Original Article

Eye care infrastructure and human resources for managing diabetic retinopathy in India: The India 11-city 9-state study

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ABSTRACT

Background: There is a paucity of information on the availability of services for diagnosis and management of diabetic retinopathy (DR) in India. **Objectives:** The study was undertaken to document existing healthcare infrastructure and practice patterns for managing DR. **Methods:** This cross-sectional study was conducted in 11 cities and included public and private eye care providers. Both multispecialty and stand-alone eye care facilities were included. Information was collected on the processes used in all steps of the program, from how diabetics were identified for screening through to policies about follow-up after treatment by administering a semistructured questionnaire and by using observational checklists. **Results:** A total of 86 eye units were included (31.4% multispecialty hospitals; 68.6% stand-alone clinics). The availability of a dedicated retina unit was reported by 68.6% (59) facilities. The mean number of outpatient consultations per year was 45,909 per responding facility, with nearly half being new registrations. A mean of 631 persons with sight-threatening-DR (ST-DR) were registered per year per facility. The commonest treatment for ST-DR was laser photocoagulation. Only 58% of the facilities reported having a full-time retina specialist on their rolls. More than half the eye care facilities (47; 54.6%) reported that their ophthalmologists would like further training in retina. Half (51.6%) of the facilities stated that they needed laser or surgical equipment. About 46.5% of the hospitals had a system to track patients needing treatment or for follow-up. **Conclusions:** The study highlighted existing gaps in service provision at eye care facilities in India.

Key words: Diabetes complications, diagnostic equipment, diabetic retinopathy, health facilities, human resources, India

Introduction

India is experiencing a rapid increase in the number of people with diabetes, and as the epidemic of diabetes matures the incidence of sight-threatening-diabetic retinopathy (ST-DR) is also likely to increase dramatically. Currently approximately 10% of the 65 million known diabetics are likely to have ST-DR, which means there are currently 6,500,000 diabetics who require a confirmatory diagnosis, treatment, and follow-up. Although much has been written about screening for DR in the middle- and low-income settings, including in India,[1-6] little has been

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Access this article online	
Quick Response Code:	Website: www.ijem.in
	DOI: 10.4103/2230-8210.179768

Cite this article as: Gilbert CE, Babu RG, Gudlavalleti AS, Anchala R, Shukla R, Ballabh PH, *et al.* Eye care infrastructure and human resources for managing diabetic retinopathy in India: The India 11-city 9-state study. Indian J Endocr Metab 2016;20:3-10.

published on the availability and quality of services for confirmatory diagnosis and treatment of ST-DR in these settings.[7]

The purpose of the study was to assess the availability of services for the diagnosis and management of DR in order to identify gaps that need to be addressed, and to ascertain whether facilities included in the study are engaged in screening for DR. Large eye care facilities in the largest cities in India were purposely selected for the study.

Methods

The study was a cross-sectional, hospital-based survey, and was conducted in 11 cities in 9 states across India. Sampling entailed a two-stage process wherein cities were first stratified based on their population (more than or <7 million). Cities to be included in the study were identified by ranking all cities in India in descending order of population size (2011 census) and the 10 most populated cities were first selected. As only one city (Kolkata) from eastern India was ranked in the most populous cities in the country from the eastern part of India, it was decided to include an additional city from the region to provide adequate representation to the eastern part of India. Therefore the twin cities of Bhubaneshwar and Cuttack were included in the study. Thus 11cities were finally covered.

The 11 cities were Ahmedabad, Bengaluru, Bhubaneshwar, Chennai, Delhi, Hyderabad, Jaipur, Kolkata, Mumbai, Pune, and Surat.

In each city, public and private providers for eye care services were identified. The size of the facility (number of beds) was taken into consideration in classifying the facilities as "large" (dedicated eye hospitals/general hospitals with an eye facility [20 or more bedded hospital with functioning ophthalmic superspecialty services, hospitals with satellite facilities, eye care departments in General Hospitals]) or "small" (individual eye care practitioners or eye hospitals with <20 eye beds) for inclusion in the study.

Prior permission was taken from the hospital administrators at the clinic/facility. At each facility semistructured interviews were conducted with the eye care provider representative who was either the head of the institution/eye department or a senior member of staff nominated by the head of the institution. Each of the six elements of the World Health Organization's framework for health systems was evaluated, i.e., number of staff and their skills; availability of infrastructure, equipment, laboratories and medication; whether clinical guidelines and protocols were available as well as information for patients. All interviews were audio-recorded after seeking permissions from the responding providers.

Information was collected on the processes used in all steps of the program, from how diabetics were identified for screening through to policies about follow-up after treatment. Multiple approaches were used to assess parameters such as collaboration and partnerships, financial sustainability, comprehensiveness and responsiveness of services; referrals between eye care and diabetic care, and the coverage of programs.

Data collection teams

Five dedicated teams were constituted for data collection. All teams were first trained at the Indian Institute of Public Health (IIPH), Hyderabad, for 3 days. Mock interviews were conducted by the team members followed by a pilot at two locations in Medak District, Telangana State. Each team consisted of a public health specialist/senior researcher from IIPH, a trained interviewer and two research assistants.

Data were entered into an access-based software package specially developed for the study and were cleaned before analysis. Stata 12 SE for Windows (Stata Corp, 4905 Lakeway Drive, Texas, US) was used for statistical analysis. Frequencies of the variables were tabulated. *t*-test was used for continuous variables and Chi-square was used for categorical variables. Results were adjusted for age, gender, education, type of city, and type of healthcare sector (public or private).

Details of the methodology used in the study have been published as a companion article.

Results

A total of 86 eye units were visited and information collected regarding available human resources, outpatient consultations and number of treatments, training needs and practices in relation to DR. About 68.6% (59) were stand-alone eye hospitals/clinics whereas 31.4% (27) were eye units located in multispecialty hospitals. Almost 60.5% (52) eye units were located in larger cities (7 million population and above) and 39.5% (34) were in smaller cities (population <7 million). Almost three quarters (73.3%) were private-funded eye units (both for profit and not-for-profit) and the remaining 26.7% (23) being public-funded. Almost half (48.8%, 42) were teaching institutions with ophthalmology residency and/or fellowship training. Around 68.6% of eye institutions had a dedicated retina clinic. This was significantly higher in stand-alone eye hospitals compared to eye units in multispecialty facilities (78% vs. 48.1%; $\chi^2 = 7.6463$; $P = 0.006$).

The availability of a dedicated retina unit was reported by 68.6% (59) facilities. This was significantly higher in stand-alone eye facilities compared to multispecialty facilities (78.0% vs. 48.1%; $\chi^2 = 7.65$; $P = 0.006$).

Patient load

The mean number of outpatient consultations per year was 45,909 per responding facility, with nearly half being new registrations [Table 1]. A mean of 631 persons with ST-DR were registered per year per facility. However, only 34.9% (30) eye units provided information related to clients with ST-DR seen at the facilities. The commonest treatment for ST-DR was laser photocoagulation (mean of 511 treatments per year per facility). Mean outpatient consultations were higher in teaching hospitals, bigger cities, private-funded hospitals and stand-alone eye hospitals. Similar trends were observed with all other parameters.

A quarter of the facilities stated that they have a waiting list for laser for DR ($n = 21$; 24.4%). The waiting list was significantly longer in teaching hospitals compared to nonteaching hospitals (38.1% vs. 11.4%; $\chi^2 = 8.32$; $P = 0.004$), multispecialty hospitals compared to stand-alone eye hospitals (71.2% vs. 40.7%; $\chi^2 = 7.26$; $P = 0.007$), public-funded compared to private-funded hospitals (47.8% vs. 15.9%; $\chi^2 = 9.32$; $P = 0.002$) and hospitals with a dedicated retina unit compared to those without a dedicated retina unit (32.2% vs. 7.4%; $\chi^2 = 6.17$; $P = 0.013$). The mean waiting time was 4 weeks (range 2–6 weeks). Waiting time was only reported by 15% (13) of the facilities.

Table 1: Annual performance statistics reported by responding eye care facilities

Parameter	Facilities with data	Mean per year per facility (range)
Total outpatient registrations/year	79	45,909 (50-323,730)
Mean new outpatient registrations/year	72	22,330 (30-286,154)
Average ST-DR registered/year	30	630.6 (10-5,000)
Inpatient beds/institution	77	50.8 (2-557)
Cataract surgeries/year	77	3879.7 (30-41,763)
Diabetic patients treated with one or more sessions of laser/year	52	511.0 (5-3,500)
Average vitreoretinal surgeries/year	48	261.0 (5-2,637)
Diabetic patients given intravitreal injections/year	56	301.2 (3-3,500)

ST-DR: Sight-threatening-diabetic retinopathy

Human resources

Data were provided by 64 facilities on the number of retina specialists (including part-time consultants) at their institution (Mean: 2.9 retina specialists/per reporting facility). Only 50 facilities reported having a full-time retina specialist (Mean: 3.5 full-time retina specialists per reporting facility). Facilities in larger cities (≥7 million population) and privately funded facilities had a higher mean number of retina specialists. Almost 15% (13) of facilities reported that they had residency training programs in ophthalmology, training from 1 to 35 residents per year.

More than half the eye care facilities (47; 54.6%) reported that their ophthalmologists would like further training in retina; 42/47 (89.4%) needed training in medical retina while 5 (10.6%) wanted training in vitreo-retinal surgery. The expressed need for training in medical retina was significantly higher among public-funded than private-funded facilities (69.6% versus 41.3%; $\chi^2 = 5.39$; $P = 0.02$), eye clinics in multispecialty hospitals compared to stand-alone eye hospitals (74.1% vs. 37.3%; $\chi^2 = 10.03$; $P = 0.002$) and in hospitals where there was no dedicated retina unit (66.7% vs. 40.7%; $\chi^2 = 5.01$; $P = 0.02$) on univariate analysis [Table 2]. However, after adjusting for variables which were found to be significant in univariate analysis, none of the associations remained statistically significant.

Table 2: Need for training of ophthalmologists, focusing on training in medical retina

Parameter	*N*	%	Chi; *P* value	Adjusted OR	95% CI
Expressed need for training in medical retina					
Type of city					
Smaller cities (≤7 million population) (34)	17	50.0		-	-
Larger cities (> 7 million population) (52)	25	48.1	χ^2=0.03; P=0.86	-	-
Type of sector					
Private funded clinics/hospitals (63)	26	41.3		1.0	
Public funded clinics/hospitals (23)	16	69.6	χ^2=5.39; P=0.02	1.7	0.1-1.3
Type of facility					
Stand-alone eye clinic/hospital (59)	22	37.3		1.0	
Multispecialty clinic/hospital (27)	20	74.1	χ^2=10.0; P=0.002	2.66	0.74-9.52
Teaching Status					
Teaching institution (42)	22	52.4			
Non-teaching institutions (44)	20	45.4	χ^2=0.41; P=0.52		
Availability of a dedicated retina unit					
Dedicated retina unit (59)	24	40.7		1.0	
Absence of dedicated retina unit (27)	18	66.7	χ^2=5.01; P=0.02	2.32	0.78-7.0

CI: Confidence interval

A high proportion of the eye care facilities had nursing personnel trained in ophthalmology [Table 3]. However, the availability of other human resources was inadequate with only 4 out of every 10 facilities employing staff qualified in low vision care and a counselor, while around a third had a trained retinal photographer. Qualified low vision personnel were more likely to be present in stand-alone facilities compared with multispecialty facilities ($\chi^2 = 17.46$; $P < 0.001$), teaching facilities compared to nonteaching institutions ($\chi^2 = 5.58$; $P = 0.02$) and in privately funded facilities compared to public-funded institutions ($\chi^2 = 6.41$; $P = 0.01$). Trained retinal photographers were more likely to be present in stand-alone compared to multispecialty institutions ($\chi^2 = 14.0$; $P < 0.001$), while qualified counselors were more likely to be present in private compared to public-funded facilities ($\chi^2 = 11.5$; $P = 0.001$) and stand-alone eye hospitals compared to multispecialty hospitals ($\chi^2 = 16.35$; $P < 0.001$). Trained optometrists were more likely to be present in larger cities compared to smaller cities ($\chi^2 = 7.01$; $P = 0.008$) whereas equipment technicians were more likely to be present in the private-funded facilities compared to public-funded facilities (47.6% vs. 17.4%; $\chi^2 = 6.44$; $P = 0.01$).

Equipment for diagnosis and treatment

Standard ophthalmic equipment, such as indirect ophthalmoscopes, was available in all facilities, but equipment for the diagnosis and management of ST-DR were not available in all facilities [Table 4]. Facilities for fundus fluorescein angiography were more likely to be present in stand-alone eye care facilities than multispecialty hospitals ($\chi^2 = 5.10$; $P = 0.02$), teaching versus nonteaching facilities ($\chi^2 = 10.66$; $P = 0.001$) and if there was a dedicated retina unit ($\chi^2 = 15.52$; $P < 0.001$). Functional lasers for treating DR were significantly higher in stand-alone facilities compared to multispecialty hospitals ($\chi^2 = 12.0$; $P = 0.001$) and in hospitals with a dedicated retina unit ($\chi^2 = 20.67$; $P < 0.001$). Differences in the availability

Table 3: Human resource availability at eye clinics

Parameter	N	%	Chi; P value
Nurses trained in ophthalmology	70	81.4	
General trained nurses	16	18.6	
Trained qualified low vision skilled personnel	38	44.2	
Eye unit in multispecialty hospital (27)	3	11.1	χ^2=17.46; P<0.001
Stand-alone eye units (59)	35	59.3	
Teaching facilities (42)	24	57.1	
Non-teaching facilities (44)	14	31.8	χ^2=5.58; P=0.02
Private-funded (63)	33	52.4	χ^2=6.41; P=0.01
Public-funded (23)	5	21.7	
Personnel trained in retinal photography	31	36.0	
Multispecialty hospital (27)	2	7.4	χ^2=14.0; P<0.001
Stand-alone eye units (59)	29	49.1	
Fully qualified counselors available	37	43.0	
Private-funded (63)	20	31.7	χ^2=11.5; P=0.001
Public-funded (23)	3	13.0	
Multispecialty hospital (27)	3	11.1	χ^2=16.35; P<0.001
Stand-alone eye units (59)	34	57.6	
Fully qualified optometrist	70	81.4	
Smaller cities (≤ 7 million) (34)	23	67.6	χ^2=7.01; P=0.008
Larger cities (> 7 million) (52)	47	90.4	
Trained equipment technician	34	39.5	
Public funded facilities (23)	4	17.4	χ^2=6.44; P=0.01
Private-funded facilities (63)	30	47.6	

Table 4: Availability of fully functional equipment at eye facilities

Type of fully functional equipment	N (n=86)	%	Chi; P value
Indirect ophthalmoscope	85	98.8	
FFA facility available	67	77.9	
Stand-alone eye facility (59)	50	84.7	χ^2=5.10; P=0.02
Multispecialty hospitals (27)	17	63.0	
Teaching hospital (42)	39	92.9	χ^2=10.66; P=0.001
Non teaching (44)	28	63.6	
Dedicated retina clinic (59)	53	89.8	χ^2=15.52; P<0.001
No dedicated retina clinic (27)	14	51.8	
Laser facilities available	65	75.6	
Stand-alone eye facilities (59)	51	86.4	χ^2=12.0; P=0.001
Multispecialty hospitals (27)	14	51.8	
Dedicated retina clinic (59)	53	89.8	χ^2=20.67; P<0.001
No dedicated retina unit (27)	12	44.4	
Functional AB scan available	76	88.4	
Larger cities (52)	49	94.2	χ^2=4.39; P=0.04
Smaller cities (34)	27	79.4	
Dedicated retina clinic (59)	58	98.3	χ^2=18.04; P<0.001
No dedicated retina unit (27)	18	66.7	
Functional fundus camera available	67	77.9	
Stand-alone eye facilities (59)	50	84.7	χ^2=5.51; P=0.02
Multispecialty hospitals (27)	17	63.0	
Teaching hospital (42)	39	92.9	χ^2=10.66; P=0.001
Non teaching (44)	28	63.6	
Dedicated retina clinic (59)	53	89.8	χ^2=15.52; P<0.001
No dedicated retina unit (27)	14	51.8	
Functional OCT available	56	65.1	
Public funded facilities (23)	8	34.8	χ^2=12.72; P<0.001
Private-funded facilities (63)	48	76.2	
Stand-alone eye facilities (59)	49	83.1	χ^2=26.61; P<0.001
Multispecialty hospitals (27)	7	25.9	
Dedicated retina clinic (59)	47	79.7	χ^2=26.61; P<0.001
No dedicated retina unit (27)	9	33.3	
Set of contact lenses for laser available	66	76.7	
Teaching hospital (42)	37	88.1	χ^2=5.92; P=0.015
Non teaching hospital (44)	29	65.9	
Public funded facilities (23)	14	60.9	χ^2=4.43; P=0.04
Private-funded facilities (63)	52	82.5	
Stand-alone eye facilities (59)	52	88.1	χ^2=13.66; P<0.001
Multispecialty hospitals (27)	14	51.9	
Dedicated retina unit (59)	54	91.5	χ^2=23.0; P<0.001
No dedicated retina unit (27)	12	44.4	
Functional VR surgery facilities	55	63.9	
Teaching hospital (42)	32	76.2	χ^2=5.33; P=0.02
Non teaching (44)	23	52.3	
Stand-alone eye facilities (59)	45	76.3	χ^2=12.37; P<0.001
Multispecialty hospitals (27)	10	37.0	
Dedicated retina unit (59)	46	78.0	χ^2=16.0; P<0.001
No dedicated retina unit (27)	9	33.3	

OCT: Optical coherence tomography, FFA: Fluorescein fundus angiography, VR: Vitreo-retinal, AB: AB ultrasound scan - A stands for amplitude scan and B stands for brightness scan of functional AB scans were statistically significant when comparing larger cities to smaller cities (χ^2 = 4.39; P = 0.04) and facilities where a dedicated retina unit was available (χ^2 = 18.04; P < 0.001). Significantly higher availability of functional fundus cameras was observed in the stand-alone eye facilities (χ^2 = 5.51; P = 0.02), teaching hospitals (χ^2 = 10.66; P = 0.001) and where dedicated retina units were located (χ^2 = 15.52; P < 0.001). Similar differences between types of eye care facilities were also observed with optical coherence tomography (OCT), the availability of a set of contact lenses for laser treatment and VR surgery facilities. Overall functional equipment status was better in stand-alone eye hospitals, teaching hospitals, private-funded hospitals and hospitals with a dedicated retina unit [Table 4].

Half (51.6%) the facilities stated that they needed laser or surgical equipment to increase the treatment options they could provide with the need being significantly higher in multispecialty hospitals than in stand-alone eye hospitals (85.2% vs. 35.6%; χ^2 = 18.23; P < 0.001), larger cities compared to smaller cities (61.5% vs. 35.3%; χ^2 = 5.67; P = 0.02) and public-funded compared to private-funded hospitals (78.3% vs. 41.3%; χ^2 = 9.23; P = 0.002).

Available treatment modalities for DR were also assessed [Table 5]. Significant differences were observed between stand-alone eye hospitals and multispecialty hospitals, teaching and nonteaching hospitals, private- and public-funded hospitals for different treatment modalities offered. Comprehensive retina treatment services were significantly better in hospitals with a dedicated retina unit (χ^2 = 13.33; P < 0.001), stand-alone eye hospitals (χ^2 = 7.27; P = 0.007), and teaching compared to nonteaching hospitals (χ^2 = 7.37; P = 0.007).

Systems, procedures, and protocols

Nearly half the hospitals (n = 40; 46.5%) had a system to track patients needing treatment or for follow-up. Better tracking systems were reported by stand-alone versus multi-specialty hospitals (62.7% vs. 11.1%; χ^2 = 19.8; P < 0.001) and by private- versus public-funded facilities (57.1% vs. 17.4%; P = 0.001).

Hospitals were asked to comment on the proportion of persons with diabetes who completed a complete course of laser. Among those who responded (68), 77.9% (53) stated that ≥75% completed the full course, the pattern being similar in all types of hospitals. Among the 72 facilities which responded on the proportion of diabetics treated with laser coming back for a follow-up 72.25% (52), stated that ≥75% of persons who received laser generally attend for the follow-up after laser. There were no significant differences between different facilities in this regard also.

Less than a quarter (23.3%) of the facilities performed routine glycosuria testing on adult patients [Table 6]. This was a more common practice in eye units in multispecialty hospitals than in stand-alone eye hospitals (37% vs. 16.0%; χ^2 = 4.19; P = 0.04) and in public- versus private-funded hospitals (43.5% vs. 15.9%; χ^2 = 7.19; P = 0.007). A higher proportion (45.3%, 30) routinely measure glycosylated hemoglobin (HbA1C) on all persons with diabetes with 17.4% only testing those with DR. Nonteaching hospitals were more likely to test HbA1C levels compared to teaching hospitals (47.7% vs. 26.2%; χ^2 = 4.27; P = 0.04) with no other significant differences by hospital type. Less than a quarter of facilities (23.3%) stated that printed protocols on indications for treatment of DR were available in outpatient clinics.

Table 5: Availability of treatment facilities at eye hospitals

Treatment available	Frequency (n=86)	%	Chi; P value
Laser photocoagulation	68	79.1	
Public-funded (23)	14	60.9	χ^2=6.28; P=0.01
Private-funded (63)	54	85.7	
Dedicated retina clinic (59)	55	93.2	χ^2=22.74; P<0.001
No dedicated retina clinic (27)	13	48.1	
Teaching hospitals (42)	37	88.1	χ^2=4.04; P=0.04
Non-teaching hospitals (44)	31	70.4	
Stand-alone eye hospital (59)	53	89.8	χ^2=13.15; P<0.001
Multispecialty hospital (27)	15	55.6	
Anti-VEGF preparations	70	81.4	
Public-funded (23)	15	65.2	χ^2=5.42; P=0.02
Private funded (63)	55	87.3	
Dedicated retina clinic (59)	56	94.9	χ^2=22.68; P<0.001
No dedicated retina clinic (27)	14	51.8	
Triamcinalone or other IV steroid	72	83.7	
Dedicated retina clinic (59)	55	93.2	χ^2=12.44; P<0.001
No dedicated retina clinic (27)	17	63.0	
Uncomplicated vitrectomy	54	62,8	
Teaching hospitals (42)	32	76.2	χ^2=6.31; P=0.01
Non-teaching hospitals (44)	22	50.0	
Dedicated retina clinic (59)	45	76.3	χ^2=14.62; P<0.001
No dedicated retina clinic (27)	9	33.3	
Stand-alone eye hospital (59)	43	72.9	χ^2=8.19; P=0.004
Multispecialty hospital (27)	11	40.7	
Complex VR surgery	55	63.9	
Stand-alone eye hospital (59)	44	74.6	χ^2=9.20; P=0.002
Multispecialty hospital (27)	11	40.7	
Dedicated retina clinic (59)	46	78.0	χ^2=16.01; P<0.001
No dedicated retina clinic (27)	9	33.3	
All retina treatment facilities provided	53	61.6	
Dedicated retina clinic (59)	44	74.6	χ^2=13.33; P<0.001
No dedicated retina clinic (27)	9	33.3	
Stand-alone eye hospital (59)	42	71.2	χ^2=7.27; P=0.007
Multispecialty hospital (27)	11	40.7	
Teaching hospitals (42)	32	76.2	χ^2=7.37; P=0.007
Non-teaching hospitals (44)	21	47.7	

VEGF: Vascular Endothelial Growth Factor, VR: Vitreo Retina

Patient information sheets on DR were available in 50% of hospitals [Table 6] being more likely in stand-alone than multispecialty hospitals (67.8% vs. 11.1%; $\chi^2 = 23.8$; $P < 0.001$), private-funded compared to public-funded hospitals (63.5% vs. 13%; $\chi^2 = 17.15$; $P < 0.001$) and hospitals with a dedicated retina unit compared to hospitals without (57.6% vs. 33.3%; $\chi^2 = 4.37$; $P = 0.04$). Access to records from the diabetic physicians was stated to be poor with only 39.5% stating that they had good access.

Outreach activities for diabetic retinopathy

Over a third of the 86 hospitals (38.4%) stated that they provided outreach screening for DR [Table 7], and many used more than one approach. There were no significant differences between the private-funded and public-funded facilities in this regard (41.3% vs. 30.4%; $\chi^2 = 0.84$; $P = 0.4$). In over half of these facilities, screening entailed clinical examination by ophthalmologists in eye camps. Only three facilities used an approach where retinal photography/digital imaging was performed by a nonophthalmologist with on the spot interpretation. All the other screening approaches were dependent on ophthalmologists either to take and/or remotely interpret images via telemedicine mechanisms. About a quarter of the facilities engaged in outreach undertook mass media campaigns to increase awareness of DR.

Discussion

In this study, the largest cities in India were purposively selected, as were the facilities in each city, in order to provide a snap shot of services for the management of ST-DR. These locations were selected for two broad reasons: Firstly, the prevalence of diabetes and rates of ST-DR among diabetics is higher in urban areas than in rural communities, and hence the need for eye care for diabetic eye disease is, therefore, greater. Second, concentrating data collection in 11 locations was feasible from a logistical point of view. However, the findings are likely to be biased, and will not reflect the level of service delivery in smaller cities and in rural areas. Our study is likely to reflect the best of what is currently available, acknowledging that services for diagnosis and treatment of ST-DR are likely to be less good in smaller cities and rural areas, even in training institutions.[8]

A need for training, particularly in medical retina, was acknowledged by half the providers, particularly in facilities in the public sector. Expertise within India to support this capacity building already exists, and funding is available from the National Control of Blindness Programme as well as external funders such as the International Council of Ophthalmology. Increasing the number of ophthalmologists skilled in medical retina

Table 6: Practice patterns at eye facilities

Practices	Frequency (*n*=86)	%	Chi; *P* value
Routine urine testing for glycosuria of all adults	20	23.3	
Stand-alone eye hospital (59)	10	16.9	χ^2=4.19; *P*=0.04
Multispecialty hospital (27)	10	37.0	
Public-funded (23)	10	43.5	χ^2=7.19; *P*=0.007
Private funded (63)	10	15.9	
HbA1c testing			
Routine for all known diabetes	30	45.3	
Only patients with diabetic retinopathy	15	17.4	
Printed protocols available in OPD			
On indications for treatment of diabetic retinopathy	20	23.3	
For laser treatment of diabetic retinopathy	9	10.5	
Patient information sheets available	43	50.0	
Stand-alone eye hospital (59)	40	67.8	χ^2=23.8; *P*<0.001
Multispecialty hospital (27)	3	11.1	
Public-funded (23)	3	13.0	χ^2=17.15; *P*<0.001
Private funded (63)	40	63.5	
Dedicated retina clinic (59)	34	57.6	χ^2=4.37; *P*=0.04
No dedicated retina clinic (27)	9	33.3	
Referral patterns			
Regular referrals from general practitioners/physicians	68	79.1	
Regularly refer to physicians for diabetic management	64	74.4	
Stand-alone eye hospital (59)	48	81.4	χ^2=4.75; *P*=0.03
Eye unit in multispecialty hospital (27)	16	59.3	
Records			
Eye personnel can access physician records	34	39.5	

HbA1c: Glycated hemoglobin, OPD: Out patient department

Table 7: Outreach services provided by eye hospitals for diabetic retinopathy

Parameter	*N*	%
Provide outreach services for diabetic retinopathy	33	38.4
Start with identification of persons with diabetes		
Conduct house-to-house survey to identify diabetics who are then examined	5	15.2
Screening using a camp approach		
Clinical examination by an ophthalmologist	19	57.6
Retinal imaging with interpretation at the site	9	27.3
Retinal imaging with interpretation via tele-ophthalmology	5	15.2
Screening in static facilities such as vision centres		
Clinical examination by an ophthalmologist	5	15.2
Retinal imaging by vision centre staff with interpreted by them	3	9.1
Retinal imaging by vision centre staff with interpretation via tele-ophthalmology	5	15.2
Screening in a physician's clinic		
Ophthalmologist visits and conducts clinical examination	10	30.3
Retinal photography/imaging with interpretation on the site	7	21.2
Retinal imaging by physician staff and interpretation via tele-ophthalmology	4	12.1
Mass media educational campaigns	9	27.3

may help to reduce waiting lists and waiting times for laser treatment. Consideration could also be given to training senior ophthalmic nurses in giving intravitreal injections, as this is now practiced as a means of meeting the demands of repeat treatment of age related macular degeneration in high-income settings.[9,10] Facilities for surgical treatment of complex cases were available in almost two thirds of the eye units, with three quarters of teaching hospitals being able to provide this level of care. Overall, there was a lower need for training ophthalmologists in VR surgery which may reflect the fact that some facilities were relatively small.

A high proportion of facilities were able to provide laser treatment and intravitreal injections for clinically significant macular edema, both being lower in public- than in private-funded institutions. Three quarters of the teaching hospitals were able to provide all forms of treatment for ST-DR. OCT machines were only available in two-thirds of facilities, which will need to be addressed as diabetic macular edema is the commonest form of ST-DR requiring treatment. Ideally all teaching hospitals should have the capacity to provide the full range of treatment for DR so that all graduating ophthalmologists have the opportunity to gain skills in the diagnosis and management of ST-DR which will become an increasing problem in the decades to come.

In terms of other cadres of eye healthcare workers, there was a shortage of low-vision therapists, counselors and personnel trained in retinal photography across all types of facilities. These allied professional health workers can play a vital role in services for people with ST-DR, particularly counselors, as compliance with lifestyle modification, medication, treatment and regular follow-up is a challenge on all chronic diseases, including DR, although evidence of effectiveness is limited in relation to dietary modification,[11] with more evidence of impact on adherence to medication.[12] Counselors could also support diabetic patients to take up yoga, which leads to better health outcomes in India compared to walking.[13] Equipment technicians are also important members of the eye care team, particularly in centers offering advanced surgery which requires complex and expensive equipment. Equipment technicians were generally lacking in public-funded institutions, an issue that needs to be urgently addressed.

Other elements of the health system that require strengthening are health management information systems, particularly in the public sector, which will allow better tracking of patients with ST-DR. There is a need for developing/adapting standard guidelines for diagnosis of DR needing treatment, protocols for laser treatment and intravitreal therapies, and educational materials for diabetic patients with DR. The recently convened National Diabetic Retinopathy Task Force by the Government of India could play a role in supporting the development and dissemination and protocols, guidelines, and information for patients.

Outreach activities

Outreach activities for the detection of DR were being implemented by just over a third of the facilities included in the study, being more frequent among private providers. However, in over half of these initiatives clinical examination by an ophthalmologist was the modality being used to detect DR, and in all but three facilities ophthalmologists were engaged in interpreting retinal images taken by other cadres. However, using highly skilled ophthalmologists to detect ST-DR is not a good use of their time, particularly as there is a considerable body of evidence that nonophthalmologists can be trained to take and interpret retinal images with high levels of competence.[14-16] This approach was only being used by three facilities in this study. Indeed, in the United Kingdom's national program for DR, retinal images are taken and interpreted by trained nonphysician technicians, who have been shown to be better at detecting milder forms of DR than clinicians.[17,18] Another limitation highlighted in this study is the lack of engagement with physicians and endocrinologists in screening, as most activities did not entail joint planning, implementation or monitoring of screening.

Conclusion

Tackling the increasing threat of ST-DR will require extensive changes to eye healthcare systems, as well as greater engagement with physicians and endocrinologists, and patients. This will be a challenge in India where the emphasis has rightly been on scaling up highly cost effective, once-off interventions such as cataract surgery and correction of refractive errors, which remain the commonest causes of blindness and visual impairment. However, as the epidemic of diabetes matures, the incidence of visual loss from DR will increase, putting at risk the sight of those who are economically productive as well as the elderly. If only 0.5% of diabetics become blind each year (i.e., one in 20 of those with ST-DR), then DR has the potential to overtake cataract as the commonest cause of blindness, particularly among those of working age.

Financial support and sponsorship

The study was supported by a grant from the Queen Elizabeth Diamond Jubilee Trust, London, UK.

Conflicts of interest

There are no conflicts of interest.

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