

Capacity building for diabetic retinopathy screening by optometrists in India: Model description and pilot results

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Purpose: The present study's objectives are 1) to describe a novel model of Diabetic Retinopathy Capacity Building (DRCB) for optometrists in the detection of diabetes-related retinal pathology in India and 2) to assess the outcomes of this model by comparing the ability of optometrists to detect these diseases using retinal photographs, vis-à-vis, a specialist ophthalmologist. **Methods:** The DRCB model for optometrists conducted between August 2016 and August 2018 included training, certification in the screening, and referral guidelines for Diabetic Retinopathy (DR) and hospital-and community-based service delivery. Training included a 7-month long fellowship in DR and mentored participation as cofacilitators in 1-day orientation workshops on DR screening guidelines across India. The sensitivity and specificity of study optometrists in screening for DR by fundus photography were compared to a retina specialist before certification. **Results:** A total of eight optometrists successfully completed their DR fellowship in the project duration of 24 months. The sensitivity and specificity of detection of any DR were 95 and 79%, any Diabetic macular edema (DME) was 80 and 86%. The sensitivity and specificity of detection of sight threatening DR were 88 and 90% and DME was 72% and 92% respectively. Seven workshops were cofacilitated by study optometrists training 870 optometrists in DR screening guidelines across India. **Conclusion:** The present DRCB model results advocate for an optometry coordinated DR screening in India. Lessons learnt from this model can be useful in designing community-based task sharing initiatives for optometrists in DR screening.

Key words: Diabetic retinopathy, India, optometrist training, task sharing

Diabetic retinopathy (DR) is an important sight-threatening microvascular complication of Diabetes Mellitus (DM). Globally, half a billion people are living with DM and these numbers are expected to rise by 25% in 2030 and by 51% in 2045.^[1] In India, 77 million people were affected with DM in 2019, which is expected to reach 134 million by 2045.^[1] About 28% of these Indians are expected to exhibit complication rates of DR.^[2] By 2020, blindness and vision impairment (VI) due to DR is expected to rise by one million and 3.6 million, respectively.^[3] Given these statistics, there is a pressing need to develop sustainable, comprehensive, and cost-effective diabetes eye care models with integral components of awareness, screening, service delivery, and capacity building, across the globe. Diabetic eye diseases, causing visual impairment and blindness, include uncorrected refractive errors, cataract, glaucoma, and DR.^[4] The associated blindness and VI can be

managed through timely screening with appropriate referrals. The screening and detection of DR-related manifestations are of primary concern to the present study.

India has approximately 9000 4-year trained optometrists and 40,000 2-year trained eye care personnel.^[5] Indian optometry regulatory bodies are making efforts to establish optometrists as an integral part of eye health team in correcting refractive error and detecting ocular disease, enabling comanaged care between ophthalmologists and optometrists.^[6] The present practice pattern of optometrists has been published in a previous paper by Thite *et al.* in 2014.^[7] The results indicate that, unlike their counterparts in the Western world,^[8-10] most optometrists are engaged only in routine refractions and initial patient work-up and there is a big disconnect between their education and practice pattern. This study alluded to the presence of huge untapped potential in this group of professionals to contribute to the alleviation of avoidable causes of blindness and VI in India. The present status of optometry in India is no different to what was reported by Thite *et al.* The Diabetic Retinopathy Capacity Building (DRCB) model

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reported in this study sought to utilize this untapped potential to address a problem of massive community relevance.

The fundus photography-screening model for DR has been the game changer.^[11,12] It has scope for building cost-effective and efficient DR screening models with a wide reach, based on principles of task sharing, teleophthalmology, and artificial intelligence (AI). Optometrists are the front-line staff for eye care in many communities across the globe, and they are the most suitable and sustainable human resource for task sharing of DR screening. The optometrist's role in DR screening and care pathways has been established in various models worldwide.^[8-10] Until now, in India, the optometrist's role in DR has been addressed solely in the research dimension.^[13,14] There is a huge need for addressing the capacity building of optometrists in DR in India. In this context, the present study's objective is to describe the results of a holistic DRCB model for optometrists in India. The study describes all the elements of the DRCB model, the outcomes of this model assessed in terms of the ability of the study optometrists to detect DR related changes in fundus photographs, and the limitations of the model that can serve as learnings for future version of this program.

Methods

The DRCB model project was implemented at a tertiary eye care Institute in South India. The DRCB model for optometrists included training and certification in the screening and referral guidelines for DR and hospital- and community-based service delivery. The project was approved by the Institutional Review Board and was in alignment with the tenets of the Declaration of Helsinki. The project duration was 2 years, from August 2016 to August 2018. The training and certification for DR was done through two components: 1. A 7-month long fellowship for optometrists in DR and retina diagnostics. 2. The participation of these optometrists as trainers under mentorship in 1-day workshops for optometrists in DR screening and appropriate referral organized across the country.

Fellowship methodology

The fellowship program was open to optometrists with a 4-year bachelor's degree in optometry from a recognized institution, typically with 3 years of didactic classroom and preclinical training and 1 year of clinical internship in a secondary or tertiary level eye care facility. The undergraduate curriculum of training was to be largely in alignment with the recommended training guidelines of the Ministry of Health and Family Welfare, Govt. of India.^[15] The program was advertised through preexisting optometry e-mail distribution list and through the website and the different social media pages of the institute. Optometrists were selected for the fellowship program through an online assessment that comprised of multiple-choice questions testing their knowledge of basic anatomy of the retina, and questions related to diabetes and DR screening aspects like fundus photography. This program was divided into three phases: 1. Observation (1 month), 2. Hands on training (4 months), and 3. Service delivery (2 months). Details of each phase of the training program are noted in Fig. 1.

The program was conducted over a period of 7 months in three phases by an experienced vitreoretinal surgeon, with 15 years of experience in the field of DR.

The author has been part of national and international capacity building groups related to DR: All India ophthalmic society DR task force and Queen Elizabeth Diamond Jubilee Trust program in collaboration with the Public health foundation of India. The curriculum is developed by the

author (vitreoretinal surgeon) from the result of interactions with various national and international experts. Various national and international optometry management guidelines related to diabetes eye care have been considered before the development of the curriculum.^[16,17] The program has been developed taking American Diabetes Association guidelines regarding the diagnosis of Diabetes into account. It has also considered the International Council of ophthalmology's guidelines regarding DR care.^[18,19]

In the first month of the first phase, the fellow was posted for observation at the retinal outpatient department and diagnostics. The second phase included clinical training of the fellow in a comprehensive examination of the eye, including assessment of the fundus, fundus photography, optical coherence tomography, fundus fluorescein angiography, and B Scan. In the third phase, the fellows were part of the DR community screening program conducted in association with a diabetologist center. An online educational portal was created to administer weekly assessments through quizzes and assignments. Theory classes related to DR were conducted and a hands-on exposure to DR screening was provided, while optometrists were posted in the retina clinics.

Following the completion of the first two phases of the program and prior to the service delivery phase, an assessment of the sensitivity and specificity of study optometrists in the screening of DR by fundus photography was done. These parameters were assessed against an ophthalmologist trained in the diagnosis and management of retinal pathology (especially diabetes-related retinal complications). During the third phase of the fellowship, study optometrists conducted an independent hospital and community-based DR screenings using nonmydriatic fundus photography. Fellowship certification was given based on fellowship performance, an exit assessment examination, and completion of an online grading certification program offered by the University of Melbourne School of Population and Global Health.^[20] A minimum of 75% marks was required for obtaining fellowship completion certificate. All trainees were provided a monthly stipend during the fellowship to sustain themselves financially. They were encouraged to conduct studies related to DR and present their findings at national and international conferences during the project period. Conference travel and logistics were supported by project funds. After the completion of fellowship, the study optometrists were used as cofacilitators for conducting DR workshops.

The assessment of the optometrists in screening for DR-related changes in fundus photography was done as follows: One hundred and fifty images of 45- and 50-degree fundus photography (single-field centered on the disc and macula) were obtained from hospital-based DR screening. The images were obtained from indigenous equipment (3 Nethra-Forus Royal). The images included all severities of DR including 5% ($n = 7$) of normal images. DR and DME were classified based on the widely accepted international DR severity scale.^[21] Sight threatening or referral retinopathy was considered as moderate, severe and proliferative, DR and sight threatening or referable DME was considered as moderate and severe DME. The diagnosis by the retina specialist was considered the gold standard, and the sensitivity and specificity values were calculated using standard formulae between the retina specialist and optometrist's fundus photo grading of DR and DME.

Workshop methodology

The 1-day workshop covered the following topics 1. Introduction to Diabetes mellitus and its effects on various

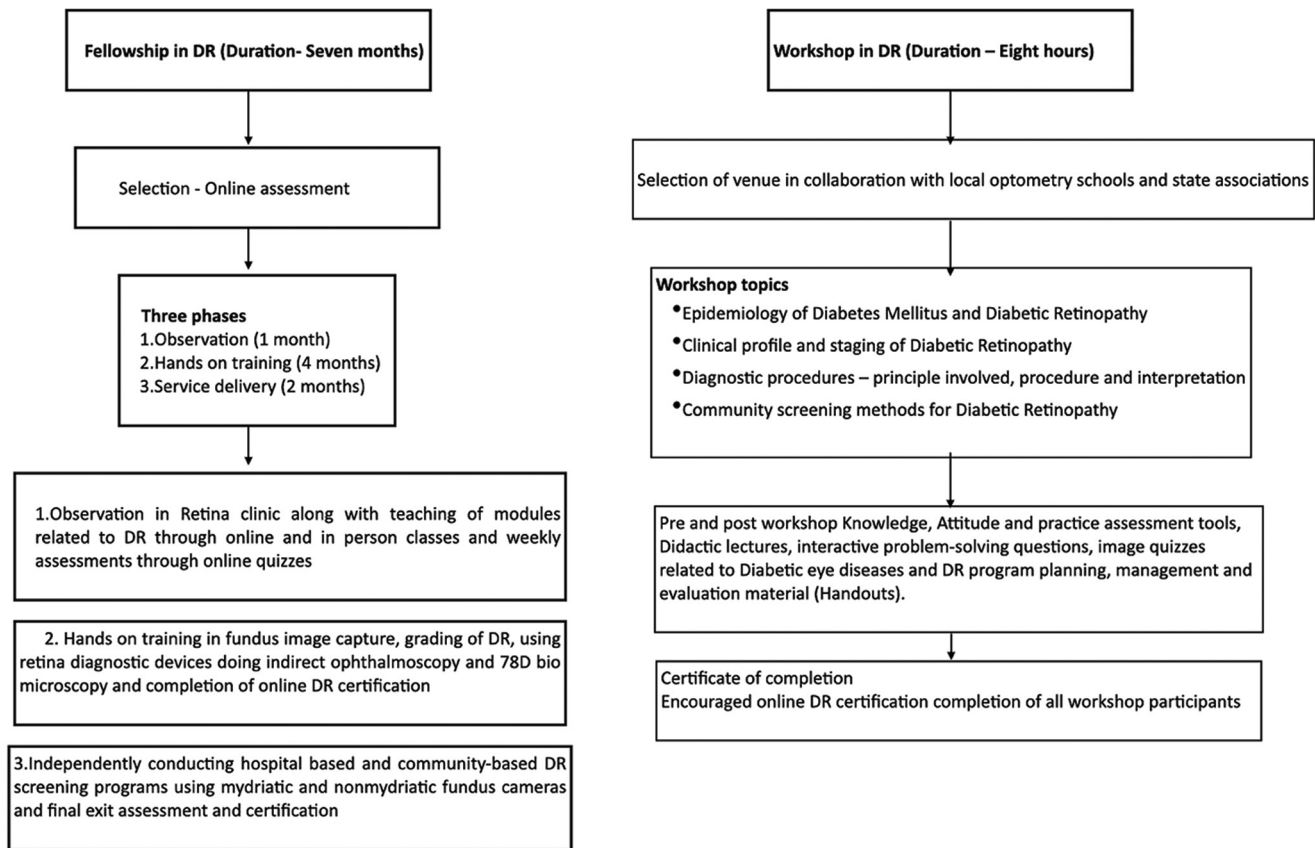


Figure 1: Training methodology – DRCB model for optometrists

anatomical systems 2. Epidemiology of DR 3. Clinical profile and staging of DR 4. The diagnostic procedures: principle involved, procedure, and interpretation 5. Community screening methods for DR Management. Detailed methodology is described in Fig. 1. The country wide, 1-day workshops were conducted with pre- and postworkshop assessment of the knowledge of DR screening and referral guidelines (Appendix 1: Knowledge, Attitude, and Practice Assessment tool).

Results

Training and certification in the screening and referral guidelines for DR

A total of eight optometrists completed all facets of the fellowship in the DR during the project duration of 2 years. Enrolled optometrists came from different rural and urban parts of the country. Six of these optometrists after selection through online assessment were nominated from within the host institute and two optometrists were nominated from their parent institution and joined the program independently. These individuals were earmarked to participate in DR related activities of the institute, post completion of the training.

Quantitative comparison of the sensitivity and specificity of the trainee optometrists against the retina specialist is shown in Table 1. The results showed that the sensitivity and specificity of detection of any DR were 95 and 79%, respectively. The sensitivity and specificity of detection of any DME were 80 and 86%, respectively. The sensitivity and specificity of detection

of sight threatening DR were 88 and 90%, respectively. The sensitivity and specificity of detection of sight threatening DME were 72 and 92%, respectively.

Impact of short-term fellowship in DR

All these optometrists have been successfully placed in careers after the completion of DR fellowship. All have secured employment opportunities in national and international research projects related to screening, teleophthalmology, and AI in DR. During the project period, all eight optometry fellows have presented various studies related to DR in national and international conferences. This exposure helped in enhancing their screening and research capacity in DR. The fellowship also benefited, on average, 10,000 people with DM through the various services offered as part of the DR services. Screening performance of optometrists is shown in Table 2.

Countrywide 1-day workshops for optometrists in DR screening and appropriate referral

A total of seven workshops on DR for optometrists were conducted across India in association with optometry institutes and hospitals during the project period. These workshops were conducted with the goal of covering various geographic regions of India (Kolkata in the state of West Bengal in Eastern India, Surat in the state of Gujarat and Jaipur in the state of Rajasthan in Western India, Manipal in the state of Karnataka, Trivandrum in the state of Kerala and Hyderabad in the state of Telangana in Southern India, and Shillong in the state of Meghalaya in North-Eastern India). A total of 870 optometry professionals from an average of 65 institutions and eye hospitals across India were oriented towards the DR screening

Table 1: Mean sensitivity and specificity of DR screening by optometrist under DRCB model.

	Sensitivity	Specificity
No DR vs DR	94.60 (SD=1.73)	78.91 (SD=13.63)
No DME vs DME	80.29 (SD=15.53)	86.07 (SD=7.92)
Non-STDR vs ST DR	87.91 (SD=9.84)	90.32 (SD=4.27)
Non-STDME vs ST DME	72.07 (SD=5.67)	91.84 (SD=6.10)

STDR - Sight threatening DR, ST DME - Sight threatening DME

Table 2: Performance of DR fellowship trained optometrists

Parameter	Number
Community screening programs coordinated	12
Subjects screened in the community screening program	554
Subjects referred for further management	174
Subjects screened for the DR (hospital based)	3000
Fundus images captured and interpreted	3000
DR grading of fundus images	1500
OCT scans conducted and interpreted	3000
Ultrasound scans conducted and interpreted	3000
FFA s done and interpreted	300

OCT- Optical Coherence Tomography, FFA-Fundus Fluorescein angiography

and appropriate referral guidelines. The costs of the 1-day workshops, including travel, food, and accommodation, were covered by the project fund. The expense of workshop materials was borne by the host institutes and a small nominal fee paid by the participants. Pre- and postassessment workshops scores of participants have shown a 68% increase in their knowledge scores about screening and referral guidelines of DR.

Discussion

Major findings of the DRCB model show holistic coverage of all components needed for capacity building of optometry cadres in DR screening. The training components of the fellowship and 1-day long workshops were able to address the task sharing capacity of optometrists in DR screening. Fellowship in DR benefited the optometrists in enhancing their screening and research capacity of DR and also in using various retinal imaging techniques.

National Institute for Clinical Excellence (NICE, UK) recommended acceptance for DR screening at 80% sensitivity, 95% specificity (and clinical failure rate <5%).^[22] The present study optometrists showed an acceptable level of sensitivity and specificity for the presence of either sight-threatening or non-sight-threatening DR and DME. This suggests that with appropriate skill transfer programs, we can build trained optometry cadre as the front-line DR screening force. We would expect that the DR screening sensitivity and specificity will improve with continuous quality improvement, in built audits of captured fundus images, periodic online skill transfer workshops, and the yearly mandatory renewal of the certificate for DR screening.

One-day workshops with postassessment scores of 68% indicate that workshops can be an effective mode to create awareness about DR screening and referral guidelines. We reached 870 optometrists from various parts of country through these workshops.

Lessons learnt in the implementation of the DRCB model

We expected to enroll 15 optometrists for the 7-month long fellowship in DR. However, probably due to the long duration of the fellowship, only eight optometrists were enrolled. This barrier can be addressed by organizing fellowship with a combination of online and hands on modules to attract a greater number of optometrists. One-day workshops were conducted with paper-based assessment of pre- and postknowledge assessment, which was tedious to implement and evaluate. This challenge can be addressed by formulating online knowledge assessment tests using Google forms®, which will be easier to administer and evaluate.

Future directions

Tele-education through online platforms is an important tool that can reach a greater number of optometrists through both fellowship and orientation workshops. Efforts are underway to implement orientation workshops with important optometry regulating authorities like the Optometry Council of India. To address the need for good quality fundus images, hands on modules for fundus imaging capture techniques have been planned for future workshops.

AI is a game changer in DR screening with various studies showing the advantages of AI and deep learning.^[23,24] If machines can screen for DR, why would we need optometrists as a task sharing screening force in the DR? AI technology is dependent on accurate, good quality fundus images, and current AI programs are unable to accurately detect DME solely based on photographs.^[23,25,26] So, the fundamental step in building an ideal DR screening model is to capture a good quality fundus image and a comprehensive assessment of the people with DM. This includes the assessment of visual acuity, refraction, IOP, glycemic control, and comorbidities. Optometrists can fill the gaps left by AI programs, performing all the above-mentioned tasks. With an appropriate knowledge transfer, we believe that optometrists can become an important human element in the DR screening model that can complement the role of the AI.

Conclusion

To conclude, the DRCB model showed promising results towards the tackling of blindness due to diabetic eye diseases by optometrists. Efforts are needed to expand the scope of task-sharing abilities in optometrists during DR screening. These are essential skills that should be common knowledge for primary eye care providers. They should be in the toolkit of every optometrist and the best way to achieve that is to imbibe these skills into the optometry curriculum. They must not be limited to a specific task force. There is a need to train educators to teach these skills to optometry students as and before they graduate. This should be promoted through public, private, and government partnerships.

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Conflicts of interest

There are no conflicts of interest.

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Appendix 1: Knowledge, Attitude, Practice Assessment Tool

1. **Which country has highest number of people with diabetes mellitus (DM)**
 - a. Pakistan
 - b. China
 - c. India
 - d. Singaporeanswer - b
2. **All are the microvascular complications of DM except**
 - a. Diabetic retinopathy
 - b. Diabetic neuropathy
 - c. Diabetic cardiopathy
 - d. Diabetic nephropathyanswer- c
3. **Retinal examination must be done in all people with diabetes, irrespective of the type of diabetes**
 - a. Once in 3 years
 - b. Once in 5 years
 - c. Once a year
 - d. When the patient has vision complaintsans-c
4. **The symptoms produced in diabetic retinopathy are**
 - a. Waterying
 - b. Itching
 - c. Redness and discharge
 - d. No specific symptomsans-d
5. **Sight threatening diabetic retinopathy includes**
 - a. Proliferative diabetic retinopathy
 - b. Diabetic macular edema
 - c. Both of the above
 - d. None of the aboveans: c
6. **The main clinical feature of severe nonproliferative diabetic retinopathy (severe NPDR) changes is**
 - a. Presence of hard exudates
 - b. Intraretinal microvascular abnormalities (IRMA)
 - c. Cotton wool spots
 - d. New vessels in the retinaans: b
7. **The pathogenesis of diabetic retinopathy is due to**
 - a. Microvascular occlusion
 - b. Microvascular leakage
 - c. None of the above
 - d. Both of the aboveans: d
8. **The first sign and hallmark of diabetic retinopathy (DR) is**
 - a. Hard-exudates
 - b. Cotton wool spots
 - c. Microaneurysms
 - d. Flame shaped hemorrhagesans: c
9. **Teleophthalmology screening of diabetic retinopathy is usually done**
 - a. By an ophthalmologist (retina specialist)
 - b. Using a nonmydriatic fundus (retinal) camera for retinal (fundus) photography
 - c. Not followed nowadays
 - d. Used only in the citiesans: b
10. **All women with pr-existing diabetes planning pregnancy**
 - a. Should be screened for diabetic retinopathy (DR) only if their blood sugar levels are high
 - b. Should be screened for DR only if they have blurred vision
 - c. Should be screened for DR prior to conception and in the first trimester of pregnancy and must be closely followed up with retinal examination during pregnancy
 - d. Should be screened for DR only if they have type 1 diabetesans: c

11. All adolescents/and or adults with type 1 diabetes must have their first retinal examination

- a. Must have retinal examination only after they become adults
- b. Must have retinal examination within the first 5 years of diagnosis of diabetes
- c. Must have a retinal examination only when they have redness in their eyes
- d. Must have retinal examination if they have any symptoms of blurred vision

ans: b

12. Important risk factors associated with diabetic retinopathy are

- a. Increased blood pressure
- b. Newly diagnosed diabetes
- c. Alcohol consumption
- d. Tuberculosis

ans: a

13. The most important nonmodifiable risk factor associated with DR is

- a. Anemia
- b. Cardiovascular disease
- c. Duration of diabetes
- d. Smoking

ans: c

14. To reduce the risk of retinopathy or slow the progression of retinopathy, the target glycemic levels (HbA1c) to be maintained is

- a. <6%
- b. <7%
- c. <8%
- d. <9%

ans: b

15. The concept of "metabolic memory" in the diabetic retinopathy, shown in DCCT, UKPDS or STENO 2 study – showed

- a. Good glucose control has a long lasting effect on microvascular complications like DR
- b. Good Blood pressure control has a long-lasting effect on DR
- c. Treatment of dyslipidemia has long lasting effect on microvascular complications like DR
- d. All of the above.

Ans: a

16. All patients with diabetic retinopathy require

- a. Laser photocoagulation
- b. Glycemic control
- c. Intravitreal anti-VEGFs (vascular endothelial growth factor)
- d. Ocular surgery

Ans: b

17. At what interval should people with diabetes with minimal diabetic retinopathy be followed up by an ophthalmologist?

- a. Every 3 months
- b. Annually
- c. Every 6 months
- d. Biannually

ans b

18. What is the first-line treatment for the management of center-involving diabetic macular edema?

- a. Intravitreal anti-VEGF
- b. Intravitreal steroids
- c. Focal laser photocoagulation
- d. Pars plana vitrectomy

ans: a

19. Which of the following is not an indication to perform fundus fluorescein angiography?

- a. Evaluation of unexplained visual loss
- b. Guide to detect laser treatment in DME
- c. Screening of diabetic retinopathy
- d. Detect clinically obscure retinal neovascularization

ans: c

20. Which of following is an indication for panretinal photocoagulation?

- a. Moderate nonproliferative
- b. Proliferative diabetic retinopathy
- c. Mild nonproliferative diabetic retinopathy
- d. Diabetic macular edema

ans: b

21. Based on screening studies from general population, what proportion of people with Type 2 diabetes are likely to have diabetic retinopathy?

- a. 5%
- b. 10%
- c. 20%
- d. 30%

ans: c

22. Referral is needed for the following patients

- a. Proliferative diabetic retinopathy
- b. Diabetic macular edema
- c. Presence of photocoagulation scars
- d. All of the above

ans: d