

Training of nonophthalmologists in diabetic retinopathy screening

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The burden of diabetes mellitus (DM) and diabetic retinopathy (DR) is at alarming proportions in India and around the globe. The number of people with DM in India is estimated to increase to over 134 million by 2045. Screening and early identification of sight-threatening DR are proven ways of reducing DR-related blindness. An ideal DR screening model should include personalized awareness, targeted screening, integrated follow-up reminders, and capacity building. The DR screening technology is slowly shifting from direct examination by an ophthalmologist to remote screening using retinal photographs, including telescreening and automated grading of retinal images using artificial intelligence. The ophthalmologist-to-patient ratio is poor in India, and there is an urban-rural divide. The possibility of screening all people with diabetes by ophthalmologists alone is a remote possibility. It is prudent to use the available nonophthalmologist workforce for DR screening in tandem with the technological advances. Capacity-building efforts are based on the principle of task sharing, which allows for the training of a variety of nonophthalmologists in DR screening techniques and technology. The nonophthalmologist human resources for health include physicians, optometrists, allied ophthalmic personnel, nurses, and pharmacists, among others. A concurrent augmentation of health infrastructure, conducive health policy, improved advocacy, and increased people's participation are necessary requirements for successful DR screening. This perspective looks at the characteristics of various nonophthalmologist DR screening models and their applicability in addressing DR-related blindness in India.

Key words: Diabetic retinopathy, nonophthalmologists, screening, training

The International Diabetes Federation estimates that the number of people with diabetes mellitus (DM) in India would increase from 77 million in 2019 to over 134 million by 2045. It translates into an increase of 74%, and it is twice the estimated population increase over the same period.^[1] The proportion of ophthalmologists in relation to the population is very low in India and much lower than in the rest of the world.^[2] According to the All India Ophthalmology Society, India has 23,000 ophthalmologists in 2021, with a ratio of 18 ophthalmologists per million population.^[3] By the current estimate, every ophthalmologist in India is required to examine 3500 people with diabetes annually. The actual number would be higher because of several nonpracticing ophthalmologists (the exact number is unknown) and people at risk of developing diabetes. On the other hand, there are only 1100 registered retinal specialists^[4]; if they alone examine all people with diabetes, it would be 64,166 for each retina specialist annually and 214 people on each working day. This is an impossible task unless there is a defined protocol-based task shifting and task sharing system of diabetic retinopathy (DR) screening.

Mass screening for DM and DR is not a cost-effective strategy. India would require an estimated 70 million screening appointments every year as a start and increase the capacity exponentially every year to meet the rising numbers of people with diabetes.^[5] Therefore, targeted and opportunistic screening are better options to achieving the optimum performance of

DR screening programs. Two strategies could help: one, use fundus photography for DR diagnosis, and two, utilize the services of nonophthalmologist technical personnel for screening and referrals. Over the years, the camera technology has improved to capture a relatively wider field (40°–45°). These have also enabled us to familiarize the nonophthalmologists in interpreting the color fundus images of retinal diseases.^[6]

This perspective examines various nonophthalmologist-based DR screening models and explores their applicability for India.

Nonophthalmologist Screening Models for Diabetic Retinopathy

Physicians, optometrists, vision technicians (VTs), nurses, and pharmacists, are potential nonophthalmologist screeners for DR. Table 1 summarizes the potentials of nonophthalmic screeners and their role in the screening of DR. Diabetic eye complications and screening for DR require horizontal linkages, unlike cataract screening programs that can be managed vertically. The tools for screening DR are ophthalmoscopy, slit-lamp biomicroscopy, and retinal photography. Ophthalmoscopy essentially needs a physician examiner, fundus slit-lamp biomicroscopy needs an ophthalmologist, but many other medical personnel could be trained to read good quality retinal photographs. Finally, in a chronic condition like DM and DR,

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Table 1: Potential screeners for DR and their roles in the DR screening process

Screening components	GP's/ MBBS	MD/ DM	Ophthalmologist	Optometrist	Nurses pharmacists	Vision technicians
Vision assessment	Yes	Yes	Yes	Yes	Yes	Yes
Direct ophthalmoscopy	Yes	Yes	Yes	Yes	No	No
Indirect Ophthalmoscopy	No	No	Y/N	No	No	No
Fundus biomicroscopy	No	No	Y/N	Yes	No	No
Digital photography (Single field 45°)	No	No	Yes	Yes	Yes	Yes
Digital Photography (4/7 field stereo)	No	No	No	Yes	No	Yes

GP: General practitioners

the patients and/or the family could be empowered to screen their retinal condition.

Physician-centered DR screening model

The physician (and diabetologist) invariably is the first contact in the health care system for people with diabetes. It could be after the common symptoms like polyuria and/or polydipsia or after detecting deranged serum glucose levels detected after a routine blood test. People with DM who were not detected in the screening may present at first to specialists with specific complaints.

Published studies suggest that primary care physicians trained in the reading of retinal photographs can identify up to 90% of DR referrals.^[7] The sensitivity and specificity were greater than 90% for detecting referable DR by physicians using nonmydriatic handheld cameras.^[8] Understandably, the ability of physicians to screen for DR using the modalities mentioned above may not equate to a retina specialist, though it is considered adequate for a DR screening program.^[9] Thus, front-line physicians can be effectively utilized for DR screening after appropriate training. However, the involved costs of ocular imaging, availability of personnel for capturing images, lack of interest in the ophthalmic diagnosis, and the requirement of necessary coordination with ophthalmologist/image reading centers can be deterrents for a physician-based model of DR screening.

Optometrists and allied ocular personnel (AOPs) coordinated screening models

Optometrists are the first contact with people with diabetes seeking eye care. It is important not to limit their role to refraction and the supply of eyeglasses. In India, optometrists as DR graders have been tried in project mode.^[10] Our capacity-building model for DR screening for optometrists in India^[10] has two components: (A) a one-day long workshop and (B) 7 month-long short-term fellowship. In our study, the sensitivity and specificity of detection for any DR were 95 and 79%; for diabetic macular edema it was 80 and 86%, and for sight-threatening, DR (STDR) it was 88 and 90%, respectively.^[10] Others and we have shown optimal sensitivity and specificity of optometrists in DR screening.^[6,10]

VTs are important primary eye care human resources for health (HRH) in remote rural areas. They are trained to 'Refraction, Recognize and Refer sight-threatening conditions' (the three Rs).^[11] It is important to train VTs on DR screening and make them familiar with the referral guidelines. We designed workshops in easy-to-understand vernacular and simplified fundus images (example: a *red spot* for microaneurysms and hemorrhages; a *yellow spot* for cotton wool spots, hard exudates; *flowers* for new vessels) to explain various stages of retinopathy. The workshops included pre-and post-knowledge assessments using Google forms.

Ophthalmic nurse practitioners had excellent sensitivity (93%) and specificity (91%) with respect to detecting any DR. They could identify all cases of STDR.^[12] Nurses in non-communicable disease clinics were trained as fundus photographers and screened in 75% of diabetic patients enrolled in these noncommunicable disease (NCD) clinics.^[13] India does not have 'ophthalmic nurse practitioners' in a strict sense; but the existing cadre of nurses as part of the AOPs could be trained for DR screening using quality fundus photographs.

The added advantage of training the optometrists and AOPs in fundus photography and DR screening is the detection of glaucoma with obvious optic cup-disc changes.

Pharmacist based screening model

Following detection of DM at the primary level, the next expected contact with the health care system lies at the level of pharmacies or pharmacists where the patients would obtain the prescribed antidiabetic medicines. We found that pharmacists are the most frequently visited health care providers by people with diabetes in India.^[14] Thus training pharmacists as diabetes educators and DR screeners is a promising option. Teleconsultation with the pharmacists using the fundus photographs is possible, but its cost-effectiveness may be limited to only rural communities where other HRH could be scarce.^[15] It is shown to reduce the risk of DR where the pharmacy works in close collaboration with primary physicians for managing cardiovascular risks.^[16] At present, the chief role of pharmacies in DR screening is seen in areas where community pharmacy services are integrated into public health, areas that are remote precluding other modalities of DR screening, and where teleophthalmology can be established.^[17] This model is not yet tried in India, but it is worth exploring.

Patient-based screening model

Empowering the patients

Self-care at the home of patients or relatives with chronic metabolic disease has been assessed for a long time. Empowering patients at the individual level can eliminate compliance problems and reduce costs; however, evaluation in the perspective of DR screening is not yet reported though the initial hypothesis indicates a possible utility.^[18] This hypothesis is centered on the patient's or attendant's ability to click the retinal photograph using a home-based device and communicate the same via teleophthalmology or use artificial intelligence (AI) for further assessment. This obviates a visit to the DR screening center; additionally, it is the only DR screening model that has the potential of overcoming issues of patient compliance. An educated patient with health-oriented behavior and attitude can inculcate this as a home-based practice. However, a major challenge is the training of the attendant or the ability of a debilitated patient to capture a gradable quality image and also attain "safe" mydriasis away from the care provider.

DR Screening Tools

Direct ophthalmoscopy

Direct ophthalmoscopy is one of the oldest techniques used for retinal evaluation. Its advantage lies in high magnification (15x), but it is limited by a narrow field of view (approximately 6°). Previously, direct ophthalmoscopy by the “trained” primary physician has been considered cost-effective for use in remote settings where fundus photography was not possible.^[19] DR screening requires an adequate view of the fundus to at least 60°–75° of the retina, and for these reasons, direct ophthalmoscopy is not preferred for DR screening; steeper learning curve, resource intensiveness, and the patient-doctor proximity at the time of examination are some of the known constraints. An ophthalmologist is best trained to perform direct ophthalmoscopy, but it is slowly out of vogue.^[20] Fundus photography seems to replace ophthalmoscopy as a screening tool by a nonophthalmologist.^[21]

Fundus photography

Fundus photography is the gold standard tool for diagnosing DR. The strategy of nonmydriatic photography with two 45° fields and mydriatic imaging of the fundus in a case of ungradable images is of proven relevance in resource-limited contexts.^[22] Advantages of fundus photography include objective documentation, effective patient counselling, and an opportunity to audit any missed cases.^[23]

Role of mydriasis

In Sri Lanka study, Piyasena *et al.*^[8] showed that 43.4% of retinal images were ungradable with Visuscout (Carl Zeiss, Germany) nonmydriatic camera, decreasing to 12.8% after pupillary dilatation. In their study, physician graders showed a sensitivity of 88.6–92.4% and specificity of 94.8–96.3% in detecting referable DR using mydriatic retinal imaging. A review of photography-based models has shown that mydriatic retinal photography improves sensitivity for all cadres of nonophthalmologists in the range of 87–100% for general practitioners and > 91% for optometrists.^[24] In Nepal, Thapa *et al.*^[25] reported that trained Allied Medical Professionals (AMP) had a substantial agreement for any retinal abnormalities and retinal hemorrhages with an ophthalmologist on fundus photographs. This study concluded that AMPs could screen DR for timely referral in low-resource income settings. We recommend mandatory training of fundus photographers (for all models of DR screening) for the quality acquisition of images.

Quality Assurance

Monitoring and evaluation of the nonophthalmologist DR screening model

An important prerequisite for developing an efficient and effective screening model is periodic evaluation and measurable indicators for all components.^[26] Periodic audit of fundus images and referrals, periodic training in DR diagnosis, reinforcement of screening guidelines, and refresher courses ensure the quality of this model.^[10] We recommend mandatory certification in DR screening and familiarity with the guidelines for all cadres of nonophthalmologists. The DR certification from the University of Melbourne, for the optometrists and VTs, is one such resource.^[27]

Future possibilities – applicability to Indian scenario

Two emerging possibilities are teleophthalmology and AI.

Teleophthalmology can provide a sustainable and scalable model for DR screening operated by nonophthalmologists. As part of a teleophthalmological project, ophthalmic photographs obtained by a qualified technician have consistently achieved over 90% adequacy for remote reading. This confirms the relevance of teleophthalmic DR screening by allied medical personnel.^[28] Teleophthalmology targeting NCD is an ideal option for India.^[5]

AI in DR screening could bridge some of the missing links of interdisciplinary coordination.^[29] Semiautomated AI-enabled public DR screening can triage for a second in-person examination. A recent study has documented its advantage in decreasing opportunity cost and patients/year.^[30] A conducive health policy is also needed for the promotion and effective implementation of AI in DR screening.^[29]

All DR screening models based on nonophthalmologists (Physician/patient/pharmacist/AOP/nurse/attendant/VT/optometrist) are essential components of the integrated telescreening/AI models. This nonophthalmologist workforce will bridge the human element necessary to acquire a good quality image, counselling of patient, and appropriate referral of the patient to the next level of care based on the image diagnosis.

Discussion

Task sharing is an important concept in the creation of a nonophthalmologist-based DR screening model. Task sharing is defined as “the rational distribution of tasks among health workforce teams, with specific tasks moved from highly qualified health workers to health workers with shorter training and fewer, but adequate qualifications, for the assigned task (under supervision), to share tasks and make their collaboration and communication more efficient to achieve a task by co-managing on common ground to make efficient use of the available human resources.”^[31] Task sharing of DR screening by optometrists and primary eye care workers is proven to benefit in resource-limited settings.^[32]

In India, a nonophthalmologist DR screening model can be effectively implemented once the existing challenges and gaps in the screening process are addressed. These include inadequate infrastructure (availability of ophthalmoscope, visual acuity charts, retinal camera) and insufficient HRH.^[33] The gap is higher in rural India, where a situational analysis has never been done.

We recommend nonophthalmologists trained in the screening and diagnosis of DR in diabetes clinics to improve early referral for treatment. An opportunistic DR screening model can improve the referral of STDR to 65% compared to the self-reported referral of 10%.^[34] Two essential requirements could be the availability of a digital, nonmydriatic fundus camera, and a uniform curriculum and certification of DR diagnosis and screening guidelines.^[35] The nonmydriatic cameras could be supplemented in the second step with mydriatic photography, where images are ungradable. Once these basic necessities are achieved, we can integrate all the functioning models with telescreening and AI to achieve successful referrals in line with a conducive health policy. The health policy should ensure that image/AI reading centers are managed by nonophthalmic personnel trained and certified in the DR screening and referral guidelines.

Conclusion

To conclude, India could benefit from a targeted, trained, nonophthalmologist DR screening model.

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Conflicts of interest

There are no conflicts of interest.

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