Diabetic retinopathy screening guidelines in India: All India Ophthalmological Society diabetic retinopathy task force and Vitreoretinal Society of India Consensus Statement

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Diabetic retinopathy (DR) is an emerging preventable cause of blindness in India. All India Ophthalmology Society (AIOS) and Vitreo-Retinal Society of India (VRSI) have initiated several measures to improve of DR screening in India. This article is a consensus statement of the AIOS DR task force and VRSI on practical guidelines of DR screening in India. Although there are regional variations in the prevalence of diabetes in India at present, all the States in India should screen their population for diabetes and its complications. The purpose of DR screening is to identify people with sight-threatening DR (STDR) so that they are treated promptly to prevent blindness. This statement provides strategies for the identification of people with diabetes for DR screening, recommends screening intervals in people with diabetes with and without DR, and describes screening models that are feasible in India. The logistics of DR screening emphasizes the need for dynamic referral pathways with feedback mechanisms. It provides the clinical standards required for DR screening and treatment of STDR and addresses the governance and quality assurance (QA) standards for DR screening in Indian settings. Other aspects incorporate education and training, recommendations on Information technology (IT) infrastructure, potential use of artificial intelligence for grading, data capture, and requirements for maintenance of a DR registry. Finally, the recommendations include public awareness and the need to work with diabetologists to control the risk factors so as to have a long-term impact on prevention of diabetes blindness in India.

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Although there are Regional Variations in the Prevalence of Diabetes in India at Present, All States in India should Implement Population-based Screening Programs for their Population for Diabetes and its Complications

Diabetes Mellitus is now a global epidemic. India is reported to have the second-highest number of people with diabetes in the world following China.[1,2] In 2019; 77, 005, 600 people were estimated to have diabetes in India.[1] Some states in India have population comparable to the whole population of some nations, highlighting the need for state-level scrutiny of diabetes as a public health burden.[3] The prevalence of diabetes in India varies widely ranging from 5% to 16% at present.[4] Undiagnosed diabetes is a significant problem in India.[4] Currently, the highest prevalence of diabetes affecting at least one in every 10 adults is observed in Chandigarh, Tamil Nadu, Punjab, and Kerala.[4,5] The concept that southern states are more at risk than the northern states and that urban population are more at risk

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of diabetes compared to their rural counterparts will no longer be the case as it is expected that, with the positive right shift of economic transition in India, the whole of India will progress towards a higher prevalence of diabetes and so each state should prioritize diabetes care urgently.[4]

All patients with Diabetes should be Screened Regularly for Sight-threatening Diabetic Retinopathy

Diabetic retinopathy (DR) is the most common microvascular ocular complication of diabetes. Sight-threatening DR (STDR), which includes proliferative diabetic retinopathy (PDR) and/or diabetic macular edema (DME) are common causes of visual impairment in people with diabetes. While individuals with no DR and mild non-proliferative diabetic retinopathy (NPDR) are considered non-referable, referable DR is defined as the grade of severity of DR more than mild NPDR (moderate NPDR and above with or without DME). Unlike reports from the Western countries that show that the prevalence of DR is about 30% in people with diabetes, population-based studies in India over the last two decades report a lower prevalence of DR of approximately 18% in urban areas and 10% in rural areas.[6-14] This is despite known risk factors associated with DR such as uncontrolled hyperglycemia, hypertension, and dyslipidemia being highly prevalent in India. There are possibly inherent genetic and local environmental protective factors for DR that are yet to be elucidated. Longer duration of diabetes carries the highest risk. However, approximately 5%–10% of people have STDR, highlighting the importance of DR screening. The current regional differences in the prevalence of diabetes, DR and the risk factors are being evaluated in the ORNATE India project.

It is important to emphasize to the patients with diabetes that DR can be associated with other complications of diabetes such as diabetic kidney disease (DKD) and cardiovascular disease.

As ophthalmologists, it is essential to ensure

- Timely detection of STDR.
- Appropriate protocols are in place for prompt treatment.
- Education of individuals with diabetes regarding their eye status and
- Referral to physicians for control of the risk factors and other associated complications of diabetes.

Other ophthalmic conditions such as cataract and retinal vascular disorders are more common in diabetes and appropriate protocols should be in place to manage these conditions.

Identification of People with Diabetes for DR Screening

There is a high prevalence of undiagnosed diabetes in India and so screening for DR cannot be restricted to people with known diabetes.

It is recommended that DR screening be done for all people with known diabetes on treatment, a single record of random blood sugar (RBS) of ≥200mg/dl (≥11.1 mmol/l), glycated hemoglobin (HbA1C) >6.5% (48 mmmol/l) or higher or gestational diabetes when first notified to a medical personnel. If facilities are not available for screening, referral to a center with DR screening facilities should be made and documented. Although at least two laboratory test results are required to prove that an individual has diabetes, we recommend that at least a single laboratory test be performed to screen for diabetes due to the urgent need to identify and treat patients with STDR to prevent blindness due to diabetes.

The Government of India has introduced non-communicable disease registers (NCD registers). People with diabetes are registered in these NCD registers and should be screened regularly for DR. The DR status should be recorded for each patient to enable regular monitoring and for audit purposes.

Patients visiting ophthalmologists for cataract surgery or any other surgical procedures should have at least one RBS test done. If the RBS is ≥200 mg/dl (≥11.1 mmol/l) or Hba1c is > 6.5%, a dilated fundus examination and status of DR should be recorded before surgery. If there is no fundus view due to dense cataract, B-scan should be performed to rule out vitreous hemorrhage (VH) or retinal detachment prior to surgery. Fundus examination for assessment of DR should be performed during the immediate post-operative review.

In camps or community screening conducted by physicians or ophthalmologists, the same recommendations have to be followed. Pharmacies/medical shops and laboratories are important sources for screening for diabetes. Patient information sheets on diabetes and its complications and need for DR screening can be developed and supplied to these local sources to increase public awareness of DR.

Each medical institution should be encouraged to maintain a diabetes registry with data on grade of DR to ensure patients can be re-called for DR screening. Robust data collection enables accurate reporting of the prevalence and incidence of STDR. This strengthening of data collection will help drive public health initiatives and blindness control programs to reduce visual impairment in people with diabetes.

DR Screening Intervals in People with Diabetes

There is a paucity of data on the incidence of DR in India. Sankara-Nethralaya Diabetic Retinopathy Epidemiology and Molecular Genetics Study (SN_DREAMS II) reported that the 4-year incidence of DR, DME, and STDR as 9.2%, 2.6%, and 5.0%, respectively. In subjects with DR at baseline, the incidence of DME and STDR increased to 11.5% and 22.7%, respectively.[7] Pre-existing DR is, therefore an important risk factor for progression. Strong association of DR progression was also observed with longer duration of diabetes, age above 40 years, higher systolic blood pressure, high HbA1C, anemia, increased serum cholesterol, obesity, low-fiber diet, albuminuria, neuropathy and foot ulcerations.[15-20]

People with pre-existing DR must be seen regularly based on the severity of DR. The diabetes registry should ensure that mechanisms are in place to screen patients with DR at least annually. Patient information sheets should be developed and given to each patient with DR. The information should contain the recommended individualized frequency of screening, explanation that STDR may occur before a patient becomes symptomatic, risk factors for progression of DR and associations of DR with other complications of diabetes.

Patients with no DR and mild NPDR with no DME may undergo a risk-based screening if all parameters of the risk score are known to the ophthalmologist or the physician. The validated retina risk scores in European population may not be applicable to the population in India. Until such risk scores for DR are validated in India, it is recommended that repetitive annual screening for DR is recommended for all patients with no DR.

Screening Models

The gold standard for grading the severity of DR is stereoscopic fundus photography through dilated pupils, using seven standard fields, and grading guidelines for these photographs established by the Early Treatment Diabetic Retinopathy Study (ETDRS) group.[21]

However, in a country such as India where there are insufficient ophthalmology services to cater to the needs of the population, a step by step approach is required. These steps include mass population based screening for DR to improve awareness of this ocular complication amongst patients, public, and healthcare personnel. More specialized services are required for those with DR to enable close monitoring and treatment. Several population-based screening and awareness programs have been conducted across the nation. Very few meet the gold standard of DR screening. However, India is at a point where it is crucial to identify every patient with STDR. So, there is a need to strike a balance between gold standard and acceptable screening protocol for the large population. Telemedicine and the use of nonmydriatic fundus camera are major steps in the set-up of DR screening.[22] However, small pupils and cataract degrade the image quality taken in un-dilated conditions.[23] It is therefore, encouraged that mydriatic screening for DR becomes routine practice and all ophthalmology departments should aim to work towards providing a mydriatic DR screening service unless non-mydriatic wide-angled cameras are used.[24]

The "Telehealth Practice Recommendations for Diabetic Retinopathy" divide DR telehealth program into 4 elements of care: Image acquisition, image review and evaluation, patient care supervision and image and data storage. These details are discussed in respective sections. American telemedicine association (ATA) has set up guidelines for telescreening that should be followed to provide quality DR screening services to people with diabetes.[25]

Screening for DR can be through community-based screening models or hospital-based screening models.

Community-based screening models:

Community Outreach is an extended service of the provider hospital. The main aim of community outreach includes reaching out to the people with diabetes at their doorsteps for DR screening and to involve the community (voluntary organizations and primary care physicians) in DR awareness creation. These outreach clinics may be targeted only for people with diabetes or general population screening for diabetes followed by DR screening. Exclusive DR camps should include diabetologists (or general medical practitioners) and ophthalmologists and paramedical personnel with sufficient equipment to screen, diagnose and refer people who require treatment to attend specialized ophthalmology care delivery centers for treatment. These referrals may be for STDR, cataract or any other ocular condition.

The screening camps for detecting diabetes followed by DR screening needs specific publicity campaigns and separate infrastructure. Screening for diabetes and DR is done simultaneously. Screening for diabetes is usually accomplished through estimation of RBS (finger prick sample). However, the yield of STDR using this method is less and is less cost-effective than screening people with known diabetes for DR.

Opportunistic DR screening in diabetes clinics/general physician clinics/pharmacy and/or medical laboratories: The point of contact and care for a person with diabetes is usually a physician/diabetologist, the pharmacy, or the laboratory and seldom an ophthalmologist. Screening for DR in clinics or pharmacies is best achieved by tele-screening. A technician captures the retinal photographs and sends the images to the ophthalmologist for a remote diagnosis. This screening pathway needs a robust information technology (IT) enabled service delivery model consisting of ophthalmic diagnostic equipment, trained technician and internet connectivity in a diabetes center and an ophthalmology center to effectively screen for DR. Thus, patients would receive remote expert ophthalmologist consultation without having to visit an eye hospital.

Screening in Primary Health Centres (PHCs): This involves either the primary health centers (PHCs) being self-sufficient to provide this service such as in Kerala or establishing a "Public Private Partnership" for DR screening. In this regard, the district health authority has to give permission to an external eyecare provider. Trained ophthalmic technicians perform fundus imaging to screen all the registered diabetes patients at the PHCs. Screening for DR at PHCs may be done on a specific day in a week. Mydriatic DR screening is recommended.

Detecting DR in Vision Centres (Primary Eye Care Centres): The core objective of Vision Centres is to provide comprehensive eye care by integrating IT effectively to provide quality eye care at the doorsteps of the rural population. Primary health center (PHC) with an associated vision center has a dedicated Para-medical Ophthalmic Assistant (PMOA). This set-up also called as Primary eye care center. The fundus images of patients with diabetes can be taken by the PMOA with the help of low-cost fundus cameras after mydriasis and the images are sent to the base hospital for opinion. The details of the screening protocol described in subsequent sections should be followed at these centers. This enables patients examined at the vision center to have tele-consultation with an ophthalmologist at the base hospital. Patients requiring further management are referred to the base hospital.

Mobile van approach in DR screening: To reach the unreachable and increase compliance, mobile van with suitable infrastructure should be used. For the patient, this approach helps reduce travel cost and saves time. Mydriatic DR screening is recommended.

Hospital-based screening models

DR screening can be done in multi-speciality hospitals as well as tertiary eye care centers where vitreo-retinal services are available to provide the expertise and treatment. All people coming to the hospital can be referred to the retina department where the retinal images are captured after mydriasis and a retinal specialist is available for further or early management of STDR. However, the limited number of trained retina specialists

Table 1: Skill based competence levels for people involved in retinal photography grading

	Level 1	Level 2	Level 3
Knowledge on DR*	Basic knowledge of all lesions of DR	Detailed knowledge of all lesions of DR	Detailed knowledge of all lesions of DR and other retinal vascular conditions
About assessing image quality	Basic knowledge about how to assess the quality fundus images	Fairly good idea on assessment of image quality	Detailed knowledge image quality and aware about techniques of image enhancement
Grading lesions of DR	Should accurately have graded at least 100 images with a mix of DR and normals in last 3 months	Should accurately have graded at least 250 images with a mix of DR and normal in the last 3 months	Should accurately have graded at least 250 images with a mix of DR and normal in the last 3 months
Certification	Is aware about the certification programs and striving to achieve it	Is certified by one of the certification program	Is certified on a regular basis by one of the certification program.
Take decision regarding referral	Not able to make decisions of referral	Able to make decision on referral of DR	Able to refer STDR† confidently
Image handling	Keeps all the images without making any changes	Keeps all the images without making any changes	Able to identify only the required images and deletes the unnecessary ones
Records	Able to keep archival database of images	Able to keep the database and take back-ups too	Able to keep the database and take back-ups too
Follow up	Not able to take decisions regarding the follow-up	Is able to instruct follow-up advice for No DR cases	Is able to instruct follow-up advice for No DR and STDR cases

*DR-Diabetic Retinopathy, †STDR - Sight Threatening Diabetic Retinopathy

and eye hospitals is a barrier for the wide implementation of hospital-based screening models.

Recommendations for DR Screening

Personnel performing retinal photography: Table 1 shows the requirements of ophthalmic photographers based on skill-based competency levels. Any person with at least level 1 competency can be involved in capturing fundus images.

Fundus camera: The AIOS recommends that DR retinal imaging equipment have a minimum resolution of 6 megapixels or 30 pixels per retinal degree, similar to the NHS-UK guideline.[25] This criterion should also be met by the smartphone used for retinal imaging. Overall, based on the current literature, the performance of smart phone-based cameras seems to be good in detecting referable DR.[23,26]

Number of fields to be taken: The American Academy of Ophthalmology guidelines for screening for DR report the existence of level I evidence that single-field fundus photography after mydriasis with interpretation by trained readers can be utilized as a screening tool to identify patients with DR for referral.[24] The disadvantage of single field is that it has lower sensitivity values compared with 7–standard field photography or 3 or 4 fields photography. However, when compared with direct ophthalmoscopy, single-field mydriatic fundus photography has the potential to improve the quality of the evaluation and the numbers of patients screened. If a single field is captured, the image should include the optic disc and macula.

To dilate or not: A higher rate of unreadable photographs has been reported through un-dilated versus dilated pupils due to the reason that diabetic individuals often have smaller pupils and a higher incidence of cataracts, which may limit image quality.[24] The unsatisfactory performance of non-mydriatic photography has led to the concept of "targeted mydriasis." Any patient with visual acuity < 6/12 (20/40 Snellen equivalent) and age > 59 years should have pupils dilated before capturing retinal images.[24] Another option is staged mydriasis.[27] In this model, a non-mydriatic single digital photograph for screening is taken. If an unsatisfactory non-mydriatic photograph is obtained, the patient undergoes pupillary dilation with 1% tropicamide eye drops and the fundus photography is repeated. Tan GS *et al*. investigated the risk of acute angle closure and the changes in intraocular pressure (IOP) after routine pupil dilation in a cohort of Asian subjects with diabetes mellitus.[28] They found that the risk of acute angle-closure was insignificant after routine dilation of pupils for fundus examination. These data substantiate the safety of dilation of pupils in Asian patients with diabetes.[28] Pandit RJ *et al*. in a systematic review found that the risk of precipitation of acute glaucoma with the use of tropicamide eye drops is zero and the risk with the use of combined or long-acting dilating eye drops lies between 1: 3380 to 1: 20000.[29] The AIOS recommends targeted or staged mydriasis using 0.5% tropicamide eye drops. It is preferable to assess the anterior chamber depth at least by a pen torchlight (Van Herrick technique). The simplest method of assessing anterior chamber depth (ACD) is by shining a pen torch into the patient's eye from the temporal canthus such that the pen torch lies in the same plane as the eye. In the case of a deep anterior chamber, the iris lies flat and the whole iris will be illuminated. In the case of a very shallow anterior chamber, the iris bows forward, blocking some of the light and very little of the iris is illuminated. Based on the amount of eye illuminated the ACD can be graded. A grade > 2 should not be dilated in the absence of an ophthalmologist.

Ungradable images: The AIOS recommends that the inability to obtain or read images should be considered a positive finding and patients with unobtainable or unreadable images should be promptly reimaged with mydriasis by the photographer or referred for evaluation by an eye care specialist. Table 2 shows a reference of labeling the quality of images. AIOS recommends that the DR should be graded in images with good and moderate quality. In many instances, ungradable images do have some pathology other than DR such as cataracts that require further evaluation by an ophthalmologist and hence need to be referred.[30]

Table 2: Recommendations to access the quality of retinal images

Image quality	Optic Disc	Macula	Superior Vascular Arcade and Inferior vascular arcade	Vessels
Good Quality	Clearly visible, well focused and gradable	Clearly visible, well focused and gradable	Both clearly visible, focused and gradable.	Are visible across >90% of image
Moderate Quality	Clearly visible but is not sharp focused and gradable	Clearly visible but is not sharp focused and gradable	Both clearly visible, focused and gradable	Vessels are seen in 80% or more of image
Poor Quality	Optic Disc is not clearly visible	Macular region is not clearly visible	At least one of the arcade is clearly visible, focused and gradable.	Vessels are seen in 60% or more of image.
Discard	Optic Disc is not visible	Macula is not clearly visible.	None of arcade is clearly visible.	Vessels are seen in <60% of image

Personnel performing the grading: Any person with a minimum level 1 competency can be involved in grading images. Table 3 shows the requirements of people based on skill-based competency levels.

Dynamic Referral Pathways with Feedback Mechanisms

An appropriate and accountable referral mechanism is integral to the screening program, to ensure a continuum of care, at the specialized eye hospitals for the management of DR. Referral consultations between physicians and ophthalmologists, are not optimal, indicative of lack of coordination and communication. There is no mechanism to track compliance to referral, rendering the physicians and ophthalmologists unaware of the outcomes of their referrals.[31] The inter-referral process has to be dynamic and provide feedback to both groups of professionals.

Electronic medical records (EMR) or electronic diabetes registry should allow all patient records to be shared across the two professional groups and this needs to be established for a successful DR screening program. It would be good to have a unique ID for linking to patient details. This will enable tracking the compliance and care process across different facilities. An EMR should ideally be deployed at all facilities (General Physician, Diabetologist, PHCs, District hospitals, Vision centers, outreach camps, and eye hospitals) for effective tracking of referral and care. However, if EMR is not available, manual registers for referrals should be maintained by the physicians and the ophthalmologists.[32]

At all facilities, it is better to have a trained data operator who is accountable for documentation, data capture, and its management, generate reports and alert appropriate levels so as to enhance compliance to referral and treatment.

Clinical Standards of Care for Screening and Management of DR in Hospitals

- Comprehensive eye examination includes visual acuity, measurement of intraocular pressure, slit-lamp examination of the anterior segment and dilated fundus examination by indirect ophthalmoscopy and slit-lamp biomicroscopy by trained ophthalmologists and retinal images captured for records.
- People with type 1 diabetes should have an initial dilated comprehensive eye examination by an ophthalmologist within 5 years after the onset of diabetes and annually thereafter.[33]
- People with type 2 diabetes should have an initial dilated comprehensive eye examination by an ophthalmologist at the time of diagnosis of diabetes and annually thereafter.[33]
- Women who develop gestational diabetes do not require an eye examination during pregnancy and do not appear to be at increased risk for developing diabetic retinopathy during pregnancy. Women with pre-existing type 1 or type 2 diabetes who are planning a pregnancy or who are pregnant should be counseled on the risk of development and/or progression of DR during pregnancy. Eye examinations prior to conception and in the first trimester and then monitoring every trimester and 6 weeks postpartum as indicated by the degree of retinopathy and as advised by the ophthalmologist. The recommended follow-up is every 3-12 months for no retinopathy or moderate nonproliferative diabetic retinopathy (NPDR), or every 1-3 months for severe NPDR.[33]
- Table 4 provides the screening and follow-up guidelines of people with varying severity of DR and the management. Prompt referral of people with any level of DME, severe NPDR, and PDR to an ophthalmologist/retina specialist who is experienced in the management of STDR is essential.

The standards of care for management of DR and its risk factors are outlined in Table 5.

Governance and Quality Assurance

Given the need for early diagnosis, the opportunistic diagnosis of DR during routine eye examination is insufficient to handle this major burden. Many countries have adopted systematic screening programs to screen their populations with diabetes to reduce the number of people developing blindness due to DR. Systematic screening of the diabetic population has been shown to greatly reduce the prevalence and incidence of blindness within the population.[34,35] The AIOS recommends that even though a licensed eye care professional may not be available at the site of DR screening, it becomes the responsibility of an ophthalmologist with expertise in evaluation of DR to monitor the overall tele-screening program, image interpretation, providing knowledge and skills to image readers and consultation for needy patients. It is important to ensure that those screened and identified with STDR undergo prompt management.

A future systematic nation-wide program to prevent visual loss due to DR will impact all components of the health system in India. This would include the governance and leadership, the health workforce (physicians/ophthalmologists/optometrists/nurses), the health management information systems, technology and

Table 3: Skill Based Skill-based competence levels for people involved in taking retinal photograph

	Level 1	Level 2	Level 3
		Basics	
Knowledge on DR*	Basic Knowledge of 1. DR 2. Grading 3. Complications of DR	Detailed Knowledge of 1. DR 2. Grading 3. Complications of DR	Basic Knowledge of Grading & Management
About Retinal Photography	Basic Knowledge about how to perform Fundus Photography	Fairly good idea on Fundus Photography, handling the machine including the optics & adjusting the illumination	Detailed knowledge on Fundus Photography, handling the machine including the optics & adjusting the illumination
About FFA†	Basic Knowledge about how to perform FFA.	Detailed Knowledge about performing FFA, concentration & techniques on injecting the dye, positioning the camera & the patient.	Comprehensive knowledge on performing FFA & FFA interpretation
About Complications	Basic Knowledge about complications of FFA.	Detailed Knowledge about complications of FFA & the treatment.	Comprehensive Knowledge on complications & its management; & ability to administer Emergency First Aid Management
Counseling	Can explain regarding the procedure to the patient	Can explain regarding the procedure to the patient including complications.	Can explain regarding the procedure to the patient including complications.
		Procedure Related	
Patient Records (EMR)‡	Can create an EMR/paper record but with slight difficulty and takes additional time	Can create EMR/paper record without any difficulty	Can create an good EMR record/paper and can also access the old EMR records with ease
Quality of image (non mydriatic)	Minimum 70% images in focus	70%-90% images in focus	>90% image in focus
Quality of image (mydriatic)	Minimum 70% images in focus	70%-90% images in focus	>90% image in focus
Focussing the lesions	Unable to identify and focus on specific lesions	Able to identify and focus on specific lesion	Identifies and takes a well-focused images of specific lesions
quality and ability to perform stereoscopic images	Unable to perform stereoscopic images	Able to perform stereoscopic images	Produces good stereoscopic images
Speed of imaging	Completes imaging of reasonable quality in <20 min	Completes imaging in <15 min	Completes imaging in<10 mins
		Post image capturing	
Basic life support	Unable to administer	Has knowledge about BLS§	Had adequate knowledge and ability to perform BLS
Image grading and reporting	Can only identify few lesions in DR	Can identify lesion and grade DR	Can grade DR as well as identify few lesions on FFA
Identify diabetic retinopathy	Can only identify few lesions	Can identify most of the lesions	Can identify all the lesion and refer the patients if required
Grade diabetic retinopathy	Cannot grade DR	Can Grade presence or absence of DR	Can identify grades of DR
Identify phases of fluorescein angiography	Cannot identify	Can identify	Can identify
Ability to differentiate STDR‖/Non STDR	Not able to differentiate	Not able to differentiate	Able to identify STDR/Non STDR
Ability to monitor disease progression	Not able to do	Not able to do	Able to monitor the progression of the disease adequately
Take decision regarding referral	Not able to make decisions of referral	Able to make decision on referral of DR	Able to refer STDR confidently
		Post-Procedure	
Image handling	Keeps all the images without making any changes	Keeps all the images without making any changes	Able to identify only the required images and deletes the unnecessary ones
Records	Able to keep archival database of images	Able to keep the database and take back-ups too	Able to keep the database and take back-ups too
Follow up	Not able take decisions regarding the follow-up	Is able to instruct follow-up advice for NO DR cases	Is able to instruct follow-up advice for NO DR and STDR cases
Complication management	Unable to manage complication	Has knowledge about the complications and its management	Has knowledge about the complication and management and able to perform basic procedures if required

*DR- Diabetic Retinopathy, †FFA- Fundus Fluorescein Angiography, ‡EMR-Electronic Medical Records, §BLS-Basic Life Support, ‖STDR-Sight Threatening Diabetic Retinopathy

Table 4: Screening and follow-up guidelines for people with and without diabetic retinopathy

Status of retinopathy	Referral to ophthalmologist	Follow-up	Recommended ocular treatment
No Diabetic Retinopathy (DR)	Within 1 year	Every 1-2 years	None
Mild Non-Proliferative DR (NPDR)	Within 1 year	Every year	None
Moderate NPDR	Within 3-6 months	Every 6 months	None
Severe NPDR	Immediate	Every 3 months	Can consider pan-retinal photocoagulation (PRP) under specific circumstances
Proliferative DR	Immediate	Every 3 months	Panretinal photocoagulation (PRP) and/or intravitreal anti-VEGF* therapy, especially if HRCs† are present
No Diabetic macular edema (DME)	Within 1 year	Every year	None
Non-CiDME (non-center involving DME)	Immediate	Every 3 months	Focal laser photocoagulation, and observe carefully for progression to CiDME
Centre involving DME (CiDME)	Immediate	Every 1-2 months	Anti-VEGF as first-line therapy. Consider focal macular laser as an rescue therapy in eyes with persistent CiDME despite anti-VEGF. Intravitreal steroids can be used as an alternative in pseudophakic eyes or in select cases if anti-VEGF is contraindicated (like recent MI or CVA)

*VEGF- Vascular Endothelial Growth Factor. †HRC-High Risk Characteristics

infrastructure, and health economics, all of which need to be sensitized, adapted and enhanced to deliver screening and management services to people with diabetes. Health management information systems will need to be adapted to monitor the nation-wide program. Programs in India such as the Ayushman Bharat provide opportunities for health financing by reimbursement of costs for treatment, although an initial capital outlay for infrastructure and equipment will be required. To ensure quality across various aspects of the Diabetic Retinal Screening Programme in India, a set of quality assurance (QA) standards need to be followed.

Quality Assurance (QA) standards

There is international consensus that screening programs for DR should achieve at least 80% sensitivity, 95% specificity, and <5% technical failure rates.

It is essential to ensure that all people with diabetes in India with their complete demographic details are registered with each person having a unique identification number (for registration and future annual recall/review visits). With government efforts in this direction, we can expect this in the near future.

Quality assurance to ensure that the fundus images are of good resolution and a gradable quality becomes important for DR screening process. The photographers (technicians/ophthalmic assistants/optometrists) must be competent after adequate training to use the nonmydriatic fundus camera. All people involved in DR grading (ophthalmologists/optometrists/ophthalmic assistants/eye technicians) must be certified graders accredited by AIOS after undergoing the online training provided by AIOS. Currently available online accreditation courses can also be availed for training graders. A subset (10% of normal images and preferably all images with DR lesions) of retinal images must be reviewed by retina specialists/ophthalmologists regularly to ensure quality checks.

Education and Training

Any healthcare professional who has been trained suitably can screen for DR. It can be ophthalmologists, optometrists, ophthalmic assistants, trained eye technicians NCD nurses or physicians. However, the screening initiative must have an ophthalmologist who plays a pivotal role and takes the overall responsibility of the program. It is important to ensure that all staff involved in fundus photography and grading and other aspects in the delivery of the DR program are appropriately trained, competent and accredited in the use of digital fundus camera for fundus imaging, storage, and grading of images with documentation of the diagnosis and review advice. The skill-based competence levels for people involved in taking retinal photographs are given in Tables 1 and 3.

Ophthalmologists managing STDR need short-term Medical Retina training in performing indirect ophthalmoscopy/slit lamp biomicroscopy, interpretation of OCT, performing laser photocoagulation for PDR and DME and administration of intravitreal injections.

IT Infrastructure

Technology and infrastructure for the registry as well as all the essential equipment for screening, diagnosis, and management are the key to a successful screening program. Appropriate backup and secure storage must be available for the personal data, medical details and as well as for the fundus images. There must be processes to identify people with more than one record on the DR screening register and to merge the records into a single electronic record. Tracking helps identify people with diabetes to be screened for DR, and after screening, to be referred to the next level for further investigations and treatment services. A robust fundus grading facility at the NCD clinics and a web-based platform for the transfer of fundus images to finalize the DR grading by a secondary grader ophthalmologist would enable swift 'DR grading diagnosis report' of the fundus images at the NCD clinic/diabetes clinic and enable instant/quick referral of those with sight-threatening DR. Facilities should be available so that the fundus images are stored and archived, added to the clinical records in the respective clinics. The secure server/cloud should enable storage of archived anonymized fundus images with separate folders with unique ids.

Table 5: Standard of Care for Management of Diabetic Retinopathy

- Fundus fluorescein angiography (FFA) is indicated at baseline in the management of STDR- to identify areas of leak in DME, ischemia (in the macula), areas of non-perfusion and subtle neovascularisation.
- Optical Coherence Tomography (OCT) has become indispensable in the management of DME. At baseline for qualitative and quantitative assessment (to identify center involving DME [CiDME]) and also during follow-up after treatment (intravitreal injections).
- Intravitreal injections of anti-vascular endothelial growth factor (VEGF) agents are indicated as the first line therapy for central-involving DME (CiDME).[43] All three drugs: aflibercept, bevacizumab, and ranibizumab are effective at improving vision over 1 and 2 years of treatment for DME.[44] Currently the role of focal laser/grid photocoagulation is for the management of non-center involving DME and also can be considered in partial/non-responding DME to anti-VEGF injections.
- Although first-line therapy for most eyes with central-involved DME consists of anti-VEGF, intravitreal injection of steroids (Triamcinolone inj/dexamethasone implant) can also be effective for DME treatment especially in pseudophakic eyes or if there is any contraindication to use of anti-VEGF like any recent stroke/myocardial infarction.[45]
- The standard doses for the conventional pharmacotherapies are: - Ranibizumab (Lucentis/Accentrix/Razumab) - 0.5 mg/0.05 ml; Aflibercept (Eylea) - 2 mg/0.05 ml; Bevacizumab (Avastin) - 1.25 mg/0.05 ml; Triamcinolone - 2 mg/0.05 ml; Ozurdex (dexamethasone implant) - 0.7 mg.
- The panretinal laser photocoagulation (PRP) therapy is the mainstay of treatment to reduce the risk of vision loss in patients with high-risk Proliferative Diabetic Retinopathy (PDR) and, indicated in some with severe Non-Proliferative Diabetic Retinopathy (NPDR) (in scenario like poor compliance with follow up, impending cataract surgery or pregnancy and status of fellow eye/precious eye, etc).
- Intravitreal injection of the Anti-VEGF can be combined with traditional PRP in cases with both macular edema and PDR.[46] Though there is evidence of effectiveness of anti-VEGF agents for PDR without DME, the task force does not recommend the use of anti-VEGF alone for PDR.
- The presence of DR is not a contraindication to aspirin therapy for cardioprotection, as aspirin does not increase the risk of pre-retinal or vitreous hemorrhage.
- Topical Non-steroidal anti-inflammatory eye drops like Nepafenac eye drops have no meaningful effect in the treatment of non-central DME (OCT measured retinal thickness).[47]
- For all people, regardless of the stage or severity of DR, medical management to optimize glycemic control, optimize blood pressure and serum lipid levels reduces the risk or slows the progression of diabetic retinopathy.[48]

Use of Artificial Intelligence Software

Given the alarming increase in the number of people with diabetes and shortage of trained retinal specialists and graders of retinal photographs, an automated approach involving a computer-based analysis of the fundus images would reduce the burden of the health systems in DR screening. In the recent past, there has been an increasing interest in the automated analysis algorithms that use artificial intelligence (AI)/machine learning/deep neural learning for analysis of retinal images in people with diabetes.[36,37] The machine after being exposed to a lot of annotated images learns to grade DR by itself. These software can automatically analyze retinal images and provide the grade and severity of DR and referral recommendations.[36-38]

The short time taken, accuracy, consistency, and scalability are the major advantages that make the role of AI in DR detection appear promising.[38] In the absence of a legal framework for use of AI in diabetic retinopathy screening in India, it is empirical for ophthalmologists to grade all those who are identified as referable by the AI algorithm and a subset of normal (10%) as identified by AI.

Data Capture and Maintenance of Registry

A variety of technologies are available for data communication and transfer. Tele- screening programs should determine specifications for transmission technologies best suited to their needs. The images and reports should be preferably be transmitted digitally via electronic picture archiving and communication systems (PACS); this eliminates the need for manual file transfer or retrieval. A PACS consists of four major components: the imaging instrumentation, a secured network for the transmission of patient information, workstations for interpreting and reviewing images, and archives for the storage and retrieval of images and reports. The universal format for PACS image storage and transfer is DICOM. To minimize errors, data communications should be compliant with DICOM standards. Digital images obtained by tele screening are typically stored locally on a PACS for rapid retrieval. Past images and reports should also be available for retrieval. Centralized or local software platforms for storage and analysis are gradually being replaced by cloud-based software. The AIOS task force recommends that images for screening be displayed on minimum 19" monitor validated for accuracy of clinical diagnosis. Images for grading must be non-compressed or lossless compressed (compressed images that can be reconstructed perfectly using algorithms) image files. The use of lossy compressed (irreversibly compressed) images and resized/resampled images is permitted after validation of their algorithms. The UK, Australia, New Zealand, and Canada have taken the lead in adopting models of chronic disease care.[39] In India, the first diabetes registry was set up in Goa as a public–private partnership, with the aim of population-based disease management.[40] As a part of National Programme for non-communicable disease, many of the states have NCD registers, which should be used to identify people with diabetes for screening DR. From 1990 to 2010, the visual impairment due to DR increased by 1.4 million (64%) worldwide.[41] An initiative to have a registry for DR in each state has to be considered as an input to strengthen the health system in each state to have a positive impact in decreasing visual impairment in people with diabetes.

Public Awareness

Public awareness is pivotal to the success of DR services. The continuous process of awareness creation should be conducted for the medical personnel, paramedical personnel, Non-Governmental Organizations (NGOs) and different partners. The following strategies can be adopted among the targeted group:

Performing Knowledge Attitude Practice (KAP) Studies are recommended to be carried out as one of the strategies to understand the level of awareness, beliefs, and practices about diabetes and DR to develop Information, Education and Communication (IEC) materials and strategies. AIOS recommends the development of IEC materials including pamphlets/brochures and posters in local languages. conveying key messages regarding the need for an annual dilated eye examination. The educational materials about diabetes and DR should be distributed during seminars, training programs, exhibitions, and guest lectures. Posters can be displayed at Primary Health Centres, Hospitals, and Diabetic clinics. Efforts should be done to organize mega diabetic fair and exhibitions/rally, awareness campaigns, media coverage during World Diabetes Day (November – 14). The various ways of creating public awareness are highlighted in Table 6.

Counseling sessions during screening camps and in the base hospital provide a perfect opportunity for awareness creation because of the one-on-one interaction between a counselor and a patient. This is a good time to provide specific and detailed information designed to increase knowledge, change attitudes, or alter incorrect practices.[29] The importance of orienting educational messages to each culture and society and to each group within each society is very important for the success of educational and outreach programs. Key steps include involvement of local populations in the local health care infrastructure, adaptation of the message to fit the needs and expectations of the target audience and the use of different modes of communication to reach as many different "market segments" as possible.[42]

Table 6: Ways to create Public Awareness

Approach	Method	Media
Mass	Press meeting Public meetings Public Announcements	Radio/Television Posters/Banners Newspaper Exhibition Chart
Group	Seminars Lectures/Presentations Patient Interactions Group Discussions.	PowerPoint Presentation Video Book/Pamphlet
Individual	Patient Education Counseling	Flip Chart Leaflet

Control of Risk Factors

It is important that as ophthalmologists, we ensure that all people with diabetes that we come across in our daily practice be told about DR and the risk factors of DR. The ophthalmologists should also ensure that the recommended optimal values of the risk factors be shared with the patients [Table 7]. Treatment of risk factors optimally can prevent development or reduce the progression of DR

Summary of the Consensus Statement

- Diabetic Retinopathy (DR) can occur in Type 1 and Type 2 diabetes. Increasing diabetes duration increases the risk for retinopathy
- Educate people with diabetes that early stages of DR are symptomatic and so screening for DR is essential.
- Routine, repetitive, life-long, expert, complete eye examination is essential for the fundamental ophthalmic care of all people with diabetes.
- Annual screening may be performed by telemedicine or by onsite fundus photography.
- Opportunistic screening for DR may be done in the community through camps, at diabetes clinics, medical laboratories but DR registry should be manitained for annual re-call.
- Fundus photography can be performed by trained eye technicians/optometrists and grading of DR can be performed by certified trained eye technicians/optometrists/ ophthalmologists.
- Women with pre-existing diabetes who are pregnant or planning a pregnancy should be counselled regarding the risk of development and/or progression of DR.
- If any level of DR is present at any examination including opportunistic screening, subsequent retinal assessment should be repeated at least annually or more frequently (in case of sight-threatening DR) as advised by the ophthalmologist.
- Prompt referral of patients with diabetic macular edema (DME), severe non-proliferative DR (NPDR) or

Table 7: Recommendations for treatment of Risk Factors

Parameter	Recommended value*	Evidence
Glycated Haemoglobin (HbA1c)[49,50]	6.5 - 7%	The Diabetes Control and Complications Trial (DCCT) in type 1 diabetes,[49] and the United Kingdom Prospective Diabetes Study (UKPDS) in type 2 diabetes.[50] The DCCT and the UKPDS have demonstrated that intensive glycemic control (HbA1c ≤7%) reduced both the development and progression of DR, with the beneficial effects of intensive glycemic control persisting for upto 10 to 20 years.
Blood Pressure (BP)[51,52]	Systolic BP: ≤130 mm of Mercury for those with Diabetic Retinopathy (DR) Systolic BP of <140 mmHg for those without DR and/or cardiac/renal complications of diabetes.	The UKPDS showed that, among patients with T2D, tight BP control (mean BP 144/82 mm Hg) resulted in a significant reduction in progression of DR (35%) as well as a decrease in significant visual loss and the need for laser photocoagulation compared to less tight control (mean BP 154/87 mmHg).[51]
Serum Lipid Levels[53]	Total cholesterol <200 mg/dl Serum Triglycerides <150 mg/dl Serum LDL (low density lipoprotein) cholesterol <100 mg/dl	The Fenofibrate Intervention and Event Lowering in Diabetes (FIELD) study found that requirement for first laser treatment for retinopathy was significantly lower in the group given 200 mg fenofibrate once daily.[53]

*Needs to be individualized

proliferative DR (PDR) to an ophthalmologist/retina specialist for further management of sight-threatening DR (STDR).
- The gold standard management of PDR is by pan-retinal laser photocoagulation and center involving DME is by intravitreal anti-VEGF agents and non-centre involving DME with focal laser therapy and regular follow-up is essential.
- Nationwide diabetes and DR registry is essential to ensure monitoring of compliance with referral and follow-up. Impact of DR screening and management on blindness can only be monitored by maintaining DR registry.
- Use Information technology to store fundus image data and application of artificial intelligence (AI) algorithms in DR detection could be way forward in telemedicine screening of DR.
- Good glycemic control and control of other systemic factors is beneficial in any stage of DR. It delays the onset and slows down the progression of DR.
- Diabetes, in general and DR, are generally life-long conditions. Regular follow-up care with a physician and an ophthalmologist is crucial for early detection of complications and benefit from timely treatment.

Conclusion

India has the second-largest population with diabetes next to China. The AIOS has completed several initiatives over the last few years to emphasize the need for DR screening in people with diabetes. This guidelines prepared by the AIOS task force committee and VRSI provide a framework for DR screening that is currently feasible in India.

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Conflicts of interest

There are no conflicts of interest.

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