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# Telemedicine and Retinal Imaging for Improving Diabetic Retinopathy Evaluation

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**RESEARCH LETTER**

## Telemedicine and Retinal Imaging for Improving Diabetic Retinopathy Evaluation

Early detection of diabetic retinopathy (DR) is crucial to prevent blindness. Timely intervention with laser therapy can reduce the risk of severe vision loss by more than 90%.[1] Despite well-accepted national and international guidelines, on average, less than 50% of patients with diabetes mellitus (DM) undergo screening for retinopathy in the United States.[2,3] Barriers to care include socioeconomic factors, geography, lack of patient education, and cultural barriers among minorities.

Telemedicine is an emerging strategy for improving DR screening through retinal imaging with remote expert interpretation. Introducing this technology at the point of care of the primary care physician could substantially reduce barriers and improve early detection of retinopathy.[4,5] Outside of the Department of Veterans Affairs (VA) system,[6,7] effectiveness data for telemedicine screening in the United States is limited.

*See Invited Commentary at end of letter*

The purpose of this study was to evaluate the impact of telemedicine on DR screening in a primary care setting with a diverse patient and payer mix. Predictors of DR were determined by analyzing clinical patient characteristics obtained at the time of image acquisition.

**Methods.** Institutional review board approval was obtained. The DR screening frequency at a University of North Carolina primary care clinic was determined prior to and 12 months after the implementation of the TRIAD ocular telemedicine network.[8] Patients who did not have a documented retinal examination within the prior 12 months were identified. A staff member obtained retinal photographs of both eyes with a nonmydriatic fundus camera along with patient demographic and clinical information. The images were securely sent over a Health Insurance Portability and Accountability Act (HIPAA)-compliant, web-based network to a single retina specialist (S.G.), who remotely classified the retinal images according to severity of retinopathy. The diagnostic and management report was transmitted to the original primary care provider within 48 hours and incorporated into the patient's electronic medical records. Based on the degree of DR, patients were either scheduled for repeated follow-up photographs in the primary care clinic or referred to an ophthalmologist for further management. Logistic regression analysis was used to determine predictors of retinopathy.

**Results.** A total of 1002 patients with DM were evaluated for retinopathy within the telemedicine network in 1 year. Of these, 869 patients had no retinopathy. The mean age was 57 years, mean hemoglobin $A_{1c}$ ($HbA_{1c}$) level was 7.6%, mean total cholesterol was 184 mg/dL (to convert to millimoles per liter, multiply by 0.0259), and mean duration of DM was 9.0 years. Twenty-two percent of patients had a smoking history, 78% had hypertension, 10% had coronary artery disease, 8% had a history of stroke, 9% had a history of myocardial infarction, and 6% had kidney disease. While the distribution of black and white patients was similar (48% vs 49%, respectively), the prevalence of DR was significantly higher among black (71%) vs white (27%) patients and was also more severe: 11.5% of black patients had mild nonproliferative retinopathy and 4.3% had moderate retinopathy vs 3.6% of white patients with mild nonproliferative retinopathy and 1.8% with moderate retinopathy.

The **Figure** shows the percentage of diabetic patients undergoing retinal evaluation during the observation period. The screening frequency improved from 32% to 71%. Race (nonwhite) was strongly associated with DR (odds ratio, 2.2; 95% CI, 1.2-4.1) along with $HbA_{1c}$ and duration of DM. The odds ratio of DR for every 1-point increase in $HbA_{1c}$ level was 1.5 (95% CI, 1.3-1.7) and for every 5-years' duration of DM was 1.5 (95% CI, 1.3-1.7).

**Comment.** We found that point-of-care retinal imaging with remote interpretation in patients with type 1 and 2 DM improved the frequency of retinal screening from 32% to 71% in only 12 months.

Visual impairment from DR results in loss of personal independence and economic productivity and de-

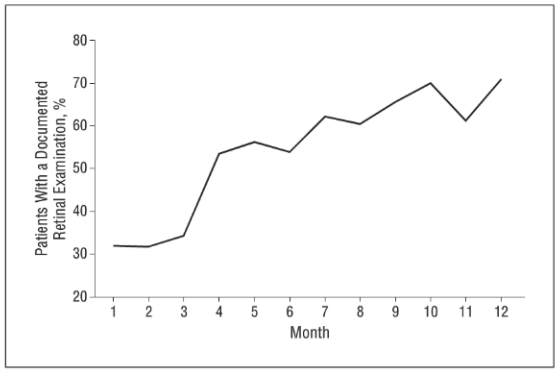


**Figure.** Percentage of patients with a documented retinal examination over a 12-month period in a University of North Carolina primary care clinic.

creased quality of life. As the prevalence of DM is projected to increase from 25 million Americans to 125 million Americans by the year 2050,[9] the number of patients requiring annual retinal evaluation will far exceed the capacity of ophthalmologists.

Primary care physicians are at the frontline of this epidemic and already play a critical role in primary prevention of retinopathy with the management of serum glucose and lipid levels and blood pressure. Telemedicine potentially allows primary care physicians to manage the screening and monitoring of this potentially blinding disease. Specifically, they can distinguish patients who only require surveillance with retinal photography from those who need urgent referral. Such a paradigm could lead to better use of physician and patient resources. In our group, for example, most patients (89%) did not have retinopathy and therefore did not need referral to an ophthalmologist for DR screening.

Telemedicine screening at the point of care of the primary care physician represents a potential paradigm shift in the management of DM, can improve screening, and may ultimately prevent vision-threatening DR.

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**Author Contributions:** *Study concept and design:* Garg, Kshirsagar, and Chaum. *Acquisition of data:* Garg and Chaum. *Analysis and interpretation of data:* Garg, Jani, Kshirsagar, and King. *Drafting of the manuscript:* Garg, Jani, Kshirsagar, and King. *Critical revision of the manuscript for important intellectual content:* Garg, Kshirsagar, and Chaum. *Statistical analysis:* King. *Obtained funding:* Chaum and Garg. *Administrative, technical, and material support:* Garg, Jani, and Chaum. *Study supervision:* Garg and Kshirsagar.
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