Changes in Detection of Retinopathy in Type 2 Diabetes in the First 4 Years of a Population-Based Diabetic Eye Screening Program

Retrospective cohort study

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OBJECTIVE—Annual diabetic eye screening has been implemented in England since 2008. This study aimed to estimate changes in the detection of retinopathy in the first 4 years of the program.

RESEARCH DESIGN AND METHODS—Participants included 32,340 patients with type 2 diabetes resident in three London boroughs with one or more screening records between 2008 and 2011. Data for 87,570 digital images from 2008 to 2011 were analyzed. Frequency of sight-threatening diabetic retinopathy (STDR) was estimated by year of screen for first screens and for subsequent screens according to retinopathy status at first screen.

RESULTS—Among 16,621 first-ever screens, the frequency of STDR was 7.1% in 2008, declining to 6.4% in 2011 ($P = 0.087$). The proportion with a duration of diabetes of <1 year at first screen increased from 18.7% in 2008 to 48.6% in 2011. Second or later screens were received by 26,308 participants. In participants with mild nonproliferative retinopathy at first screen, the proportion with STDR at second or later screen declined from 21.6% in 2008 to 8.4% in 2011 (annual change −2.2% [95% CI −3.3 to −1.0], $P < 0.001$). In participants with no retinopathy at first screen, STDR declined from 9.2% in 2008 to 3.2% in 2011 (annual change −1.8% [−2.0 to −1.7], $P < 0.001$). Declining trends were similar in sociodemographic subgroups.

CONCLUSIONS—After the inception of population-based diabetic eye screening, patients at lower risk of STDR contribute an increasing proportion to the eligible population, and the proportion detected with STDR at second or subsequent screening rounds declines rapidly.

Diabetes Care **36:2663–2669, 2013**

Diabetic retinopathy is one of the leading causes of preventable blindness in developed countries and is an increasing cause of blindness in middle-income countries (1). Diabetic retinopathy accounts for ~5% of the 37 million individuals in the world who are blind (1). The social and medical costs of diabetic retinopathy are substantial. It is estimated that up to 39% of newly diagnosed patients with type 2 diabetes have evidence of retinopathy (2–7). Laser photocoagulation can reduce visual loss in patients with sight-threatening diabetic eye disease (8,9). This observation has stimulated the development and introduction of population screening for diabetic retinopathy. The American Diabetes Association recommends that all diabetic patients have an annual eye examination, with the pupil dilated, in order to detect evidence of retinopathy (10).

Population-based diabetic eye screening programs have been established in a number of Western European countries. The incidence and prevalence of blindness is lower among diabetic populations where screening programs have been implemented compared with populations who have not had access to organized population-based screening (11). The overall prevalence of diabetic retinopathy among patients with type 2 diabetes has remained stable over the past 20 years despite an increase in the prevalence of diabetes (12).

In England, a national diabetic eye screening program was implemented between 2003 and 2008. Uptake is good (13). Recent increases in the prevalence of known diabetes have led to a substantial increase in the size of the population eligible for screening. These observations have led to suggestions that the screening interval may be increased for selected patients with lower risk of sight-threatening diabetic retinopathy (STDR) (14,15).

When a screening program is established in a previously unscreened population, the initial yield of screening, in terms of cases of STDR detected, may be substantial. However, as participants with more advanced disease, or higher risk, leave the eligible population, the yield of screening may be expected to decline. This study aimed to estimate changes in the detection of retinopathy among the screening population over a 4-year period. We specifically aimed to estimate whether the frequency of STDR detected at first screen and at second or later screen changed between 2008 and 2011 and to determine whether any changes in the frequency that STDR detected among the

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Received 17 January 2013 and accepted 7 March 2013.
DOI: 10.2337/dc13-0130
The views expressed are those of the authors and not necessarily those of the NHS, the NIHR, or the Department of Health.

screening population were similar across sociodemographic subgroups. Progression to STDR is more likely among patients who already have evidence of retinopathy when first screened (15) so changes were evaluated in relation to existing background retinopathy.

RESEARCH DESIGN AND METHODS

—This study was a retrospective cohort study, using anonymized longitudinal data for all patients attending the South East London diabetic eye screening service between 2008 and 2011. The service evaluation was approved by the National Health Service (NHS) Research and Development Office for South London; informed consent from individuals within the database was not required as only anonymized data were analyzed for this study.

The screening program

As part of the NHS Diabetic Eye Screening Program, all individuals registered in primary care with diabetes 12 years of age or older are invited for annual screening by digital retinal photography through a call and recall system. The national program was rolled out between 2003 and 2008 with the intention of inviting all eligible patients for eye screening at least once by September 2007. The program was developed from a pre-existing hospital-based service for diabetes clinic patients.

The South East London diabetic eye screening service uses monoscopic fundus photos with a 45° angle for coverage using a nonmydriatic camera (the fundus camera used is TopCon TRC NW6s with Nikon D80 back). Pupils are dilated. One image of the macular is taken and one of the fovea, which are assessed in color and red-free.

Retinal images are graded according to the NHS Diabetic Eye Screening Program specification to allow identification of changes suggestive of the development of retinopathy or maculopathy. Normal images are assessed by one grader, and all other images are assessed by a second grader (with any disagreement between graders resolved by a third arbitration grader). Screen graders must meet the NHS Diabetic Eye Screening Program's quality criteria (16,17). Individuals who are identified as having STDR are referred for ophthalmologic investigation and treatment and are no longer invited for screening.

Participants

The study was set in three inner London boroughs with a combined resident population of ~830,000 people. The study population for our analyses included all patients with type 2 diabetes resident in the three boroughs who attended a screening at least once between 2008 and 2011. Characteristics of patients from this screening service in 2008 have been reported previously (18).

Data

The screening program provided anonymized data for 233,847 screening episodes recorded from 1992 to February 2012. Data available for analysis included age, self-reported ethnicity, and sex. The dataset also included physician-recorded date of diagnosis of diabetes, which was used to calculate the duration of diabetes grouped into <1, 1, 2, 3, 4, 5–9, 10–14, or ≥15 years or unknown. The Indices of Multiple Deprivation score was included as a measure of social and material deprivation. In England, small areas of ~1,000 households are assigned a deprivation score, which was linked to participants using their postal code (zip code) of residence. The score is a composite measure based on seven domains of deprivation, including income, unemployment, health, disability, education, and housing and is published by the U.K. Office for National Statistics. The deprivation score was divided into quintiles according to the distribution for England in 2010. The three London boroughs where the study was set have a particularly high level of deprivation compared with the rest of England. Diabetic eye screening as part of the NHS Diabetic Eye Screening Program is a stand-alone service, and data cannot readily be linked to other measures of care.

Analysis

Screening results were classified as STDR if either eye was graded as moderate or severe nonproliferative retinopathy (referred to as R2), proliferative retinopathy (R3), or referable maculopathy (M1) (19,20). Example images of diabetic eye disease can be viewed from reference sources (21). Visual acuity is considered as a surrogate marker for macular edema when grading referable maculopathy; visual acuity <6/12 with microaneurysms is graded as M1. Optical coherence tomography to determine macular thickness is not used as part of the English Diabetic Eye Screening Program.

We tabulated the number of participants attending for their first-ever screen, the number attending for a second or later screen, and the proportion with STDR by study year. We also tabulated the proportion with each screening grade that comprises STDR and the proportion with STDR by age, sex, ethnicity, and deprivation. Linear trends by study year were estimated from a linear regression model for number of participants attending for their first-ever or a second or later screen. For the second or later screens, we excluded participants with STDR detected at a previous screen. Generalized linear models with an identity link and binomial family were used to estimate univariate linear trends in the proportion with STDR between 2008 and 2011 among participants attending for their first-ever and a second or later screen, changes in the proportion with each screening grade that comprises STDR, and changes in how long first-time attendees had been diagnosed with diabetes. Data for second or later screens were grouped according to their first-ever screening grade (mild nonproliferative retinopathy or no retinopathy) after excluding participants with STDR at the first screen. A logistic regression model was used to evaluate whether the year of first-ever screen, or grade at first-ever screen, affected the linear trend between screening year and frequency of STDR among participants attending for a second or subsequent screen (adjusting for age-group, sex, ethnicity, deprivation, and duration of diabetes and using one episode per participant per year). Logistic regression was also used to evaluate the interaction effect between sociodemographic subgroups and screening year on frequency of STDR (using one episode per participant per year, clustering by participant, and excluding participants who had previously had STDR detected). The logistic regression models allowed us to estimate whether any changes in the proportion with STDR over time differed within sociodemographic subgroups. We estimated the annual change in frequency for each sociodemographic subgroup using univariate generalized linear models with a binomial family and identity link and clustering by participant. All analyses were conducted using STATA version 12.1 (22).

RESULTS

Characteristics of the sample

The initial dataset included 233,846 screening episodes for 48,484 patients. Records were eligible for analysis for participants resident in the three boroughs for

the period during which the population-based screening program was fully implemented, from 1 January 2008 to 31 December 2011. We excluded 146,276 screening episodes for 16,144 participants, including 102,026 recorded before 1 January 2008 or after 31 December 2011, 34,323 episodes for participants resident outside the three boroughs, 8,426 with type 1 diabetes, and 270 for which the participant was registered as blind or <12 years of age or the screening record was archived, and 1,231 unassessable screens. The final dataset comprised 87,570 screening episodes for 32,340 participants. Participants were divided equally by sex (male 51.6%), 65–74 years of age (24.6%), and being in the fourth (46.2%) or fifth (42.8%) most deprived quintile. The majority of participants were of a white ethnic origin (43.9%), followed by participants of a Caribbean (16.0%) and African (13.5%) origin. Over the study period, 96.5% of patients invited for screening had attended at least once.

Changes in the frequency of STDR at first-ever screen

The proportion of screens that were first-ever screens decreased from 31.3% in 2008 to 15.4% in 2011 (annual change −4.8% [95% CI −5.0 to −4.5]) (Table 1). Among 16,621 participants attending for their first-ever screen between 2008 and 2011, 7.1% had STDR detected. The frequency of STDR at first-ever screen did not change between 2008 and 2011. The proportion of first screens was 7.1% in 2008 and 6.4% in 2011 (annual change −0.3% [−0.6 to 0.04]) (Table 1). Over the same period, there was a decline in the proportion of participants attending for their first screen who had been diagnosed with diabetes for a longer duration and an increase in the proportion with newly diagnosed diabetes (Table 2). In 2008, 18.7% of participants attending for their first-ever screen had been diagnosed with diabetes for <1 year, compared with 48.6% of participants in 2011 (annual change 10.2% [9.5–10.7]). In contrast, 4.1% of participants attending for their first-ever screen in 2008 had been diagnosed with diabetes for >15 years, and this declined to 2.5% in 2011 (annual change −0.6% [−0.8 to −0.4]).

Changes in the frequency of STDR at second or later screen

Over the study period, 26,308 participants received at least one second or later screen. The proportion of participants attending for a second or later screen increased from 68.7% of all screens in 2008 to 74.6% in 2011 (annual change 4.9% [4.6–5.1]) (Table 1). The frequency of STDR among participants attending for a second or later screen depended on the screen result at the first-ever screen. Among participants who had mild nonproliferative retinopathy detected at their first-ever screen, 21.6% has STDR detected at a second or later screen in 2008, and 9.2% of participants who had no retinopathy detected at their first-ever screen had STDR detected at a second or subsequent screen (Table 1). The frequency of STDR among participants at a second or later screen decreased between 2008 and 2011 for both groups of participants. In 2011, the frequency of STDR was 8.4% for participants with mild nonproliferative retinopathy detected at their first-ever screen and 3.2% for participants with no retinopathy at their first-ever screen. The annual decline was −2.2% (−3.3 to −1.0) for participants with mild nonproliferative retinopathy at first screen and −1.8% (−2.0 to −1.7) (Table 1) for participants with no retinopathy at first-ever screen.

In logistic regression analyses, the decline in STDR at second or later screening rounds was independent of when the participant first attended screening and the screening grade they received at their first-ever screen (Table 3). In 2008, 9.2% had STDR detected compared with 6.5% in 2009 (adjusted odds ratio 0.73 [95% CI 0.67–0.80]), 4.7% in 2010 (0.55 [0.50–0.61]), and 3.6% in 2011 (0.43 [0.39–0.48]). The frequency of STDR was lower among participants who were screened for the first time more recently (0.87 [0.86–0.89]) and among participants who had no retinopathy detected at their first-ever screen (5.5 vs. 9.8%, 0.19 [0.17–0.22]).

Changes in the frequency of the screening grades that comprise STDR

For each year, the greatest proportion of participants who had STDR detected at screening had referable maculopathy detected (Table 1). There was a decrease in the proportion of participants who had referable maculopathy detected between 2008 and 2011 ($P < 0.001$). In 2008, 8.1% of participants had referable maculopathy, which reduced to 3.7% in 2011 (annual change −1.4% [95% CI −1.6 to −1.3]). There was also a decrease in the proportion of participants who had proliferative retinopathy detected between 2008 and 2011 (from 0.5 to 0.2%, annual change −0.1% [−0.1 to −0.1]). There was no change in the proportion of participants who had moderate or severe nonproliferative retinopathy detected at screening between 2008 and 2011 ($P = 0.770$).

Change in the frequency of STDR within sociodemographic subgroups

Trends were analyzed separately by area deprivation quintile, ethnicity, sex, and age-group. The declining trend in STDR over time appeared to be consistent within sociodemographic subgroups (Table 4). There was weak evidence of an interaction between age and screening year ($P < 0.001$), with the frequency of STDR reducing slightly more between 2008 and 2011 among participants 55–64 years of age (annual change −1.8% [95% CI −2.1 to −1.5]) than those 12–44 years of age (annual change −1.2% [−1.7 to −0.8]). There was no interaction between screening year and area deprivation quintile ($P = 0.740$), or screening year and sex ($P = 0.758$), or screening year and ethnicity ($P = 0.203$).

CONCLUSIONS—This study estimated change in the detection of STDR among the population eligible for screening in the first 4 years of a diabetic eye screening program. At the start of population-based screening, participants with a longer duration of diabetes constituted a substantial proportion of new entrants into the program and the frequency of STDR was high. Frequency of STDR among new entrants did not decrease significantly over the period. Participants identified as having STDR were referred for ophthalmologic investigation and treatment and exited the screening program. Among those participants remaining in the program, the frequency of STDR at a second or later screen decreased. There was a decrease in the frequency of STDR within all sociodemographic subgroups. The frequency of STDR was lower among participants attending a second or later screen who had no retinopathy detected at their first-ever screen, compared with participants with mild nonproliferative retinopathy detected at their first screen and those attending their first screen. Referable maculopathy was more commonly detected at screening than the other grades that comprise STDR, but its frequency reduced over time.

Table 1—*Changes in the frequency of STDR over time*

	Screen year					
	2008	2009	2010	2011	Annual change (95% CI)	*P* value
Number of participants screened[a]	19,043	19,447	20,259	21,598	848 participants (210 to 1,485)	0.029
Number of participants with first-ever screens (% of screens)	5,966 (31.3)	4,098 (21.1)	3,221 (15.9)	3,336 (15.4)	−4.8% (−5.0 to −4.5)	<0.001
Frequency of STDR among participants at first-ever screen (% of first screens)	423 (7.1)	316 (7.7)	206 (6.4)	214 (6.4)	−0.3% (−0.6 to 0.04)	0.087
Number of participants with a second or later screen (% of screens)	13,093 (68.7)	15,366 (78.9)	17,080 (74.1)	18,333 (74.6)	4.9% (4.6 to 5.1)	<0.001
Frequency of STDR among participants at a second or later screen (%)						
Mild nonproliferative retinopathy at first-ever screen	8/37 (21.6)	122/956 (12.8)	130/1,401 (9.3)	144/1,721 (8.4)	−2.2% (−3.3 to −1.0)	<0.001
No retinopathy at first-ever screen	1,195/13,056 (9.2)	872/14,410 (6.1)	672/15,679 (4.3)	523/16,612 (3.2)	−1.8% (−2.0 to −1.7)	<0.001
Eye grade among participants with STDR (% of participants)[b]						
Moderate or severe nonproliferative retinopathy (R2)	172 (0.9)	127 (0.7)	107 (0.5)	194 (0.9)	0.01% (−0.1 to 0.04)	0.770
Proliferative retinopathy (R3)	97 (0.5)	88 (0.5)	56 (0.3)	45 (0.2)	−0.1% (−0.1 to −0.1)	<0.001
Referable maculopathy (M1)	1,539 (8.1)	1,244 (6.4)	955 (4.7)	803 (3.7)	−1.4% (−1.6 to −1.3)	<0.001

[a]Sum of number of first screens and second or later screens is greater than number of screens as some first and second screens occurred in the same screening year.
[b]Categories of retinopathy and maculopathy are not mutually exclusive.

This study is one of the first to show evidence that the frequency of STDR among a diabetic eye screening population has decreased after the full implementation of organized screening. Frequency of STDR among patients with type 2 diabetes attending screening in England between 2007 and 2009 was 11% in a study conducted by Gulliford et al. (18) and 4% among patients with type 2 diabetes attending screening in Wales between 2005 and 2009 (23). Outside the U.K., some research has estimated that the prevalence of "vision-threatening" retinopathy in the U.S. is between 4 and 8% (24,25). These figures are higher than the 3.2% having STDR detected at a second or later screen in 2011

Table 2—*Distribution of duration of diabetes for those with a first screen in 2008, 2009, 2010, or 2011*

	Screen year				
Diabetes duration (years)	2008 (n = 5,966)	2009 (n = 4,098)	2010 (n = 3,221)	2011 (n = 3,336)	Annual percent change (95% CI)
Up to 1	1,117 (18.7)	1,429 (34.9)	1,285 (39.9)	1,622 (48.6)	10.2 (9.5 to 10.7)
1	1,423 (23.9)	1,006 (24.6)	917 (28.5)	757 (22.7)	0.2 (−0.4 to 0.8)
2	644 (10.8)	249 (6.1)	212 (6.6)	167 (5.0)	−1.7 (−2.0 to −1.4)
3	394 (6.6)	213 (5.2)	107 (3.3)	104 (3.1)	−1.2 (−1.5 to −0.9)
4	398 (6.7)	138 (3.4)	90 (2.8)	72 (2.2)	−1.4 (−1.6 to −1.1)
5 to 9	981 (16.4)	476 (11.6)	272 (8.4)	254 (7.6)	−2.9 (−3.3 to −2.5)
10 to 14	304 (5.1)	163 (4.0)	99 (3.1)	96 (2.9)	−0.8 (−1.0 to −0.5)
≥15	246 (4.1)	137 (3.3)	73 (2.3)	82 (2.5)	−0.6 (−0.8 to −0.4)
Unknown	459 (7.7)	287 (7.0)	166 (5.1)	182 (5.5)	−0.8 (−1.1 to −0.5)

Figures are frequencies (column percent except where indicated).

Table 3—*Frequency of STDR at second or later screens by screen year, year of first screen, and eye grade at first screen*

	Total	Number with STDR (%)	Adjusted odds ratio[a] (95% CI)	*P* value
Total	63,872	3,666 (5.7)	—	—
Year of current screen				
2008	13,093	1,203 (9.2)	Reference	—
2009	15,366	994 (6.5)	0.73 (0.67–0.80)	<0.001
2010	17,080	802 (4.7)	0.55 (0.50–0.61)	<0.001
2011	18,333	667 (3.6)	0.43 (0.39–0.48)	<0.001
Grade at first-ever screen				
Mild nonproliferative retinopathy	4,115	404 (9.8)	Reference	—
No retinopathy	59,757	3,262 (5.5)	0.19 (0.17–0.22)	<0.001
Year of first-ever screen (range 1992–2011)	—	—	0.87 (0.86–0.89)	<0.001

[a]Adjusted for age-group, sex, ethnicity, duration of diabetes, and deprivation category.

(among those with no retinopathy at their first screen) reported in the current study. These results mirror Kristinsson et al.'s (26) finding that prevalence of visual impairment among patients with diabetes in Iceland decreased after the implementation of systematic screening. They also reflect some evidence from cancer screening that suggests that breast and colorectal cancer detection rates are lower at incident screens than at prevalent screens (27,28). It is important to note that our findings reflect changes in incidence in the screening population rather than the resident population of the study area.

Our findings provide further support to the argument for less frequent monitoring of patients who do not have retinopathy detected at screening. The decrease in frequency of STDR among participants attending a second or later screen can most likely be attributed to patients with existing STDR having been identified at screening and removed from the eligible population, with lower-risk patients contributing a larger fraction of the eligible population for subsequent screening rounds. Participants with mild nonproliferative retinopathy detected at their first-ever screen were more likely to have STDR detected at a second or later screen compared with participants who did not have retinopathy detected at their

Table 4—*Changes in frequency of STDR among participants over time by sociodemographic subgroups*

	n with STDR/total screened (% of total screened)				
	2008	2009	2010	2011	Annual percentage change (95% CI)
Deprivation quintile					
Lowest and second least deprived	17/277 (6.1)	16/300 (5.3)	10/300 (3.3)	12/350 (3.4)	−0.9 (−1.9 to −0.1)
Third	134/1,843 (7.3)	110/1,974 (5.6)	84/1,994 (4.2)	81/2,126 (3.8)	−1.1 (−1.5 to −0.7)
Fourth	756/8,744 (8.7)	628/9,019 (7.0)	486/9,450 (5.1)	388/9,944 (3.9)	−1.8 (−1.8 to −1.4)
Most deprived	719/8,179 (8.8)	556/8,154 (6.8)	428/8,515 (5.0)	400/9,178 (4.4)	−1.4 (−1.7 to −1.2)
Ethnicity					
White	573/8,813 (6.5)	433/8,942 (4.8)	380/9,179 (4.1)	272/9,673 (2.8)	−1.2 (−1.4 to −1.0)
Mixed	123/1,003 (12.3)	115/1,173 (9.8)	91/1,203 (7.6)	72/1,277 (5.6)	−2.2 (−2.9 to −1.5)
South Asian	162/1,838 (8.8)	138/1,859 (7.4)	84/1,909 (4.4)	108/2,139 (5.1)	−1.3 (−1.8 to −0.9)
Caribbean	350/3,304 (10.6)	294/3,311 (8.9)	172/3,237 (5.3)	160/3,382 (4.7)	−2.0 (−2.4 to −1.7)
African	256/2,311 (11.1)	195/2,342 (8.3)	150/2,581 (5.8)	144/2,858 (5.0)	−1.9 (−2.4 to −1.5)
Black other	90/838 (10.7)	69/751 (9.2)	42/858 (4.9)	62/966 (6.4)	−1.5 (−2.3 to −0.8)
Other ethnicity	67/908 (7.4)	62/1,036 (6.0)	57/1,021 (5.6)	55/1,129 (4.9)	−0.8 (−1.4 to −0.1)
Sex					
Male	840/9,600 (8.8)	715/9,969 (7.2)	520/10,386 (5.0)	475/11,054 (4.3)	−1.5 (−1.7 to −1.3)
Female	786/9,432 (8.3)	593/9,462 (6.3)	488/9,849 (5.0)	406/10,515 (3.9)	−1.4 (−1.6 to −1.2)
Age-group (years)					
12–44	152/2,083 (7.3)	149/2,076 (7.2)	110/2,270 (4.9)	96/2,365 (4.1)	−1.2 (−1.7 to −0.8)
45–54	388/3,879 (10.0)	299/4,006 (7.5)	255/4,282 (6.0)	208/4,627 (4.5)	−1.7 (−2.1 to −1.4)
55–64	408/4,549 (9.0)	317/4,625 (6.9)	209/4,861 (4.3)	185/5,403 (3.4)	−1.8 (−2.1 to −1.5)
65–74	452/5,159 (8.8)	338/5,159 (6.6)	264/5,153 (5.1)	220/5,222 (4.1)	−1.4 (−1.7 to −1.2)
75–84	205/2,876 (7.1)	181/3,037 (6.0)	139/3,088 (4.5)	151/3,350 (4.5)	−0.9 (−1.2 to −0.5)
≥85	21/497 (4.2)	26/544 (4.8)	31/605 (5.1)	21/631 (3.3)	−0.3 (−1.1 to 0.5)

first-ever screen. Therefore, screening patients less frequently may increase the cost-effectiveness of diabetic eye screening programs. Biyearly screening among patients with no retinopathy is recommended by a number of the major American insurance providers and in Australia. Olafsdóttir et al. (14) reviewed the effect of screening patients without retinopathy every other year over 10 years and concluded that this screening frequency was safe and effective. Similarly, Jones et al. (15) reported that few patients who had no retinopathy detected at baseline developed preproliferative, proliferative, or STDR after 5–10 years of follow-up. It would be interesting to include participant blood pressure and blood glucose levels in future research to attempt to identify whether certain populations are suitable for less frequent screening.

The decline in frequency of STDR in previously screened participants may also be attributed to better treatment of the metabolic conditions of diabetes and an increase in the proportion of patients who have good blood pressure control and metabolic control of their condition (11). Observational data support this reasoning. In England, the organizations that commission local health care, called primary care trusts, are awarded Quality and Outcomes Framework points to reflect the health of patients and recording of patient health status in primary care. Higher points are suggestive of better performance. The three primary care trusts associated with the boroughs studied here have collectively seen around a one percentage point increase between 2008/2009 and 2010/2011 in the proportion of possible Quality and Outcomes Framework points awarded for indicators relating to the percentage of patients with a blood pressure measurement of <145/85 mmHg and a cholesterol measurement of <5 mmol/L among patients with diabetes (29). Reassuringly, the decrease in the frequency of STDR among participants over time was observed within all sociodemographic subgroups, suggesting that inequalities in the frequency of STDR are not widening.

There was no significant decline in the frequency of STDR among participants attending their first-ever screen, despite first-time attendees being increasingly more likely to have been recently diagnosed with diabetes. This may be because newly diagnosed patients are less likely to have been contributing to the number with STDR than those diagnosed for a longer time period. Participants diagnosed with diabetes for >4 years still comprised between 13 and 26% of first-time attendees over the study period.

The diabetic eye screening program in England aims that all patients with diabetes are invited for screening within 3 months of diagnosis. In our study, first-time attendees were increasingly more likely to have been more recently diagnosed with diabetes. If newly diagnosed patients continue to be screened close to their diagnosis date, in the short-term, we may see a decrease in the frequency of STDR at first screen as the development of STDR is associated with a longer duration of diabetes (18,23,30,31). In the longer term, as the frequency of type 2 diabetes increases (32) and the currently newly diagnosed patients have diabetes for longer, we may see a corresponding increase in the number of patients with STDR in the screening (and wider) population.

We describe an increase in the number of participants attending a second or later screen, particularly among those with mild nonproliferative retinopathy detected at their first-ever screen. As the screening program developed, an increasing number with mild nonproliferative retinopathy detected at a first screen were invited for second or subsequent screens.

We analyzed a large number of screening episodes for all general practitioner–registered patients recorded as having type 2 diabetes who were resident in three inner London boroughs. This is one of the first studies estimating changes in the detection of retinopathy over time to differentiate analyses between first screens and subsequent screens and divided according to retinopathy status at first screen. We limited analyses to patients resident in the three London boroughs under investigation, but we could have restricted analyses to patients registered in primary care in these three boroughs as this is the catchment area for the South East London screening service. However, only 655 of the included participants were not both resident and registered with a GP in the three boroughs and 4,199 participants were excluded who were registered in the three boroughs but not resident.

Previous photocoagulation was not included in our definition of STDR as it could have been used to treat retinopathy that, as a result, was no longer present. A small number of included participants may have had STDR detected and treated using photocoagulation at another ophthalmology department that we did not have a record of.

Four years after the introduction of population-based, annual diabetic eye screening, patients who are at lower risk of STDR comprise a greater proportion of the screening population and may be suitable for less frequent screening. The frequency of STDR among participants attending a second or later screen has declined rapidly.

Acknowledgments—This research was funded by the South London Health Innovation and Education Cluster and was supported by the National Institute for Health Research (NIHR) Biomedical Research Centre at Guy's and St Thomas' NHS Foundation Trust and King's College London.

No potential conflicts of interest relevant to this article were reported.

A.S.F. analyzed the data with guidance from M.C.G. and wrote the manuscript. A.F., C.C., A.D.C., H.D., and S.M. facilitated obtaining the data, contributed to the discussion, and reviewed the manuscript. S.S. contributed to the discussion and reviewed the manuscript. M.C.G. conceived of the study, facilitated obtaining the data, and wrote the manuscript. M.C.G. is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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