

From The JAMA Network

Telemedicine Screening for Eye Disease

Kurt Kroenke, MD

JAMA OPHTHALMOLOGY**Effect of a Teleretinal Screening Program on Eye Care Use and Resources**

Joel E. Chasan, MD; Bill Delaune, PhD; April Y. Maa, MD; Mary G. Lynch, MD

IMPORTANCE Telemedicine is a useful clinical method to extend health care to patients with limited access. Minimal information exists on the subsequent effect of telemedicine activities on eye care resources.

OBJECTIVE To evaluate the effect of a community-based diabetic teleretinal screening program on eye care use and resources.

DESIGN, SETTING, AND PARTICIPANTS The current study was a retrospective medical record review of patients who underwent diabetic teleretinal screening in the community-based clinics of the Atlanta Veterans Affairs Medical Center from October 1, 2008, through March 31, 2009, and who were referred for an ophthalmic examination in the eye clinic.

EXPOSURES Clinical medical records were reviewed for a 2-year period after patients were referred from teleretinal screening. The following information was collected for analysis: patient demographics, referral and confirmatory

diagnoses, ophthalmology clinic visits, diagnostic procedures, surgical procedures, medications, and spectacle prescriptions.

MAIN OUTCOMES AND MEASURES The accuracy between referring and final diagnoses and the eye care resources that were used in the care of referred patients.

RESULTS The most common referral diagnoses were nonmacular diabetic retinopathy (43.2%), nerve-related disease (30.8%), lens or media opacity (19.1%), age-related macular degeneration (12.9%), and diabetic macular edema (5.6%). The percentage of agreement among these 5 visually significant diagnoses was 90.4%, with a total sensitivity of 73.6%. Diabetic macular edema required the greatest number of ophthalmology clinic visits, diagnostic tests, and surgical procedures. Using Medicare cost data estimates, the mean cost incurred during a 2-year period per patient seen in the eye clinic was approximately \$1000.

CONCLUSIONS AND RELEVANCE Although a teleretinal screening program can be accurate and sensitive for multiple visually significant diagnoses, measurable resource burdens should be anticipated to adequately prepare for the associated increase in clinical care.

JAMA Ophthalmol. 2014;132(9):1045-1051.
doi:10.1001/jamaophthalmol.2014.1051

Telemedicine is increasingly used for disease monitoring and management of chronic medical and mental disorders, but also has screening and diagnostic applications such as teleradiology and teledermatology. Indeed, "therapy at a distance" will complement office-based care in the 21st century. Another screening application is teleophthalmology, in which digital photography with telemedicine links has proven cost-effective for retinal disorders, including diabetic retinopathy and retinopathy of prematurity.^{1,2}

In a recent study in *JAMA Ophthalmology*, Chasan et al³ complemented prior cost-effectiveness analyses of teleretinal screening programs by examining both the accuracy of diabetic teleretinal screening as well as the subsequent eye care use and resources required in such a program. Regarding accuracy, screening tests that have good sensitivity and specificity are likely to be more cost-effective. Regarding resource use, implementation of screening generates more referrals, testing, and procedures. The cost-effectiveness of any screening program is therefore contingent on reasonable test accuracy coupled with a sufficient supply of resources to meet the increased demand.

Chasan et al³ conducted the study in community-based clinics of a single Veterans Affairs (VA) medical center. Of 1935 patients who underwent diabetic retinal screening, 465 (24%) had an abnormal finding on the retinal photograph and were referred to the VA eye clinic, of whom 326 were seen by an eye specialist and had a confirmatory diagnosis. The most common reasons for referral were nonmacular diabetic retinopathy (43.2%), nerve-related disease (30.8%), lens or media opacity (19.1%), age-related macular degeneration (12.9%), and diabetic macular edema (5.6%). The percentage of agreement between retinal screening and the ophthalmic examination for all diagnoses was 90.4%, with a sensitivity of 73.6%. Sensitivity may have been somewhat inflated for 2 reasons. First, only patients with abnormal retinal photographs were referred, thus greatly increasing the number of cases with disease and minimizing the number of cases without disease. This verification bias (also known as "workup bias" or "referral bias") is a type of measurement bias in which the results of a diagnostic test affect whether the gold standard procedure is used to verify the test result. Second, it is not clear that the clinician performing the ophthalmic examina-

tion was masked to the retinal photograph, which could bias the clinician toward greater agreement and sensitivity.

Of the 465 patients referred, 260 patients (56%) made and kept an appointment at the VA eye clinic (another 66 received ophthalmic care outside the VA). Using Medicare cost data estimates, the mean cost incurred during a 2-year period per patient seen in the eye clinic was approximately \$1000. Costs may have been underestimated because medications and spectacles were not included in cost estimates. However, this is not a substantial limitation because it is a reflection of who is actually responsible for certain health care costs. Some eye medications are considered over-the-counter and, like spectacles, may not be covered by insurance. Accordingly, the patient bears the additional costs. Also, screening costs (cameras, computers, personnel doing the imaging and reading) were not included in the cost analysis.

The yield of screening may have been overestimated because only 43.6% had a visually significant condition detected for the first time. However, sometimes "the second time is the charm," not only for eye disorders but for other conditions as well, such as risk factors (hypertension, hyperlipidemia) or behaviors warranting lifestyle changes (weight loss, smoking cessation, exercise). Patients may need to hear something more than once before taking a screening result or health care recommendation seriously and to move through the stages of change from precontemplation to action. Of the patients referred, there was a 30% nonadherence rate with making and keeping an appointment in either the VA or a non-VA eye clinic. Not surprisingly, patients with historical high no-show rates for medical appointments were less likely to keep an appointment. Because neither age nor driving distance was associated with no-show rates, identifying other potential barriers (patient preferences for treatment, inadequate education about risks, less severe symptoms) is important.

Another recent study in *JAMA Ophthalmology* provided promising results for telemedicine diagnosis of cytomegalovirus retinitis, a disease common in resource-poor countries with a high burden of human immunodeficiency virus and limited access to highly active antiretroviral therapy.⁴ Conducting the study in Thailand, Yen et al⁴ found good agreement between nonexpert and expert graders evaluating 182 fundus photographs: the mean sensitivity and specificity values of non-expert diagnosis using expert consensus as the reference standard were 93.2% and 88.4%, respectively. Mean intrarater reliability also was high (mean κ , 0.83). Training consisted simply of a 2-hour workshop, and there were some raters with lower accuracy. The authors argued for more intensive training and periodic evaluations if nonexperts are to be used in clinical practice. A 2-hour training session of nonexpert grad-

ers produced similar accuracy for telemedical diagnosis of retinopathy of prematurity.⁵ In contrast, a telemedicine program for diabetic retinopathy in the United States had a more intense 3-day training program after which imagers served a probationary period with senior imager supervision and ongoing quality improvement and assurance.⁶ The optimal amount of training likely depends on current or previous health care experience of the trainees, whether screening is focused on 1 type or multiple types of eye disease, and the degree of posttraining supervision and attention to quality improvement.

A review of 21 articles on the economic evidence for diabetic retinopathy screening concluded that systematic screening is cost-effective and that telemedicine retinal screening has the potential to deliver cost-effective, accessible screening to rural and hard-to-reach populations.¹ However, the authors found that variation in adherence rates, frequency of screening (annual vs 2- to 3-year intervals), age at onset of diabetes, glycemic control, and screening sensitivities influence cost-effectiveness. The cost per quality-adjusted life-year (QALY) of teleretinal screening for both diabetic retinopathy and retinopathy of prematurity falls well below the standard benchmark of \$50 000 per QALY.^{1,2}

There are several implications of this emerging evidence supporting telemedicine for eye disorders. First, telemedicine in general is often promoted as a means of increasing access to care for individuals living in rural, remote, or resource-poor regions. However, it also may be cost-effective in urban areas by identifying the individuals who may benefit most from specialty referral as well as by reducing time and travel costs by screening at community clinics closer to where individuals reside. Second, telemedicine screening may be more feasible, at least for now, in larger integrated health care systems like the VA, health maintenance organizations, or accountable care organizations. A recent study from the VA found that telemedicine screening for diabetic retinopathy did not become cost-effective until the patient pool exceeded 3500.⁷ However, if the Affordable Care Act fulfills its promise by providing health coverage for a greater proportion of the US population, telemedicine coverage may also expand. Third, other factors may identify subgroups in which telemedicine screening is more or less cost-effective. For example, the same VA study found that teleretinal screening was actually cost-saving in patients younger than 50 years, cost-effective for those aged 50 to 80 years, and no longer cost-effective after a patient exceeds the age of 80 years.⁷ Fourth, as telemedicine extends to many conditions, lessons learned from one disease may generalize to others. As the pressures increase for health care to become more patient-centered and cost-effective, telemedicine is one strategy for fostering both principles.

ARTICLE INFORMATION

Author Affiliations: VA HSR&D Center for Health Communication and Information, Indianapolis, Indiana; Regenstrief Institute, Indiana University School of Medicine, Indianapolis, Indiana.

Corresponding Author: Kurt Kroenke, MD, Regenstrief Institute, Fifth Floor, 1050 Wishard Blvd, Indianapolis, IN 46202 (kkroenke@regenstrief.org).

Conflict of Interest Disclosures: The author has completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest and none were reported.

Disclaimer: The views expressed in this article are those of the author and do not necessarily represent the views of the Department of Veterans Affairs.

REFERENCES

1. Jones S, Edwards RT. Diabetic retinopathy screening. *Diabet Med*. 2010;27(3):249-256.
2. Jackson KM, Scott KE, Graff Zivin J, et al. Cost-utility analysis of telemedicine and ophthalmoscopy for retinopathy of prematurity management. *Arch Ophthalmol*. 2008;126(4):493-499.
3. Chasan JE, Delaune B, Maa AY, Lynch MG. Effect of a teleretinal screening program on eye care use and resources. *JAMA Ophthalmol*. 2014;132(9):1045-1051.
4. Yen M, Ausayakhun S, Chen J, et al. Telemedicine diagnosis of cytomegalovirus retinitis by nonophthalmologists. *JAMA Ophthalmol*. 2014;132(9):1052-1058.
5. Williams SL, Wang L, Kane SA, et al. Telemedical diagnosis of retinopathy of prematurity. *Br J Ophthalmol*. 2010;94(3):351-356.
6. Cavallerano JD, Silva PS, Tolson AM, et al. Imager evaluation of diabetic retinopathy at the time of imaging in a telemedicine program. *Diabetes Care*. 2012;35(3):482-484.
7. Kirkizlar E, Serban N, Sisson JA, Swann JL, Barnes CS, Williams MD. Evaluation of telemedicine for screening of diabetic retinopathy in the Veterans Health Administration. *Ophthalmology*. 2013;120(12):2604-2610.