7/15/2022 06:00 pm

Technology Symposium

Evaluation of a Robotically Aligned Optical Coherence Tomography System and Artificial Intelligence in Patients from the Emergency Department

- Nita Valikodath, MD, MS
- Ailin Song
- Kyung-Min Roh, BSE
- Jay Lusk
- Eleonora Lad, MD, PhD
- Alex Limkakeng
- Joseph Izatt, PhD
- Ryan McNabb
- Anthony Kuo
- Lejla Vajzovic, MD, FASRS

Objective:
To evaluate the performance of an artificial intelligence (AI) system to screen robotically aligned optical coherence tomography (RAOCT) images of the macula in patients presenting to the emergency department (ED).

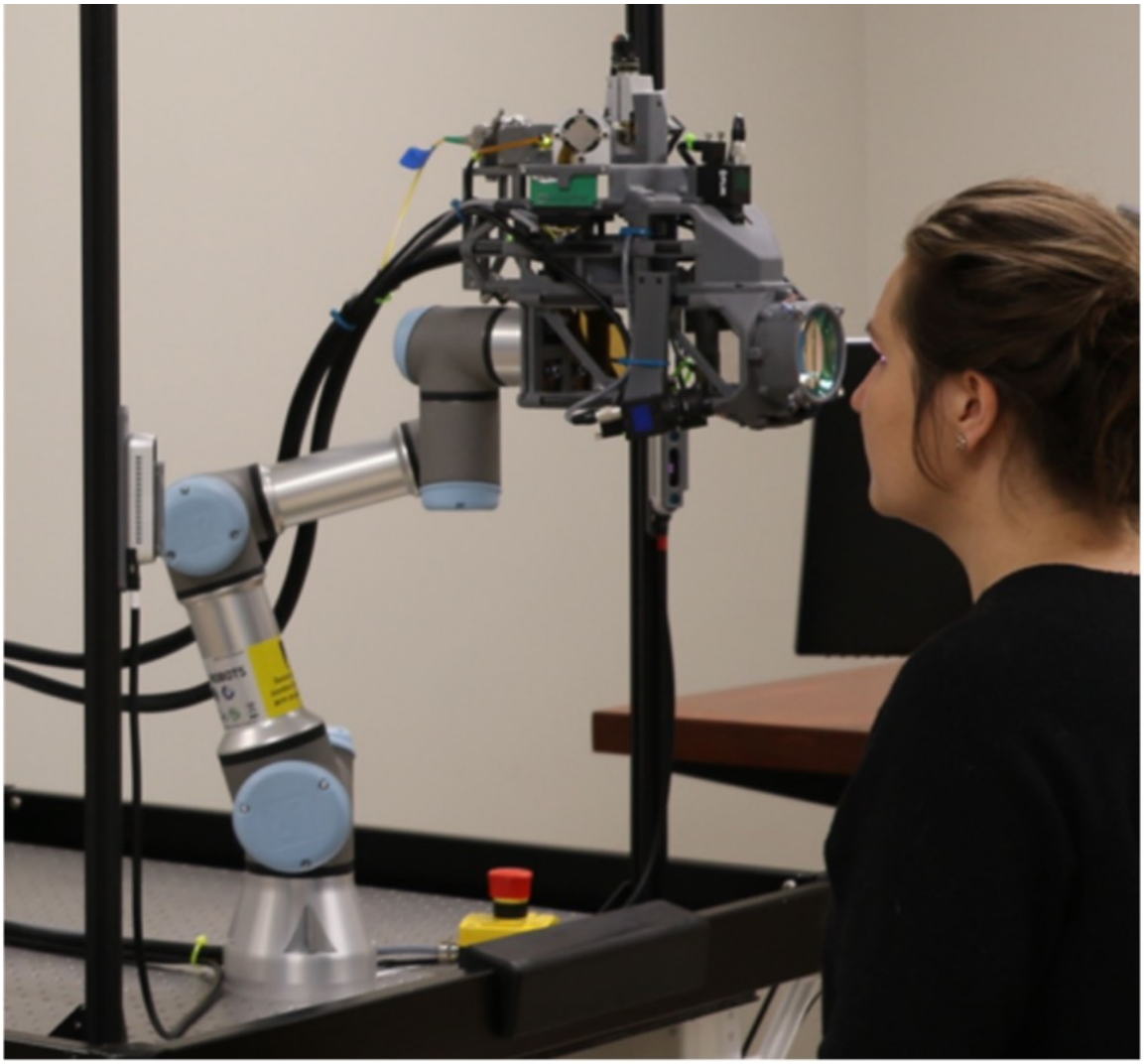
Purpose:
Patients present to the ED with retinal issues, but ED providers are limited in their tools in evaluating the retina and ophthalmologists may not be available. This could lead to over and under-triage of ophthalmology referrals. Devices that assist ED providers in ophthalmology referral decision-making can help triage patients more efficiently.

Methods:
We used our previously reported RAOCT system (Draelos, 2021) which consists of a custom swept source OCT system (100 kHz with λ_0=1040nm) with a 32° field of view sample arm mounted on a robot arm (Universal Robots UR3). The subject sits in front of the system with no chin or head rests, and the RAOCT's face and integrated pupil cameras automatically find the eye of interest, keeping the OCT system aligned to the pupil (Figure 1). A remote operator confirms the presence of the retina in the OCT scan and triggers the acquisition. High resolution macular swept-source OCT scans (700 x 250 volumes and 2000 x 100 averages [A scans x B scans]) were captured in 58 eyes in 33 adult patients presenting to the ED under IRB-approved protocols. Inclusion criteria included patients over 18 years old with suspected posterior eye conditions and receiving a fundus exam during an ophthalmology consult placed by the ED team. Patients with optic nerve pathology were excluded. An AI algorithm, previously trained and internally validated, was used to classify macular OCT images as referable vs non-referable for ophthalmology evaluation. A reference standard diagnosis was established by two masked retina specialists and the ophthalmology consult diagnosis. Accuracy, sensitivity, and specificity analyses were performed.

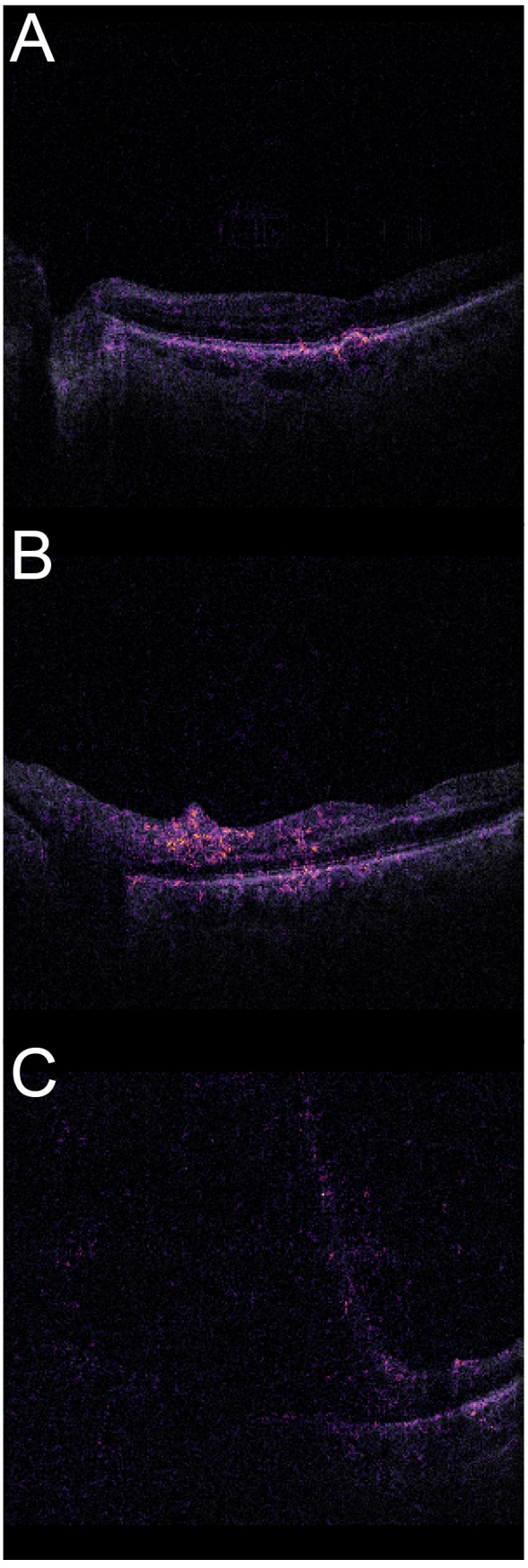
Results:
Of the 58 RAOCT volumes, 25 (43%) had referable pathology. The accuracy of the algorithm was 79%. The area under the receiver operating characteristic for the detection of referable retinal pathology was 0.86 with sensitivity of 92% and specificity of 70%. Reference standard diagnoses included drusen (16%), epiretinal membrane (10%), retinal artery occlusion (5%), retinal vein occlusion (3%), retinal atrophy from geographic atrophy (3%), exudates from diabetic retinopathy (3%), intraretinal fluid of unknown etiology (3%), retinal detachment (2%), and chorioretinal lesion of unknown etiology (2%). Figure 2 shows examples of retinal pathology with heatmaps demonstrating that regions contributing most to model classification matched pathologic regions according to clinician interpretation.

Conclusion:
The deep learning algorithm showed good sensitivity in identifying macular pathology. With further improved performance, this automated robotic OCT imaging system could assist clinicians in the evaluation of patients with retinal pathology.

IRB APPROVAL Yes



Robotically aligned OCT system


A
B
C

RAOCT images with heatmap overlay for drusen (A), BRAO (B), and RD (C)

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Technology Symposium

Real-Time Diagnosis of Diabetic Retinopathy by a Handheld Retinal Camera, Artificial Intelligence and Simultaneous Specialist Confirmation: Closing the Gap

- Gustavo Melo, MD, PhD, FASRS
- Fernando Malerbi, PhD
- Viviane Cardoso
- Thiago Chagas
- José Stuchi
- Rajat Agrawal, MD MS

Objective:
The use of a handheld retinal camera equipped with artificial intelligence and a real-time remote validation system by retina specialists opens a new perspective to the diagnosis of diabetic retinopathy, especially in underserved areas

Purpose:
To report on the clinical use of a portable handheld retinal camera with an embedded artificial intelligence (AI) platform, and an instantaneous notification system for the screening of diabetic retinopathy (DR) in an underserved rural area.

Methods:
This is an analysis of Retina Global's Project "Iluminar" in Caninde de Sao Francisco (human development index: 0.57), in the drylands of Northeastern Brazil. A total of 740 diabetic individuals currently monitored in the public primary care health system were invited by various advertising strategies. A portable handheld retinal camera, with its embedded AI system designed to detect retinal changes, was used. Fundus and anterior segment images were taken of both eyes of all participants. Immediate and automatic push notifications were remotely sent to four retina specialists whenever significant abnormal findings were detected by AI. Physicians would classify images as referrable or non-referrable in real time. Referral criteria were more than mild DR, glaucoma or cataract suspects, and those with poor image quality. All exams considered normal by the AI system were later reviewed to check for false negatives. All referred patients were scheduled for a complete ophthalmic work-up and subsequent treatment.

Results:
A total of 400 patients were screened over a 5-day period, accounting for 54% of the known diabetic population. The AI screening indicated that 111 individuals met the referral criteria: 57 with more than mild DR or poor-quality images preventing DR classification, 45 with suspected cataract and 5 with suspected glaucoma. All altered exam outcomes were checked by a retina specialist in real time, and the subject was informed of his/her status instantaneously by the technician after remote physician feedback. Retina specialist review of the non-referrable cohort confirmed there were no false negatives. After further analysis, 30 out of 57 with more than mild DR or poor-quality images were sent for treatment of diabetic macular edema or proliferative DR, while 6 required cataract surgery, and 2 had other sources of media opacities.

Conclusion:
Our portable device, using AI validated in real-time by telemedicine, was effective in screening for DR in an underserved area with an enormous gap in ophthalmological care. Only one fourth of the individuals were referred for review, thus saving time for the patient and the physicians. We believe such a disruptive innovation allows for real time review and response, which helps triage those patients who do not really need to see a retina specialist. This in turn contributes to higher acceptance from those living in underserved areas, which will prevent avoidable blindness. With the increase in the prevalence of diabetes, technological advances will play a major role, especially in scenarios of social inequalities.

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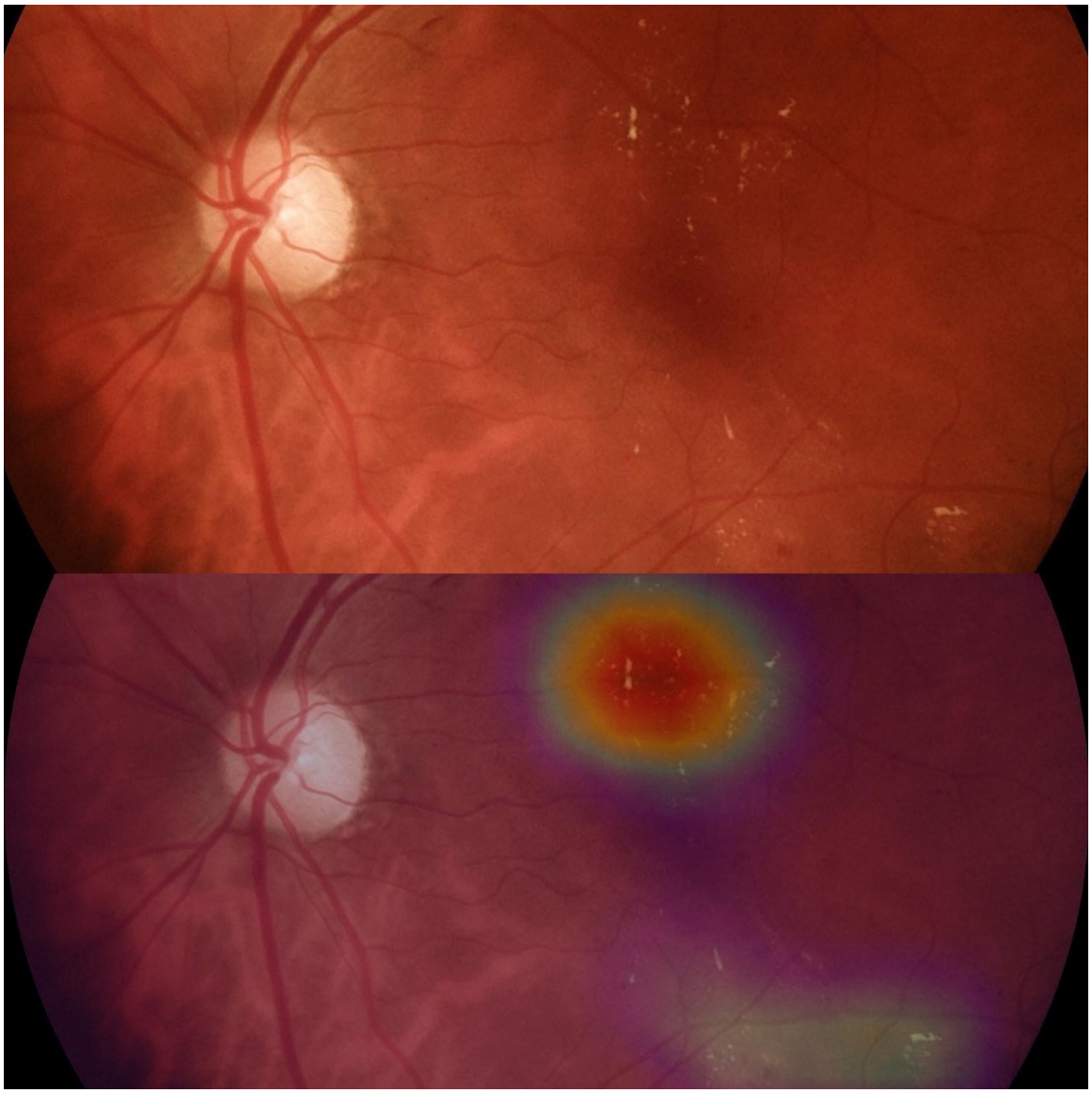

Top: retinal image from the camera. Bottom: heat map with AI analysis

Technician performing an exam with the handheld retinal camera

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Technology Symposium

Smartphone-Based Home Vision Monitoring: Enablers and Barriers to Deployment in Clinical Practice Settings

- Edward Korot, MD
- Nikolas Pontikos, PhD
- Faye Drawnel, MBA PhD
- Aljazy Jaber, MSc
- Dun Jack Fu, BM BCh PhD
- Gongyu Zhang
- Marco Miranda
- Bart Liefers
- Sophie Glinton
- Siegfried Wagner
- Caroline Kilduff
- Darius Moshfeghi, MD, FASRS
- Pearse Keane
- Dawn Sim
- Peter Thomas
- Konstantinos Balaskas

Objective:
To quantify the associations between patient characteristics and clinical measures with vision monitoring app uptake and engagement.

Purpose:
Telemedicine is accelerating the remote detection and monitoring of medical conditions, such as vision-threatening diseases. Meaningful deployment of smartphone apps for home vision monitoring should consider the barriers to patient uptake and engagement and address issues around digital exclusion in vulnerable patient populations.

Methods:
Cohort study and survey in a tertiary referral center of consecutive adult patients attending Moorfields Eye Hospital receiving intravitreal injections for retinal disease between May 2020 and February 2021. Patients were offered the Home Vision Monitor (HVM) smartphone app to self-test their vision. A patient survey was conducted to capture their experience. App data, demographics, survey results, and clinical data from the electronic health record were analyzed via regression and machine learning. Main outcome measures were association (odds ratio) of patient uptake, compliance, and use rate.

Results:
Of 417 included patients, 236 (56.6%) were female, and the mean (SD) age was 72.8 (12.8) years. A total of 258 patients (61.9%) were active users. Uptake was negatively associated with age (OR, 0.98; 95% CI, 0.97-0.998; $P = .02$) and positively associated with both visual acuity in the better-seeing eye (OR, 1.02; 95% CI, 1.00-1.03; $P = .01$) and baseline number of intravitreal injections (OR, 1.01; 95% CI, 1.00-1.02; $P = .02$). Of 258 active patients, 166 (64.3%) fulfilled the definition of compliance. Compliance was associated with patients diagnosed with neovascular age-related macular degeneration (OR, 1.94; 95% CI, 1.07-3.53; $P = .002$), White British ethnicity (OR, 1.69; 95% CI, 0.96-3.01; $P = .02$), and visual acuity in the better-seeing eye at baseline (OR, 1.02; 95% CI, 1.01-1.04; $P = .04$). Use rate was higher with increasing levels of comfort with use of modern technologies ($\beta = 0.031$; 95% CI, 0.007-0.055; $P = .02$). A total of 119 patients (98.4%) found the app either easy or very easy to use, while 96 (82.1%) experienced increased reassurance from using the app.

Conclusion:
This evaluation of home vision monitoring for patients with common vision-threatening disease within a clinical practice setting revealed demographic, clinical, and patient-related factors associated with patient uptake and engagement. These insights inform targeted interventions to address risks of digital exclusion with smartphone-based medical devices.

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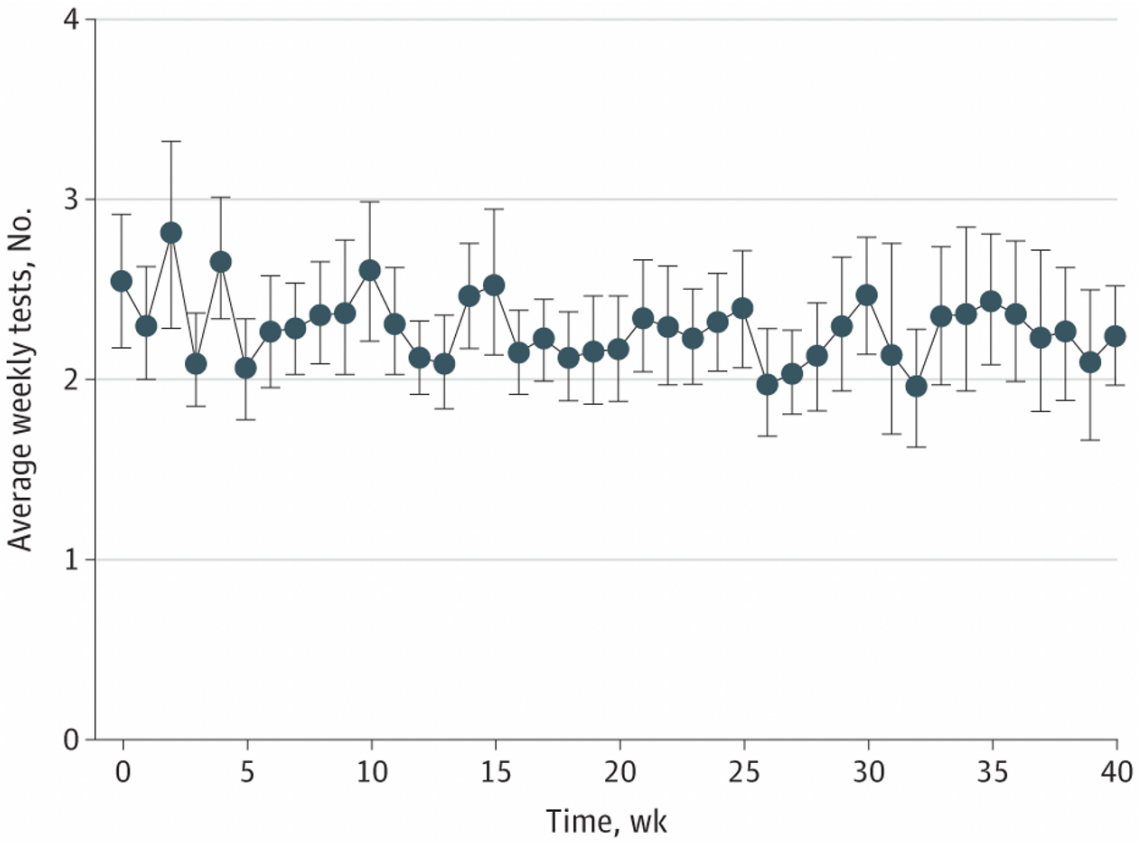
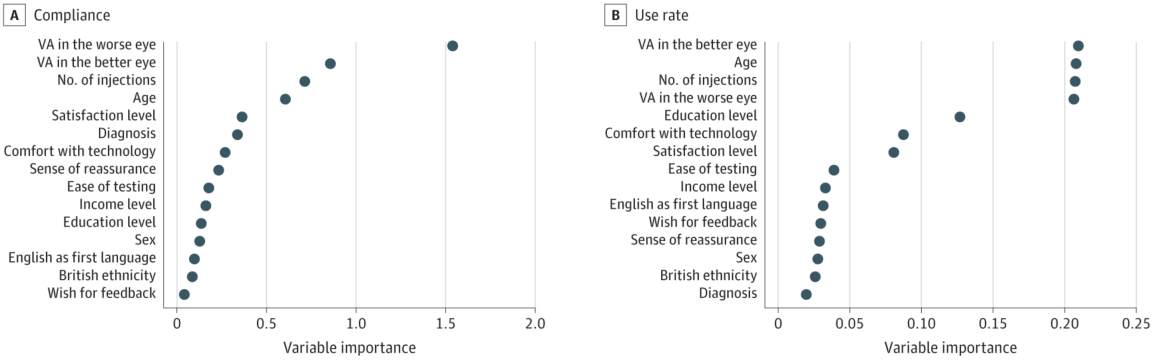


Mean App Usage by Study Week in Active Patients:



Machine Learning Feature Importance Analysis (Random Forest)