SCIENTIFIC REPORT

Biennial eye screening in patients with diabetes without retinopathy: 10-year experience

E Ólafsdóttir, E Stefánsson

Br J Ophthalmol 2007;**91**:1599–1601. doi: 10.1136/bjo.2007.123810

Aims: To evaluate the safety of every-other-year eye screening for patients with diabetes without retinopathy.

Methods: Since 1994, patients with diabetes without retinopathy in Iceland have received eye screening every other year. 296 patients with diabetes who had no diabetic retinopathy in 1994/95 were followed with biennial eye examinations until they had developed retinopathy. The 10-year experience of this approach is reviewed.

Results: Out of the 296 diabetic individuals, 172 did not develop diabetic retinopathy during the 10-year observation period. 96 patients developed mild non-proliferative retinopathy, six developed clinically significant diabetic macular oedema, 23 developed preproliferative retinopathy, and four developed proliferative diabetic retinopathy during the 10-year observation period. All the patients who developed macular oedema or proliferative retinopathy had already been diagnosed as having mild nonproliferative retinopathy and entered an annual screening protocol before the sight-threatening retinopathy developed. No patient had any undue delay in treatment.

Conclusion: Every other year screening for diabetic eye disease seems to be safe and effective in diabetics without retinopathy. Such an approach will reduce the number of screening visits more than 25%. This reduces health costs and strain on resources considerably and relieves the patients with diabetes from unnecessary clinic visits and examinations.

Iceland was the first country to initiate systematic screening for diabetic eye disease.[1] The programme started in 1980, with annual eye examinations of patients with diabetes.[2] Annual examinations have been the routine in most diabetic eye-screening programmes and recommended by most health authorities and ophthalmology organisations.[3–5]

A review of the first 10 years of diabetic screening in Iceland between 1980 and 1990 revealed that no patient had progressed from no retinopathy to sight-threatening retinopathy in less than 2 years.[6] We concluded, and reported, that it was adequate to examine patients with diabetes without retinopathy every other year and immediately introduced this routine into our screening system. We now examine the 10-year experience from 1995–2005, where, according to our screening protocol, patients with diabetes without retinopathy have been screened every other year. If they developed retinopathy, the screening protocol called for an immediate change to annual examinations.

MATERIAL AND METHODS

A total of 296 patients with diabetes in our screening system had no retinopathy when examined in 1994 and 1995 and were alive on 1 January 2005. Ninety-seven patients had type 1 diabetes mellitus, and 199 had type 2. One hundred and twenty of the patient-group were female, and 176 were male. The average age of the women was 62 years (range 19–90 years), and the average age of the men was 58 years (range 16–87 years). The average duration of diabetes mellitus was 18 years (table 1). In addition, 16 patients in the screening programme had diabetes mellitus and no retinopathy in 1994–1995, but died before 1 January 2005. Three of these patients developed mild nonproliferative retinopathy, and none developed sight-threatening retinopathy. The mean age of this group in 1994 was 67 years (range 38–76 years), and the mean duration of diabetes was 9 years (range 0–28 years).

The Icelandic diabetic population and our screening programme have been described in detail.[7 8] Data on visual acuity (VA), retinopathy grade, treatment and course of the disease were gathered from clinic files. Visual acuity was measured on a Snellen chart at 6 m with the best refractive correction. The retinopathy stage was determined by an ophthalmologist using slit-lamp examination of the fundus with a 90-diopter lens with dilated pupils. Colour photographs of the fundus were taken at each visit. The visual acuity of each patient was reported as the visual acuity of the better eye. Retinopathy level of each patient was determined as the stage of the worst eye. Table 1 lists clinical data including mean blood pressure, fasting blood glucose levels, glycosylated haemoglobin, cholesterol and triglycerides.

Eye screening was performed every other year while the patients had no retinopathy. Once they developed any retinopathy, the screening schedule went to annual examinations. More frequent eye examinations were scheduled for some patients based on the clinical judgement of the ophthalmologist.

RESULTS

Of the 296 patients, 172 remained without retinopathy for the 10-year period. Ninety-six patients developed mild nonproliferative retinopathy with microaneurysms and point haemorrhages. Six

Table 1 Characteristics of the participants in the study

	Diabetes population mean (SD)
Gender (male/female)	176/120
Diabetes duration (years)	18 (6.1)
Fasting whole blood glucose (mmol/l)	9.3 (2.6)
HbA_{1c} (%)	8.0 (1.6)
Total cholesterol (mmol/l)	5.1 (1.0)
HDL cholesterol (mmol/l)	1.36 (0.45)
Triglycerides (mmol/l)	1.73 (1.26)
Creatinine (μmol/l)	84 (26)
Systolic blood pressure (mm Hg)	135 (13)
Diastolic blood pressure (mm Hg)	81 (5)

Abbreviations: DME, diabetic macular oedema; PDR, proliferative diabetic retinopathy; VA, visual acuity

Table 2 Visual acuity in patients with sight-threatening diabetic retinopathy.

Patient	Diabetes type	Retinopathy grade	Visual acuity 1995	Visual acuity 2005
1	2	DME	1.0/1.0	0.25/0.13
2	2	DME	0.9/1.0	0.6/0.2
3	2	DME/PDR	1.0/1.0	0.5/0.1
4	1	DME/PDR	1.2/1.0	0.33/0.33
5	1	DME	0.7/1.0	0.7/1.0
6	2	DME	1.0/1.2	0.5/0.4
7	2	PDR	1.2/1.2	1.2/1.2
8	1	PDR	1.5/1.5	1.2/1.2

DME, diabetic macular oedema; PDR, proliferative diabetic retinopathy.

patients developed clinically significant diabetic macular oedema. Twenty-three patients developed preproliferative diabetic retinopathy with cotton-wool spots and intraretinal microvascular abnormalities. Four patients developed proliferative diabetic retinopathy during the 10-year period. In one patient with type 2 diabetes, the grade of retinopathy could not be determined from the clinical files at the end of the observation period.

The group of 172 patients who had no retinopathy during the entire period had 912 eye examinations, averaging 5.3 examinations each in 10 years. The 96 patients who had developed mild non-proliferative retinopathy had 631 examinations, on average 6.6 examinations in 10 years. The six patients who developed clinically significant diabetic macular oedema had a total of 67 visits, on average 11.2 visits in 10 years. The 23 patients who developed preproliferative diabetic retinopathy had 174 visits, on average 7.5 visits in 10 years, and the four patients who developed proliferative diabetic retinopathy had 61 visits, averaging 15 visits in 10 years.

No patient went from no retinopathy to sight-threatening retinopathy in less than 2 years. All patients who developed sight-threatening retinopathy had been diagnosed, before that happened, as having retinopathy and placed on at least an annual examination schedule.

Of the eight patients who, during the 10-year period, developed a sight-threatening retinopathy, four had macular oedema, and the other four had proliferative retinopathy, two of those also with macular oedema. Five out of the six patients with macular oedema suffered some reduction in visual acuity, whereas the two patients who had only proliferative retinopathy did not (table 2). All patients who developed clinically significant diabetic macular oedema or proliferative diabetic retinopathy had been placed on an annual screening protocol before they developed proliferative retinopathy or macular oedema.

Table 3 shows the visual acuity of the entire group at the beginning of the study and at the end. Five individuals had a visual acuity less than 0.3 in their better eye at the end of the study. In one patient, this was due to diabetic macular oedema, whereas the others had other eye diseases, mostly age-related macular degeneration, to blame for the reduced vision (table 3).

Table 3 Visual acuity at the beginning and end of the observation period

	1995	2005
	No. of patients	No. of patients
VA≥1.0	260	196
1.0>VA≥0.3	35	95
0.3>VA≥0.1	1	5
0.1>VA	0	0

VA, visual acuity.

For the patients who did not develop retinopathy during the entire period, there were 46 type 1 patients with diabetes and 126 type 2. Their HbA1c was 7.8 (1.6%) (mean (SD), and duration of diabetes 18 (7) years. In the group of patients who developed mild retinopathy, 38 had type 1 diabetes, and 58 had type 2. The mean duration was 18 (6) years, and HbA1c was 8.1 (1.3%). In the group of 23 patients who developed preproliferative retinopathy, there were 11 with type 1 diabetes and 12 with type 2. Their mean duration was 19 (5) years and mean HbA1c 8.4 (1.7%). Of the six patients who developed significant macular oedema, two had type 1 diabetes, and four had type 2. The duration of diabetes was 20 (4) years, and HbA1c was 9.6 (1.4%). Of the four patients who developed proliferative retinopathy, two had type 1, and two had type 2. They had a diabetes duration of 18, 15, 18 and 12 years, respectively, and a mean HbA1c of 9.5.

DISCUSSION

We have reviewed the 10-year experience from 1995 to 2005, when patients with diabetes without retinopathy were screened every other year. This approach is safe and does not risk the visual acuity of patients with diabetes. The patients who developed sight-threatening retinopathy had all first been diagnosed as having mild retinopathy and placed on at least an annual examination schedule. No patient had any undue delay in treatment of sight-threatening retinopathy.

In our patient group, there are more type 1 patients with diabetes than would be expected in a general population, most likely because in our screening for diabetic retinopathy in Iceland, we have been able to include all the type 1 patients with diabetes but a smaller proportion of type 2 patients.[7 8] The type 1 patients with diabetes are more prominent in the groups with a higher grade of diabetic retinopathy. Patients with a longer duration and higher HbA1c are also found more frequently in the groups with a higher grade of retinopathy.

Regular screening and preventative treatment for diabetic retinopathy is a powerful tool to reduce blindness. In Iceland, the prevalence of blindness within the diabetic population had decreased from 2.4% to 0.5%, and this is largely attributable to the public health programme.[2 6–10] Similar success has been seen with other similar programmes.[11–14]

We have a worldwide epidemic of diabetes on our hands[15] where the number of patients with diabetes in the world will double in 20 years. While public health programmes with diabetic eye screening are very effective and indeed highly cost-effective,[16] they can be expensive to operate, owing to the very large number of patients. The cost per screening visit in the Icelandic screening system is approximately €60, and the cost involved in photographic screening programmes is only slightly lower. In countries with millions of patients with diabetes, it may be possible to save large amounts of money, if diabetic eye screening visits can be reduced in number, without risking the patient's safety.

The prevalence of diabetic retinopathy varies between diabetic populations.[17] In a cross-sectional study of the Icelandic diabetic population,[18] 50% of the type 1 diabetic population and 60% of the type 2 patients with diabetes have no retinopathy and would be suitable for eye screening every other year (biennial). This reduces the number of screening visits by more than 25% without reducing safety. The financial savings are substantial, and the patients are spared from unnecessary visits and examinations with dilated pupils.

The progression of diabetic retinopathy depends on blood glucose control, blood pressure, duration of diabetes and other factors. The Icelandic diabetic population has reasonably good glycaemic and blood-pressure control (table 1), and our results may not apply to patient groups with very poor glycaemic and blood-pressure control. In patients with diabetes who have good glycaemic and blood-pressure control and have a relatively short duration of diabetes mellitus, it may well be possible to reduce the number screening visits even more. Kalm[19] has suggested that in patients with diabetes with no retinopathy, short duration of diabetes and good metabolic control, the screening visits may be reduced to every 3–5 years. Younis *et al*[20] measured the cumulative incidence of any retinopathy, maculopathy and sight-threatening diabetic retinopathy, and calculated optimal screening intervals by retinopathy grade at baseline for patients with type 1 diabetes attending an established photographic retinal screening programme. They include moderate preproliferative retinopathy in sight-threatening diabetic retinopathy, whereas we only include diabetic macular oedema and proliferative retinopathy in sight-threatening diabetic retinopathy. For a 95% likelihood of remaining free of sight-threatening diabetic retinopathy, they found mean screening intervals by baseline status to be: no retinopathy 5.7 (95% CI 3.5 to 7.6) years, background 1.3 (0.4 to 2.0) years and mild preproliferative 0.4 (0 to 0.8) years. Their conclusion is similar to ours, and they state that screening at 2–3-year intervals is appropriate for patients without retinopathy in type 1 diabetes.[20] In type 2 diabetes, Younis *et al*[21] found the 95% probability of remaining free of sight-threatening diabetic retinopathy, with mean screening intervals of 5.4 years (95% CI 4.7 to 6.3) for no retinopathy, background 1.0 years (0.7 to 1.3), and mild preproliferative 0.3 years (0.2 to 0.5). They suggest a 3-year screening interval for type 2 patients with no retinopathy, but yearly or more frequent screening is needed for patients with higher grades of retinopathy.[21]

The Icelandic screening programme employs ophthalmologists, who screen patients with diabetes with biomicroscopy at the slit lamp, whereas the Liverpool screening programme[20 21] uses photographic screening. While the direct screening system might be expected to be more sensitive in detecting mild retinopathy changes, the conclusions based on data from each programme are similar: it is not necessary to screen diabetics without retinopathy annually. Biennial screening examinations suffice in both type 1 and type 2 patients with diabetes without retinopathy, and more extended screening intervals may even be feasible.

ACKNOWLEDGEMENTS

The authors thank Helga Halblaub for assistance in gathering clinical data.

Authors' affiliations

E Ólafsdóttir, E Stefánsson, University of Iceland, Reykjavik, Iceland

Competing interests: None declared.

Correspondence to: E Stefánsson, University of Iceland, University Hospital Landspitali, 101 Reykjavik, Iceland; einarste@landspitali.is

Accepted 14 June 2007
Published Online First 12 July 2007

REFERENCES

1 **Danielsen R**, Jonasson F, Helgason T. Prevalence of retinopathy and proteinuria in type 1 diabetics in Iceland. *Acta Med Scand* 1982;**212**:277–80.
2 **Kristinsson JK**, Hauksdottir H, Stefansson E, *et al.* Active prevention in diabetic eye disease. A 4-year follow-up. *Acta Ophthalmol Scand* 1997;**75**:249–54.
3 **Backlund LB**, Algvere PV, Rosenqvist U. New blindness in diabetes reduced by more than one-third in Stockholm County. *Diabet Med* 1997;**14**:732–40.
4 **AAO Retina Panel**. *Preferred practice pattern, diabetic retinopathy*. San Francisco: American Academy of Ophthalmology, 2003.
5 **Piwernetz K**, Home PD, Snorgaard O, *et al.* Monitoring the targets of the St Vincent Declaration and the implementation of quality management in diabetes care: the DIABCARE initiative. The DIABCARE Monitoring Group of the St Vincent Declaration Steering Committee. *Diabet Med* 1993;**10**:371–7.
6 **Kristinsson JK**, Gudmundsson JR, Stefansson E, *et al.* Screening for diabetic retinopathy. Initiation and frequency. *Acta Ophthalmol Scand* 1995;**73**:525–8.
7 **Kristinsson JK**, Stefansson E, Jonasson F, *et al.* Screening for eye disease in type 2 diabetes mellitus. *Acta Ophthalmol (Copenh)* 1994;**72**:341–6.
8 **Kristinsson JK**, Stefansson E, Jonasson F, *et al.* Systematic screening for diabetic eye disease in insulin dependent diabetes. *Acta Ophthalmol (Copenh)* 1994;**72**:72–8.
9 **Stefansson E**, Bek T, Porta M, *et al.* Screening and prevention of diabetic blindness. *Acta Ophthalmol Scand* 2000;**78**:374–85.
10 **Zoega GM**, Gunnarsdottir T, Bjornsdottir S, *et al.* Screening compliance and visual outcome in diabetes. *Acta Ophthalmol Scand* 2005;**83**:687–90.
11 **Hansson-Lundblad C**, Holm K, Agardh CD, *et al.* A small number of older type 2 diabetic patients end up visually impaired despite regular photographic screening and laser treatment for diabetic retinopathy. *Acta Ophthalmol Scand* 2002;**80**:310–5.
12 **Henricsson M**, Tyrberg M, Heijl A, *et al.* Incidence of blindness and visual impairment in diabetic patients participating in an ophthalmological control and screening programme. *Acta Ophthalmol Scand* 1996;**74**:533–8.
13 **Jeppesen P**, Bek T. The occurrence and causes of registered blindness in diabetes patients in Arhus County, Denmark. *Acta Ophthalmologica Scandinavica* 2004;**82**:526–30.
14 **AAO Rotina Panel**. *Preferred practice pattern, diabetic retinopathy*. San Francisco: American Academy of Ophthalmology, 2003.
15 **Zimmet P**, Alberti KG, Shaw J. Global and societal implications of the diabetes epidemic. *Nature* 2001;**414**:782–7.
16 **Javitt JC**, Aiello LP, Chiang Y, *et al.* Preventive eye care in people with diabetes is cost-saving to the federal government. Implications for health-care reform. *Diabetes Care* 1994;**17**:909–17.
17 **Williams R**, Airey M, Baxter H, *et al.* Epidemiology of diabetic retinopathy and macular oedema: a systematic review. *Eye* 2004;**18**:963–83.
18 **Kristinsson JK**. Diabetic retinopathy. Screening and prevention of blindness. A doctoral thesis. *Acta Ophthalmol Scand Suppl* 1997:1–76.
19 **Kalm H**. *Diabetic retinopathy screening: Method and strategy*. Gothenburg, Sweden: University of Gothenburg, 1993.
20 **Younis N**, Broadbent DM, Harding SP, *et al.* Incidence of sight-threatening retinopathy in Type 1 diabetes in a systematic screening programme. *Diabet Med* 2003;**20**:758–65.
21 **Younis N**, Broadbent DM, Vora JP, *et al.* Incidence of sight-threatening retinopathy in patients with type 2 diabetes in the Liverpool Diabetic Eye Study: a cohort study. *Lancet* 2003:195–200.