

Screening for diabetic retinopathy in primary care with a mobile fundal camera – evaluation of a South African pilot project

Bob Mash, Di Powell, Felicity du Plessis, Unita van Vuuren, Margaret Michalowska, Naomi Levitt

Background and aims. In South Africa diabetes makes a significant contribution to the burden of disease. Diabetic retinopathy is a leading cause of adult blindness, and screening can reduce the incidence. This project aimed to implement and evaluate a new service for retinal screening that uses a non-mydratic mobile fundal camera in primary care. This is the first time such a service has been evaluated in an African primary care context.

Methods. The service was implemented as an operational research study at three community health centres and data were collected to evaluate the operational issues, screening, reporting and referral of patients.

Results. Out of 400 patients screened 84% had a significantly reduced visual acuity, 63% had retinopathy (22% severe non-

proliferative, 6% proliferative and 15% maculopathy), 2% of eyes could not be screened and 14% of patients required dilatation. Referral was necessary in 27% of cases for cataracts, in 7% for laser treatment and in 4% for other specialist services. Repeat photography was needed in 8% and urgent follow-up in 12%. A SWOT analysis of the pilot project was completed and recommendations were made on how to integrate it into the district health system.

Conclusion. Screening with a fundal camera improved the quality of care for diabetic patients and is feasible in the South African public sector, primary care setting. A single technician should be able to photograph almost 10 000 patients a year.

S Afr Med J 2007; 97: 1284-1288.

Division of Family Medicine and Primary Care, Department of Interdisciplinary Health Sciences, Stellenbosch University, Tygerberg, W Cape

Bob Mash, MB ChB, MRCP, DRCOG, DCH, PhD

Eye Care Services, Cape Town Metropolitan District Health Services

Di Powell, Dip Mid, Dip Opth, Dip Gen Nur

Felicity du Plessis, BA Cur (Nurs), Dip Opth

Cape Town Metropolitan District Health Services

Unita van Vuuren, BA Cur (Nursing), Dip Psych, Dip Mid

Margaret Michalowska, MB ChB

Division of Endocrinology and Diabetes, Department of Medicine, University of Cape Town

Naomi Levitt, MD, FCP

Corresponding author: B Mash (rm@sun.ac.za)

In South Africa diabetes affects 5 - 10% of the adult population,¹ and in Cape Town it is estimated that 25 800 diabetic patients are known to the Metro District Health Services (MDHS). Out of this diabetic population 55% are likely to have retinopathy,² although only 11% have their eyes routinely examined.³ This is of concern because diabetic retinopathy is a leading cause of adult blindness and a third of patients already have retinopathy when type 2 diabetes is diagnosed.⁴ Retinopathy is asymptomatic until an advanced stage, and consequently screening for its presence is essential in order to identify eyes that would benefit from laser therapy.⁴ Screening for retinopathy can reduce the incidence of blindness.⁴



Although an annual review for all diabetics is recommended in the national guidelines,⁵ including testing of visual acuity and fundoscopy, this is not done to an acceptable degree. Ideally diabetic patients should be evaluated by an ophthalmologist, but given the capacity of the public health system and the financial constraints on patients, this is not feasible. As a result, the responsibility falls on the primary care services, where attempts to improve the rate of fundoscopy have largely been unsuccessful. Even when other aspects of the process of care have improved, fundoscopy has been resistant to improvement.⁶

When performed, the sensitivity of fundoscopy by primary care staff is quite low and even in the best of circumstances may be lower than the recommended standards for screening (sensitivity >80%, specificity >95% and technical failure <5%).⁷ Retinal photography has been shown to have a much better sensitivity⁷ and also compares favourably with examination by an ophthalmologist.⁸

Screening by retinal photography has been shown to be acceptable to patients and an opportunity for motivation of better glycaemic control.⁹

Reporting of the images can be accurate in the hands of a well-trained doctor, who does not have to be a consultant ophthalmologist.¹⁰ The main aim in the primary care context is not necessarily to reach a specific diagnosis but to determine who does and does not require referral.

'Digital retinal imaging is now widely accepted as the screening method of choice ... The challenge remains to establish screening systems which are effective, robust and cost efficient in the circumstances of each health district.'⁴

This paper reports on the evaluation of such a pilot project in public sector primary health care centres within the Cape Town metropolitan district health services. This is the first time that photographic screening has been attempted in South African primary care, and indeed there are no published reports of similar initiatives in the sub-Saharan region.

Methods

Screening was piloted at three community health centres on the Cape Flats for a period of 3 months. One serves a predominantly black Xhosa-speaking community and the other two a predominantly coloured and Afrikaans-speaking community. The patients seen in these health centres are uninsured and come from low socio-economic backgrounds. Each health centre provides diabetic care through a special 'club' on a specific day once a week. The diabetic club is run by a professional nurse with support from one of the doctors.

The mobile camera (a Canon Digital Non-mydratic EOS-20D camera and associated equipment costing R180 000) was transported in a panel van and operated by a trained photographer who had previously been a community health

worker. The camera was set up in a darkened room at each health centre separate from the club room. The photographer was supervised by an ophthalmic nurse who also trained the club staff in performing visual acuity tests on the patients prior to screening. Screening was performed once a week on the same day as the diabetic club.

Photographs were assessed by a doctor with an ophthalmic background at the MDHS who used criteria based on the UK system¹¹ to complete a report and recommend further management. Only good-quality photographs were then assessed for retinopathy and maculopathy. Retinopathy was graded as:

- None
- Mild to moderate non-proliferative
- Severe non-proliferative
- Proliferative.

Inter-rater reliability with an expert ophthalmologist was performed on a random sample of 80 photographs.

A report on the assessment then recommended one of the following management options:

- Repeat photography due to poor quality
- Routine follow-up after 1 year
- Urgent follow-up after 6 months
- Referral for assessment and laser treatment
- Referral for other specialist assessment and non-laser treatment.

Patients who needed laser treatment were referred to a dedicated service for the project, which meant that the already over-burdened tertiary ophthalmology departments were not expected to absorb these patients. Patients with cataracts were referred to a local district hospital that offered cataract surgery.

The project team met on a 2-weekly basis to manage the project and reflect on the lessons learnt. At the end of the pilot the team conducted a review of the project's strengths, weaknesses, opportunities and threats (SWOT analysis).

Data were analysed in Statistica Version 7 by a consultant statistician. Nominal variables were compared across the three health centres using contingency tables and a *p*-value was obtained by the chi-square test. Continuous and ordinal data were compared using analysis of variance (ANOVA).

Results

The pilot project screened 400 patients over a period of 3 months, and once fully trained, the photographer was able to photograph 30 - 40 new patients a day. The majority were middle aged (58%), female (77%) and hypertensive (84%), and had had type 2 diabetes (97%) for a mean of 7.4 years (Table I). Of the patients 44% were black and 56% coloured; there were no white patients. The evaluation of patients when they



attended for the retinal screening in the health centre is shown in Table I.

The evaluation of the retinal photographs and the management recommendations are shown in Table II. Inter-rater analysis of the project doctor compared with a retinal expert showed a good contingency coefficient of 0.72, which represents high agreement.

Strengths

The project improved the quality of care, and in the MDHS annual audit the average rate of retinal screening at these three health centres improved from 18% to 42% after the pilot project.³ Staff reported that patients were more satisfied with the diabetic service and more positive that the 'clubs' were really trying to help them. Staff also reported that they felt more purposeful and had increased motivation to offer a better

service. The importance of the annual review was reinforced and staff gained skills in measuring visual acuity and detecting cataract.

The project's success relied on the availability of referral services for laser treatment and cataract surgery, outside of the established tertiary centres. It would have been unethical to identify patients if treatment was not available or accessible. The project's success was also supported by the non-government sector and community health workers who assisted with measuring visual acuities, organising patients for photography, recalling patients and transporting them to the referral centres.

Weaknesses

The commitment of some members of the chronic care teams to the retinal project was poor and varied between the health

Table I. Evaluation of diabetic patients during screening visit (N (%))

	Khayelitsha (N=158)	Retreat (N=130)	Elsies River (N=112)	All (N=400)	p-value
Patient's eyes dilated	31 (19.6)	21 (16.2)	3 (2.7)	55 (13.7)	0.000
Unable to screen one eye*	10 (3.2)	4 (1.5)	0 (0)	14 (1.7)	>0.05
Patient referred	47 (29.7)	43 (33.1)	26 (23.2)	116 (29.0)	0.227
Patient with cataract	57 (36.1)	51 (39.2)	33 (29.5)	141 (35.2)	0.269
Visual acuity readings	N=316	N=256	N=217	N=789	
6/6 - 6/9	47 (14.9)	17 (6.6)	64 (29.5)	128 (16.2)	0.000
6/12 - 6/18	172 (54.4)	100 (39.1)	72 (33.2)	344 (43.6)	
6/24 - 6/36	68 (21.5)	101 (39.5)	58 (26.7)	227 (28.8)	
≤6/60	29 (9.2)	38 (14.8)	23 (10.6)	90 (11.4)	

*N is doubled for 2 eyes per patient.

Table II. Evaluation of retinal photographs (N (%))

	Khayelitsha (N=158)	Retreat (N=130)	Elsies River (N=112)	All (N=400)	p-value
Poor quality photograph	34 (21.5)	19 (14.6)	17 (15.2)	70 (17.5)	0.984
Retinopathy	N=124	N=111	N=95	N=330	
None	39 (31.5)	45 (40.5)	39 (41.1)	123 (37.3)	0.033
Mild-moderate non-proliferative	34 (27.4)	39 (35.1)	36 (37.9)	109 (33.0)	
Severe non-proliferative	36 (29.0)	22 (19.8)	15 (15.8)	73 (22.1)	
Proliferative	12 (9.7)	5 (4.5)	3 (3.2)	20 (6.1)	
Other	3 (2.4)	0 (0)	1 (1.1)	4 (1.2)	
Maculopathy	27 (21.8)	10 (9.0)	13 (13.7)	50 (15.2)	0.021
Management plan	N=158	N=130	N=112	N=400	
Referred at screening visit for cataract	42 (26.6)	42 (32.3)	24 (21.4)	108 (27.0)	0.014
Repeat photograph	17 (10.8)	6 (4.6)	8 (7.1)	31 (7.8)	
Routine follow-up	52 (32.9)	57 (43.9)	56 (50.0)	165 (41.2)	
Urgent follow-up	20 (12.7)	16 (12.3)	14 (12.5)	50 (12.5)	
Refer for laser	14 (8.9)	7 (5.4)	8 (7.1)	29 (7.2)	
Refer to specialist	13 (8.2)	2 (1.5)	2 (1.8)	17 (4.3)	



centres. Although the project was theoretically reducing workload by taking away the club's responsibility to perform retinal screening, because screening was rarely done in practice this was not experienced as a decrease in workload. Chronic care teams struggled to organise patients and perform visual acuity tests, and therefore photography often started late in the morning. As a result of this experience the project developed a checklist of criteria that indicated 'readiness to screen' for future health centres.

The health centres sometimes lacked suitable space to set up the camera, and as the equipment was heavy and bulky it was not as mobile as originally anticipated. Transport in an ordinary vehicle was problematic and a panel van was eventually obtained.

The Optolite® software provided with the camera was designed for the stand-alone ophthalmologist and only captured basic patient identifiers. Transfer of data from the camera's laptop to the doctor's laptop was technically difficult and was not solved by the end of the pilot. Further IT problems were experienced by the initial failure to make regular back-up files.

The patients' postal addresses and telephone numbers were sometimes non-existent or unreliable, and outside of their visits to the health centre it was therefore difficult to recall them for repeat photography or referral.

The initial training in the use of the camera and software was too superficial and during the first 2 weeks of the project the photographer and ophthalmic nurse struggled to take quality photographs.

Threats

Staff were all seconded to the project from other duties or employed on a temporary locum basis. If the project is to become a part of the routine service, then posts for ophthalmic technicians and nurses need to be officially created.

The continuation and expansion of the project will be dependent on the commitment of the MDHS to incorporate the service into their official policy for chronic disease management. The MDHS are in the process of significant restructuring, and the ability of the organisation to incorporate new innovations during this process may be limited. The reluctance of funders to provide salaries in the short term and the lengthy process of policy formation and budgetary decision making by government could negate the momentum and motivation built up during the pilot.

Opportunities

The goals of the project are in line with those of the World Health Organization, the International Diabetes Foundation, and the national and provincial Departments of Health. The project's innovation and success could be replicated in other parts of the country and even other parts of Africa. The project

also offers the opportunity to train and employ new cadres of health workers – registered ophthalmic nurses and technicians.

Discussion

The pilot project has shown the feasibility of screening for diabetic retinopathy in South African urban primary care with a non-mydratic mobile fundal camera. The project has demonstrated improvement in the quality of care and confirmed the importance of screening as 63% of patients had some degree of retinopathy and 11% required immediate referral for laser and other specialist treatments. The value of performing visual acuity and a red reflex is also reinforced as 84% had significantly reduced readings, 35% had cataracts and 27% required referral prior to photography. Although the average duration of diabetes overall was only 7.4 years, the rates of ocular complications were high.

Several important lessons were learnt regarding the implementation of retinal screening in primary care. The high rate of poor-quality photographs was partly due to the large number of patients with cataracts who were still photographed even though many of them were referred for surgery. In future, patients who are referred for cataract will not be photographed as their retinas will be assessed at the referral centre and their photographs are often of poor quality. Another reason for initial poor quality was the learning curve of the ophthalmic staff in terms of operating the equipment. This project however concurs that it is feasible to train non-professional photographers to operate the camera.¹²

In expanding the pilot to the whole MDHS it is planned that the camera should be operated by only an ophthalmic technician, who ideally should also drive the transport. The preparation of patients, including visual acuity and cataract detection, will be the responsibility of the chronic care team and not the ophthalmic nurse. The ophthalmic nurse will manage the project, take responsibility for training the chronic care teams and supervise the screening system. The chronic care team must also administrate the report, counsel the patient and refer if recommended. If one camera and ophthalmic technician can screen 30 routine patients a day, in a week 150 would be screened; if screening is conducted for 48 weeks a year it would reach 7 200 patients. For every 30 routine patients a further 6 - 10 patients may need repeat photographs or urgent recall, and the technician would therefore need to see up to 40 patients a day in total or 9 600 a year. In Cape Town, with an estimated 25 770 diabetics, 4 camera-technician teams will therefore be required to perform an annual review on all patients.

In future it may be possible to train the ophthalmic nurse to interpret the photographs, and eventually the ophthalmic technician, who could then take the photograph and make an assessment at the same visit. The doctor would then only be required for treatment at the hospital. If this model is more



widely implemented there will be a need to create posts for ophthalmic technicians and to standardise and accredit their training at a national level. The model also points to the role of the ophthalmic nurse in managing the screening service as one aspect of their job description. Screening services must ensure sufficient access to laser and specialist treatment.

There remains a need to create or obtain affordable software capable of capturing photographs and transferring them via network or Internet to a central reporting and treatment centre. The software should also create reports for individual patients, facilities, districts and the project as a whole. In rural areas there may also be the potential to use satellite or telemedicine technology to export photographs to a central assessment centre, as has been demonstrated in India (<http://www.aravind.org>).

Ideally the camera should be set up in a mobile van that can be parked next to the health centre and photography performed within the van. Although this would solve the problem of insufficient space, lifting the equipment and to some extent security, the cost of this type of vehicle may be prohibitive.

It is hoped that the lessons learnt from this operational research will assist other districts with decision making regarding the feasibility of implementing retinal screening with a fundal camera.

The project was funded by a grant from the World Diabetes Foundation via Dr Tim Kedijang at NovoNordisk SA Ltd. The project is grateful to Dr James Rice from Ophthalmology at Groote Schuur Hospital for the inter-rater reliability testing and for his

expert support; to Dr Peter Clarke-Farr and Mr Michael Jowell at the Ophthalmic Sciences Department, Cape Peninsula University of Technology, for hosting the laser service; to Dr Rob Martell for managerial support at the MDHS; to Ms Zanele Majebe for taking the photographs; and to Professor Daan Nel at the Centre for Statistical Analysis at Stellenbosch University for analysing the data. The project also acknowledges the provision of cataract surgery from Eerste River District Hospital and the chronic care teams at Khayelitsha, Elsies River and Retreat Community Health Centres.

References

1. Motala A, Omar M, Pirie F. Epidemiology of type 1 and type 2 diabetes in Africa. *J Cardiovasc Risk* 2003; 10: 77-83.
2. Levitt N, Bradshaw D, Zwarenstein M, Bawa A, Maphumolo S. Audit of public sector primary diabetes care in Cape Town. *Diabetic Medicine* 1997; 14: 1073-1077.
3. Martell R, Van Vuuren U. Metro District Health Services Diabetic Audit 2005-7. Cape Town: Provincial Government Western Cape, 2007.
4. Taylor R. *Handbook of Retinal Screening in Diabetes*. Chichester: Wiley, 2006.
5. SEMSDA. Type II diabetes mellitus clinical guidelines at primary health care level. *S Afr Med J* 1997; 87: 493-512.
6. Mash B, Levitt N. Quality improvement in the care of people with diabetes in Khayelitsha. *S Afr Fam Pract* 1999; 20: 123-125.
7. Owens D, Gibbins R, Lewis P, Wall S, Allen J, Morton R. Screening for diabetic retinopathy by general practitioners: ophthalmoscopy or retinal photography as 35 mm colour transparencies? *Diabet Med* 2007; 15: 170-175.
8. Chia D, Yap E. Comparison of the effectiveness of detecting diabetic eye disease: diabetic retinal photography versus ophthalmic consultation. *Singapore Med J* 2004; 45: 276-279.
9. Eiser J, Eiser C, Riaz A, Taylor D, Hammersley S, Tooke J. Screening for diabetic retinopathy is well received by patients and may improve self-management intentions. *Diabet Med* 2001; 18: 835-841.
10. Carmichael G, Carp G, Welsh N, Kalk W. Effective and accurate screening for diabetic retinopathy using a 60 degree mydriatic fundal camera. *S Afr Med J* 2005; 95: 57-61.
11. Harding S, Greenwood R, Aldington S, et al., Diabetic Retinopathy Grading and Disease Management Working Party. Grading and disease management in national screening for diabetic retinopathy in England and Wales. *Diabet Med* 2003; 20: 965-971.
12. Maberley D, Morris A, Hay D, Chang A, Hall L, Mandava N. A comparison of digital retinal image quality among photographers with different levels of training using a non-mydriatic fundus camera. *Ophthalmic Epidemiol* 2004; 11: 191-197.