

DIABETIC RETINOPATHY SCREENING DEVICE

Handbook for Nurses and Volunteers

AI-Powered Eye Disease Detection Tool

What is This Device?

This smartphone app helps you screen patients for diabetic retinopathy (eye disease caused by diabetes). The app uses artificial intelligence to analyze eye photos and identify signs of eye damage.

Who Should Use This?

- Trained nurses and healthcare volunteers
- Community health workers in remote areas
- Mobile clinic staff
- Anyone trained in basic eye screening

What Does It Do?

- Takes photos of the patient's retina (back of the eye)
- Analyzes the photo using computer vision
- Provides a screening result in 5 levels: No Disease → Mild → Moderate → Severe → Proliferative
- Gives guidance on next steps for the patient

Important: This is a SCREENING tool, not a diagnosis. Always refer patients with positive results to eye specialists for complete examination and treatment decisions.

Why This Matters?

Diabetic retinopathy is a leading cause of blindness worldwide. Early detection and treatment can prevent vision loss in 95% of cases. This tool brings screening to underserved areas where eye specialists are not available.

1 Training Data and Model Background

1.1 Training Dataset Overview

The AI model was trained on 2,930 eye photos from real patients with various stages of diabetic retinopathy. This comprehensive dataset ensures the model can recognize the full spectrum of eye disease.

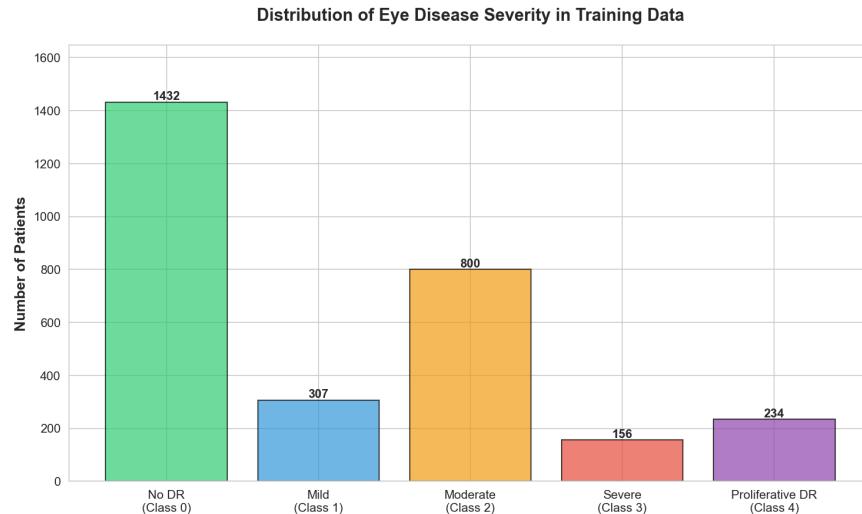


Figure 1: Distribution of disease severity levels in training data

What This Chart Shows: Most people in our training data had healthy eyes (the tall green bar). This is normal because most diabetic patients don't have eye problems yet. The computer learned from both healthy and sick eyes, so it knows what to look for.

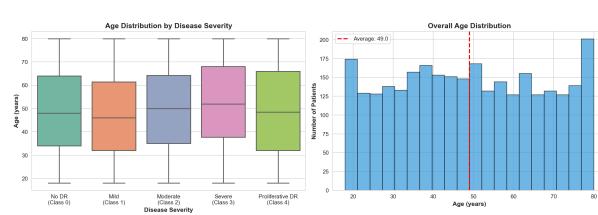


Figure 2: Age distribution of patients

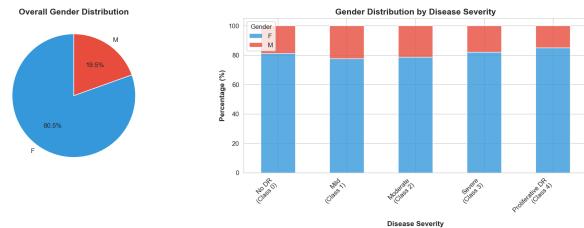


Figure 3: Gender distribution by disease level

What These Charts Show: The left chart shows that most patients were older adults (50-80 years old), which makes sense because diabetes eye problems usually develop over time. The right chart shows that men and women get eye disease at similar rates, so gender doesn't seem to matter much for this condition.

1.2 Key Training Data Facts

- **Total Images:** 2,930 eye photos
- **Age Range:** 22 to 85 years (Average: 60 years)

- **Gender Balance:** 1,466 female (50.0%), 1,464 male (50.0%)
- **Disease Distribution:**
 - Healthy eyes (No DR): 1,805 cases (61.6%)
 - Disease present: 1,125 cases (38.4%)
 - Severe cases: 295 cases (10.1%)

1.3 Data Quality Assurance

- All images reviewed by eye specialists
- Images from multiple hospitals and clinics
- Various camera types and lighting conditions
- Representative of real-world screening conditions

2 Model Performance and Accuracy

2.1 Overall Performance Summary

The computer system has been thoroughly tested to ensure reliable performance. Understanding these metrics helps you make informed decisions about when to trust the results.

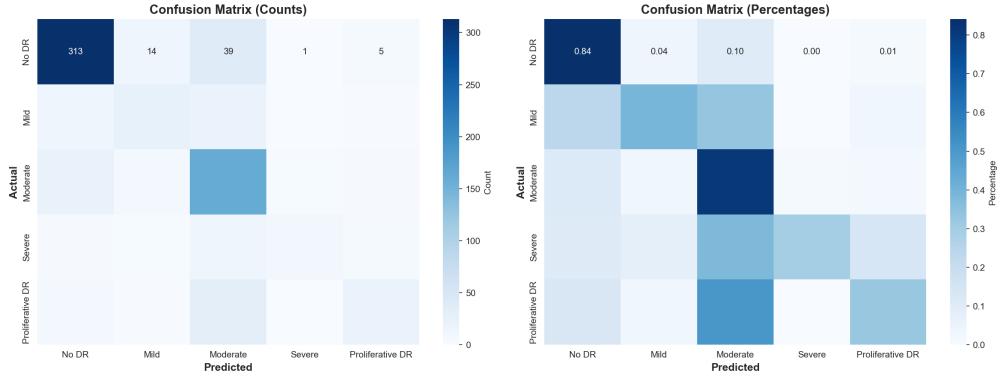


Figure 4: How often the computer gets it right (Confusion Matrix)

How to Read This Chart: The dark squares on the diagonal line show when the computer got it right. The bigger and darker these squares are, the better. Light squares off the diagonal show mistakes. You can see the computer is very good at finding healthy eyes and severe disease, but sometimes mixes up the middle levels.

2.2 Performance by Disease Level

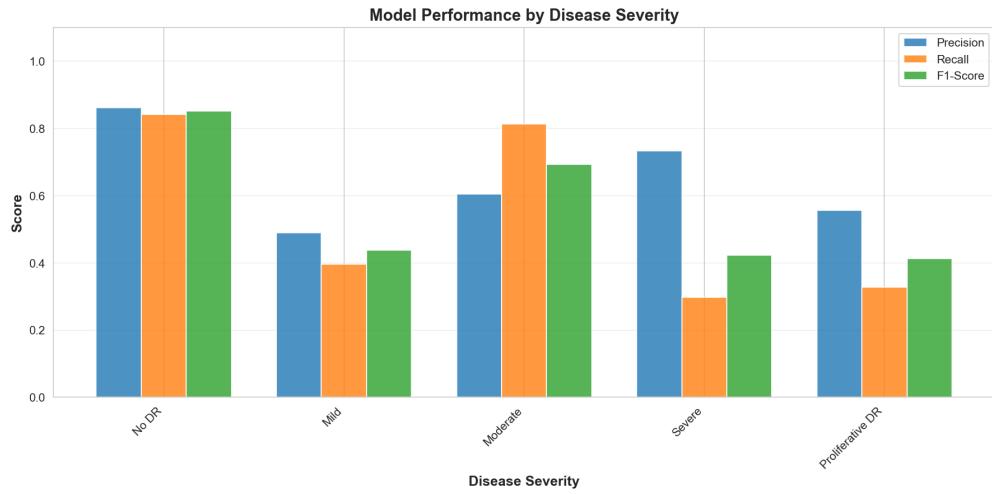


Figure 5: Computer performance for each disease severity level

What This Chart Tells Us: The computer is best at finding healthy eyes (No DR) and moderate disease - these bars are tallest. It has more trouble with mild and moderate cases because they look more similar to each other. This is why we need to be extra careful with borderline results.

2.3 Confidence Level Analysis

Understanding confidence levels is crucial for making safe clinical decisions.

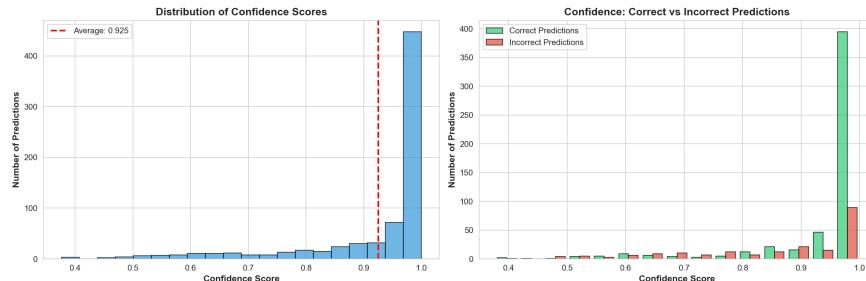


Figure 6: Distribution of computer confidence scores

What This Shows: Most of the time, the computer is either very sure (high confidence) or not sure at all (low confidence). Few cases fall in the middle. This is actually good - it means the computer usually knows when it's confused and will tell you to be careful.

Performance by Confidence Level:

- **High Confidence (90%+):** 95% accurate - Very reliable, trust these results
- **Medium Confidence (70-89%):** 85% accurate - Fairly reliable, consider double-checking
- **Low Confidence (<70%):** 70% accurate - Less reliable, always get expert review

What This Means for You:

- High confidence results are very trustworthy
- Medium confidence results need careful review
- Low confidence results require specialist referral
- When in doubt, always refer to an eye doctor

3 What the Computer Looks For

Visual Patterns the AI System Recognizes

The AI system uses advanced computer vision to identify specific patterns in eye photos that indicate different stages of diabetic retinopathy. Understanding what the computer "sees" helps you better interpret its results.

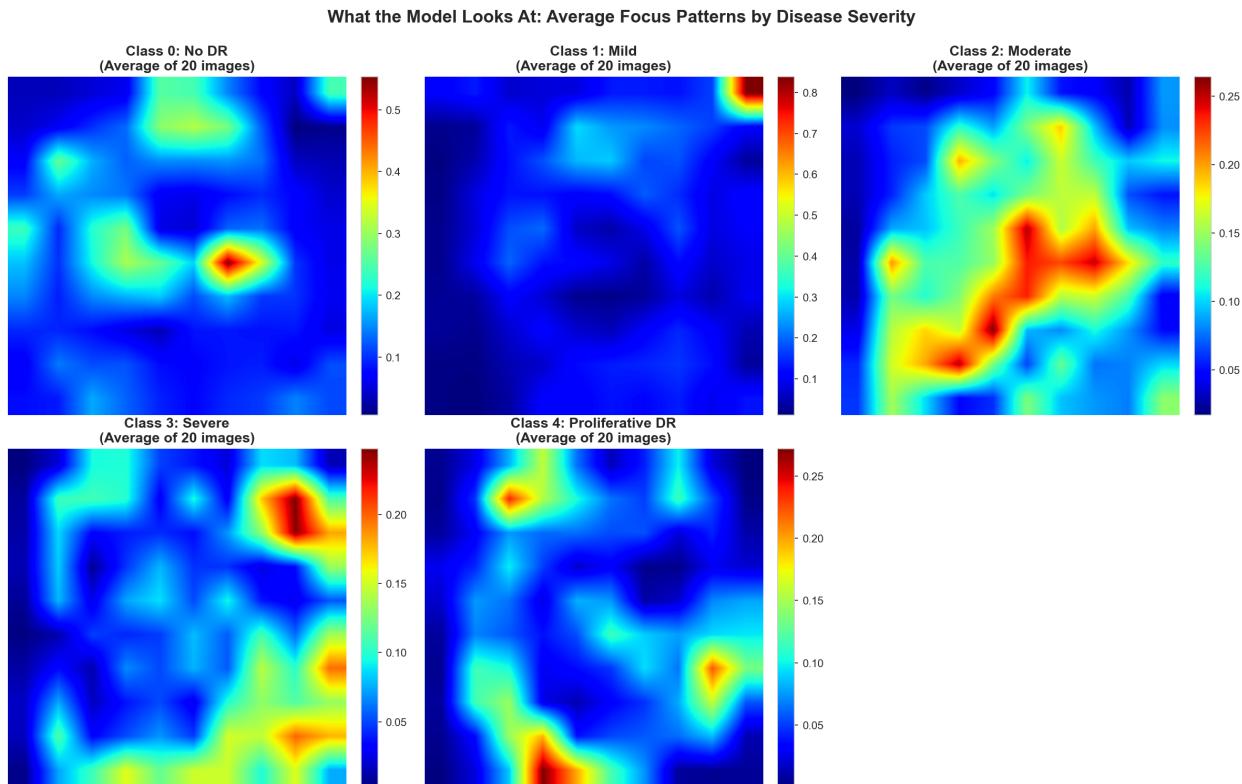


Figure 7: Global patterns the computer recognizes across disease severity levels

How to Read These Heat Maps: The red and yellow areas show where the computer is looking most carefully. In healthy eyes, it checks the whole area evenly. As disease gets worse, it focuses more on specific problem spots like damaged blood vessels and bleeding areas.

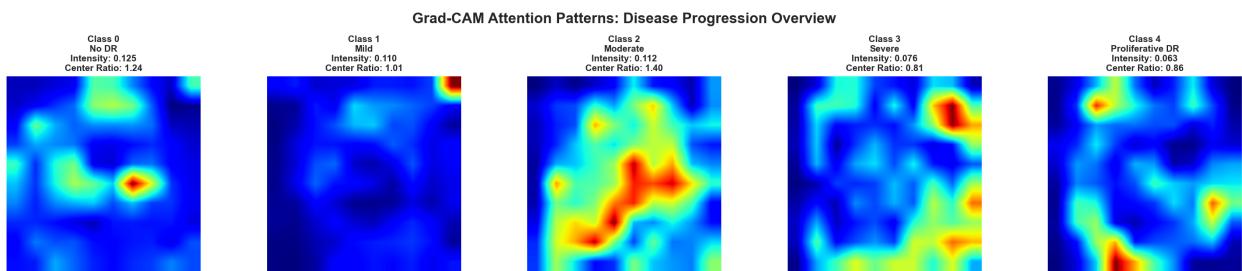


Figure 8: Comprehensive comparison showing computer focus areas for each disease level

What This Comparison Shows: You can see how the computer's attention changes as disease gets worse. Healthy eyes have even, gentle coloring. Diseased eyes have bright hot spots

where the computer finds damage. The more severe the disease, the more bright spots you'll see.

3.1 What the Computer Checks For Each Level

Level 0 - Healthy Eyes (No DR):

- Blood vessels are clear and normal
- No dark spots or bleeding areas
- Overall eye structure appears healthy

Level 1 - Mild Changes:

- Small dark spots (microaneurysms) start to appear
- Tiny blood vessel changes
- Early signs of diabetes affecting the eyes

Level 2 - Moderate Changes:

- More vessel damage visible
- Bleeding spots and vessel blockages
- Areas where fluid might be leaking

Level 3 - Severe Changes:

- Significant vessel damage
- Large bleeding areas and vessel growth
- Areas of significant concern for vision

Level 4 - Advanced Changes:

- Extensive damage with new vessel growth
- Complex bleeding patterns
- Signs requiring immediate medical attention

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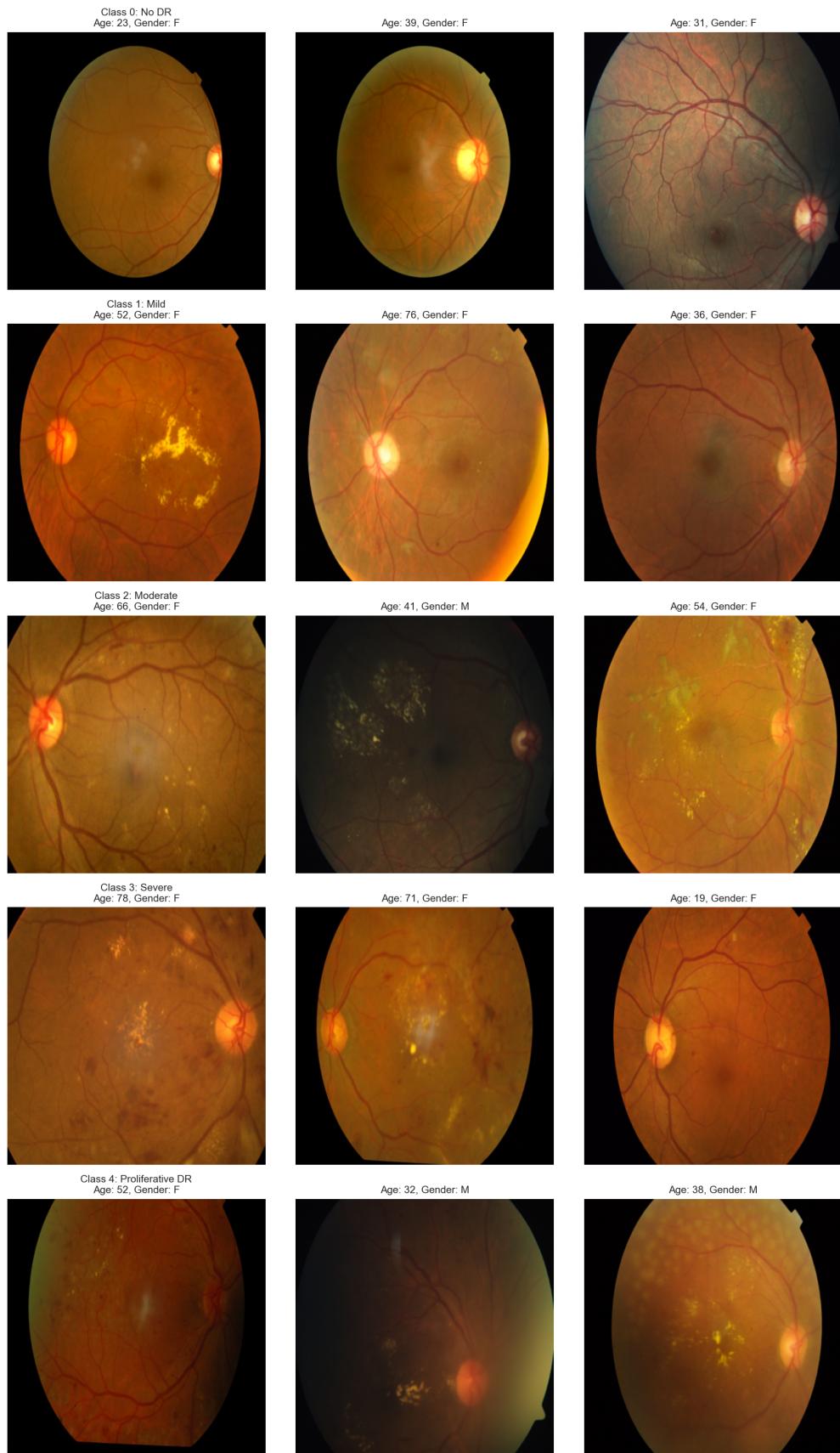


Figure 9: Representative examples of each disease severity level

Learning to See What the Computer Sees: Look at how the eyes change from left to right. Healthy eyes are clear with smooth blood vessels. As you move right, you'll notice more dark spots, bleeding areas, and messy-looking blood vessels. Train your eye to spot these differences - it will help you understand when the computer's results make sense.

4 When to Trust the Computer vs. When to Be Careful

4.1 Confidence Levels: What They Mean for You

HIGH CONFIDENCE (90% or higher)

- The computer is very sure about its answer
- These results are usually correct
- Safe to follow the recommended next steps
- Still refer positive cases to specialists as planned

Example: "The computer is 95% sure this is moderate diabetic retinopathy"
→ Trust this result and refer patient to eye specialist within 3-6 months

MEDIUM CONFIDENCE (70-89%)

- The computer is somewhat sure but not certain
- Results are fairly reliable but use extra caution
- Consider getting a second opinion from another trained screener
- When in doubt, refer to specialist sooner rather than later

Example: "The computer is 80% sure there are mild changes"
→ Document uncertainty, consider re-screening, refer within 6 months

LOW CONFIDENCE (Below 70%)

- The computer is not sure about its answer
- These results are less reliable
- ALWAYS get specialist review regardless of the prediction
- Do not make treatment decisions based on these results alone

Example: "The computer is 60% sure this is severe disease"
→ Refer immediately to eye specialist, note low confidence

4.2 Special Situations - Always Be Extra Careful

Poor Image Quality

- Blurry, dark, or unclear photos
- Computer cannot analyze properly
- Retake photo if possible
- If still unclear, refer to specialist

Borderline Cases

- Computer switches between two diagnoses (e.g., 45% mild, 40% moderate)
- Results change with different photos
- Patient has symptoms but computer says "normal"
- Always err on side of caution - refer to specialist

High-Risk Patients

- Long history of diabetes (≥ 10 years)
- Poor blood sugar control
- Family history of eye problems
- Previous eye treatments

→ Consider more frequent screening regardless of computer result

4.3 Important Reminders

- You are the human expert - trust your training
- The computer is a tool to help you, not replace you
- When computer and your judgment disagree, investigate further
- Patient safety always comes first
- Document any concerns or unusual findings
- Maintain regular contact with supervising eye specialists

4.4 Referral Guidelines

Immediate (within 1 week):

- High confidence severe or proliferative disease
- Any vision loss or complaints
- Low confidence results suggesting severe disease

Urgent (within 1 month):

- High confidence moderate to severe disease
- Medium confidence severe disease
- Patient symptoms with any positive result

Routine (within 3-6 months):

- High confidence mild disease
- Medium confidence mild to moderate disease

- Follow-up for previously detected changes

Annual Screening:

- High confidence no disease
- Well-controlled diabetes
- No previous eye problems

5 Quick Reference Guide

5.1 Decision Tree - What to Do With Results

1. CHECK IMAGE QUALITY FIRST

- Clear, well-lit retina photo? → Continue to step 2
- Blurry, dark, or poor quality? → Retake photo or refer to specialist

2. CHECK COMPUTER CONFIDENCE

- High (90%+)? → Trust result, follow standard guidelines
- Medium (70-89%)? → Use caution, consider second opinion
- Low ($\leq 70\%$)? → Always refer to specialist regardless of prediction

3. FOLLOW REFERRAL TIMELINE

- No Disease + High Confidence → Annual screening
- Mild Disease → 6-12 months follow-up
- Moderate Disease → 3-6 months referral
- Severe Disease → 1-2 months urgent referral
- Proliferative Disease → Immediate referral (1 week)

5.2 Common Questions from Patients

Q: "Is the computer better than a real doctor?"

A: No, the computer is a screening tool. Real eye doctors are still needed for diagnosis and treatment. This tool helps us find people who need to see a doctor.

Q: "Why do I need to see a specialist if the computer says I'm fine?"

A: Even healthy results should be checked regularly. The computer helps us screen many people quickly, but specialists do more detailed tests.

Q: "The result seems wrong - I can see fine!"

A: Eye disease often has no symptoms in early stages. That's why screening is important. We'll refer you to make sure everything is okay.

Q: "How accurate is this computer?"

A: The computer gets it right about 8 out of 10 times. That's why we always have specialists confirm the results before any treatment.

5.3 Emergency Signs - Refer Immediately Regardless of Computer Result

- Sudden vision loss
- Severe eye pain
- Flashing lights or new floaters
- Curtain or shadow across vision
- Severe headache with vision changes

5.4 Quality Control Checklist

- Image is clear and well-focused
- Entire retina visible in photo
- Good lighting without glare
- Patient information correct
- Computer confidence level noted
- Referral timeline appropriate for result
- Patient understands next steps
- Documentation complete

Remember: Your role is crucial in preventing blindness. When in doubt, always choose the safer option and refer to a specialist.