



Diabetic Retinopathy Screening Intervals: Balancing Safety Against the Cost of Annual Recall

Marina Yiannaki^{1*}, Anders Wikstrom² and Mihai Dinu³

¹Department of Ophthalmology, Troodos Institute of Diabetes Care, Nicosia, Cyprus

²Department of Ophthalmology, Vanern Institute of Metabolic Research, Karlstad, Sweden

³Department of Health Economics, Oltenia Institute of Diabetes Care, Craiova, Romania

*Correspondence to: Marina Yiannaki, Department of Ophthalmology, Troodos Institute of Diabetes Care, Nicosia, Cyprus

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Abstract

Annual screening for diabetic retinopathy has been standard for two decades, and the interval was set by expert opinion rather than by evidence. Extending it for people at low risk has since been recommended and, in England, implemented for those with no detectable retinopathy at two consecutive visits. The economic case is not uniform. A Welsh cost-utility analysis of 26,812 people with type 2 diabetes and 1,232 with type 1 reported that moving to biennial screening saved the health service £71,243 per quality-adjusted life year forgone in type 2 diabetes but only £23,446 in type 1, and at a lower discount rate the type 1 figure fell to £14,221, below the threshold at which the trade is considered acceptable. A randomised equivalence trial has tested intervals of 6, 12 and 24 months by individual risk. The unresolved question is equity: the safety evidence derives largely from populations of white ethnicity, and analysis of 105,083 people has raised the possibility that extending intervals delays detection in some groups.

Keywords: Diabetic retinopathy; Screening interval; Risk stratification; Cost-effectiveness; Health equity

Introduction

Systematic photographic screening for diabetic retinopathy is among the more successful screening programmes in medicine, and is highly cost-effective compared with no screening [1,2,3]. Annual invitation for everyone aged 12 and over was introduced across the United Kingdom by 2007 [4,24]. International guidance recommends screening at intervals adapted to available resources, and national position statements differ in the intervals they endorse [20,21].

The choice of a one-year interval was not derived from trial evidence. It was based on expert opinion, and the question of the optimal frequency has remained open since [4,5]. Progression from no retinopathy to sight-threatening disease is slow in most people, which raises the possibility that annual recall over-investigates a large low-risk majority [6,7,16,17]. Retinopathy remains a leading cause of certifiable sight loss in working-age adults, which is why the question is handled cautiously [22,23].

In 2016 the UK National Screening Committee recommended that people at low risk could be screened every two years, and since October 2023 those with no detectable retinopathy at two consecutive visits in England are invited biennially [4,8]. This review examines the evidence behind that change and what remains unsettled.

Material and Methods

Search strategy: PubMed and the archives of the major ophthalmology, diabetes and health economics journals were searched for studies of screening intervals in diabetic retinopathy. Search terms combined diabetic retinopathy screening with interval, biennial, risk stratification, cost-effectiveness and equity. Reference lists of the health technology assessment [9] and the randomised trial protocol [4] were screened by hand for primary sources.

Eligibility: Studies were included if they compared screening intervals in defined populations, modelled the

cost-effectiveness of extending them, or examined differential effects between population groups. Modelling studies are identified as such and distinguished from empirical cohorts.

Data extraction and handling: Design, population, the risk definition used and the reported estimate were extracted as published. Whether an estimate derives from a model or from observed outcomes is stated alongside every figure, because most of the case for extended intervals rests on modelling rather than on measured events. No pooling or re-analysis was performed. Figures 1 to 6 and Tables 1 to 3 reproduce published values only. This is a narrative synthesis and was not registered as a systematic review.

Results

Who counts as low risk: The definition adopted in practice is the absence of detectable retinopathy at two consecutive screening episodes. Modelling of national longitudinal data from Scotland, using a continuous-time hidden Markov model fitted to observed transitions, confirmed that this group faces the lowest risk of progressing to referable disease [10]. Two studies have shown that progression to sight-threatening retinopathy is significantly higher in those with background retinopathy in both eyes than in one or neither [4,11]. Modelling of Scottish national data predicted the consequences of extension directly [17], community programme data describe how status progresses between episodes [16], and delay has been shown to raise the rate at which referable disease is found when screening does occur [29].

The randomised evidence: A two-arm parallel-assignment equivalence trial randomised individuals aged 12 and over in a single English programme 1:1 to annual screening or to individualised variable-interval screening, with recall at 6, 12 or 24 months for those at high, medium and low risk respectively, determined at each episode by a risk-calculation engine using local demographic and clinical data (Figure 1). Minimum follow-up was two years [4,12].

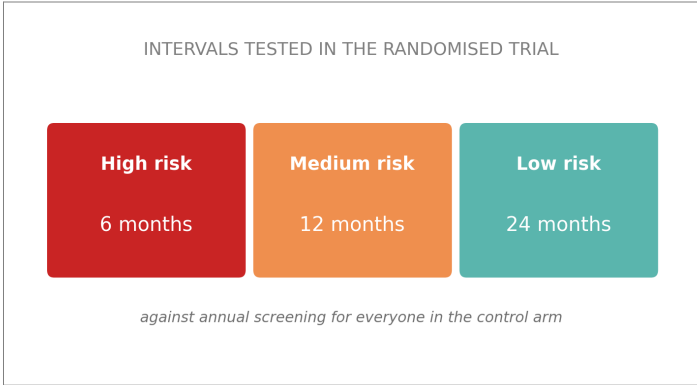


Figure 1: Screening intervals tested in the randomised equivalence trial [4,12]

The economic case, and where it divides: A retrospective cost-utility analysis in the Welsh programme linked screening records to primary care data for people with two prior screening

events and no retinopathy. Transition probabilities were estimated from 26,812 people with type 2 diabetes and 1,232 with type 1 (Figure 4). The analysis reported decremental cost-effectiveness ratios of £71,243 per quality-adjusted life year for type 2 diabetes and £23,446 for type 1 at a 3.5 per cent discount rate, against a threshold of £20,000 (Figure 2) [13].

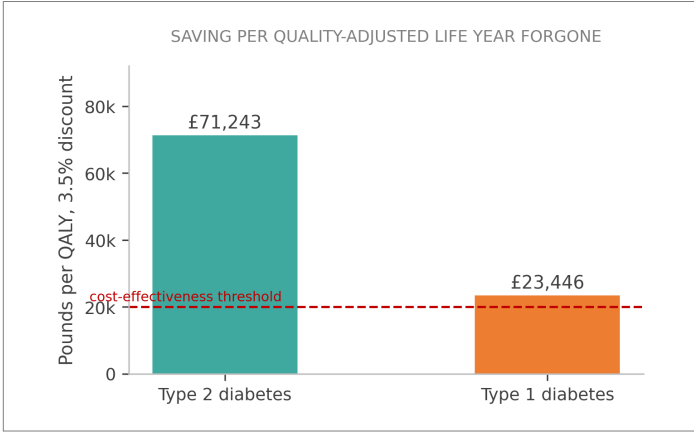


Figure 2: Saving per quality-adjusted life year forgone by moving to biennial screening [13]

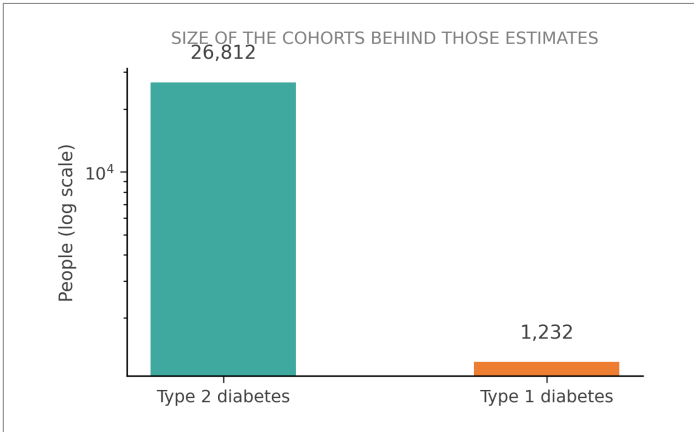


Figure 4: Size of the cohorts from which those estimates were derived [13]

The discount rate changes the answer: At a 1.5 per cent discount rate the same analysis produced £56,822 for type 2 diabetes and £14,221 for type 1 (Figure 3). The type 2 figure remains well above the threshold; the type 1 figure falls below it. The investigators concluded that biennial screening is cost-effective in type 2 diabetes irrespective of HbA1c and duration, but that annual screening should be maintained in type 1 diabetes, particularly where HbA1c exceeds 80 mmol/mol or duration exceeds 12 years [13]. Mean HbA1c in the modelled populations was 7.5 per cent for type 2 and 8.7 per cent for type 1 (Figure 5).

Table 1: Saving per quality-adjusted life year forgone, by diabetes type and discount rate [13]

Table 2: Screening strategies and the evidence supporting each

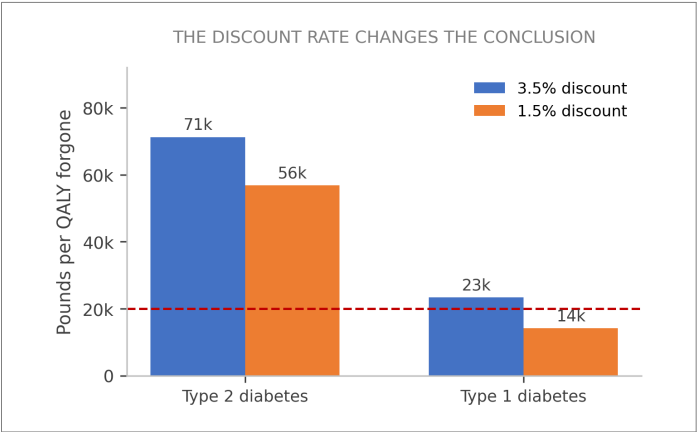


Figure 3: Effect of the discount rate on the economic conclusion [13]

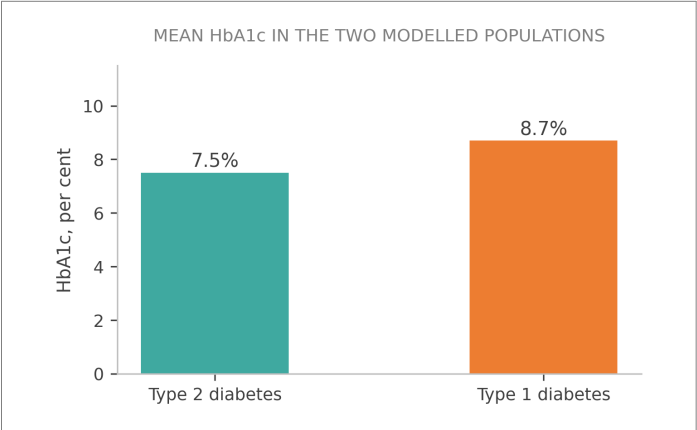


Figure 5: Mean HbA1c in the two modelled populations [13]

Population	3.5% discount	1.5% discount	Conclusion
Type 2 diabetes	£71,243	£56,822	Biennial cost-effective
Type 1 diabetes	£23,446	£14,221	Annual should be maintained
Threshold applied	£20,000	£20,000	—

Longer intervals in modelling: A health technology assessment modelled several stratified strategies and found that screening low-risk patients every five years and high-risk patients every two would be the most cost-effective approach, while noting considerable uncertainty in the natural history of progression, the relationship between utility and visual acuity, and the effectiveness of treatment for maculopathy [9]. A separate algorithm validated in 9,690 people in England calculated individual risk of preproliferative retinopathy, proliferative disease and maculopathy from clinical data [7]. Commentators on that work cautioned that a five-year ceiling may be dangerously long, because clinical risk factors change within the interval, and that intervals of three to five years would require risk to be recalculated in the diabetes or general practice clinic in the meantime [7,14,30]. Automated image analysis and deep learning systems have been proposed to reduce the workload that frequent screening generates [18,19].

Strategy	Basis	Status
Annual for everyone	Expert opinion	Long-standing default [4,5]

Strategy	Basis	Status
Biennial if no retinopathy twice	Observational plus modelling	Implemented in England [8,10]
Variable 6, 12 or 24 months	Risk-calculation engine	Tested in a randomised trial [4,12]
Five-yearly for low risk	Cost-effectiveness model	Modelled only; cautioned against [7,9,14]

The equity question: Analysis of the North East London programme identified 105,083 people with no retinopathy at two consecutive visits between 2012 and 2023 and linked them to electronic health records, in order to examine whether annual and biennial screening carry equitable risk of sight-threatening disease among those classed as low risk [8]. The investigators noted that the research supporting extended intervals has mainly included people of white ethnicity, that a systematic review judged the evidence insufficient to warrant extension, and that recent work suggests extension may delay detection of sight-threatening retinopathy, particularly in certain sociodemographic groups (Figure 6) [8,15]. Inequalities in participation by socioeconomic position and ethnicity are long documented [32,33], as is variation in the prevalence of retinopathy between ethnic groups attending the same programmes [34], against national prevalence figures that provide the denominator [28].

THREE CAUTIONS ATTACHED TO EXTENDING THE INTERVAL

The annual interval was never tested
it was set by expert opinion, not evidence

The evidence is mostly from one ethnic group
equity of extended intervals is unresolved

Type 1 and type 2 behave differently
the economic case does not hold for both

Figure 6: Three cautions attached to extending the screening interval [4,8,13]

Concern	What has been raised
Evidential basis of the annual interval	Set by expert opinion, never tested [4,5]
Composition of the evidence	Mainly populations of white ethnicity [8]
Differential delay	Detection may be delayed in some groups [8,15]
Disengagement	Being told one is low risk may reduce engagement [4]
Type 1 diabetes	Economic case does not hold at lower discount rates [13]

Table 3: Cautions attached to extending the screening interval

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Discussion

The first thing to say is that the comparison is not between a validated standard and a proposed departure from it. The annual interval was chosen by expert opinion when systematic screening was introduced, and no trial had tested it [4,5]. Extending to two years is therefore a change from one unevidenced interval to another with more supporting analysis behind it, which is a weaker claim than it is usually given.

The economic finding is easy to misread and worth stating carefully. The Welsh analysis is decremental: biennial screening is expected to produce slightly worse health outcomes and substantially lower cost, and the ratio expresses how much money is saved for each quality-adjusted life year given up [13]. A figure of £71,243 in type 2 diabetes means the saving is large relative to the health forgone and therefore acceptable against a £20,000 threshold. It does not mean biennial screening is better.

The divergence between diabetes types deserves more attention than it receives. At a 3.5 per cent discount rate the type 1 figure of £23,446 clears the threshold only narrowly, and at 1.5 per cent it falls to £14,221 and does not clear it at all [13]. The type 1 estimate also rests on 1,232 people against 26,812 for type 2, so it is the less certain of the two, and mean HbA1c in that group was 8.7 per cent against 7.5. A policy applied uniformly to both populations is not supported by this analysis.

The equity concern is the one that should give most pause. The evidence that extended intervals are safe was generated largely in populations of white ethnicity, and a systematic review considered it insufficient to justify extension at all [8,15]. If progression is faster in some groups, then a policy calibrated on the average will delay detection unevenly, and the people affected will be those already less well served. That is a specific, testable concern rather than a general caution, and the North East London work was designed to address it.

A softer risk also runs through this literature and is difficult to quantify. If patients are told that they are low risk and need not attend for two years, some may reasonably conclude that their diabetes requires less attention generally [4]. The screening appointment is, for a proportion of people, the most regular contact they have with any part of the service. Removing half of those contacts to save money is a trade that the eye-specific modelling does not capture.

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Study limitations

The limitations belong to the underlying literature. Most of the case rests on modelling rather than measured outcomes, and the health technology assessment explicitly noted considerable uncertainty in the natural history of progression, the utility weights and the effectiveness of maculopathy treatment [9,25]. Whether the interval could safely be doubled in type 2 diabetes without retinopathy has been asked directly [26], and systematic review has examined the relationship between interval and incident visual loss [27]. The Welsh analysis is retrospective and its type 1 estimate derives from 1,232 people, so the confidence around it is wide [13]. Cost-effectiveness conclusions are sensitive to the discount rate, which is an analytic convention rather than an empirical quantity [13]. The randomised trial was conducted in a single English programme with a minimum of two years of follow-up, which is short relative to the progression it is designed to detect [4,12]. Definitions of low risk differ between programmes, and grading systems are not identical internationally, so results do not transfer directly [1,9]. The evidence base under-represents non-white populations, which is the specific gap the equity work addresses [8,15]. And screening intervals interact with attendance, which itself varies by deprivation and is not held constant in these analyses [2,8,32]. Quality assurance frameworks for these programmes predate the interval debate [31].

Conclusion

Extending the screening interval for people with no detectable retinopathy is reasonable, better evidenced than the annual interval it replaces, and economically sound in type 2 diabetes by a wide margin. Three things qualify that. The economic case in type 1 diabetes is marginal at one discount rate and fails at another, and rests on a cohort twenty times smaller. The safety evidence was generated mainly in white populations, and the possibility that extension delays detection in other groups is open rather than excluded. And the screening appointment is for some people their most reliable contact with diabetes care, which is a value the eye-specific modelling does not measure. A single interval applied to everyone classed as low risk is the part of the policy least supported by what has been shown.

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Conflict of Interest

The authors declare no competing interests.

Ethics Statement

This article reviews previously published studies only. No new patient data were collected and no participants were recruited, so ethical approval was not required.

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