Diabetic Eye Screening Intervals - A review of evidence

Marianne Scholes, Emma Reed, Sarah Bagland
Health Improvement Analytical Team
Department of Health
6 November 2014

Aim:
To assess, using a cost utility approach, whether it is cost effective to change screening intervals, within the NSC diabetic eye screening programme, according to patient risk, using pre-publication results from Oxford University.

Conclusions:
Analysis suggests that **IT IS cost effective to increase screening intervals from one year to two years for low risk diabetic patients**, defined as those that are graded as having no background retinopathy or maculopathy in either eye (R0M0 R0M0).

Analysis suggests that **it IS NOT cost effective to reduce screening intervals from one year to 6 months for high risk but non-referable diabetic patients**, defined in this case as those that have background retinopathy (R1) in both eyes but no maculopathy in either eye (R1M0 R1M0).

If screening intervals are extended to 2 years for low risk patients, this will reduce total demand for screening by 35% compared to the current system of everyone on annual screening. These appointments could be re-deployed in efforts to increase uptake in the eligible diabetic population and would significantly counteract the large increases in demand resulting from the growth in the number of people with diabetes.

Background

A national programme for diabetic eye screening was established following the Department of Health's publication in 2001 "The National Service Framework for Diabetes: Delivery Strategy"; and has been fully rolled out since 2007. NICE guidance from 2002[i] recommended that the eyes of people with type 2 diabetes should be examined at the time of diagnosis and at least annually thereafter, including those registered blind and partially sighted.

Also in 2001, a report by Keele University was commissioned by the National Screening Committee (NSC) to analyse the cost effectiveness of different technical screening options (Indirect ophthalmoscopy, Digital Camera (fixed), Digital Camera mobile van). The report also provided an overall estimate of the cost effectiveness of annual diabetic eye screening. This found that annual DES is actually **net saving** when all societal costs are included; and when only NHS costs are included it is very cost effective at £2,254 per QALY (estimate for screening using a digital format and performed by optometrists, 2001 prices)[1]. This is consistent with another study from Iceland[ii] which

[1] The cost effective threshold used in this analysis is £15,000 per QALY. This means that if the cost per quality adjusted life year gained through this programme is £15,000 or less, the programmes will be cost effective. £15,000 per QALY is the recommended threshold according to Department of Health guidance. (Note that NICE recommends a slightly higher threshold of £20,000 - £30,000 per QALY and DH have only recently moved to the lower figure of 15,000).

found that, from a public health standpoint, screening for diabetic eye disease is one of the most cost effective health procedures available at $3,190 per QALY gained (2000 prices).

Evidence of optimal screening intervals

There is good evidence that annual screening for the whole eligible population for diabetic retinopathy is cost effective compared to no screening. But there might be more **optimal** screening intervals options, in cost-effectiveness terms, where different diabetic groups have different intervals. These options might *increase* screening intervals, which would result in savings and a decrease in health gain; or *decrease* screening intervals, which would result in higher costs and an increase in health gain (since there is no expectation that diabetic eye screening causes any harm, more screening will always create a health gain and less screening a health loss). To deem whether an option is optimal compared to annual screening for all, the *Incremental Cost Effectiveness Ratio (ICER)* is calculated. This is effectively the cost per QALY gained for moving from the less expensive option to the more expensive option. This is then compared to the DH threshold of £15,000 per QALY. Options that incur additional costs less than £15,000 per additional QALY gained are deemed to be cost effective. Also, options that save more than £15,000 per QALY lost are deemed to be cost effective.

Options for DES have been developed around different screening intervals based on patients being stratified by risk of developing referable retinopathy. Now that annual screening is fully implemented across the UK, we have sufficient data to answer this issue. Indeed, this has been the subject of extensive research, and alternative risk assessment techniques have been developed. Recent publications suggest 2 consecutive photos 1 year apart is the optimal way to identify low, medium and high risk patients[iii]. Some research has already been published into the cost effectiveness of changing screening intervals. We found one such paper by Chalk, D et al (2012)[iv] which concluded that low risk patients could move to 2-yearly intervals without increasing their risk of vision loss, and would reduce screening costs by ~25%.

The Four Nations Diabetic Retinopathy Screening Intervals Project
The Four Nations Diabetic Retinopathy Screening Intervals Project Study Group was assembled to address the question: Can we determine optimal screening intervals for different risk groups that can be identified in the current data set? Their conclusions were published in a report in December 2013, and were as follows:

- *"If accurate and consistent grading were assured, the data from the seven programmes suggest that an appropriate yield for identifying diabetic retinopathy in screening would be 2.5%, at which point* ***the optimal intervals would be two to three years for the low risk group, annual for medium risk, and six monthly for the high risk group[2]. "***
- *"Robust systems of internal and external Quality Assurance are necessary to meet the requirement of accurate and consistent grading."*
- *"Our analyses demonstrate a range of issues to be addressed in any future implementation of risk-based variable intervals, including tackling unwarranted variation in grading practice, ensuring better capture of basic patient-level data and the need for prospective analyses to track the impact on outcomes."*

[2] The study approach segments patients into nine risk groups based on screening results at two consecutive screening episodes. Our analyses concentrate on Low risk (Group 9: R0 in both eyes on first occasion and second occasion) and High risk (Group 1: R1/M0 in both eyes on first occasion and on second occasion). There are seven intermediate groups, and the Medium referred to in this report is Group 5 (R1/M0 in one eye only and R0 in the other eye, on first occasion and second occasion).

A key limitation of the study identified in the report was that it did not include a cost effectiveness analysis.

Emerging evidence

A Health Technology Appraisal is underway and due to report in late November 2014, which will evaluate the cost effectiveness of different screening intervals. This is being led by Gloucestershire Hospitals NHS Foundation trust[v] with Health Economic and statistical input is from the University of Oxford. [vi] This team have kindly shared their findings with us ahead of publication for the purposes of making their high level findings known to NSC in November 2014. We are very grateful to the team for the additional work they have undertaken to enable these results to be shared before publication of the HTA.

Description of the HTA modelling

The HTA model is a Markov model of the natural history of true diabetic retinopathy (DR) states, with a health economic model overlaid on top showing outcomes from different screening intervals. The model assesses the impact of changes to screening intervals based on true DR states. In order to simulate intervals based on observed DR states, the model was adapted to incorporate a distribution of true states against each observed state. The model incorporates lifetime costs and QALYs and links both to visual acuity which is impacted by progression of the true DR state and access to treatment.

Results from the HTA modelling

Increasing the intervals for the low risk group

Results from the HTA suggest that **IT IS** cost effective to increase screening intervals from one year to two years for low risk diabetic patients, defined as those that are graded as having no background retinopathy or maculopathy in either eye (R0M0 R0M0). While there is a very small decrease in average health as a result of this change (equating to a decrease of 45 lifetime QALYs per 100,000 low risk patients, as shown in Appendix 1), there is a significant saving at a population level. The incremental cost effectiveness ratio (ICER)[3] of annual screening compared to 2-yearly screening for low risk patients is £404,000 per QALY gained. Put another way, in moving to 2-yearly screening, **for every one QALY lost, the programme will save £404,000**. The Department of Health recommends a threshold of £15,000 per QALY. This means that **the £404,000 that is spent on gaining one QALY through annual screening could otherwise be used to generate over 26 QALYs if used elsewhere in the health system, including within the diabetic eye screening programme.**

The HTA modelling indicates there is a 100% probability of this being cost effective at the £15,000 per QALY threshold compared with annual screening.

[3] The incremental cost effectiveness ratio (ICER) shows the cost of gaining one quality adjusted life year (QALY), which is defined as one year in full health. Moving from annual screening to screening every two years for this group leads to a reduction in the lifetime costs per patient, as well as a marginal reduction in the lifetime QALYs per patient. The reduction in total QALYs is marginal compared to the reduction in costs.

Table 1: ICER of annual screening compared to screening every two years

	Annual screening	Every two years	Difference
	National average uptake		
Total lifetime costs per 100,000 low risk patients	£3.673bn	£3.655bn	£18m
Total lifetime QALYs per 100,000 low risk patients	621,298	621,253	-45
ICER			£404,207

Sensitivity analysis: Impact of changing uptake on increasing intervals for low risk patients

There is good reason to anticipate that extending intervals could reduce uptake of screening. We have assessed the impact of changes in the uptake of screening, on cost effectiveness. The table below shows that even if uptake decreases to 73%, changing the screening intervals is still be incredibly cost effective.

Table 4: ICER compared to annual screening for three scenarios of varying uptake

Scenarios, low risk screening every 2 years.	National average uptake (81%)	89% uptake (+10% of 81%)	73% uptake (-10% of 81%)
ICER compared to annual screening	£404,207	£524,831	£334,319

Implementing the change in intervals will require an update to the existing IT systems, and the cost impact of this is currently unknown. The potential scenarios range from no additional cost (which is assumed in the scenarios above) to a maximum total one off cost of £800,000.
When including this cost in the analysis, screening every two years remains incredibly cost effective, as shown in the table below.

Table 5: ICER compared to annual screening for three scenarios of varying uptake; including £800,000 national IT costs

Scenarios, low risk screening every 2 years.	National average uptake (81%)	89% uptake (+10% of 81%)	73% uptake (-10% of 81%)
ICER compared to annual screening	£403,292	£523,630	£333,561

Reducing the intervals for the high risk group

Reducing the screening interval for those in the high risk category from annual screening to screening every 6 months is not cost effective. The cost per additional QALY gained from reducing

screening intervals is £272,000. This far exceeds the Department of Health £15,000 cost effectiveness threshold. The £272,000 that would be spent in order to gain one QALY by reducing intervals could generate over 18 QALYs if spent elsewhere in the healthcare system, including within diabetic eye screening.

The HTA modelling indicates there is a 0% probability of this being cost effective at the £15,000 per QALY threshold compared with annual screening.

Applicability of the HTA results

Variation in Risk Stratification
The HTA model supports extending intervals for low risk patients when low risk is defined from a single photo plus risk factors. As indicated earlier, there is emerging evidence that suggests that use of two photos is the best way to identify low risk patients. Should two photos be the preferred method of identifying low risk patients, then since this has been shown to be a more precise method of stratifying risk, the HTA's results would still support these individuals being screened at 2-yearly intervals in cost effectiveness terms.

Variation in Grading
This analysis does not account for the variation in grading identified through the Four Nations Study. They found variation in quality and consistency in grading practice within England, some variation within Scotland, and the least amount of variation within Wales and Northern Ireland. However, since the data for this study was collected, the New Common Pathway has been introduced which should help to reduce any variation in grading. The variation in grading can impact on this cost-effectiveness analysis through the percentage correctly identified as having retinopathy or the percentage correctly identified as not having retinopathy. The sensitivity and specificity values have been estimated by Oxford University using the modelled Gloucester data.

Model Limitations
This was a cohort model which simulated progression across true retinopathy states but not across observed states. It was therefore not possible to model changes in screening intervals given what was observed in previous screening rounds. Within the simulation model the proportion of people within each true underlying state was used (87% true R0M0 R0M0, 11% true R1M0 R0M0 etc.) and the screening intervals were fixed (i.e. every year or every two years) until their death in the simulation model. This limitation is likely to under-estimate the benefit of moving to intervals based on individuals' risk.

England Only
This model is only based on data from one screening programme in England. Due to differences in processes, more work may need to be done to determine if the results are applicable to all four nations.

Interpretation

With finite resources in the NHS and the healthcare system, it is responsible to maximise the cost effectiveness of NHS programmes. These results show that it is no longer justifiable in cost effectiveness terms to continue to screen low risk patients annually and they should be screened every 2 years instead. This would free up resources that could be re-deployed on other, cost-effective screening activity, or the resource should be decommissioned. Looking ahead, there are two main ways that the resource could be re-deployed within DES:

1. To meet the growing demand for DES resulting from the steady growth of the diabetic population.
2. To increase uptake in the eligible diabetic population. Uptake is around 80% now and if this can be increased, the DES programme will deliver greater overall benefit.

Given the evidence that diabetic eye screening overall is very cost effective compared to no screening, these are both very cost effective options.

Capacity saved

There were 1.93million people screened in 2012/13 in England, with an overall uptake rate for diabetic eye screening of 80%[4]. It is estimated that 68%[vii] of diabetic patients in screening, will be classified as low risk using the requirement to be "ROMO ROMO" in two consecutive photos.

We estimate that, based on these numbers, there would have been 656,000 fewer screens (35% of all screens) in 2012/13; had low risk patients been on 2-year intervals.

There will in fact be a one-year delay factor if 2-year screening is introduced, since patients need to attend an appointment before they can be moved onto a 2-yearly interval. The reduced demand for screenings will start one year after the new intervals are introduced.

Assuming that the diabetic population has been growing and continues to grow by 5% per annum, then we estimate that by 2017, the number of appointments required to keep up with demand would be 2,365,000 screens with annual screening, versus 1,527,000 with 2-yearly screening; a saving of approximately **837,000 screens**.

Potential re-deployment of screening appointments

Graph 1 below shows simplistic projections of screens required per annum under three scenarios, all assuming the diabetes population increases by 5% p.a.:

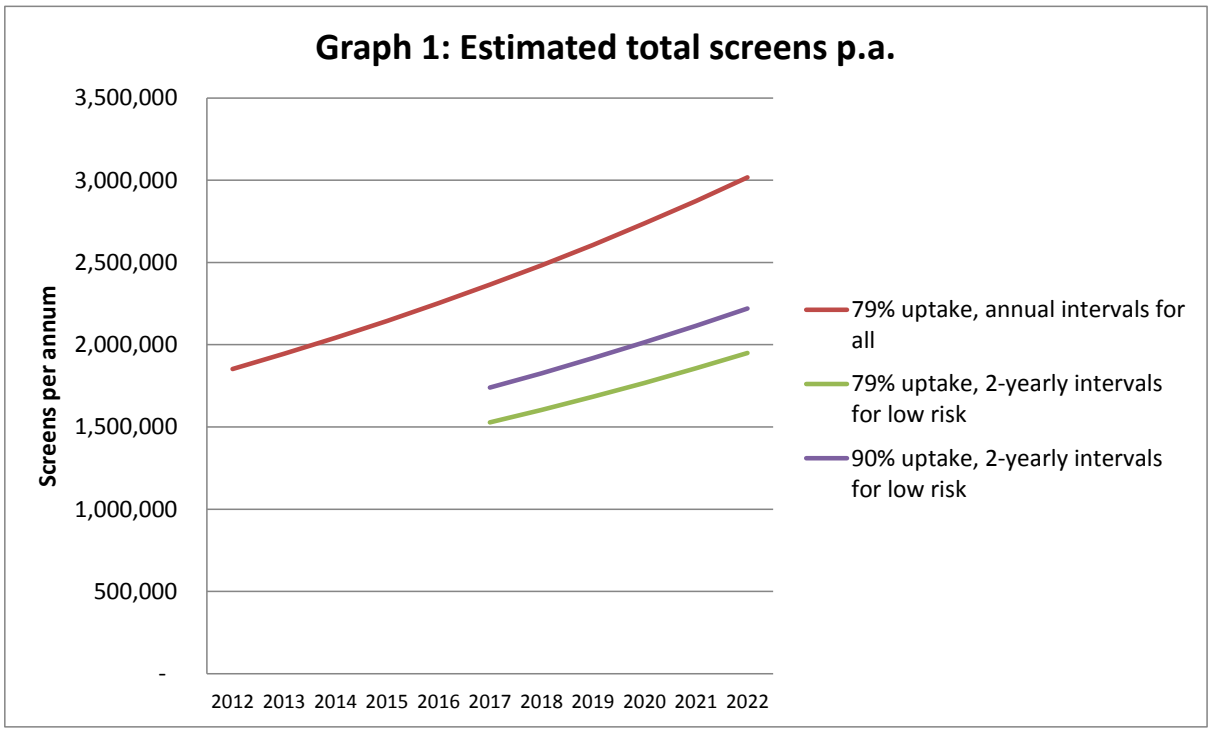
1. Maintaining uptake with annual intervals for all patient screened
2. Maintaining uptake with 2-year intervals for low risk patients and annual for others
3. Increased uptake of 90% with 2-year intervals for low risk patients and annual for others

Scenarios 2 and 3 are only drawn from 2017 onwards by way of illustration that the impact will have a 1 year lag from the point in time that the new intervals are implemented.

All the data-points are estimates based on the 2012 position. This graph demonstrates:

- In 2014, if the programme is maintaining 79% uptake and 1 year screening intervals, we estimate they will deliver 2.0 million screens.
- By 2022, to maintain 79% uptake and 1 year screening intervals, we estimate the programme will need to deliver a total of 3.0 million screens; a 50% increase on current numbers.
- If 2-year screening intervals are introduced, then the programme could maintain 79% uptake to past 2022 within the current capacity of 2 million screens, i.e. keeping up with the growth in the diabetic population
- If 2-year screening intervals are introduced, then the programme could keeping up with the growth in the diabetic population and still have capacity to increase uptake to 90% within the current capacity of 2 million screens up to 2019.

[4] Uptake assumptions in this report vary from 79% to 81%. Actual uptake has remained steady in this region for some time.



Acknowledgements

We would like to acknowledge the following people who have been tremendously helpful in providing us with the information we required to undertake this work:

- Jose Leal, Ramon Luengo-Fernandez and Jason Oke from Oxford University
- Irene Stratton from Gloucester Diabetic Retinopathy Research Group
- Peter Scanlon from NHS Diabetic Eye Screening Programme
- Lynne Lacey, Donna Prentis and Adam Gregory from the National Diabetic Eye Screening Programme
- John Fox from Havering Diabetic Eye Screening Centre
- Jo Taylor, Bev Atack and Kathryn Flynn from Department of Health
- Bob Young from the National Diabetes Audit
- Naomi Holman from Public Health England
- Martin Land from Landmark Health Consulting

Appendix 1 – Detailed results from HTA

Increasing the intervals for the low risk group

The incremental cost effectiveness ratio (ICER) shows the cost of gaining one quality adjusted life year (QALY), which is defined as one year in full health. Moving from annual screening to screening every two years for this group leads to a reduction in the lifetime costs per patient, as well as a marginal reduction in the lifetime QALYs per patient. The reduction in total QALYs is marginal compared to the reduction in costs.

The table below shows that in losing one QALY, you are saving the programme £404,000. If this is expressed in reverse and we were assessing the move from every two years to annual screening for this group, the cost per QALY gained would be £404,000. The Department of Health recommends a threshold of £15,000 per QALY, this is calculated by ranking a range of measures by their cost per QALY and implementing all measures, most cost effective first. The cost per QALY of the final measure that is implemented within the budget is set as the cost effectiveness threshold.

This means that **the £404,000 that is spent on gaining one QALY through annual screening could otherwise be used to generate over 26 QALYs if used elsewhere in the health system, including within the diabetic eye screening programme.**

Table 1: ICER of annual screening compared to screening every two years

	Annual screening	Every two years	Difference
	National average uptake		
Total lifetime costs per 100,000 low risk patients	£3.673bn	£3.655bn	£18m
Total lifetime QALYs per 100,000 low risk patients	621,298	621,253	-45
ICER			£404,207

NB: The reason for the small percentage increase in total costs is that screening, assessment and treatment account for a small proportion of the total lifetime costs associated with diabetic retinopathy for those that start off as low risk patients. The largest component of total costs is social care costs. The "secondary care costs – other" include A&E visits, outpatient appointments and any other secondary care not including treatment of diabetic retinopathy. A breakdown of costs is given below:

Lifetime mean costs per patient	Annual screening	Every two years
Screening	£ 281	£ 141
Assessment/diagnosis at referral	£ 71	£ 34
Secondary care - Treatment	£ 27	£ 14
Secondary care - other	£ 13,384	£ 13,390
Social care	£ 22,970	£ 22,972

Note that no patient travel costs have been included here although they will be available in the HTA.

Impact of changing uptake

We anticipate that changing the screening intervals is likely to have an impact on screening uptake, primarily among those whose screening interval has increased. There are a number of reasons for this:

- Behavioural – Being classed as 'low risk' may cause patients to conclude that they are unlikely to ever develop retinopathy, or at least they are safe for a long time, and so will neglect their screening.
- Routine – In the current system, patients know that every year around a certain date they undergo eye screening, changing that to every other year may lead to patients forgetting to go to their appointment; this impact should be mitigated however by sending invitations and reminders to patients.

The University of Liverpool are currently conducting research into the impact of changing intervals on uptake.

We have assessed the impact of changes in the uptake of screening and assessment, on cost effectiveness. The table below shows that even if uptake decreases to 73%, changing the screening intervals is still incredibly cost effective.

	Annual screening	Every two years		
	National average uptake (81%)	**National average uptake (81%)**	89% uptake (+10% of 81% uptake)	73% uptake (-10% of 81% uptake)
Total lifetime costs per low risk patient	**£36,734**	**£36,551**	£36,570	£36,532
Total lifetime QALYs per low risk patient	**6.2130**	**6.2125**	6.2127	6.2124
ICER		**£404,207**	£524,831	£334,319

Impact of additional IT costs

Stratifying patients into risk groups and altering their invitation date according to their recommended interval is likely to require changes to the IT system. Adam Gregory has estimated that implementing the screening interval changes to stratify risk using two consecutive annual photos within the current IT system would cost around £800,000 + VAT. If a new national IT System were implemented then the changes could be incorporated into the specification for the new system and there would be no cost incurred for introducing the interval change. Finally, if the screening interval changes were implemented after the completion of a national IT system then the costs would be around £100,000 to implement and test.

The results below show the ICER when the maximum IT costs of £800,000+VAT for changing recall intervals are included.

	Annual screening	Every two years		
	National average uptake (81%)	National average uptake (81%)	89% uptake (+10% of 81% uptake)	73% uptake (-10% of 81% uptake)
Total lifetime costs per low risk patient	£36,734	£36,551	£36,570	£36,533

Total lifetime QALYs per low risk patient	6.2130	6.2125	6.2127	6.2124
ICER		**£403,292**	£523,630	£333,561

Reducing the intervals for the high risk group

Reducing the screening interval for those in the high risk category from annual screening to screening every 6 months is not cost effective. The cost per additional QALY gained from reducing screening intervals is £272,000. This far exceeds the Department of Health £15,000 cost effectiveness threshold. The £272,000 that would be spent in order to gain one QALY by reducing intervals could generate over 18 QALYs if spent elsewhere in the healthcare system, including within diabetic eye screening.

	Annual screening	Screening every 6 months
	National average uptake	National average uptake
Total lifetime costs per high risk patient	£ 40,510	£41,335
Total lifetime QALYs per high risk patient	9.284	9.287
ICER		£272,081

Appendix 2 – Background information on diabetes and the DES programme

Current system

Process

In the current system, all diabetics known to the individual programme are invited for screening on an annual basis. Screening involves taking a high definition photo of the retina and grading the photo by identifying whether the photo displays a list of features. From this, the patient receives a different treatment according to their grade:

– Patients that are **R0M0** (meaning they have no signs of background retinopathy (R0) and no signs of maculopathy (M0)) or **R1M0** (meaning that they have signs of background retinopathy but no signs of maculopathy) are invited to return the following year for their screen.

– Patients that are graded **R2M0** are referred to the hospital eye service where they are kept under surveillance and screened more frequently (every 3-9 months) to monitor the progression of the retinopathy.

– Patients that are graded **R3M0 (**active) are referred to the Hospital Eye Service where they receive treatment. They will then return to the screening programme.

– Patients that are identified as having **maculopathy**, regardless of their stage of retinopathy are referred to the Hospital Eye Service for treatment.

The purpose of the diabetic eye screening programme, and the basis on which it is evaluated, is to identify and treat retinopathy. The identification and treatment of maculopathy through DES is a by-product and is not considered in any evaluation of the programme.

Screening takes place in hospital, in GP surgeries, in optometry practices and in mobile vans.

Number of programmes

There are currently 83 programmes operating in England, 1 in Wales, 1 in Scotland and 1 in Northern Ireland.

Total costs

Local programme funding information costs for the 86 programmes are no-longer available to the National Programme. Financial funding information can only be provided for their own National Programme budget. With a few assumptions, the national programme budget is: pay costs: £1.5m, programme centre and non-pay costs: £0.3m; and other (including IT change control of up to £1.4m).

The Diabetic Eye Screening Population

Latest available reliable diabetic screening figures for England relate to Q2 2012/13. There were 1.93million people (aged 12 or over) who received diabetic screening, at an uptake rate of 80%. Approximately 90% of all diabetics have Type 2 diabetes.

- 2.65m people with diabetes identified by screening programmes
- 2.40m people offered screening (98% offered)
- 1.93m people received screening (80% uptake)
- 0.26m people excluded from screening

More recent figures for the whole country are not yet available due to the IT changes brought in as part of the New Common Pathway. Changes brought in by the New Common Pathway included the introduction of a surveillance category and more consistent data definitions, pathways and data flows. The National Screening Programme is still in the process of collating this new information from across the programmes meaning that comparable figures for the 86 centres are not yet available. However, figures from three

early adopters of the pathway have been provided on: (i) the proportion of people with R0M0 in the worst seeing eye (ii) the proportion of people in surveillance (iii) and the proportion of people recommended for treatment at the eye hospital.

- 67% of people screened have R0M0 in the worst seeing eye
- 4% of people screened are in surveillance
- 2% of people screened are recommended for treatment in the eye hospital

Growing diabetic population

The UK diabetic population growing is growing at a rate of 5% per annum (five year average in annual growth rates identified from the QOF).

As the size of the known diabetic population grows, so does the size of the population eligible for diabetic eye screening. The national programme has observed an increase of 6% per annum in the number of people receiving diabetic eye screening.

---

[i] National Institute for Clinical Excellence. Inherited Clinical Guideline E. Management of type 2 diabetes: Retinopathy – screening and early management. London: National Institute for Clinical Excellence, 2002.

[ii] Screening and prevention of diabetic blindness, Einar Stefa´nsson. Acta Ophthalmol. Scand. 2000: 78: 374–385

[iii] Validation of model to estimate risk of progression of diabetic retinopathy using screening and clinical data in 3 cohorts. Stratton, I.M. et al. NIHR HTA

[iv] Can the Retinal Screening Interval Be Safely Increased to 2 Years for Type 2 Diabetic Patients Without Retinopathy? Chalk D., et al, *Diabetes Care 35:1-6, 2012*

[v] Prof. Peter Scanlon, Steve Aldington, Irene M. Stratton M.Sc. FFPH

[vi] Jose Leal, Ramon Luengo-Fernandez, Jason Oke

[vii] Figures were provided through correspondence with the National Screening Programme. Figures represent data from three screening centres that are early adopters of the New Common Pathway.