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# Screening Diabetic and Hypertensive Patients for Ocular Pathology using Telemedicine Technology in Rural West Virginia: A Retrospective Chart Review

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## Abstract

**Purpose:** There is a disparity between the number of people who need healthcare and availability of medical services in rural areas. This paper describes the experience of using telemedicine technologies for ophthalmologic evaluation in diabetic and hypertensive patients presenting to a community health center in rural West Virginia. **Methods:** A registered nurse at a community health center in McDowell County, WV was trained to use a retinal camera to capture high-resolution digital images of the retina. Patients with diabetes or hypertension were screened during their routine primary care visits. Retinal photos were transmitted to an ophthalmologist for review and reports from the screenings were returned with

instruction for follow-up care or specialist referral when indicated. **Findings:** A retrospective chart review of 643 patients with diabetes or hypertension who were screened for ocular problems from October 2003 to December 2009 was completed. 44.8% of patients who were screened in the primary care center were identified as having 1 of 34 types of eye pathology that were previously unknown, of which 33% of patients were recommended to seek prompt attention by a retina consultant or glaucoma specialist for suspected ocular pathology. **Conclusions:** Our review demonstrates the actual benefits of telemedicine in the effective screening of diabetic and hypertensive patients for eye pathology, and our experience suggests that using distance medicine and telemedicine technologies is valuable for screening rural populations.

## Introduction

Access to healthcare is a challenge for rural citizens in the United States. Approximately 25% of individuals living in America reside in rural areas. Of doctors in our nation, only 10% provide care to individuals in non-urban areas.<sup>1</sup> There is a disparity between the number of people who need healthcare and availability of medical services in rural areas. For the past several decades, efforts have been made to improve access for this population. In 1978, the National Rural Health Association (NRHA) was established to provide leadership for issues unique to smaller, more isolated communities.<sup>2</sup> Despite these efforts, considerable inequities remain. Retaining well-trained and highly motivated providers in rural areas has become a major problem in many small towns across the country.<sup>3</sup>

One potential approach for reducing isolation and improving access to specialty care in rural areas

lies in the application of telemedicine technology. Broadly defined as the use of telecommunications to provide medical information and services, telemedicine has been shown to help reduce the isolation gap between urban and rural areas.<sup>4</sup> In April 2009, a study commissioned by the United States Chamber of Commerce looked at the potential of new technologies for healthcare solutions, and encouraged expansion of broadband-enabled telemedicine applications.<sup>5</sup> This paper describes the experience of the use of telemedicine technologies for ophthalmologic evaluation of patients presenting to a community health center in rural West Virginia.

## The Target Population

In West Virginia, nearly 45% of the citizens live in a rural area.<sup>6</sup> Many of the residents are burdened with chronic illnesses, such as diabetes, hypertension, and cardiovascular disease. A majority of these individuals are geographically isolated and have limited access to care. McDowell County is a 535 square mile landlocked area located in the Southwestern West Virginia. Its largest city and county seat is Welch with a population of 2,180. Of West Virginia's 55 counties, McDowell ranked last in overall health outcomes.<sup>7</sup> Demographically, 89.1% of county residents are Caucasian and 9.5% are African American, compared to statewide totals of 93.9% Caucasian and 3.3% African American. 40.8% of the population is below the Federal Poverty Level, and only 25% have some college education.<sup>8</sup> The unemployment rate is 11.8%, and 15% of residents are uninsured. Obesity, hypertension, and diabetes are major health problems in this county,

and contribute to a considerable number of deaths yearly.<sup>7,8</sup>

## Methods

In May of 2001, a grant from the Minority Health Program of the U.S. Health Resources and Services Administration facilitated the formation of a partnership between Tug River Health Association in McDowell County and the Robert C. Byrd Center for Rural Health at the Joan C. Edwards School of Medicine at Marshall University (JCESOM) for the purpose of screening diabetic and hypertensive patients for retinopathy and other ocular pathology.

Primary care providers at Gary Community Health Center, affiliated with Tug River Health Association, presented a voucher to all patients diagnosed with diabetes or hypertension to participate in an eye screening program during their office visit. The patients did not need a formal referral, nor schedule another appointment with an eye doctor. A

nurse trained to use a high-resolution digital retinal camera (Topcon TRC-NW6S Non-Mydriatic Retinal Camera, Figure 3) documented high-resolution images of the fundus and used a tono-pen to record intraocular pressures. While most patients could be screened effectively without pupil dilatation, approximately 5% of patients required pupil dilation to obtain adequate imaging.<sup>9</sup> A brief standard history, retinal images, and intraocular pressure value (Figure 1) was transmitted either electronically via a secure HIPPA approved T-1 line or by storage media to a board certified ophthalmologist at JCESOM. The ophthalmologist provided an interpretation of the images and recommendations were returned within 1 to 2 weeks.

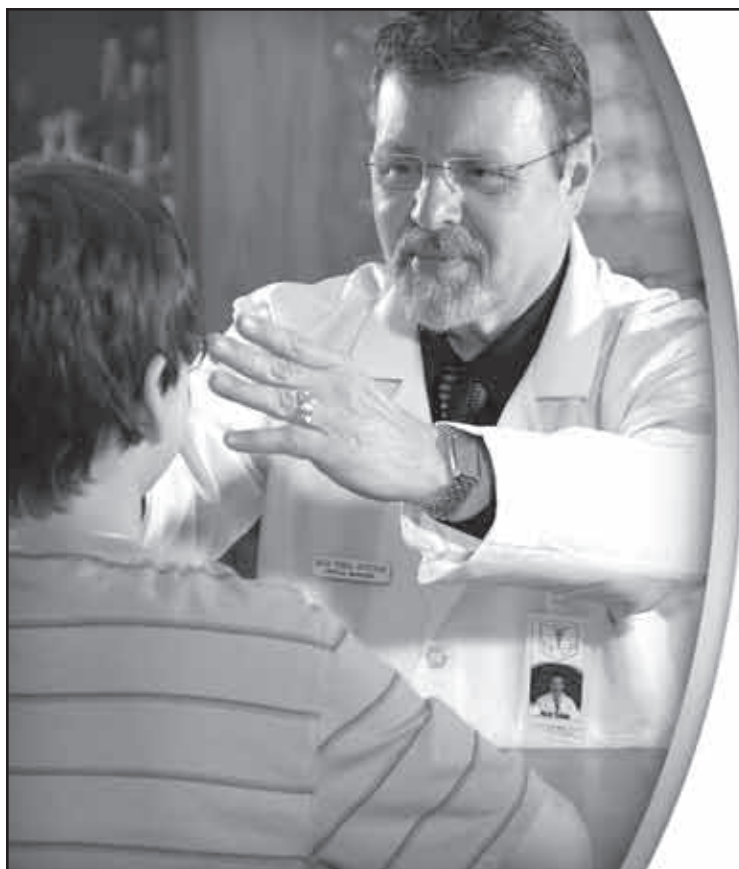
Subsequently, patients were notified of the results from their screenings. The nursing staff at GCHC assisted patients who required further evaluation by scheduling an appointment with an optometrist or ophthalmologist

as recommended. Depending on the nature of the complaint, some patients could be managed locally, while others were sent to a specialist elsewhere within the state.

A retrospective chart review was completed on all patients evaluated with the digital retinal camera at GCHC for the 7 year period from 2003 through 2009. Data regarding demographic information along with clinical diagnosis and recommendations was collected.

## Results

During the 7-year study period, a total of 643 patients (Table 1) were screened in the clinic and 44.8% were identified as having an ocular problem. Though the image quality was generally very good, an estimated 5% of photos could not be used to interpret subtle changes. In these cases, the results were discarded and patients were recalled for repeat imaging.<sup>9</sup> There were a total of 34 different types of eye



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**Figure 1.** Screening form used at Gary Community Health Center in McDowell County, WV for Ophthalmological Review.

**TUG RIVER CLINIC OPHTHALMIC PHOTOGRAPH REPORT**

Photograph Date: \_\_\_\_\_ Photographer: \_\_\_\_\_ Provider: \_\_\_\_\_

Patient's Name: \_\_\_\_\_  
 (Last Name) (First Name) (M. Initial)

D.O.B. \_\_\_\_\_ Age: \_\_\_\_\_ S.S.# \_\_\_\_\_  
 (Month)(Day)(Year)

SC	20/		
CC	20/	TA	

Other Current Medical Conditions:

Current Medications:

SYSTEMIC/SOCIAL		Patient	Family
ALLERGIES-DRUG			
ASTHMA/RESPIRATORY			
CARDIAC DISEASE			
DIABETES-ENDOCRINE			
HYPERTENSION/VASCULAR			
GIBEPATITS			
GU/KIDNEY STONES			
MUSC./ARTHRITIS			
SKIN CONDITIONS			
NEUROLOGICAL			
FAM. HX EYE PROBLEMS			
CANCER			
OCULAR TRAUMA			
STEROID USE			
SMOKING			
ALCOHOL			
NEURO:			
MOOD: NORMAL, DEPRESSED, ANXIOUS, OTHER			

ORIENTATION: INTACT / OTHER

**FUNDUS PHOTO REPORT:**

Cup to Disc Ratio:		
Diabetic Retinopathy Background	Y	N
Proliferative Retinopathy	Y	N
Hypertensive Retinopathy	Y	N
Unacceptable Photograph	Y	N
Normal Fundus Photo	Y	N

Additional Comments:

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

**DISPOSITION:**

1. Follow up photo in one year
2. Immediate referral (retina consultant)
3. Immediate referral (glaucoma specialist)
4. Ophthalmic evaluation in one month
5. PRN follow up based on clinic evaluation

**Figure 3.** Topcon TRC-NW6S Non-Mydriatic Retinal Camera.

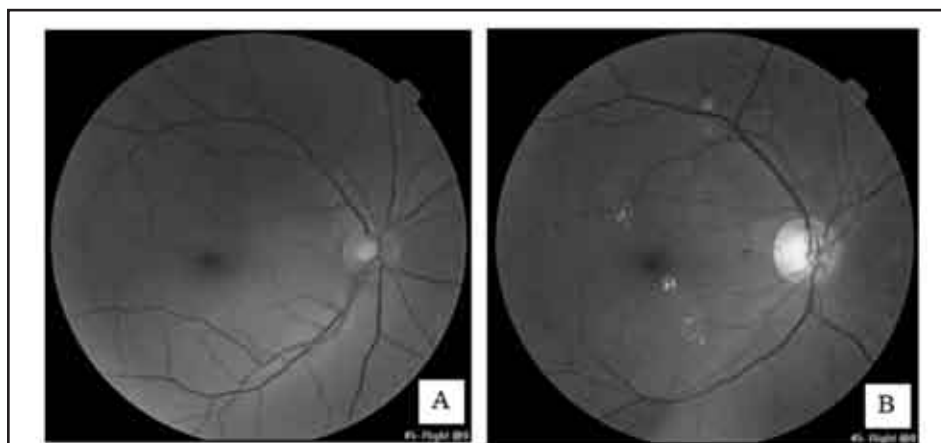


pathology identified in 288 patients (Table 2). The most common finding was glaucoma suspect (34%) and the targeted problems of diabetic retinopathy and hypertensive retinopathy were present in 15.6% and 4.2% of this group respectively. Examples of typical images taken using the retinal camera are shown in Figure 2A. Based upon the specific pathology identified, the following recommendations were provided to the patients as determined by the reviewing ophthalmologist: (1) follow up evaluation in one year, (2) immediate referral to a retina consultant, (3) immediate referral to a glaucoma specialist, (4) formal ophthalmic evaluation in one month, or (5) No specific instruction. (Table 3)

**Discussion**

The use of digital retinal photo technology at the community health center in rural McDowell County, West Virginia resulted in the detection of previously unknown eye pathology in 44.8% of diabetic and hypertensive patients screened. All 643 patients had retinal images interpreted by a board certified ophthalmologist at the JCESOM. Of

**Figure 2A.** Normal fundus photo of right eye.



**Figure 2B.** Fundus photo of the right eye showing some characteristic features of nonproliferative diabetic retinopathy, including microaneurysms, hard exudates, and intraretinal dot and blot hemorrhages.

**Table 1. Demographic Parameters of the Sample Population vs. General Population in McDowell County, WV**

Variable	Sample Population % (N=643)	Local County %
<b>Race<sup>8</sup></b>		
Caucasian	82.3 (529)	89.1
African American	17.6 (113)	9.5
Other	0.2 (1)	1.4
<b>Sex<sup>8</sup></b>		
Female	58.1 (374)	51.0
Male	41.8 (269)	49.0
<b>Age<sup>11</sup></b>		
25-34	4.8 (31)	10.5
35-44	13.5 (87)	12.9
45-54	31.3 (201)	18.4
55-64	31.1 (200)	13.6
65-74	12.6 (81)	7.8
75+	6.7 (43)	7.8

**Table 2. Number of Patients by Ocular Pathology**

Ocular Pathology	Number of Patient (%)
Glaucoma	97 (33.4%)
Cataract	73(25.3%)
Diabetic Retinopathy	45 (15.6%)
Age Related Macular Degeneration	41(14.2%)
Atherosclerosis	15(5.2%)
Hypertensive Retinopathy	12 (4.2%)
Presbyopia	6 (2.1%)
Retinal Tear	6 (2.1%)
Drusen of optic nerve	5 (1.7%)
Ocular Hypertension	5 (1.7%)
Macular edema	4 (1.3%)
Medullated Nerve Fiber	3 (1.0%)
Amblyopia	3 (1.0%)
Papilledema	3 (1.0%)
Posterior Vitreous Detachment	3 (1.0%)

\*\* [ $\leq 1.0\%$  of total patient pool] Retinitis Pigmentosa, Keratoconjunctivitis Sicca, Choroidal Nevi, Histoplasmosis, Iris Nevi, Macroaneurysm, Lens Subluxation, Corneal Edema, Blepharitis, Optic Atrophy, Venous Congestion in Eye, Branch Vein Occlusion, Ocular Melanosis, Retinal Telangiectasias, Venous Stasis Retinopathy, Amourosis Fugax, Retina Vein Occlusion, Sudiferous cysts of lids, Papillitis

**Table 3. Clinical Recommendations Following Screening**

Instruction	Number of Patients (%)
Follow up photo in one year	96 (33.3%)
Immediate referral (retina consultant)	40 (13.9%)
Immediate referral (glaucoma specialist)	56 (19.4%)
Ophthalmic evaluation in one month	75 (26.0%)
No instruction	21 (7.3%)

the various abnormalities discovered through the ophthalmologic screening process, several were identified specifically by the use of the digital retinal camera, which may have otherwise gone unrecognized.

The screening program at the community health center is very convenient for the patients and their families. Since the screening takes place in the primary care center at the time of the regular visit, compliance with care guidelines for this population is considerably enhanced. This allows for detection of serious ocular pathology at its early stages. In the study done at the community health center, 33% of patients were recommended to seek prompt attention by a retina consultant or glaucoma specialist for suspected ocular pathology. In special cases, where the nurse visualized a bleed in the retinal vessels or measured an intraocular pressure more than 30mmHg, patients were sent to the nearest ophthalmologist for immediate care.

The overall cost of operating an eye-screening program is reasonable. In our study, the purchase of all equipment and ancillary material were supported through a one time grant of \$46,000. This allowed for the purchase of a digital retinal camera, tono-pen, and desktop computer. Continuing supply costs were minimal and included local anesthetics. Support staff were provided and trained by the community health center.

There are several challenges and obstacles to starting up an eye-screening program in a rural community using digital retinal technology. A mutually supportive partnership between a community health center and qualified ophthalmologist is essential. The primary care providers at the participating clinic must actively participate in targeting select populations and encourage their

patients to participate at the time of their regular visits. In the 7-year study, some of the physicians were more aggressive than others in recommending this technology to their patients. There must also be sufficient staff trained to use the camera and tono-pen. At the community health center, limited trained staff resulted in some patients who were not screened at the time of their primary care visit when staff was absent or not available. Though some images were instantly sent over a T1 connection, using high speed internet was very costly to the participating community health center; alternatively, by sending images by mail, there was a natural delay between date of screening and reporting of results.

Further study is important to determine the specificity of this screening method, and to reduce type I statistical error. The target population may need to be expanded to include children and patients other than those diagnosed with diabetes or hypertension.

In a study by the National Association of School Nurses, results showed that the early detection of a vision problem from school age children might have sustainable educational and behavioral benefits.<sup>10</sup> It would be interesting to do a cohort study to assess patient satisfaction with their eye screening and monitor the long term impact of the eye screening on patient's health and well-being. Additional research is needed to assess patient compliance with the ophthalmologist's recommendations and clinical outcomes.

Since diabetic retinopathy is the number one cause of blindness in working age adults in the United States, the importance of regular ophthalmologic screening in at-risk populations is evident. For a patient living in a rural community, the ability to be evaluated at their nearby

primary care health center helps alleviate transportation costs and allows for close monitoring of visual changes. Telemedicine is expected to play an important role in helping improve health for the citizens of our nation. In March 2011, WV Telehealth Alliance expanded broadband technologies to 93 locations around the state and continues to expand connectivity. Our review demonstrates the actual benefits of telemedicine in the effective screening of diabetic and hypertensive patients for eye pathology, and our experience suggests that distance and telemedicine offer a viable solution to issues of access to specialty care in rural and isolated communities

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