e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15(1); 1240-1246

Original Research Article

Comparative Analysis of 3 Community-Based Models Developed for Screening Diabetic Retinopathy

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Received: 19-12-2022 / Revised: 11-01-2023 / Accepted: 30-01-2023
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Conflict of interest: Nil

Abstract

Introduction: Numerous eye conditions, such as cataracts, glaucoma, ocular surface issues, recurrent styes, diabetic retinopathy, non-arteritic anterior ischemic optic neuropathy, and diabetic retinopathy can develop as a result of uncontrolled diabetes. The most frequent and serious eye complication is diabetic retinopathy, which can damage the retina in a way that could jeopardize vision and possibly result in blindness. Retinal examination may involve fundus examination or retinal photography (ophthalmoscopy). In comparison to direct and indirect ophthalmoscopy, mydriatic and non-mydriatic color retinal photography has demonstrated higher sensitivity in the detection of diabetic retinopathy.

Aims and Objective: To assess the effectiveness of 3 different community-based models in terms of effectiveness of detection and cost in a screening programme of diabetic retinopathy.

Methods: The study used 3 different models for studying their effectiveness in terms of detection of Diabetes Mellitus (DM) and Diabetic Retinopathy (DR). This study was conducted on 80 patients of suspected diabetes who visited to the screening camp and gave consent for the study. A screening program was conducted, which is divided into 3 models. All 80 patients underwent in 3 different models to evaluate the effectiveness of each model. A thorough patient history including demographic information, diabetes history, and treatment information was included in the ophthalmological evaluation, which also included vision tests, measuring intraocular pressure, and performing a dilated fundus examination.

Results: The study found that the highest percentage of DR was detected in Model 3 followed by Model 2 and Model 1. This rate of detection of DR was found to be significant($p<0.05$). The rate of detection of DM was also highest in Model 3 but it was not significantly different as compared to Model 2 and Model 1. The most practical model for identifying newly diagnosed diabetes was model 1. Model 2 had the highest overall pickup rate for DR patients despite being more financially difficult. Less new DR patients were picked up by Model 3.

Conclusion: The study concludes that the screening of diabetic retinopathy in camps, is difficult as compared to diabetes alone due to poor cost effectiveness. However, institutional screening is cost-effective with higher detection rate of diabetic retinopathy.

Keywords: Diabetic Retinopathy, Diabetic Mellitus, Screening, Blood Glucose, Screening Programmes.

Introduction

The long-term effects of diabetes mellitus bring on a microvascular condition called diabetic retinopathy (DR). The retina may suffer vision-threatening damage due to diabetic retinopathy, which could ultimately result in blindness. In the western world, it is the most typical cause of significant vision loss in individuals who are working for age groups [1,2]. The best way to prevent diabetic retinopathy from leading to blindness is through early detection and prompt intervention. By 2050, there will be 16.0 million diabetic retinopathy patients in the United States, with 3.4 million having problems that could result in blindness. Clinical studies like the UK Prospective Diabetes Study (UKPDS) and Diabetes Control and Complication Trial demonstrated the value of tight glycemic control (DCCT) [3,4].

Numerous eye conditions, such as cataracts, glaucoma, ocular surface issues, recurrent styes, diabetic retinopathy, non-arteritic anterior ischemic optic neuropathy, and diabetic retinopathy can develop as a result of uncontrolled diabetes. The most frequent and serious eye complication is diabetic retinopathy, which can damage the retina in a way that could jeopardize vision and possibly result in blindness [5,6].. A worsening of diabetic retinopathy is linked to poor glycemic control, dyslipidemia, uncontrolled hypertension, male sex, nephropathy, and obesity. Typical diabetic retinopathy fundus characteristics include microaneurysms, hard exudates, diabetic macular edema (DME), and new vasculature (in proliferative DR or PDR). Strict systemic condition control, intravitreal medication, and laser photocoagulation are available care strategies. Most DR patients can attain good final visual acuity with early diagnosis and prompt treatment [7-9].

In DR, chronic hyperglycemia is thought to be the main pathogenic factor (as described by UKPDS and DCCT) [10]. The polyol pathway and other alternative glucose metabolism routes are activated by hyperglycemia. Advanced glycation end products are produced as a result of oxidative stress, protein kinase C activation, and non-enzymatic protein glycation (AGEs) [11]. The activation of cytokines, growth factors and vascular endothelial dysfunction that results from these alternate pathways finally causes an increase in vascular permeability and microvascular occlusion. Microvascular blockage causes retinal ischemia, which results in the development of IRMA (intraretinal microvascular abnormalities) and neovascularization [12,13].

Increased reactive oxygen species (ROS) levels cause oxidative stress, which damages cells and tissues [14].

In the signaling process, protein kinase C is involved. Its activation causes changes to the basement membrane and vascular structures, including vascular stasis, capillary occlusion, enhanced vascular permeability, and the release of angiogenic growth factors.

In non-enzymatic protein glycation, reducing sugars interact with free amino acids from proteins, lipids, and nucleic acids to produce endproducts of advanced glycation that are in charge of changing the extracellular matrix proteins [15-17].

Retinal examination may involve fundus examination or retinal photography (ophthalmoscopy). In comparison to direct and indirect ophthalmoscopy, mydriatic and non-mydriatic color retinal photography has demonstrated higher sensitivity in the detection of diabetic retinopathy [18].

Opportunistic screening for diabetes has been effectively implemented in many places and areas; many of these practices are well-established and provide high-quality care. Opportunistic screening is typically done when a patient attends other examinations [19,20].

Materials and Methods

Research Design

This study was conducted from March, 2022 to February, 2023 on 80 patients of suspected diabetes who visited to the screening camp and gave consent for the study. A screening program was conducted, which is divided into 3 models. All 80 patients underwent in 3 different models to evaluate the effectiveness of each model. The models are described below in details.

Model 1: In this scheme, radio stations in the nearby area were used for pre-camp advertising. The screening locations were chosen to be areas with high population movement, such as train stations and bus terminals, and banners were placed. At the campsite, a van-mounted information kiosk was put up, and brochures were distributed. A spot glucometer was used to measure glycemic levels after a brief medical history. The patient was told of the recorded blood sugar levels, and they were recorded in the main file. All diabetics were given the hospital route map, and newly discovered patients were recommended to contact a doctor and an ophthalmologist. Four employees were needed for this model: a driver, a lab technician, a nurse, and a counselor.

Model 2: This comprised 2-4 weeks of pre-camp publicity, which involved making announcements over the public address system. Local groups for the arts, religious organizations, and non-governmental organizations also contributed to the publicity. Distribution of pamphlets took place one week before the camp. All campers were subjected to glucometer screening, and individuals with excessive blood sugar levels and known diabetes were evaluated by ophthalmologists. 8 to 10 employees were needed, including a driver, two nurses, two counselors, two optometrists, and one or two ophthalmologists.

Model 3: This involved choosing a public or private service provider with at least 500 employees. Following the formation of DR awareness, screening exercises were conducted. Prior to the camp, the institution's human resources department worked to alert the staff by posting awareness posters and internal notices throughout the building.

A thorough patient history including demographic information, diabetes history, and treatment information was included in the ophthalmological evaluation, which also included vision tests, measuring intraocular pressure, and performing a dilated fundus examination. A skilled ophthalmologist used direct and indirect ophthalmoscopy to examine the retina. DR was divided into three categories using the modified ETDRS classification: advanced diabetic eye disease (ADED), proliferative DR (PDR), and mild, moderate, and severe no proliferative DR (NPDR).

Inclusion and Exclusion Criteria

The study included individuals of suspected type-2 diabetes who had already had diabetes of more than 10 years and still not diagnosed with any diabetes related oculopathy. The patients who did not diagnose with any eye disorder in the past were only included. The patients who did not give consent for this study were excluded. Those patients who had a history of eye surgery were also excluded.

Statistical Analysis

The study used SPSS 25 for effective analysis. The study employed ANOVA for significance test. The continuous variables were expressed as mean±standard deviation while discrete variables were expressed as frequency and respective percentage. The level of significance was considered to be $p<0.05$.

Ethical Approval

The patient was explained the whole study process. The written consent was obtained from all the patients. The Ethical

Committee approved the study process before it was started.

Results

The study found that the highest percentage of DR was detected in Model 3 followed by Model 2 and Model 1. This rate of detection of DR was found to be significant(p<0.05). The rate of detection of DM was also highest in Model 3 but it was not significantly different as compared to Model 2 and Model 1 (table 1).

Table 1: Effectiveness in detection of DR in each model

Camp model	Total number of patients screened	DM detected	DR detected
Model 1; n (%)	80 (100)	35 (43.75)	09 (11.2)
Model 2; n (%)	80 (100)	38 (47.5)	12 (15)
Model 3; n (%)	80 (100)	39 (48.7)	21 (26.25)
p-value		0.692	0.041

DM, Diabetes Mellitus; DR, Diabetic Retinopathy

Table 2 displays the average cost calculation for each camp model. Publicity, transportation, setting up the hall, providing meals for the staff and volunteers, blood sugar checks, and staff salaries are all included in the cost of the camp. The most practical model for identifying newly diagnosed diabetes was model 1. Model 2 had the highest overall pick up rate for DR patients despite being more financially difficult. Less new DR patients were picked up by Model 3.

Table 2: Calculated cost per model in this study

	Model 1	Model 2	Model 3
Cost per out patient	42.5 ± 6.39	68.1 ± 9.56	75.6 ± 11.54
Cost per DM patient	361.2 ± 21.12	441.12 ± 29.34	660.51 ± 36.89
Cost per DR patient	14931.7 ± 351.23	3715.02 ± 70.34	3531.9 ± 62.09
p-value	0.0258	0.036	0.031

Discussion

Taking into account the background and financial position of the population, diabetes and diabetic retinopathy prevalence varies. Both in the setting of the community and the eye hospital, people older than 40 years were screened for diabetes. Urine dipsticks were used for initial screening, which was followed by random blood sugar testing. Blood sugar levels above 140 mg/dl were seen as a sign of diabetes. An intermediate-level ophthalmologist then performed indirect ophthalmoscopy on all of the diabetic patients with dilated pupils to look for any signs of diabetic retinopathy. A public, patient, and professional health education effort was also carried out. When compared to poor hospital patients or the rural community, the prevalence of diabetic retinopathy was two times higher in wealthy hospital patients. There has been four previously unknown diabetes in the rural community for every known diabetic, and there were two previously unknown diabetics in the hospital-based population [21].

For the first time in Saudi Arabia, a study was done to examine the incidence rates of cataracts in people with diabetes who also had and did not have diabetic retinopathy. We also looked at the influence of numerous other known determinants, the age of diabetes onset, and a few new factors. According to the findings, systolic blood pressure, age, the length of diabetes, and diabetic retinopathy were discovered to be separate risk factors for cataracts. Gender, BMI, HbA1c, insulin use, and diastolic blood pressure show no discernible correlation with cataracts. Diabetes onset age was noticeably greater in those with cataracts. The majority of cataracts were cortical, then PSC and just a small number were nuclear. DR is a separate risk factor for cataract development in people with diabetes. Age, hypertension, and the length of DM are a few others. We find that a novel factor, age at the onset of diabetes, has a strong correlation with cataracts [22].

The Remidio Fundus on Phone, a smartphone-based fundus camera, was tested in a study that compared its specificity and sensitivity to a traditional tabletop fundus camera and a clinical examination for the detection of diabetic retinopathy (DR). The Remidio FOP gadget was discovered to have excellent grader agreement and high specificity and sensitivity for the identification of any grade of DR. The Remidio FOP somewhat improved image quality while lowering the rate of ungradable images to an acceptable level [23].

Diabetes mellitus has spread throughout the world. It leads to serious microvascular problems like nephropathy, retinopathy, and neuropathy as well as macrovascular issues like peripheral artery disease, coronary artery disease, and stroke. The major cause of blindness in people in their working years is known as diabetic retinopathy, which may go unnoticed until vision loss occurs. It has been demonstrated that screening for diabetic retinopathy can prevent blindness through early detection and efficient laser treatment. Worldwide, screening for diabetic retinopathy is conducted as part of national screening programs, hospital-based initiatives, or community-based screening programs. In this article, we examine various screening techniques, including the grading system used to identify sight-threatening retinopathy and the more recent screening techniques [24].

A study was done to see how well Remidio Non-Mydriatic Fundus on Phone, a smartphone-based, nonmydriatic retinal camera, performed in detecting referable diabetic retinopathy (RDR) in images taken by a minimally trained healthcare worker. Remidio Non-Mydriatic Fundus on Phone is a proprietary, offline, automated system of analysis of retinal images. Any diabetic retinopathy that is more severe than moderate diabetic retinopathy, whether it has diabetic macular edema or not, is referred to as referable diabetic retinopathy. The results indicate that a community screening for referable diabetic retinopathy using a smartphone-based fundus camera using an offline AI algorithm is promising. The application of AI would make it possible to screen for referrable diabetic retinopathy in remote locations without access to ophthalmologist services. Diabetes patients who visited a dispensary that offers primary-level curative care to the populace were the subjects of this study. To apply the findings to a screening of the general population, however, a study with a larger sample size could be required [25,26].

Conclusion

The study concludes that the screening of diabetic retinopathy in camps, is difficult as compared to diabetes alone due to poor cost effectiveness. However, institutional screening is cost-effective with higher detection rate of diabetic retinopathy. This infers that the cost-effective and applicable screening of diabetic retinopathy can only be done in institutional setup in India but not in any other temporary camps. The authors also suggest to conduct more analysis of the screening camps in various places of India to bring out the larger picture. However, this current study has brought forward a effectiveness and feasibility of screening programmes which would help to contribute in shaping social medicine and related health policies of our country.

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