ORIGINAL ARTICLE

Project I See in NC:
Initial Results of a Program to Increase Access to Retinal Examinations Among Diabetic Individuals in North Carolina

Ramon Velez, Marshall Tyler, John Chen, Michael Babcock, William P. Moran

BACKGROUND Diabetic retinopathy is the leading cause of preventable blindness in adults. Project I See in NC was begun to determine whether access to eye screening for Medicaid recipients and uninsured patients with diabetes in North Carolina could be improved.

METHODS We targeted Medicaid recipients and uninsured adults with diabetes for screening in 2 Community Care of North Carolina Networks. Screenings were performed in primary care settings throughout 6 counties in the Northwest Community Care Network and 6 counties in Access III of Community Care of the Lower Cape Fear. Patients were screened using a high-resolution digital retinal camera with images read at a centralized reading center at Wake Forest School of Medicine.

RESULTS A total of 1,688 patients were screened from October 2005 through September 2007. Nearly 15% (282) were found to have mild, nonproliferative-to-proliferative retinopathy, while the majority of patients had no evidence of diabetic retinopathy. Nearly 12% (196) required referral to an ophthalmologist, with 5% (86) requiring urgent referral for potentially sight-threatening retinopathy.

LIMITATIONS We were not able to confirm which patients kept their ophthalmologic appointments; however, we are currently analyzing data from the Medicaid patients in our study who required ophthalmologic referral.

CONCLUSIONS Remote digital retinal screening for diabetic retinopathy is feasible in primary care settings in both urban and rural areas of North Carolina, and it may prove to be an effective means of reaching more patients who require annual screening examinations.

Diabetic retinopathy is the leading cause of preventable blindness in adults in the United States and is one of the complications most feared by patients [1]. With >600,000 North Carolinians at risk of losing their vision because of diabetic retinopathy, this complication has become an important state public health issue [2]. The American Diabetes Association recommends that patients with diabetes have annual dilated eye examinations to screen for retinopathy [3]. Patients found to have vision-threatening retinopathy can then be referred to ophthalmologists for consideration of laser photocoagulation, a treatment that has been shown in randomized controlled studies to prolong useful vision and reduce severe vision loss by >50% [4].

Despite the availability of effective treatments proven to reduce blindness among diabetic patients with retinopathy, many such patients continue to lose their vision [2]. A recent study examining the quality of diabetic care among low-income patients in North Carolina found a history of documented dilated eye examinations in only 6% of these patients [5].

Telemedicine screening for diabetic retinopathy has emerged as an important method for providing increased access to appropriate eye screening in primary care settings [6-8]. This technology has been widely accepted in large health care systems such as the US Department of Veterans Affairs [6, 9, 10] and the British National Health Service [11].

In an effort to increase the number of Medicaid recipients and uninsured patients with diabetes who receive annual dilated eye examinations and thereby decrease the number of patients at risk of developing blindness, Project I See in NC was developed as a collaborative effort between Community Care of North Carolina (CCNC) and Wake Forest School of Medicine (Winston Salem, NC). The collaboration was supported by grants from The Duke Endowment, the Kate B. Reynolds Charitable Trust, and the North Carolina Foundation for Advanced Health Programs. CCNC is a state-created program that connects Medicaid beneficiaries with medical homes and consists of 14 local health care networks with >3,200 primary care professionals [12]. CCNC has been a pioneer organization in improving clinical care quality and has programs aimed at improving care for patients with diabetes.

Here we describe outcomes from the first 2 years of this project's operations, in which 2 CCNC networks were chosen as demonstration populations for intervention. In these networks, a trained photographer screened Medicaid recipients and uninsured patients with diabetes for retinopathy, using a high-resolution nonmydriatic digital fundus camera.

Methods

Project I See in NC was designed to evaluate the feasibility of using high-resolution digital photography of the retina in a primary care setting to screen for sight-threatening dia-

Electronically published January 30, 2012.

Address correspondence to Dr. Ramon Velez, Section of General Internal Medicine, Department of Internal Medicine, Wake Forest School of Medicine, Medical Center Blvd, Winston-Salem, NC 27157 (rvelez@wakehealth.edu).

N C Med J. 2011;72(5):360-364.
0029-2559/2011/72502

betic eye disease among uninsured patients and Medicaid enrollees in 2 CCNC networks: Northwest Community Care Network (NCCN; formerly Access II) and Access III of Community Care of the Lower Cape Fear (CCLCF). These networks were chosen because together they encompass 12 counties and represent both urban and rural communities in North Carolina.

Figure 1 shows a map of North Carolina and the location of the networks of our intervention. NCCN consists of 6 counties (Forsyth, Stokes, Surry, Yadkin, Davie, and Wilkes), and CCLCF consists of 6 counties (New Hanover, Brunswick, Columbus, Bladen, Pender, and Onslow). We screened individuals at 12 sites in NCCN and 23 sites in CCLCF.

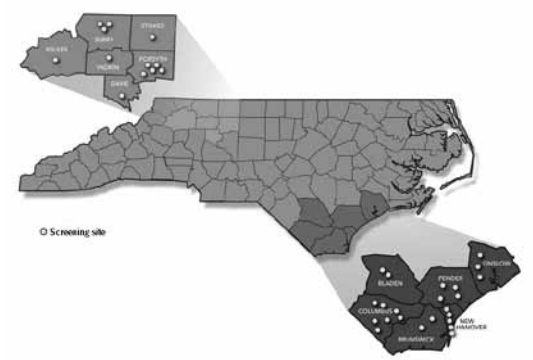
Patient recruitment. Screening was performed in primary care offices serving large numbers of Medicaid recipients, in health departments, in hospital-based outpatient clinics, and in free clinics serving uninsured patients. Trained personnel worked collaboratively with Medicaid nurse case managers to identify and invite Medicaid patients with diabetes to participate in screening. All eligible patients were required to sign a study consent form before their enrollment. A variety of other strategies were used to target Medicaid recipients and uninsured patient populations, including public announcements on local television stations, newspaper advertisements, letters from participants' physicians inviting them to participate in screening, and telephone calls to patients.

Intervention. At screening, all participants underwent a visual acuity examination, using Stereo Optec 800X visual acuity screening equipment. Patients' pupils were then dilated using 1% tropicamide eye drops. Patients with a history of glaucoma were excluded from pupil dilation and had photographs of undilated retinas taken. At least two 45° retinal photographs of each eye were taken. The first field of view was centered on the macula and the optic nerve. The second image field documented the supertemporal vascular arcade. In addition, each patient completed a questionnaire in which they were asked to provide information about age, sex, race, previous history of dilated eye examination, duration of diabetes, self-reported vision changes in the previous year, knowledge of comorbid conditions, and awareness of any existing retinopathy.

Screener and grader training. The 2 screeners received training from a member of of the study team (M.T.), who is a certified retinal angiographer. Screeners were trained on the use of the retinal camera, image storage, and transfer and received individual instruction with patients. They were given a textbook on ophthalmic photography to guide them [13], which was coauthored by one of the coinvestigators (M.T.). Additional training occurred on site as well, through continuous feedback on image quality provided to the 2 screeners.

We asked the screeners to make an initial assessment of image quality and abnormal findings in the field and asked that graders be alerted to patients potentially in need of urgent triage. The initial grader (R.V.) is a physician who trained himself in reading retinal photographs, using 2 training modules [14, 15]. The second grader (M.T.) is a certified retinal angiographer with >35 years as an ophthalmic photographer. The first grader read all of the images and triaged all images with abnormal findings to the second grader for verification of grading. An ophthalmologist was available for consultation with challenging images. We did not measure inter- or intragrader variability.

FIGURE 1.
Screening Sites in 2 Community Care of North Carolina Networks (CCNC) Participating in Project I See in NC



Note. Participating CCNC networks consisted of the Northwest Community Care Network (formerly Access II; top left) and Access III of Community Care of the Lower Cape Fear (bottom right).

Images were graded as normal, mild nonproliferative retinopathy (defined as <5 microaneurysms or hemorrhages), moderate-to-severe nonproliferative retinopathy (>5 microaneurysms or hemorrhages with or without cotton wool spots, hard exudates, and venous beating), or proliferative retinopathy (any neovascular changes or vitreous hemorrhages). Various other nondiabetic changes were commented on in our reports to primary care physicians, including disc changes suggestive of glaucoma and hypertensive changes.

Photographs were uploaded to the Internet by use of secure methods and were stored in a central computer at Wake Forest School of Medicine. The photographs were read by 2 trained readers, with an ophthalmologist available as needed. Individual reports containing the results of the eye examination and retinopathy screening were generated and mailed to the patients' primary care physicians, along with appropriate recommendations regarding the need for a referral to an ophthalmologist for further evaluation and/or the need for treatment of sight-threatening diabetic retinopathy or annual follow-up screening.

Data analysis. Descriptive analyses were performed to summarize means and standard deviations for continuous variables and to generate proportions for categorical variables. The bivariate relationships between the 2 networks and demographic characteristics, grade of diabetic retinopathy, and pattern of referral to ophthalmologists were examined. Continuous data were analyzed with the Student t test, and

TABLE 1.
Demographic Characteristics of Study Participants

Characteristic	Access III of Lower Cape Fear Network (N = 658)	Northwest Community Care Network (N = 1,030)
Age, y, mean, by sex		
Female	53	54
Male	52	52
Sex		
Female	456 (69)	655 (64)
Male	202 (31)	375 (36)
Race		
African American	328 (50)	411 (40)
White	292 (44)	506 (49)
Hispanic	30 (5)	107 (10)
Other	8 (1)	6 (1)
Insurance type		
Medicaid	266 (40)	413 (40)
Medicare	12 (2)	0
Uninsured	380 (58)	617 (60)
Diabetes type		
Type 1	35 (5)	78 (8)
Type 2	616 (94)	679 (66)
Unknown	7 (1)	273 (26)

Note. Data are no. (%) of participants, unless otherwise indicated.

categorical data were analyzed using the χ^2 test. Statistical significance was set at a P value of <.05 for all tests. Analyses were done using SAS, version 9.2 (SAS Institute).

Results

From October 2005 through September 2007, a total of 1,688 patients (679 Medicaid recipients, 12 Medicare recipients, and 997 uninsured patients) were screened for diabetic retinopathy (Table 1). The mean age of study participants was 53.3 years for females and 52.2 years for males. More Hispanics were screened in the NCCN than in the CCLCF (10.4% vs 4.6%). The majority of patients (59.1%) were uninsured. The proportion of patients reporting having type 1 diabetes was similar for both networks (5.3% in the CCLCF and 7.6% in the NCCN); however, more patients in the NCCN reported that they did not know what type of diabetes they had (26.5% vs 1.1%). This apparent difference may have resulted from an interviewer bias. The interviewer in the CCLCF was a nurse and may have probed patients for more information when they reported not knowing what type of diabetes they had; furthermore, there were more Hispanics in the NCCN, and language barriers may have contributed to this apparent difference.

Referral and retinopathy grades. Patterns of referrals to ophthalmologist are shown in Table 2 and grades of retinopathy are described in Table 3. There were no regional differences in the grade of retinopathy as diagnosed by teleretinal imaging, with 86% of participants overall showing no retinopathy, 8.5% showing mild nonproliferative retinopathy, 4.3% showing moderate-to-severe retinopathy, and 1.0% showing proliferative retinopathy. A total of 0.2% of participants had nongradable images. All patients with moderate-to-severe nonproliferative retinopathy or proliferative retinopathy were referred to an ophthalmologist. Urgent referrals were called in to the primary care physician's office, and all physicians were mailed patient reports with information when referrals were recommended within 3 or 6 months. Patients with poor visual acuity (less than 20/40 in either eye) were encouraged to see an eye specialist for refraction. If there was any suspicion of macular edema, patients were directed to an ophthalmologist.

Discussion

A recent article by Martin [16p1121] asks why the US health care system does not "keep people with preventable disabilities such as diabetes-related blindness from becoming disabled." Diabetic retinopathy is the most common cause of irreversible vision loss in persons with diabetes. Screening for retinopathy facilitates early detection, when this condition is most amenable to treatment. Indeed, retinopathy meets all of the criteria for conditions meriting screening: (1) the prevalence of the condition is high, (2) there is an accurate screening test, (3) an effective treatment is available, and (4) screening is cost-effective [17]. Despite this, systematic screening for diabetic retinopathy is not universally practiced.

Recent developments in digital retinal photography have made it cost-effective to bring this technology to primary care settings, where diabetic patients receive most of their care [7, 18, 19]. We were interested in reaching Medicaid recipients and uninsured patients because previous studies have shown that these groups are not being adequately screened [5, 20]. Other investigators have shown the feasibility of using digital retinal photography in primary care settings [10, 21].

Our approach was different in that we purposely selected to screen at multiple sites over a wide geographic region in North Carolina, which included urban and rural areas. These locations included primary care physicians' offices, public health departments, free community clinics, and hospital-based primary care clinics. The benefit of screening in these sites, instead of referring patients to ophthalmologists' or optometrists' offices for screening, is supported by a previous study with a similar population of patients. In that study, patients were randomized to receive either a digital retinal screening performed during their primary care visit or to be referred to an ophthalmologist for screening at a subsequent time [21]. All of the patients who received digital screening during their primary care visit received screening, whereas only 31% of those referred to an ophthalmologist's office actually kept their scheduled appointment for screening.

We did not encounter any reported adverse reactions due to pupil dilation with 1% tropicamide eye drops. The risk of precipitating acute narrow angle glaucoma is very small and may be smaller than the risk of missing proliferative retinopathy in a diabetic patient [22]. We advised patients to be aware of symptoms and to seek acute medical care in the event of an episode of acute narrow angle glaucoma. The absence of acute angle glaucoma in this study should reassure primary care physicians and encourage them to relearn the art of performing dilated eye examinations by use of the direct ophthalmoscope. In addition, the low frequency of nongradable images in our study is likely attributed to having patients' eyes dilated unless contraindicated and is consistent with the rate in a previous report [23].

In our study, nearly 12% (196) of the patients we screened required referral to ophthalmologists for further assessment. Urgent referral was required for 5% of patients (86) for evaluation of potentially vision-threatening retinopathy. At the time of our screening, none of the 196 patients referred to ophthalmologists were aware that they had retinopathy. Although we were not able to confirm which patients actually kept appointments with ophthalmologists, we are currently merging our study patients with North Carolina Medicaid claims data to evaluate actual health care use.

A 30%-50% reduction in the incidence of blindness has been observed in 2 population-based studies from areas that had universal screening for retinopathy [24, 25]. These observations contributed to the establishment of national screening programs for diabetic retinopathy in the United Kingdom [11, 26]. In the United States, a similar program of digital retinal screening was initiated in the Veterans Administration system in 2005 [6, 9].

Our study demonstrated that it is feasible to achieve widespread retinal screening of Medicaid patients in these 2 CCNC networks. Currently, North Carolina Medicaid does not reimburse digital retinal screening in primary care, although Medicare and most types of private insurance do. Given the serious consequences of not screening and treating people at risk for diabetic retinopathy, we encourage Medicaid to reconsider coverage of digital retinal screening for diabetic patients in the primary care setting. The medical and social consequences of vision loss resulting from undiagnosed diabetic retinopathy are too great to be ignored [27]. The CCNC networks provide an ideal medical home in which to provide comprehensive care of diabetic patients that includes diabetic eye screening and referral. NCMJ

TABLE 2.
Retinopathy Status Among Study Participants and Protocols for Referral to Ophthalmologists

Retinopathy status, referral protocol	No. (%) of participants: Access III of Lower Cape Fear Network (N = 658)	No. (%) of participants: Northwest Community Care Network (N = 1,030)
None[a]	571 (87)	921 (90)
Nonurgent, refer in 6 mo	13 (2)	20 (2)
Nonurgent, refer in 3 mo	32 (5)	44 (4)
Urgent, refer promptly	42 (7)	45 (4)

Note. Differences in percentages between networks, stratified by referral protocol, were not statistically significant.
[a]Rescreen in 1 year.

TABLE 3.
Grade of Diabetic Retinopathy Among Study Participants

Grade	No. (%) of participants: Access III of Lower Cape Fear Network (N = 658)	No. (%) of participants: Northwest Community Care Network (N = 1,030)
None	551 (83.7)	901 (87.5)
Mild, nonproliferative	61 (9.3)	82 (8.0)
Moderate to severe, nonproliferative	38 (5.8)	35 (3.4)
Proliferative	6 (0.9)	11 (1)
Nongradable	2 (0.3)	1 (0.1)

Note. Differences in percentages between networks, stratified by grade, were not statistically significant.

Ramon Velez, MD, MSc professor, Section on General Internal Medicine, Department of Internal Medicine, Wake Forest School of Medicine, Winston-Salem, North Carolina.
Marshall Tyler, BS, CRA instructor, Department of Ophthalmology, Wake Forest School of Medicine, Winston-Salem, North Carolina.
John Chen, MD, PhD investigator, Houston Veterans Affairs Health Services Research and Development Center of Excellence, and associate professor, Section on Health Services Research, Department of Medicine, Baylor College of Medicine, Houston, Texas.
Michael Babcock, MD cardiology fellow, Department of Cardiology, University of Florida College of Medicine, Jacksonville, Florida.
William P. Moran, MD, MS director, Division of General Internal Medicine and Geriatrics, Department of Medicine, Medical University of South Carolina, Charleston, South Carolina.

Acknowledgments

We are grateful to the late James D. Bernstein of the North Carolina Foundation for Advanced Health Programs, for his support in the early planning of Project I See in NC; Gaye Hennis, for managing the project; and Amanda Goode, for her editorial assistance and encouragement. We also thank the following collaborating partners in North Carolina, for their support: in Bladen County, the Bladen County Health Department (Elizabethtown) and Bladen Medical Associates (Elizabethtown); in Brunswick County, the Brunswick County Health Department (Bolivia) and the Shallotte Medical Lab (South Brunswick); in Columbus County, the Chadbourn Family Practice (Chadbourn), the Columbus County Health Department (Whiteville), the Dream Center (Whiteville), G&G Healthcare (Cerro Gordo), Primary Care (Tabor City), Signet Healthcare (Whiteville), and Whiteville Medical Associates (Whiteville); in New Hanover County, Abrons Family Practice (Wilmington), Coastal Family Medicine (Wilmington), New Hanover Community Health (Wilmington), the New Hanover County Health Department (Wilmington), and the Wilmington Health Associates–Porters Neck (Wilmington); in Onslow County, the Onslow County Health Department (Jacksonville), the Penslow Health Clinic (Holly Ridge), and Sneads Ferry Medical Clinic (Sneads Ferry); in Pender County, Black River Family Practice (Burgaw), Black River Health Center (Atkinson), Maple Hill Medical Center (Maple Hill), and the Pender

County Health Department (Burgaw); in Davie County, the Davie County Hospital (Mocksville); in Forsyth County, Community Care Clinic (Winston-Salem), the Downtown Health Plaza (Winston-Salem), Forsyth County Health Department (Winston-Salem), Novant Diabetic Nutrition Services (Winston-Salem), and the Wake Forest OPD Clinic (Winston-Salem); in Stokes County, the Stokes-Reynolds Memorial Hospital (Danbury); in Surry County, Foothills Family Medicine (Elkin), Northern Hospital of Surry County (Mt. Airy), and Pilot Mountain Civic Center (Pilot Mountain); in Wilkes County, the Wilkes Regional Medical Center (North Wilkesboro); and in Yadkin County, Hoots Memorial Hospital (Yadkinville).

Financial support. The Duke Endowment, the Kate B. Reynolds Charitable Trust, the North Carolina Foundation for Advanced Health Programs, and the North Carolina Lions Foundation.

Potential conflicts of interest. All authors have no relevant conflicts of interest.

References

1. Centers for Disease Control and Prevention (CDC). National Diabetes Fact Sheet: National Estimates and General Information on Diabetes and Prediabetes in the United States, 2011. Atlanta, GA: CDC, US Department of Health and Human Services; 2011.
2. Diabetes Prevention and Control Branch, North Carolina Division of Public Health. The Burden of Diabetes in North Carolina: Prevalence, Complications, and Costs, 2008. Raleigh, NC: North Carolina Department of Health and Human Services; 2008. Available at: http://www.ncdiabetes.org/library/_pdf/Diabetes%20Burden%20Bk.pdf. Accessed April 20, 2011.
3. Executive summary: standard of medical care in diabetes—2011. Diabetes Care. 2011;34(Supp 1):S4-S10.
4. Mohamed Q, Gillies MC, Wong TY. Management of diabetic retinopathy: a systematic review. JAMA. 2007;298(8):902-916.
5. Bell RA, Camacho F, Duren-Winfield VT, et al. Improving diabetes care among low-income North Carolinians: Project IDEAL. N C Med J. 2005;66:96-102.
6. Conlin PR, Fisch BM, Orcutt JC, Hetrick BJ, Darkins AW. Framework for a national teleretinal imaging program to screen for diabetic retinopathy in Veterans Health Administration patients. J Rehabil Res Dev. 2006;43(6):741-748.
7. Merin LM, Guentri K, Recchia CC. Digital detection of diabetic retinopathy—increasing access, reducing risk, improving outcomes. J Ophthalmic Photog. 2004;26(2):59-66.
8. Silva PS, Cavallerano AA, Aiello LM, Aiello LP. Telemedicine and diabetic retinopathy: moving beyond retinal screening. Arch Ophthalmol. 2011;129(2):236-242.
9. Cavallerano AA, Cavallerano JD, Katalinic P, et al. A telemedicine program for diabetic retinopathy in a Veterans Affairs Medical Center—the Joslin Vision Network Eye Health Care Model. Am J Ophthalmol. 2005;139(4):597-604.
10. Conlin PR, Fisch BM, Cavallerano AA, Cavallerano JD, Bursell SE, Aiello LM. Nonmydriatic teleretinal imaging improves adherence to annual eye examinations in patients with diabetes. J Rehabil Res Dev. 2006;43(6):733-740.
11. Verne J. A national screening programme for diabetic retinopathy. BMJ. 2001;323:5-6.
12. Dobson AL, Hewson DL. Community Care of North Carolina—an enhanced medical home model. N C Med J. 2009;70(3):219-224.
13. Tyler ME, Saine PJ, Bennett TJ. Practical Retinal Photography and Digital Imaging Techniques. Philadelphia, PA: Butterworth-Heinemann Medical; 2003.
14. Brucker J. Visual Impairment and Treatment of Five Complications of Diabetes: A Guide for Primary Care Practitioners. Module 2. Philadelphia, PA: Pennsylvania Diabetes Academy; 1985.
15. Towler HMA, Patterson JA, Lightman S. Diabetes and the Eye [CD-ROM]. 2nd ed. Oxford, United Kingdom: BMJ Books; 1998.
16. Martin T. Going blind on our watch. Health Aff (Millwood). 2006; 25(4):1121-1126.
17. Tugwell P, Knottnerus A, Idzerda L. New tutorial on screening. J Clin Epidemiol. 2011;64(3):229-230.
18. James M, Turner DA, Broadbent DM, Vora J, Harding SP. Cost effectiveness analysis of screening for sight-threatening diabetic eye disease. BMJ. 2000;320:1627-1631.
19. Javitt JC, Canner JK, Sommer A. Cost effectiveness of current approaches to the control of retinopathy in type 1 diabetics. Ophthalmology. 1989;96(2):255-264.
20. Moss SE, Klein R, Klein BEK. Factors associated with having eye examinations in persons with diabetes. Arch Fam Med. 1995;4:529-534.
21. Taylor CR, Merin LM, Salunga AM, et al. Improving diabetic retinopathy screening ratios using telemedicine-based digital retinal imaging technology: the Vine Hill study. Diabetes Care. 2007;30(3):574-578.
22. Pandit RJ, Taylor CR. Mydriasis and glaucoma: exploding the myth. A systematic review. Diabet Med. 2000;17(10):693-699.
23. Pugh JA, Jacobson JM, Van Heuven WA, et al. Screening for diabetic retinopathy: the wide-angle retinal camera. Diabetes Care. 1993;16(6):889-895.
24. Arun CS, Ngugi N, Lovelock L, Taylor R. Effectiveness of screening in preventing blindness due to diabetic retinopathy. Diabet Med. 2003;20:186-190.
25. Stefansson E, Bek T, Porta M, Larsen N, Kristenssen K, Agardh E. Screening and prevention of diabetic blindness. Acta Ophthalmol Scand. 2000;78:374-385.
26. Christie B. Scotland to start screening programme for diabetic retinopathy. BMJ. 2002;324:871.
27. Rein DB, Zhang P, Wirth KE, et al. The economic burden of major adult visual disorders in the United States. Arch Ophthalmol. 2006;124:1754-1760.