Visilant: Increasing Access to Eye Care through Community-Based Telemedicine

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The Problem

Lack of access to eye care globally leads to a high prevalence of preventable vision loss

- 161 million cases of visual impairment in India alone
- 80% of cases are preventable
- Current outreach efforts only reach 20% of patients in need of care, leaving 130 million individuals without access to eye care

Barriers to Eye Care Access:

- Lack of trained ophthalmologists (1:91,000)
- Efforts are limited by geographical location and high costs of current screening methods
- Patients do not have consistent touch points and integration with eye care systems
- Lack of awareness in remote communities

Proposed Solution

Visilant: An integrated, end-to-end patient outreach & diagnostic system optimized to serve eye care systems in low-to-middle income countries

Collaboration with Aravind Eye Hospital in India

Figure 1. Visilant's system for community screening consisting of a low bandwidth mobile app for data collection/transfer, clinician web portal, standardized image capture, and algorithm for real time triage

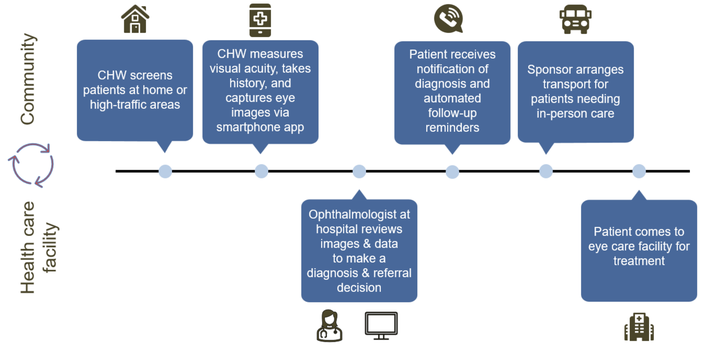


Figure 2. Visilant's community-based model for decentralized eye screening integrates communities into healthcare facilities

Methods

Diagnostic Concordance Pilot Study

Undergoing steps to compare ability of Community Health Workers (CHW) to diagnose conditions based on our training and imaging guidelines and compare their accuracy with that of trained ophthalmologists

Machine Learning Algorithm Development

- Images captured using 1st generation hardware
  - N=261 images of cataract, with varying lens opacities
  - N=169 normal eye images
- Images labeled using in-person ophthalmologist exam diagnosis
- Developed Referral Criteria by selecting relevant exam information

Standardization of Image Capture

First generation hardware

- Macro lens and torchlight

Second generation hardware

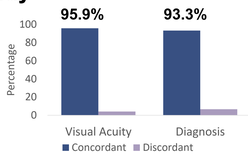
- Standardized scope length to ensure image focus
- Scope designed to block out ambient light
- Focus within ideal range for anterior diseases
- Simplified design for minimally trained users

Results

Diagnostic Concordance Pilot Study

Smartphone-based examination vs. in-person ophthalmologist examination

- **95.9%** visual acuity agreement between MLOP (mid-level ophthalmologic personnel) and CHW (community health worker)
- **93.33%** patient level diagnostic concordance



Machine Learning Algorithm Development

	Image Count	Precision	Recall	Average Precision
Cataract	261	89.4%	80.8%	94.2%
Normal Eye Exam	169	81.3%	76.5%	86.6%
Overall	430	86.1%	79.1%	92.1%

Figure 3. Proof of concept for automated, smartphone-based cataract diagnosis using 1st generation images.

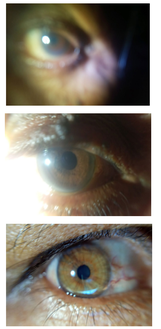
1st vs. 2nd Generation Images

First Generation Hardware

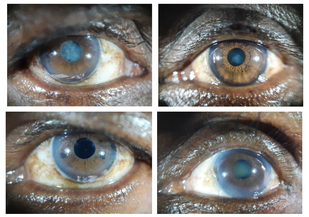
17.4% Out of Focus

25.9% Improper Lighting

48.1% Diagnosable Images



Second Generation Hardware



85/90 (94.4%) "Referrable"
81/90 (90%) "Diagnosable"

Figure 4. Images taken before (left) vs. images taken after (right) after implementation of our device showing improved lighting and positioning of eye

Next Steps

Large Scale Validation Study

Diagnostic validation study using 2nd generation device

- N=2000 eyes of 1000 patients
- Evaluate acceptability in key stakeholders

Machine learning algorithm using 2nd generation device

- N=2000 eyes of 1000 patients
- Combine images, visual acuity, and eye history data
- Diagnose cataract, refractive error, normal eye exam

Use "back end" platform to improve health system performance

- Track CHW performance
- Integrate data into electronic health record
- Pragmatic trials to optimize patient follow-up

Conclusion and Acknowledgments

Visilant's end-to-end patient outreach and diagnostic system, facilitates the collection of accurate, high quality, diagnostic level patient information and anterior segment images by minimally trained community health workers.

Preliminary machine learning results show proof of concept for automated, smartphone-based, real-time triage of anterior segment diseases

The large-scale validation study starting in May will show that:

(1) CHWs can use smartphones to capture eye images and clinical data from rural patients and submit findings for remote, asynchronous review;

(2) Remote ophthalmologists can review smartphone screening data to diagnose cataract with good concordance with in-person eye camp exams;

(3) A machine learning (ML) algorithm can diagnose cataract with high concordance with remote ophthalmologist graders.

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