{2,5}

- Image resolution is **≤ 40 μm**
- Image field of view is **30-50°**

COST AND USABILITY

- Manufacturing cost is **≤ \$450**
- Ease-of-use is **≥ 3** on user-defined scale

SAFETY AND OPERATION TIME⁵

- Battery has **> 4 hr.** of standby power
- Light intensity is safe (**< 70,000 lux**)

Innoscope: A Portable Camera that Efficiently Captures Retinal Images for DR Screening

\$450 | 3 lb.

1. MAGNIFY RETINA OPTICAL SYSTEM

2. ILLUMINATE RETINA LIGHT SYSTEM

3. TAKE RETINAL IMAGE SCREEN & USER INTERFACE

4. INTERPRET RETINAL IMAGE IMAGE EXPORT

Innoscope Resolves DR Microaneurysms, Safely Illuminates the Retina, and is Clinically Usable by PCPs

Image Quality

Image Resolution and Field of View are Sufficient for DR Screening

37.5 μm
AVG. RESOLUTION

43°
FIELD OF VIEW

- Used *ISO 10940* to measure field of view.
- Angle found using: $\tan^{-1}(\text{diameter}/1000)$
- Resolution measured based on smallest distinguishable bars on USAF1951 target.

Battery Life and Light Safety

Current Handheld Retinal Camera: 4 hr.

Innoscope: 10 hr.

6 hr.
Avg. Half-Shift Duration for Nurses

61,000 lux
MAXIMUM LIGHT INTENSITY

Clinical Validation

Ease of Image Capture After Training

4.6 out of 5
EASE OF TAKING AN IMAGE

Figure 3. Clinical usability data. Innoscope (n=5) was reported as significantly easier to capture images than a current retinal camera (n=8). Student's unpaired t-test utilized.

Conclusions and Impact

- Protects vision of **200 million diabetics**
- Clinics **save up to \$19,500** per camera
- Portable, efficient, and easy-to-use by nurses
- **Next steps:** Fine-tune illumination system, continue clinical studies. File provisional patent.

Acknowledgements and References

Thank you to UTHealth School of Public Health's Dr. Joseph McCormick and Edward Yao, and to our mentors: Dr. Madhavi Reddy, Jiawei Lu, Joseph Bailey, Hae Won Jung, Dr. Matthew Wettergreen, and Prof. Casey Howard.

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