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Cost Savings Analysis for a Diabetic Retinopathy Teleretinal Screening Program Using an Activity-Based Costing Approach

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Purpose: To examine the costs and cost savings associated with a large, urban teleretinal screening program for diabetic retinopathy (DR).

Design: Retrospective analysis.

Participants: Eighteen thousand twenty-five patients (36 050 eyes) screened via the Harris Health System (HHS) DR teleretinal screening program between June 2013 and April 2014.

Methods: Activity-based costing applied to the operational screening pathway was implemented to determine the cost of screening. Actual costs were calculated based on retrospective chart review and figures obtained from the HHS and Centers for Medicare and Medicaid Services. Theoretical costs of in-clinic examinations and delayed intervention were compared with actual costs of screening and treatment to determine costs savings.

Main Outcome Measures: Costs and cost savings in United States dollars were estimated.

Results: The per-patient cost of teleretinal screening itself was found to be $27.35, whereas the average total cost (factoring in treatment) per patient was determined to be $43.14. The physical examination-only and treatment-only models yielded cost savings estimates of $2 047 442.53 and $1 148 597.35, respectively.

Conclusions: The cost savings yielded by the HHS DR teleretinal screening program compared with conventional screening are substantial and corroborate the findings of similar studies that have analyzed teleretinal screening. Additionally, it can be presumed that there are additional indirect economic benefits resulting from earlier detection and treatment of disease. *Ophthalmology Retina 2018;■:1–8 © 2018 by the American Academy of Ophthalmology*

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Diabetes mellitus (DM) is one of the most rapidly growing health concerns globally. More than 29.1 million Americans have a diagnosis of DM, costing an estimated $245 billion annually in healthcare expenses and lost productivity.[1,2] One major complication of DM is diabetic retinopathy (DR), the leading cause of preventable blindness in the working-age population.[3,4] Early detection of DR can reduce or prevent complications of sight-threatening diabetic eye disease (STDED), typically defined as severe nonproliferative DR, proliferative DR, or diabetic macular edema (DME); hence, guidelines published by the American Academy of Ophthalmology and the American Diabetes Association recommend annual dilated funduscopic examinations for patients with DM.[4,5] Unfortunately, compliance rates with this recommendation are notably poor (35%–65%) because of barriers to care such as a relative shortage of ophthalmic providers in the context of a burgeoning diabetic population, lack of patient awareness, and financial challenges.[6–10] To address these gaps, teleretinal screening programs have been implemented with promising results in quality metrics, including reliability of identifying patients with DR, accuracy in assessing DR severity, and effectiveness in recommending patients for intervention.[8,11–15]

The value derived from preventative DR management is considerable, especially when teleretinal imaging is incorporated. Simulated modeling techniques have been used to measure cost per quality-adjusted life-year and have found teleretinal screening programs to be cost-effective, especially for large populations.[16–22] Early identification and treatment of patients with STDED results in significant cost savings in terms of quality of life, societal productivity, and healthcare system expenses.[23–28] However, these benefits are difficult to quantify because of the absence of a counterfactual, a common situation encountered in preventative medicine studies in which the more severe and costly disease state is never observed. The difficulty in quantifying costs and cost savings from DR screening arguably has contributed to it being undervalued. Only 2 Current Procedural Terminology (CPT) codes currently exist for teleretinal screening: 92227 for the detection of retinal disease and 92228 for the monitoring of active retinal disease.[29] Problematically, these codes are either

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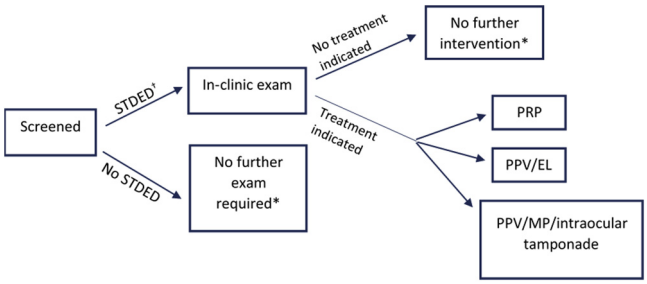

Figure 1. Diagram showing potential outcomes of the screening pathway. STDED = sight-threatening diabetic eye disease; PRP = panretinal photocoagulation; PPV/EL = pars plana vitrectomy plus endolaser; PPV/MP/intraocular tamponade = pars plana vitrectomy plus membrane peel plus intraocular tamponade. *Patient directed to return for repeat teleretinal imaging per protocol †STDED referrals include ungradeable images and non–diabetic retinopathy findings; the latter were not included in the present analysis.

undervalued or require disease presence along with physician review and interpretation, which limit their applicability. As a result, despite the enormous potential of DR teleretinal screening programs, only a limited number of programs currently exist; most of these depend on governmental or other third-party (e.g., research organization, healthcare network) funding.

If more objective data on teleretinal screening costs were available, perhaps the reimbursement of teleretinal screening would reflect its value more accurately. In this study, we performed a cost analysis and cost savings estimation for the DR teleretinal screening program in the Harris Health System (HHS; Houston, Texas), one of the largest county health systems in the United States (Fig 1). This screening program detects STDED-level DR with the aim of referring patients with advanced DR for more timely evaluation and treatment. Our analysis used activity-based costing (ABC), an accounting model in which resources consumed by services are tabulated as indirect costs, that generally is accepted as a more precise method than traditional accounting for calculating overhead costs.[30] To the authors' knowledge, this type of economical approach has not been applied in this area before. This study methodically quantified the real-world cost of each step of the operational process flow to tabulate a cost-per-screened patient value. Various theoretical models then were used to estimate cost savings by teleretinal imaging to identify selectively the patients in need of in-depth examination in contrast to relying entirely on conventional examinations.[11,31]

Methods

This quality improvement study was approved by the Quality Improvement Council of HHS; was reviewed and exempted by the institutional review boards of Baylor College of Medicine, the University of Texas at Houston, and HHS; and complied with the tenets of the Declaration of Helsinki and the Health Insurance Portability and Accountability Act. Patient consent requirement was waived by the institutional review board due to the retrospective nature of this study, but all data was deidentified and followed all protocols for protection of health information. Briefly, the HHS DR teleretinal screening program was implemented in 2013 and is based on nonmydriatic funduscopic cameras (DRS; CenterVue, Padova, Italy) situated at 8 different HHS primary care clinics. Patients with a known diagnosis of DM without a documented eye examination within the previous year are identified by their primary care provider and are directed to have a 45° macula-centered funduscopic image captured by trained personnel. The images are obtained through a 1-frame capture technique that uses patient autosensing, autoalignment, autofocus, and autoflash adjustment to photograph the most ideal image minimizing inter-user variability. Images are uploaded to a Health Insurance Portability and Accountability Act-compliant cloud-based server, where they are hosted and processed by Intelligent Retinal Imaging Systems (Pensacola, FL). Third-party graders review all images, and a binary referral or observation recommendation is provided. Interpretations are based on the single 45° funduscopic photograph, not on the standard 7 stereoscopic 60° fields used by the Early Treatment Diabetic Retinopathy Study group.[32,33] Although an Early Treatment Diabetic Retinopathy Study photograph-based validation has not been performed, the program's ability to detect STDED reliably and accurately was reported in a previous publication in which a subset of patients at referral threshold were evaluated both with teleretinal screening and clinical examination.[8] Our program likely falls near category 2 according to the American Telemedicine Association DR telehealth program validation classification (excepting DME), although no formal validation has been conducted.[34] The current algorithm mandates that all patients with STDED (defined in this study as severe nonproliferative or proliferative DR) or ungradeable images are referred for an in-clinic examination, whereas those patients whose images do not meet STDED criteria are recommended to return in 1 year for repeat imaging. Patients who were referred for DME were not included in cost calculations because the screening technology is neither intended nor validated for detection of DME. After screening, clinic personnel are responsible for contacting the patients and fulfilling the appropriate referrals.

Teleretinal screening results were obtained for all 18 025 diabetic patients (36 050 eyes) screened from June 2013 through April 2014. Charts were reviewed for the 651 patients who sought an in-clinic evaluation. Analysis was performed to identify the total cost per patient to operate the HHS teleretinal screening program. Of note, because HHS is a government-funded entity, all costs are calculated from the perspective of society as a whole. Activity-based costing depends on a precise operational process flowchart that was developed by live observation of patients undergoing teleretinal screening while timing each step. Costs of durable goods, including the fundus camera (based on a 125% cost depreciation over 5 years), commercial real estate rental prices in Houston, Texas, in 2014, utility charges accrued to HHS for electricity and internet, and per-click fee and interpretation fee (paid to Intelligent Retinal Imaging Systems for data hosting and image interpretation) were obtained from HHS administration. These costs then were allocated by time, geographical area, or number of patients where appropriate (Appendix A, available at www.ophthalmologyretina.org).

Personnel costs were based on time spent between the primary care physician, patient care technician, or registered nurse and the patient during the screening process. The hourly wages of all healthcare professionals involved in patient care were obtained, and a dollar amount per minute spent with each patient was calculated. Fringe costs were not included in this analysis because of a significant proportion of part-time employees whose compensation did not include fringe benefits.

Cost savings calculations were derived from 2 different models: a physical examination-only model and a treatment-only model. The former captures savings from performing the less costly