

Diabetes mellitus in the Tamil Nadu State—Noncommunicable diseases nurse model in diabetic retinopathy screening

Rengappa Ramakrishnan, Syed Mohideen Abdul Khadar¹, Karthik Srinivasan², Hariesh Kumar³, Valaguru Vijayakumar⁴

Tamil Nadu is one of the states in India, where the diabetic retinopathy (DR) project was implemented in the Tirunelveli District. Aravind Eye Hospital, Tirunelveli was the mentoring institution and ophthalmology department of Tirunelveli Medical College and Hospital (TVMCH) was the implementing partner. The objective of the project was to develop a district level model for building capacity at the government health system for effective screening, diagnosis and management (primary to tertiary) of diabetic retinopathy. The DR screening, counseling, referral and follow-up tasks were included in the scope of Non-Communicable Disease (NCD) nurses at the respective Community Health Centres and Primary Health Centres using the tele-medicine platform. During the project period (December 2016 to June 2019), 8,574 people with diabetes were registered at the 18 CHCs/PHCs. 6,462 (75.4% of those registered) were screened by NCD staff. The government has agreed to scale up services in 3 more districts.

Key words: Community health nurse, diabetes mellitus, diabetic retinopathy, non-communicable diseases, primary health center, screening, sight threatening diabetic retinopathy

Access this article online

Website:
www.ijo.in

DOI:
10.4103/ijo.IJO_1987_19

Quick Response Code:



Diabetes mellitus (DM) is a chronic metabolic disorder due to insulin deficiency or resistance which can affect multiple organs of the body such as the kidneys and eyes. Diabetic retinopathy (DR) is one of the commoner microvascular complications of diabetes, which occurs in both type 1 and type 2 DM, and the risk increases with increasing duration of diabetes and poorly controlled hyperglycemia and hypertension.

DR is often asymptomatic and can progress rapidly.^[1] Hence, the periodic retinal examination is required to monitor the onset and progression of the disease and to detect and manage vision-threatening DR.^[2] Timely treatment with laser photocoagulation or intravitreal pharmacological agents can prevent visual loss in proliferative DR and can stabilize or improve vision in diabetic macular edema (DME). Before the start of the current pilot project, screening for DR was not being undertaken for people with diabetes who attend government primary health centers (PHCs)/community health centers (CHCs) in India. So, integrating DR screening at the health care system is very essential for the early detection of DR.

The government of India has initiated the National Program for Prevention and Control of Cancer, Diabetes, Cardiovascular

Diseases and Stroke (NPCDCS) and National Programme for Health Care for Elderly (NPHCE).^[3] The essential function of the noncommunicable disease (NCD) cell at the district level is to ensure the implementation and supervision of health promotion, early diagnosis, treatment, and referral, and further facilitate the partnership with laboratories for early diagnosis and monitoring of NCDs.^[4] Deputy director of health services is in charge of all public health activities in the district including the PHCs and CHCs.^[5]

In CHCs and PHCs, NCD nurses are responsible for DM screening and maintaining records. Laboratory facilities are available to test random and fasting blood sugars, postprandial blood sugar, total cholesterol, urea, and creatinine. Diabetes is confirmed as per the Indian Council of Medical Research (ICMR) criteria,^[6] and patients are registered and demographic details, anthropometric details (height, weight, body circumference), and important systemic association (hypertension) are recorded. Individuals are referred to the physician for further management and advised regular follow-up. People with diabetes visit the CHCs/PHCs every month to collect their free medication.

The DR project, which was supported by the Queen Elizabeth Diamond Jubilee Trust, UK (the Trust), was implemented

The Chief Medical Officer, Aravind Eye Hospital, Tirunelveli, ¹Department of Retina Vitreous Services, Aravind Eye Hospital, Tirunelveli, ²Department of Retina Vitreous Services, Aravind Eye Hospital, Chennai, ³Department of Community Outreach, Aravind Eye Hospital, Tirunelveli and ⁴Project Division at Lions Aravind Institute of Community Ophthalmology, Madurai, Tamil Nadu, India

Correspondence to: Dr. Karthik Srinivasan, Retina Vitreous Services, Aravind Eye Hospital, 10, Poonamalle High Road, Noombal, Ambattur, Chennai - 600 077, Tamil Nadu, India. E-mail: karthiksrinivasan@aravind.org

Received: 29-Oct-2019

Revision: 26-Nov-2019

Accepted: 01-Dec-2019

Published: 17-Jan-2020

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

Cite this article as: Ramakrishnan R, Abdul Khadar SM, Srinivasan K, Kumar H, Vijayakumar V. Diabetes mellitus in the Tamil Nadu State—Noncommunicable diseases nurse model in diabetic retinopathy screening. Indian J Ophthalmol 2020;68:S78-82.

in Tirunelveli district, southern Tamil Nadu by Aravind Eye Hospital (AEH), Tirunelveli (mentoring institution) [Fig. 1]. Five blocks in Tirunelveli District were selected for implementing DR Project, which have five CHCs and 99 PHCs. The DR project was implemented in all five CHCs/upgraded PHCs and 13 of 99 PHCs attached to the CHCs (total 18 centers). The main objective of the Trust DR project was to develop a district-level model to build the capacity of the government health system for effective screening, diagnosis, and management (primary to tertiary care) of DR.

Methods

Project activities were integrated into different levels of the health system [Table 1].

Training noncommunicable disease (NCD) staff

Following 4 days of training for NCD staff at AEH, Tirunelveli, DR screening, counseling, referral, and follow-up tasks were included in the scope of NCD nurses at CHCs/PHCs. The training included didactic lectures (on the anatomy and physiology of the eye, common eye diseases, normal retina, DM and its complications, DR, the role and responsibilities of NCD staff in screening patients with DM for DR, overview on ophthalmic photography) and hands-on training on visual acuity measurement, fundus photography, maintenance of fundus camera, fundus image capturing and uploading, and documentation and communication of the findings of the screened patients [Table 2].

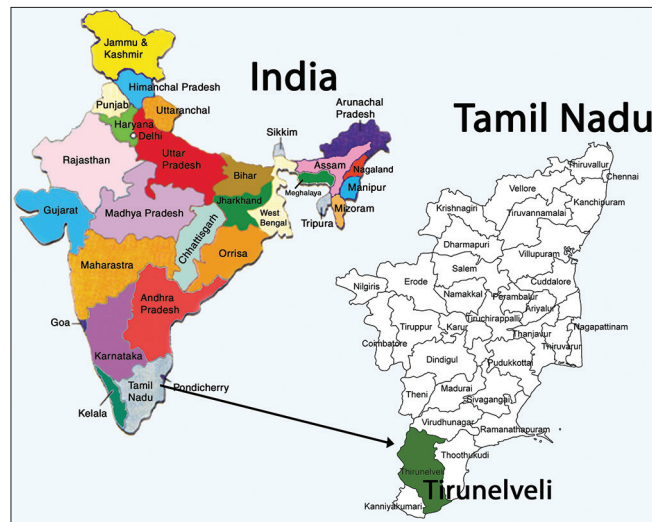


Figure 1: Project area (Tirunelveli district) in Tamil Nadu, India

Capacity building of ophthalmologists

2-month structured training was provided to four government ophthalmologists on laser treatment of DR. The training covered the techniques of indirect ophthalmoscopy, slit-lamp biomicroscopy, and interpretation of fundus fluorescein angiography (FFA), ultrasonography (USG), and optical coherence tomography (OCT), with didactic lectures on the diagnosis and management of DR, laser treatment (indications, technique of laser treatment, and complications) and surgery for advanced DR. The training provided extensive hands-on experience supplemented by live demonstrations.

Capacity building of general physicians: the Public Health Foundation of India (PHFI’s) “Certificate Course in Evidence-Based Management of Diabetic Retinopathy” (CCDR) program was conducted for CHC general physicians at the mentoring institution (AEH, Tirunelveli) to know, identify and refer the patients with DR. Totally 12 medical officers from Department of Public Health and PHCs and three private practitioners in Tirunelveli district participated in the training program.

Total 198 health professionals (project staff: 8, paramedical ophthalmic assistants (PMOA): 41, ophthalmologists and residents: 16, NCD staff: 16, nurses, sector health nurse (SHN), village health nurse (VHN), pharmacist: 101, and physicians/diabetologists: 16) [Table 2] had undergone the training. There were no dropouts found during the training.

Diabetic retinopathy (DR) screening logistics

A field coordinator was appointed for each block to coordinate and oversee the screening process, referral, and follow-ups. They designed the screening schedule for each center and coordinated the screening process with the help of NCD staff to cover project CHCs and their PHCs. Five non-mydriatic fundus cameras (Forus 3-Netra, Bangalore, India) were provided for DR screening in each block. The camera was kept in a center until 70–80% of people registered as diabetic had been screened for DR, and then the camera was shifted to the next centers. The NCD staff also enrolled new people with diabetes. Standard information-education-communication (IEC) posters were prepared during the initial phase of the project and were placed in all CHC/PHCs. People with diabetes were educated using the “Total Diabetes Care booklet” and DR brochures. In order to create a seamless screening process the following measures were undertaken: checkpoints were created in PHCs at pharmacies and laboratories to ensure the DR screening of

Table 1: Project activities at different levels of the health system in Tirunelveli district, India

Level	Project activities	Person/organization responsible	Remarks
Primary	People with diabetes: case detection, screening for DR, counseling, and referral to secondary/tertiary level	NCD nurse at CHC/PHCs	Coordination by project field workers
Secondary	Detailed ophthalmic examination to identify those with vision-threatening DR: Enable investigations, reading, and grading of images, medical treatment (laser) for DR and referral to tertiary centers	Department of Ophthalmology, Tirunelveli Medical College and Hospital	Coordination by project manager
Tertiary	Diagnostic examination: investigations, medical and surgical treatment for DR (laser, injection, surgery), training and project implementation	Aravind Eye Hospital, Tirunelveli (mentoring organization)	Coordination by project manager

NCD nurse=Noncommunicable disease nurse; CHC=Community health center; PHC=Primary health center

Table 2: Capacity building of staff at different levels of the health system

Level of service delivery and target group	Type/topic of training	Number
Aravind Eye Care System: project staff: field coordinators	Project orientation	8
NCD clinics, PHC/CHCs, district hospitals, Tenkasi and Tirunelveli Medical College Hospital, Tirunelveli: PMOAs and staff nurses	Fundus photography	37
Tirunelveli Medical College Hospital: ophthalmologists	Laser training	4
Tirunelveli Medical College Hospital: ophthalmologists and postgraduates (residents)	Reading and grading images (PGs doing 1 st or 2 nd year at TVMCH were given orientation on reading and grading of fundus images using ADRES Software at AEH, Tirunelveli)	12
NCD clinics, CHCs and PHCs: staff nurses	DRROP software developed by PHFI for Trust program	16
CHCs/PHCs: PMOAs	FFA and OCT	4
CHC and PHCs: nurses, SHN, VHN, pharmacists, PMOAs	Diabetes and DR	101
Tirunelveli district: physicians and diabetologists	CCDR course on management of diabetes and DR	16
Total		198

CHC=Community health center; PHC=Primary health center; PMOAs=Paramedical ophthalmic assistants; SHN=Sector health nurse; VHN=Village health nurse; FFA=Fundus fluorescein angiography; OCT=Optical coherence tomography; DRROP: Diabetic retinopathy-retinopathy of prematurity; PHFI=Public Health Foundation of India; CCDR=Certificate course in diabetic retinopathy

every walk-in patient who visited the NCD clinic; the unique NCD registration number was used in all reports to ease the follow-up and treatment, and DR outpatient card was introduced.

DR screening process

The following process was adopted in CHCs/PHCs: 1) [Fig. 2] NCD staff measured visual acuity using Snellen's charts placed at 6 m; 2) NCD staff used non-mydratic fundus camera to capture five images for each eye: the macular area and one in each quadrant;^[7] 3) the images were uploaded and transmitted via the internet to AEH, Tirunelveli for grading (see below). Refraction was not done at this level. In the third year, Tirunelveli Medical College Hospital (TVMCH) was equipped with Reading & Grading Centre and the ophthalmologists were trained. When images were ungradable due to technical errors, patients were referred to CHCs/PHCs for repeat imaging. DM Patients with cataracts were referred for free cataract surgery at TVMCH and NGO Hospital. Dilatation of eyes was not included in the screening protocol and patients whose fundi were ungradable due to small pupils or other reasons were referred to AEH or TVMCH for detailed examination.

The non-mydratic fundus camera was selected based on the ability to have low maintenance with reliable handling and picture quality. The same camera was installed in all centers to have better quality control and ease of training. Regular training and updating on the quality of images of NCD staff were monitored.

Image grading and reporting

Reading and grading centers were set up in AEH and TVMCH under the project with high-configuration computers and printers and used the Aravind Diabetic Retinopathy Evaluation Software (ADRES) for reading and grading fundus images.^[7] The images were graded by a trained grader (an ophthalmologist who had undergone short-term training) with the help of ADRES. The turnaround time (TAT) for image grading at the specially dedicated reading and grading center by a medical retina-trained ophthalmologist was 5–15 min depending upon the quality and number of images. The TAT for grading the images was ranging from 30 min to 1 h. The

NCD nurse was responsible for the follow-up of the patients for repeat imaging at CHC/PHC. There was no monetary support provided to the patients to visit the CHC/PHC. A total of 1,111 patients were advised for repeat imaging (due to patients with small pupil and other technical issues) out of this, 80 (7%) patients had come for the follow-up for repeat imaging within a months' time. The images not suitable for grading would include cases with media opacities and poor mydriasis. These cases were identified and further evaluated at the base hospital or after better mydriasis. The PHFI introduced Aadhar-based diabetic retinopathy—retinopathy of prematurity (DRROP) software in the mid-2017 to upload DR screening data to integrate all partners across India. The final version evolved in 2019.

A real-time report from the reading and grading center (at AEH/TVMCH) of the DR status in each eye and the management recommended was generated and shared with the patients at CHCs/PHCs by the NCD nurse. Patients who were diagnosed with confirmed/suspected DR were taken by the grading center to the medical officer in the respective PHCs/CHCs by the NCD Nurses. The medical officer was responsible for providing appropriate advice to the patients based on the stage of DR, the need for further investigation, or treatment at the base hospital. The NCD nurses were given ICE materials for counseling to the confirmed or suspected cases of DR.

Patients with sight-threatening DR (STDR)/those who need further investigation were referred to AEH or TVMCH. These individuals were given a referral card. The American Academy of Ophthalmology "Preferred Practice Pattern" guidelines were followed for the treatment and follow-up.^[8] NCD nurses counseled patients accordingly. A tracker sheet of people with DR, with unique ID and face photograph, was maintained at the AEH, Tirunelveli to monitor follow-up visits. Patients referred from CHCs/PHCs were investigated and treated with no cost at AEH and at TVMCH. OCT and lasers were provided to the medical college through the project for investigation and treatment.

Results

During the project period (December 2016 to June 2019), 198 health professionals were trained and 8,574 people with

diabetes were registered at the 18 CHCs/PHCs [Table 2]. 6,462 (75.4% of those registered) were screened by NCD staff, but images were not gradable in almost a third (32%) [Table 3]. The main reasons for ungradable images were small pupils and cataracts. 581 (13% of those with gradable images) had DR [Table 3], out of 160 patients identified with STDR and clinically significant macular edema (CSME) were referred to the base hospital, out of which 77% were followed up and 38 (23%) did not visit at the tertiary care center, and 64 (1.5% of those with gradable images; 40% of the 160 referred) individuals were treated for STDR.

Females had a higher number in all categories: 61% among the registered DM patients; 62% among the screened patients; 60% among the DR patients; 57% among STDR patients; and 55% among the treated patients were females.

The project reveals the prevalence of DR among the registered DM population in 18 CHC/PHCs from five blocks in the Tirunelveli district where the project was implemented. The average prevalence rate among the total DM population from all five blocks is 9%. Radhapuram block has the highest prevalence rate of 10.4% comparing to other blocks. Ambasamudram block recorded the lowest prevalence rate of 7%. The prevalence of DR in Manur block is 8.5%, in Pappakudi block is 9.3%, and in Kalakadu is 9.8%.

Discussion

Challenges and lessons learned

There were frequent transfers of NCD nurses and many PHCs were deputing reproductive child health (RCH) staff. AEH imparted a training program for new NCD staff. A third of registered DM patients did not undergo DR screening and in a third of those screened images were not gradable due to cataract, small pupils or technical errors. Patients' contact addresses and phone numbers for treatment/follow-up were often inaccurate.

Compliance with follow-ups and treatment was higher in patients with STDR than other categories of retinopathy, and over three quarters (77%) of patients with STDR attended the base hospital for investigation and treatment but 23% did not.

Sustainability

As existing NCD staff were entrusted with screening and counseling people with DR, extra manpower would not be required for the same. This holistic approach led to relatively high compliance with screening. A reading and grading center was established at the local medical college for DR-related telemedicine, and the capacity of staff was built to diagnose and manage STDR. AEH, Tirunelveli acted as the referral center. DR screening was made mandatory in the respective CHCs/PHCs by the NCD staff. Since the NCD clinics provide value-added services to the patients, the follow-up of the patients would be easier and referral dropout to other clinics was likely to be low.

Scaling up

DR screening and management is likely to continue after the project period through support provided by the Government of Tamil Nadu and the commitment of AEH, Tirunelveli. The Health and Family Welfare Department, Tamil Nadu government has committed to scaling up project activities in three more districts (Salem, Cuddalore, and Vellore) following a request by the project director, State Blindness Control Society (SBCS). The trust provided the equipment to the Tamil Nadu Government and agreed to bear the training cost. AEH has agreed to provide training for NCD staff, PMOA, ophthalmologists, and other eye health personnel. AEH at Salem, AEH at Pondicherry, and AEH at Chennai will provide mentoring and technical support to enhance DR services in these districts. AEH, Tirunelveli will provide necessary guidance in terms of sharing screening protocols, IEC materials, and training curricula.

Considering the frequent transfers of NCD staff in the government system, a continuous training program was designed to train the new NCD staff. Ungradable images with the non-mydratic fundus camera are one of the challenges in DR screening. In the eyes with cataract, there was no consistent improvement in image quality over time.^[9] Other causes were small pupils and possible technical errors. In the current project, 32% of (approximately one-third) images were ungradable [Table 3]. Patients with cataracts can be counseled to undergo free cataract surgery through a national program by NPCB at district hospitals, government

Table 3: Results of screening for diabetic retinopathy

Number screened	Total	Percentage
Registered DM patients	8,574	
Screened for DR by NCD staff	6,462	75.3%
Gradable images among screened patients	4,404	68%
Ungradable images	2,058	32%
Reasons for ungradable images		
Cataract	947	46%
Small pupils	532	26%
Poor focusing/others	579	28%
Diabetic retinopathy among those with gradable images		
Any DR	581	13%
People with DR referred for diagnosis	160	27.5% of DR detected 3.6% of those with gradable images
Treated for DR with laser/injection/surgery	64	40% of those referred 1.5% of those with gradable images

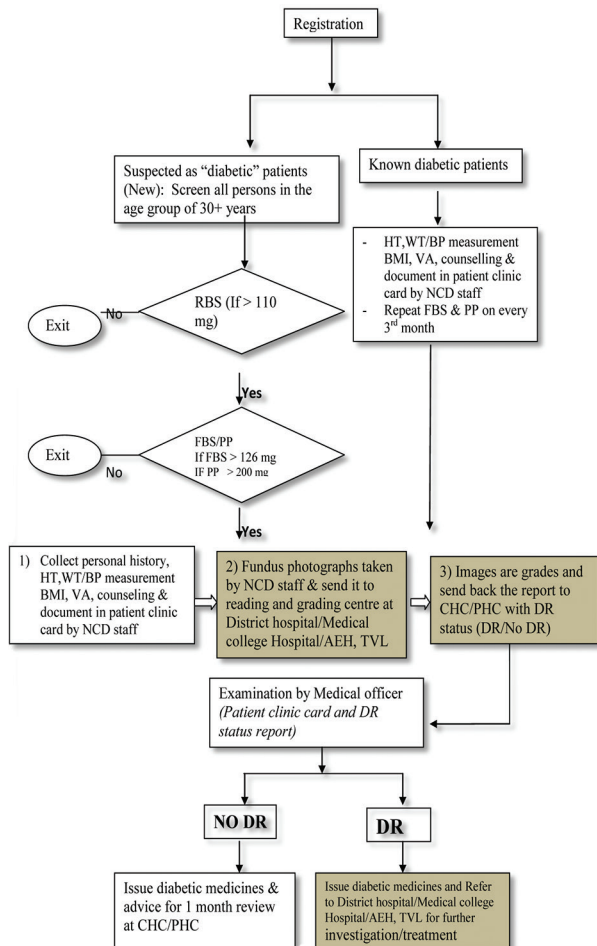


Figure 2: Patients' flow at noncommunicable diseases (NCD) clinics in community health center (CHC)/primary health center (PHC)

medical colleges, and NGO hospitals. This will address a major proportion (approx. 46%) of the ungradable images at the grading centers.

Conclusion

To conclude, this method of screening, diagnosis, and management of DR is a novel using the telemedicine platform. Through this, nearly 70% of the patients with DM were screened for DR from rural areas where there are no ophthalmologists and facilities to screen DR. Teamwork is necessary for the effective, efficient functioning of this project.

Acknowledgements

We acknowledge the support of Principal Secretary (Health), Department of Health and Family Welfare, Government of Tamil Nadu, Mission Director, National Rural Health Mission, The District Collector -Tirunelveli, The Dean- Tirunelveli Medical College and Hospital, Tirunelveli, Joint Director, Health Services, Tirunelveli, Deputy Director Health Services, Tirunelveli, Project Director, Tamil Nadu State Blindness Control Society (TNSBC) and Head of the Department of Ophthalmology

and District Programme Manager (DBCS), TVMCH, Tirunelveli in implementation of this project in Tirunelveli District.

Financial support and sponsorship

The Queen Elizabeth Diamond Jubilee Trust, London, UK.

Conflicts of interest

There are no conflicts of interest.

References

1. International Council of Ophthalmology. ICO guidelines for diabetic eye care-Updated 2017. International Council of Ophthalmology; 2017. Available from: <http://www.icoph.org/downloads/ICOGuidelinesforDiabeticEyeCare.pdf>. [Last accessed on 2019 Oct 29].
2. Vision 2020: The Right to Sight INDIA. Guidelines for the comprehensive management of diabetic retinopathy in India, developed by Aravind Eye Care System. New Delhi: Vision 2020: The Right to Sight INDIA; 2008. p. 3-4. Available from: <https://www.iapb.org/wp-content/uploads/Guidelines-for-the-Comprehensive-Management-of-DR-in-India.pdf>. [Last accessed on 2019 Oct 29].
3. Directorate General of Health Services, Ministry of Health & Family Welfare. National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases & Stroke (NPCDCS), Operational Guidelines – Revised 2013-2017. New Delhi: Ministry of Health & Family Welfare, Government of India; 2013. Available from: <https://mohfw.gov.in/sites/default/files/Operational%20Guidelines%20of%20NPCDCS%20%28Revised%20-%202013-17%29.pdf>. [Last accessed on 2019 Sep 16].
4. Ministry of Health & Family Welfare. National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases & Stroke (NPCDCS). Training Manual for NCD Programme Managers at State and District Level. New Delhi: Ministry of Health & Family Welfare, Government of India; 2017. Available from: <https://mohfw.gov.in/sites/default/files/Training%20Manual%20for%20NCD%20Programme%20Managers%20at%20State%20and%20District%20Level.pdf>. [Last accessed on 2019 Sep 16].
5. Ministry of Health and Family Welfare. Role in Prevention & Control of Non Communicable Diseases (NCDs). Book No. 8. New Delhi: Ministry of Health & Family Welfare, Government of India; 2009. Available from: <https://www.nhp.gov.in/sites/default/files/pdf/NCD.pdf>. [Last accessed on 2019 Sep 16].
6. Indian Council for Medical Research. ICMR Guidelines for Management of Type 2 Diabetes. Indian Council for Medical Research; 2018. Available from: <https://medibulletin.com/wp-content/uploads/2018/05/ICMR.diabetesGuidelines.2018.pdf>. [Last accessed on 2019 Sep 16].
7. Perumalsamy N, Prasad NM, Sathya S, Ramasamy K. Software for reading and grading diabetic retinopathy: Aravind Diabetic Retinopathy Screening 3.0. *Diabetes Care* 2007;30:2302-6.
8. American Academy of Ophthalmology Retina/Vitreous Panel. Preferred Practice Pattern® Guidelines. Diabetic Retinopathy. San Francisco, CA: American Academy of Ophthalmology; 2017. Available from: <https://www.aao.org/Assets/9f2de0c1-1c30-442f-a3bb-c76e2cf19502/636492239481630000/final-diabetic-retinopathy-update-2017-pdf>. [Last accessed on 2019 Sep 16].
9. Davila JR, Sengupta SS, Niziol LM, Sindal MD, Besirli CG, Upadhyaya S, *et al*. Predictors of photographic quality with a handheld non-mydratic fundus camera used for screening of vision threatening diabetic retinopathy. *Ophthalmologica* 2017;238:89-99.