

The effectiveness of diabetic retinopathy screening by primary care providers: A
systematic review of literature

Submitted by
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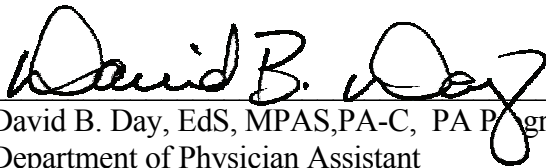
Wichita State University
College of Health Professions
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We hereby recommend that the research project prepared under our supervision by Jena Shackelford entitled The effectiveness of diabetic retinopathy screening: A systematic review of literature will be accepted as partial fulfillment for the degree of Master of Physician Assistant.

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Abstract

Introduction: Diabetic retinopathy is the leading cause of preventable blindness in the United States and much of the industrialized world. This complication has the potential to affect all patients with diabetes, regardless of type. Many patients with diabetes are unaware of any vision loss and may not receive treatment before it is too late. Primary care providers play an important role in screening for any retinal changes in between patients' annual visits with an ophthalmologist. Many health care providers feel inadequate in their ability to accurately screen for diabetic retinopathy using the conventional ophthalmoscope. There has recently been a new ophthalmoscope, the PanOptic, which claims to be just as accurate. There is also an emerging form of screening by way of telemedicine. Telemedicine occurs when digital images are obtained and evaluated off site by an ophthalmologist. Methodology: The purpose of this paper was to perform a systematic review of the literature and examine the effectiveness of screening for diabetic retinopathy by primary care providers by comparing the conventional and PanOptic ophthalmoscopes with telemedicine. Articles ranged from 1999-present. Results: Twenty-nine articles matched the criteria and were reviewed using evidence-based methods. After analyzing the data, it appears that the PanOptic is not very effective in screening for diabetic retinopathy. The conventional ophthalmoscope is still effective, but telemedicine is an even better option. Conclusion: Telemedicine appears to be the most effective option for primary care providers to screen for diabetic retinopathy.

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Introduction

Disease prevention is an important aspect of providing health care to an individual. Accordingly, primary care providers should be educating all diabetic patients regarding complications that may arise if the diabetes is not controlled. One of these complications, diabetic retinopathy, is the leading cause of preventable blindness in the industrialized world.¹⁻⁵ Of the over sixteen million Americans affected with diabetes, half of these patients have some degree of diabetic retinopathy.¹ The prevalence of retinopathy increases with the duration of diabetes, whether type 1 or type 2.⁶ Diabetic retinopathy is often asymptomatic and patients may not notice a change in their vision; however, the damage is always irreversible if not caught in a timely fashion.

The American Diabetes Association (ADA), recommends that after the initial evaluation for diabetic eye disease, routine follow-up exams should occur annually at a minimum.⁷ This requires pupil dilation and the use of biomicroscopy and seven-standard field stereoscopic 30° fundus photography as the tests of choice in diagnosis.^{7,8}

Primary care providers play a critical role in the management of diabetes and preventing retinopathy. Patients may help reduce the risk of retinopathy by controlling blood sugar, blood pressure, and lipids levels. Many primary care providers utilize or have at least had training to screen for diabetic retinopathy via a conventional hand-held ophthalmoscope. However, there are new pieces of equipment and technological advances that have been emerging in the treatment of this diabetic complication.

As technology continues to evolve, it is important for the primary care providers to incorporate the latest advances in order to provide the most accurate and up-to-date diagnostic and management options for patients. One technology that has increasing

global utilization is telemedicine for the screening of diabetic retinopathy. Telemedicine is broad term that covers various technologies used to transmit information for medical purposes. It uses electronic information and communication technologies to provide and sustain health care when distance divides the patients from the health care specialist.

Literature Review

Diabetic retinopathy is the leading cause of preventable blindness in the United States for people 20 to 64 years of age.¹ Diabetic retinopathy primarily affects the retina and occurs in two forms: non-proliferative and proliferative. Patients with either type 1 or type 2 diabetes mellitus are at risk for developing diabetic retinopathy.

Non-proliferative retinopathy is the less serious form and occurs when an abnormality develops in the retinal capillaries, allowing fluid to leak into the tissue of the eye. The most common signs include hemorrhages, cotton wool spots, dilated retinal veins, and hard exudates.^{1,6} Many patients with non-proliferative retinopathy may not notice a change in their vision. Vision may be reduced if blood, lipids, or exudates start to leak into the retina near the macula or if ischemia occurs. The macula may begin to thicken and cause macular edema.

As time passes, non-proliferative retinopathy may progress into proliferative retinopathy due to increasing ischemia. Lack of oxygen to the eye may cause neovascularization around the optic disc, iris, or across the retina. The patient still may not have noticed a problem with their vision. Without treatment, however, hemorrhages can occur in the vitreous humor, the retina may detach, and rubeotic glaucoma can occur.^{1,6} When any of these processes begin, a severe loss of vision or irreversible

blindness may or may not occur. Fifty percent of untreated patients with proliferative retinopathy become legally blind within five years.⁹

Retinopathy rarely occurs before the onset of puberty or within the first five years after diagnosis in type 1 diabetes.^{6,7} However, within twenty years of diagnosis, almost all type 1 patients develop some form of retinopathy. Patients with type I diabetes are more likely to develop proliferative retinopathy because they typically are diagnosed with diabetes at a much younger age and will have had the disease longer than patients with type 2 diabetes. Younis et al., found a strong association between duration of diabetes and presence of any form of retinopathy when a patient is first screened, regardless of type.² Type 2 diabetics tend to already have some form of retinopathy when they are first diagnosed with diabetes and may also have more macular edema than type 1 diabetics.⁶

Type 1 diabetics should be advised to receive their first eye examination within three to five years after the diagnosis, although younger patients do not need an eye examination until at least age 10. Type 2 patients should be advised to get their initial exam when the diabetes is diagnosed. The exam needs to be performed by an ophthalmologist or optometrist and follow-up exams should occur at least annually.^{7,10}

There are several options for the treatment of retinopathy if diagnosed in a timely manner. If the retinopathy is not sight-threatening, the patient needs to be advised on how to prevent or reduce hypertension, which could accelerate the disease by increasing the ischemia in the retina. The swelling and vision loss from macular edema may be reduced with focal or grid laser treatment.¹ A more elaborate laser treatment is needed for proliferative retinopathy to stop the abnormal blood vessel growth. However, in some

cases the disease progression may be too extensive. If traction retinal detachment occurs, the patient may be a candidate for vitreoretinal surgery.^{1,6,11}

There are many differing opinions regarding what constitutes adequate screening for diabetic retinopathy. Techniques that have been studied include direct ophthalmoscopy through dilated or nondilated pupils, indirect ophthalmoscopy, and stereoscopic or non-stereoscopic retinal photography through mydriasis or non-mydriasis.¹² According to Griffith et al., screening tests, whether for diabetic retinopathy or any other disease, should focus primarily on the accurate ability to refer a patient to a specialist for further diagnosis; the test should not be considered accurate solely on the basis of its ability to diagnose a particular disease. They also note, however, an appropriate screening should be sensitive enough to “identify all patients with disease needing further evaluation...and specific enough to eliminate from further evaluation most patients without disease.”¹²

In a study by Mukamel et al., only sixteen percent of patients with diabetes obtained an annual screening exam in two consecutive years.¹³ Even if diabetic patients are fortunate enough to see a primary care provider, many do not get the proper screening for retinopathy, because the practitioner lacks either proper equipment or expertise.¹⁴ Several studies have shown that primary care providers are lacking in their ability to diagnose diabetic retinopathy. In fact, Sussman et al., found that less than sixty percent of significant lesions are diagnosed by internists, diabetologists, and medical residents when examining the fundi of diabetic patients with pupils dilated. Compare that with the fact that ophthalmologists and retinal specialists were able to identify greater than ninety-six percent.¹⁵

In a study by Ozerov and Monderer, only fifty percent of providers believed they were satisfactory in performing a fundoscopic exam. Less than thirty percent felt their skills were adequate at detecting diabetic retinopathy.¹⁶ Roberts et al., surveyed seventy-two doctors regarding their feelings toward fundoscopy, specifically addressing sufficiency in training and need for improvement in fundoscopic skills. Eighty-three percent felt they would benefit with more training and ninety-seven percent felt their fundoscopy skills could be improved.¹⁷ The doctors also listed reasons for not performing fundoscopy, which included: insufficient time, not enough skill, lack of available equipment, or felt fundoscopy was not useful. Some general practitioners were able to improve their eye exam skills through small training sessions.^{9,18} Verma et al., found that if non-ophthalmologists received twenty-five hours of training over the course of five weeks consisting of fundus photography and examinations typical of diabetic retinopathy, they were better able to screen diabetics and appropriately refer patients to the ophthalmologist.⁹

It is clear that primary care providers feel inadequate in their ability to accurately screen for diabetic retinopathy with a conventional ophthalmoscope. With the practice of medicine constantly under revision, how can a health care provider feel that they are adequately screening their patients? There have been several advances in equipment and technology to assist providers in screening.

One of the newest additions is the PanOptic, a nonmydriatic direct ophthalmoscope. The PanOptic increases the magnification and field of view by twenty degrees more than the conventional ophthalmoscope providing an enhanced fundoscopic exam.¹⁹

A trend that appears to be spreading world-wide is the use of telemedicine. Many countries have incorporated telemedicine in their screening of diabetic patients.^{20,21} For this particular disease, telemedicine encompasses retinal photography to be performed by the health care provider or trained personnel.³ The concept of telemedicine comes into play when the images are sent through the Internet, phone line or mailed to a satellite clinic or reading center for later analysis by an ophthalmologist. This allows for more accurate screening of those patients who need further referral.

The use of telemedicine in health care appears to bring much needed assistance to the skill of screening for diabetic retinopathy. This study will review the effectiveness of diabetic retinopathy screening by primary care providers, specifically comparing the conventional ophthalmoscope, the PanOptic ophthalmoscope and telemedicine. Primary care providers should be motivated to make sure they are properly screening their patients, which will not only preserve the vision of their patients but also decrease medical costs to treat the complications. Primary care providers need to work together with eye specialists to make sure diabetic vision preservation becomes a priority.

Purpose of Study

Diabetic retinopathy is a preventable complication of diabetes. The purpose of this study is to educate primary care providers on the different technologies and different pieces of equipment available to view the eyes of their patients with diabetes. Specifically, this paper intends to compare the conventional ophthalmoscope with the PanOptic ophthalmoscope and telemedicine. As more providers become aware of the newest technologies that are able to accurately screen for diabetic retinopathy, the easier

it will be to make a more accurate and timely referral for their patients to the ophthalmologist.

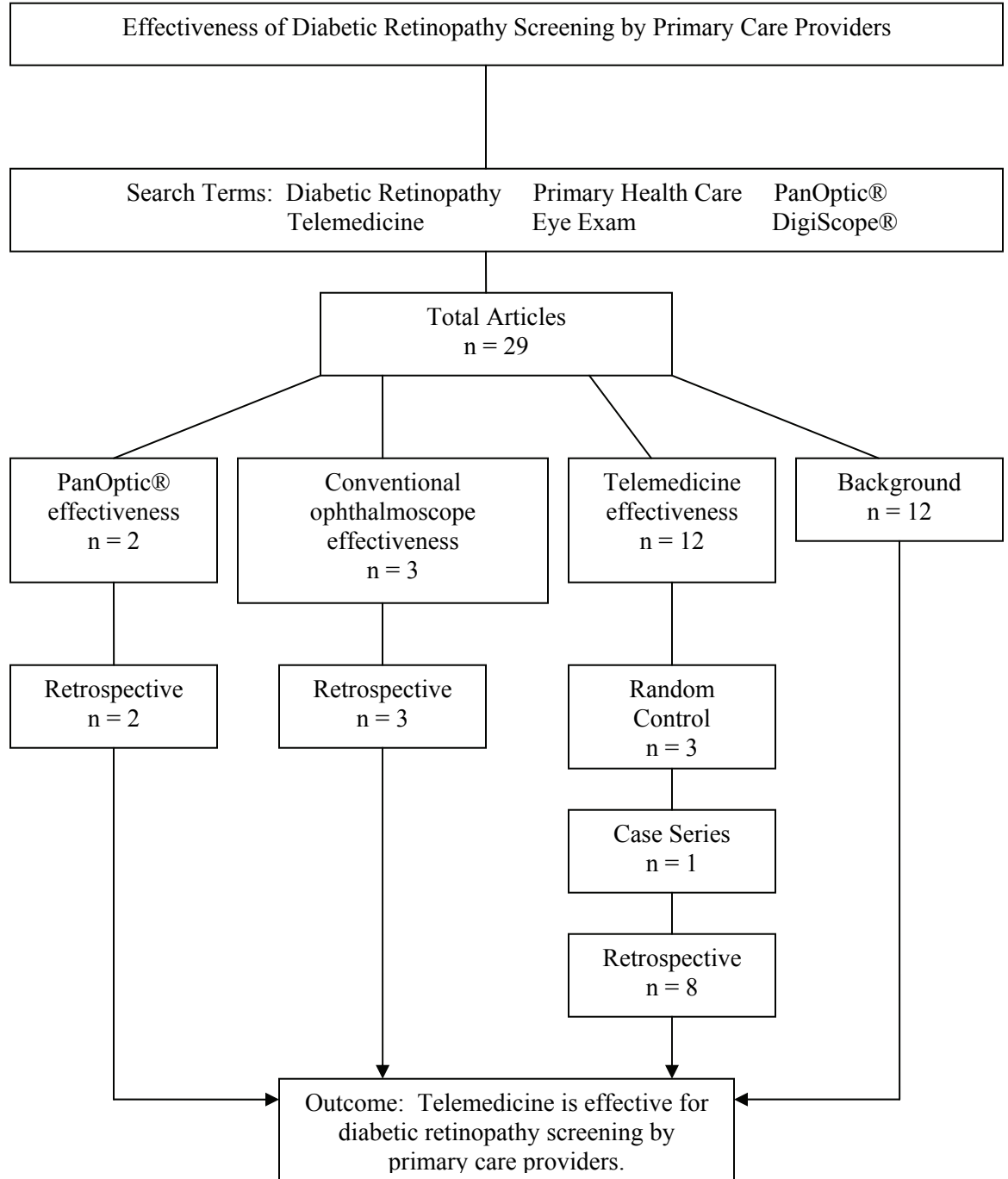
Methodology

This systematic review of literature was conducted using Medline, FirstSearch, and Infotrac Web Databases. Journal articles were only selected if they were peer-reviewed and dated from 1999 to the present. This time frame was selected to cover changes in technology and equipment used in detecting diabetic retinopathy. One study that occurred in 1993 was included because it is considered to be a foundational work in the screening of diabetic retinopathy. Another study from 1982 was included that discussed the accuracy of primary care providers in screening for diabetic retinopathy compared to ophthalmologists. The search utilized the following keywords: diabetic retinopathy, telemedicine, primary health care, PanOptic, DigiScope, and eye exam.

Results

Based on the inclusion material, (Figure1) twenty-nine articles were selected dating from 1999-present with the exception of two foundational articles. Twelve of the articles consisted of background information regarding diabetic retinopathy, which included: epidemiology, signs and symptoms, diagnosis, treatment options, and inadequacies of screening by primary care providers.^{1-4,6,7,10-13,15,16}

Figure 1: Literature Review Flow Sheet



Two of the articles found a conventional ophthalmoscope to be effective in screening for diabetic retinopathy.^{9,18} Both of these articles stated that screening by general practitioners improved after receiving a short period of training by an

ophthalmologist. Verma et al., found that the general practitioner's agreement with the ophthalmologist had a mean sensitivity of 97% and a mean specificity of 86%.⁹

One study suggested that conventional ophthalmoscopy is not effective.¹⁷ In this study, the fourteen participating physicians were more likely to correctly diagnose a microscopic slide showing diabetic retinopathy than with examination through an ophthalmoscope.

Only two studies discussed the PanOptic ophthalmoscope.^{14,19} One study using eight medical students, compared the accuracy of the PanOptic and conventional ophthalmoscope (CO), against a benchmark established by an ophthalmologist.¹⁹ The other compared eleven family physicians' referrals against an ophthalmologist's recommendation for referral based on standardized criteria.¹⁴ In comparing the CO against the PanOptic, medical students were slightly more accurate using the CO. The students felt the PanOptic was much easier to use, but gave duller illumination and a less clear image than the CO.¹⁹ Gill et al., found a weighted mean sensitivity of the family physicians' referral assessment to be 87%. A weighted mean specificity of 57% was noted.¹⁴

Twelve of the articles found telemedicine to be effective in screening for diabetic retinopathy. Forty-two percent of those articles compared telemedicine against an ophthalmologist's use of the gold standard.^{8,22-25} Fifty-five percent of the studies did not dilate the patients' eyes with mydriatic drops prior to obtainment of the retinal photographs.^{5,24,26-29} Forty-five percent of the studies did choose to dilate the subjects' pupils before images were taken.^{8,21-23,25} One study went as far to compare the effectiveness of telemedicine with mydriatic vs. non-mydriatic images.²⁰ Four studies

took one image per eye of the subjects.^{5,20,24,29} Five studies took two images per subject eye.^{8,21,25-27} One study took four images of the patients' eyes.²⁸ The two studies discussing the DigiScope, took fifteen ocular images per eye.^{22,23}

Discussion

Evidence in Literature

Diabetic retinopathy screening by primary care providers is very important with the severity of the disease based on the stage in which it is discovered. This paper is intended to evaluate the effectiveness of the screening for diabetic retinopathy by comparing the conventional ophthalmoscope, the PanOptic ophthalmoscope, and the use of telemedicine. Several professional groups require a minimum sensitivity of eighty percent and specificity of ninety-five percent to be considered effective when screening for diabetic retinopathy.^{8,25}

Conventional ophthalmoscopes have been the main piece of equipment used by primary care providers over the last several decades. However, as noted earlier, many primary care providers feel uncomfortable with their ability to accurately screen for diabetic retinopathy using a CO. A study by Roberts et al., stated that primary care providers were more likely to correctly diagnose a fundal abnormality from a microscopic slide than through an ophthalmoscope.¹⁷ In fact, only fifty percent of the participants were able to accurately diagnose the patients who had DR.

Sixty-six percent of the studies discussing the conventional ophthalmoscope found that primary care providers improve in accuracy after small training workshops over five to six weeks.^{9,18} Confos et al., found that practitioners were able to improve

their screening accuracy, but only required the participants to reach a minimum of sixty percent sensitivity and specificity.¹⁸

Gill et al., suggested that by using the PanOptic, primary care providers were somewhat accurate in screening their patients.¹⁴ Eleven participants were introduced to PanOptic and trained using the eye watch screening criteria (EWSC). The EWSC defined a positive screening test as a hard exudate being found within one disc diameter of the macula or three or more hemorrhages/microaneurysms temporal to the macula. Using this criteria and the PanOptic, the primary care providers, as well as a trained ophthalmologist, were asked to refer if a positive screening test was met, not to refer if patient did not meet the criteria, or refer due to inability to properly evaluate the patient.

Out of the seven patients that were assessed, seventy-five percent should have been referred for further evaluation based on the EWSC criteria. The study had an acceptable sensitivity; however it showed that the primary care providers using the PanOptic were not very accurate in diagnosing diabetic retinopathy. They justified the high sensitivity with a low specificity on the presumption that a false-negative exam would be more troublesome for the patients than a false-positive. It was also believed that the accuracy would improve from more training and practice with the new piece of equipment.

Medical students found the PanOptic much easier to use than a conventional ophthalmoscope when asked to determine a vertical cup/disc ratio in the fundi of the subjects.¹⁹ Both scopes were rated as easier to use when examining a dilated pupil. Students and the consultant ophthalmologist found the PanOptic to give a duller illumination and less clear image of the optic disc than the conventional ophthalmoscope.

The more time primary care providers spend using conventional ophthalmoscopes, the more comfortable they will begin to feel with their ability to appropriately screen their patients. However, it would be much easier to take the guesswork out by taking a digital image and having it evaluated by a professional. This is where telemedicine comes into play in screening for diabetic retinopathy.

Although the studies regarding telemedicine differed on the number of digital images obtained, they were all successful in diagnosing diabetic retinopathy.^{5,8,21-29} Only five articles regarding telemedicine discussed the sensitivity of the digital images, all of which met the accepted level of more than eighty percent.^{8,20,22,23,25}

There were several different grading scales used throughout the studies. Three of the studies graded the images against the scale established by the Early Treatment Diabetic Retinopathy Study, which is protocol used by many ophthalmologists.²²⁻²⁴ Some studies used scales established by the Airlie House Classification, European Working Party Guidelines or Joslin Vision Network.^{8,20,29} Yet other studies approached the grading of lesions as simply whether or not diabetic retinopathy was present.^{5,25,27}

The majority of studies had at least eighty-five percent of the obtained images deemed gradable. If an image was not gradable, the patient was always sent for a referral. According to Cavallereno and Aiello, any image that was not gradable was considered the most severe finding because the highest level of pathology was typically found in this patient.²⁹

An example of telemedicine that may be implemented is the DigiScope, a camera specifically designed to function in a primary care setting.²² A pilot study found the camera to show the same amount of detail as that seen in color fundus photography

when the pupils were dilated. In order to be practical for a primary care setting, the DigiScope was designed with the following criteria in mind: low cost, ease of use by non-eye care personnel, resolution and contrast to be able to detect abnormal vasculature, and digitalization of the data. The camera (DigiScope) met the desired criteria and alleviated the need of a trained photographer to obtain adequate digital images. This study had the highest sensitivity and specificity of all telemedicine studies.

The conventional ophthalmoscope is still an effective piece of equipment, more so than the PanOptic¹⁹; however, the use of telemedicine appears bright in the future of screening for diabetic retinopathy. With the exception of one article, there was no difference in effectiveness of screening based on the use of mydriatic drops or lack thereof and number of images obtained per patient. As long as guidelines are met to assure quality of the images and photographs are read in a timely fashion, telemedicine will play an important role. This form of screening will help take the uncertainty away from the primary care provider, who can be assured that patients are receiving proper screening when the image is graded by an ophthalmologist. It will also allow diabetic retinopathy screening for rural areas or patient populations that would not necessarily have access to an evaluation by an ophthalmologist or retinal specialist.

Weaknesses in the Literature/Limitations

There were a limited number of studies that discussed conventional and PanOptic ophthalmoscopes. The PanOptic is a newer piece of equipment; the longer it is on the market, the greater the likelihood it will be used in more studies to evaluate its effectiveness in the primary care setting. The conventional ophthalmoscope, although it has been the main piece of equipment used in screening patients, only had three articles

addressing effectiveness in primary care. There would probably be many more articles discussing the conventional ophthalmoscope if the time frame established in the beginning of this paper were broadened.

One foreseeable limitation that may arise in analyzing the data is a conflict of interest regarding the PanOptic ophthalmoscope and DigiScope. One of the studies discussing the PanOptic reported no conflict of interest; however, the study was funded by Welch Allyn, the maker of the PanOptic. There may also be a conflict of interest in the DigiScope study because the developers would be inclined to say their product is equally effective in screening for retinopathy as other ophthalmologic devices.

An area that may limit the use of telemedicine is the quality of the images. Although most of the studies had images that were considered gradable, there is a chance that a lesion may be missed during the screening process. However, if a retinal photograph did not show a gradable image, the patient was usually sent for an immediate referral to make sure the problem was truly due to the image and not a missed case of retinopathy. The majority of patients that had poor images usually were greater than sixty-five years of age, had cataracts, corneal opacities or poor pupil dilation.^{21,24,27,28} Skeptics may feel that the initial cost to obtain the equipment is too high or that having to train someone to obtain the images is not cost-effective. They may also feel that if this trend is established, the element of face-to-face care will diminish.⁴ It was difficult to accurately assess all the different grading criteria used in the studies regarding telemedicine. Some of articles were very specific in breaking down the level of diabetic retinopathy that was present. Others chose to focus the grading criteria on whether or not fundal lesions were present.

Validity of the review

The article selection process was completed by collecting peer-reviewed articles using Medline, FirstSearch, and Infotrac Web Databases with the previously mentioned key words. Once obtained, the articles were examined closely, making sure all chosen met strict criteria mentioned in the methodology section. The data was then separated and organized into Figure 1, where it was reevaluated and reviewed for accuracy with the research advisor.

Weaknesses in the review

This paper was a systematic review of literature to discuss the effectiveness of diabetic retinopathy screening. The internal validity of the articles is based solely on the assumption that the researchers were accurate in their results and reporting of such. The author and advisor of this paper were not blinded from journals or author names, which may not protect against bias.

Conclusion

Diabetic retinopathy is the leading cause of preventable blindness in the United States for people age 20-64 years.¹ Disease progression and resulting vision loss can be managed with accurate and timely screening. Diabetics need to be screened annually by an ophthalmologist.^{1,6,7} Screening for diabetic retinopathy in the primary care setting will not replace the vital role that eye care specialists play. Early detection can help to not only decrease the amount of unnecessary referrals, but also allow specialists the time needed to properly diagnose and treat diabetic retinopathy.

The conventional ophthalmoscope is still an effective piece of equipment; however it may require small workshops or extra practice in order to increase accuracy of

screening. The use of telemedicine in screening for diabetic retinopathy holds much promise for protecting vision loss in diabetic patients. The cost of initially setting up the piece of equipment or training the personnel to accurately take the photographs may be alarming to some providers at first. However, by taking the guess work out the screening process and allowing the images to be assessed accurately by an eye professional, the overall benefits outweigh any set-up costs, especially when it will be able to encompass a large population of patients. If our diabetic patients have their annual eye exams by an eye care professional and then at least have their eyes photographed at a timely interval, this would greatly help to decrease the number of patients with preventable vision loss in between annual visits.

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Appendix A
Raw Data

<u>Study and Year</u>	<u>Research Addresses</u>	<u>Level of Evidence</u>	<u>Demographics</u>	<u>Findings</u>	<u>Supportive of Research</u>
	<ol style="list-style-type: none"> 1. Handheld ophthalmoscope 2. Telemedicine 3. Background 	<ol style="list-style-type: none"> 1. Retrospective 2. Random control 3. Case series 4. Background 	Main data		<ol style="list-style-type: none"> 1. PO effective in DR screening 2. PO not effective in DR screening 3. CO effective in DR screening 4. CO not effective in DR screening 5. Telemedicine effective in DR screening 6. Background
Gill et al 2004	1	1	11 family physicians assessed 28 patients with DM	*PO vs ophthalmologist; mean sensitivity for family physicians =87%, mean specificity=57%; ophthalmologist: 81% sensitivity, 71% specificity	2
McComiskie et al 2004	1	1	8 medical students examined eyes of 10 subjects	*PO vs CO; No statistical difference in level of accuracy between PO & CO, students graded PO easier to use, but gave duller illumination & less clear image	2
Chen et al 2004	2	1	113 subjects from general population aged 40 or older	*digital imaging vs indirect ophthalmoscopy; digital imaging had higher detection rate than indirect	5
Schiffman et al 2005	2	2	111 patients with DM	*digital imaging vs Gold standard; no case of treatable disease missed with the DigiScope	5

Zeimer et al 2002	3	1	n/a	*Telemedicine: detailed description of the DigiScope, an example of telemedicine, effective for primary care	5
Ozerov & Monderer 2001	3	4	58 general practitioners were surveyed	*background: 50% of providers felt they had satisfactory fundoscopic exam skills; only 26% believed they had good skills in detecting DR	6
Roberts et al 1999	1	1	41 general practitioners surveyed; 14 doctors performed fundus exam	* Less than half of physicians felt confident in performing fundoscopic exams; almost all believed their funduscopy skills could improve; physicians more likely to accurately diagnose a slide with fundal abnormality than with CO	4
Sinclair & Delvecchio 2004	1	4	n/a	*background: signs & symptoms, treatment, need for DR screening *telemedicine looks promising for the future	6
Lin et al 2002	2	3	197 patients with DM	*Telemedicine vs ophthalmoscopy & mydriatic images; the form of telemedicine didn't miss any patients graded appropriate for referral by the ophthalmologist	5

Scanlon et al 2003	2	2	3611 patients	*Telemedicine; mobile digital photography can be used as a screening method in the United Kingdom	5
Younis et al 2002	3	4	8062 pts with DM	*background: prevalence of retinopathy in pts with DM	6
Griffith et al 1993	3	4	n/a	*background: definition, various screening techniques	6
Choremis & Chow 2003	2	1	415 pts with DM	*Telemedicine; NPDR & PDR were found in small number of pts; study struggled with consistent quality of images due to poor exposure	5
Davis et al 2003	2	2	59 pts with DM, aged 18 and older	*Telemedicine; pts more likely to receive eye exam through telemedicine at primary care practice than pts left to see usual eye care provider	5
Lisenfeld et al 2000	2	1	Images from 129 pts with DM were sent to 5 different grading centers in Europe	*Telemedicine vs Gold Standard; median sensitivity = 85%, median specificity = 90% for detection of NPDR or STDR	5
Bhavsar 2002	3	4	n/a	*background: definition, signs, treatment options	6

Lightman & Towler 2003	3	4	n/a	*background: definition, risk factors, screening	6
Fong et al 2004	3	4	n/a	*background: risk factors, guidelines	6
Confos et al 2003	1	1	15 general practitioners	*health care providers can improve their eye exam skills with small workshops	3
Stellingwerf et al 2001	2	1	469 pts with DM	*Telemedicine vs ophthalmologist examination; 83% sensitivity for detecting any DR, 88% specificity	5
Rowe et al 2004	3	4	n/a	*background: screening recommendations	6
Ferris et al 1999	3	4	n/a	*background: clinical manifestations, treatment, prevention	6
Verma et al 2003	1	1	200 pts with DM	*with adequate training, general practitioners can correctly refer cases of DM	3
Cavallerano & Aiello 2005	2	3	n/a	*background: pros & cons to telemedicine	6

Mukamel et al 1999	3	4	4410 pts with DM	*background: only small % of diabetic pts receive annual screening in 2 consecutive yrs	6
Luzio et al 2004	2	1	390 pts with DM aged > 12 yrs	*Telemedicine; TOSCA project allows adequate screening of DR in Europe; pts and providers were satisfied with overall procedures	5
Stillman et al 2004	2	1	83 children with DM aged 6-18 yrs	*Telemedicine; majority of images were graded good or excellent	5
Cavallerano et al 2005	2	1	1,219 pts w/ DM, impaired fasting glucose, or impaired glucose tolerance	*Telemedicine; images obtained were able to classify the severity of DR for appropriate triage	5
Sussman et al 1982	3	4	n/a	*background: primary care providers were not very accurate in diagnosing DR as compared to ophthalmologists	6

Notes:

Handheld = CO or PO
DR = diabetic retinopathy
DM = diabetes mellitus

CO= conventional ophthalmoscope
PO = PanOptic ophthalmoscope
NPDR = non-proliferative DR

PDR= proliferative DR
SPDR= severe proliferative DR

Vita

Name: Jena Shackelford

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Education:

2004-2006	Master – Physician Assistant (M.P.A) Wichita State University, Wichita, Kansas
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