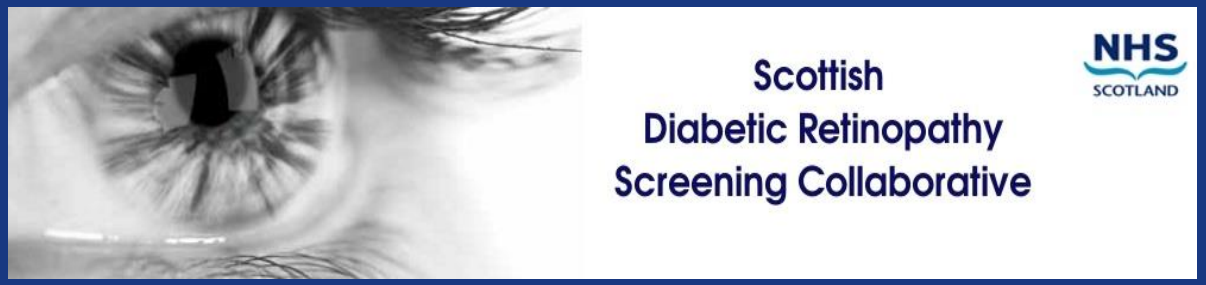
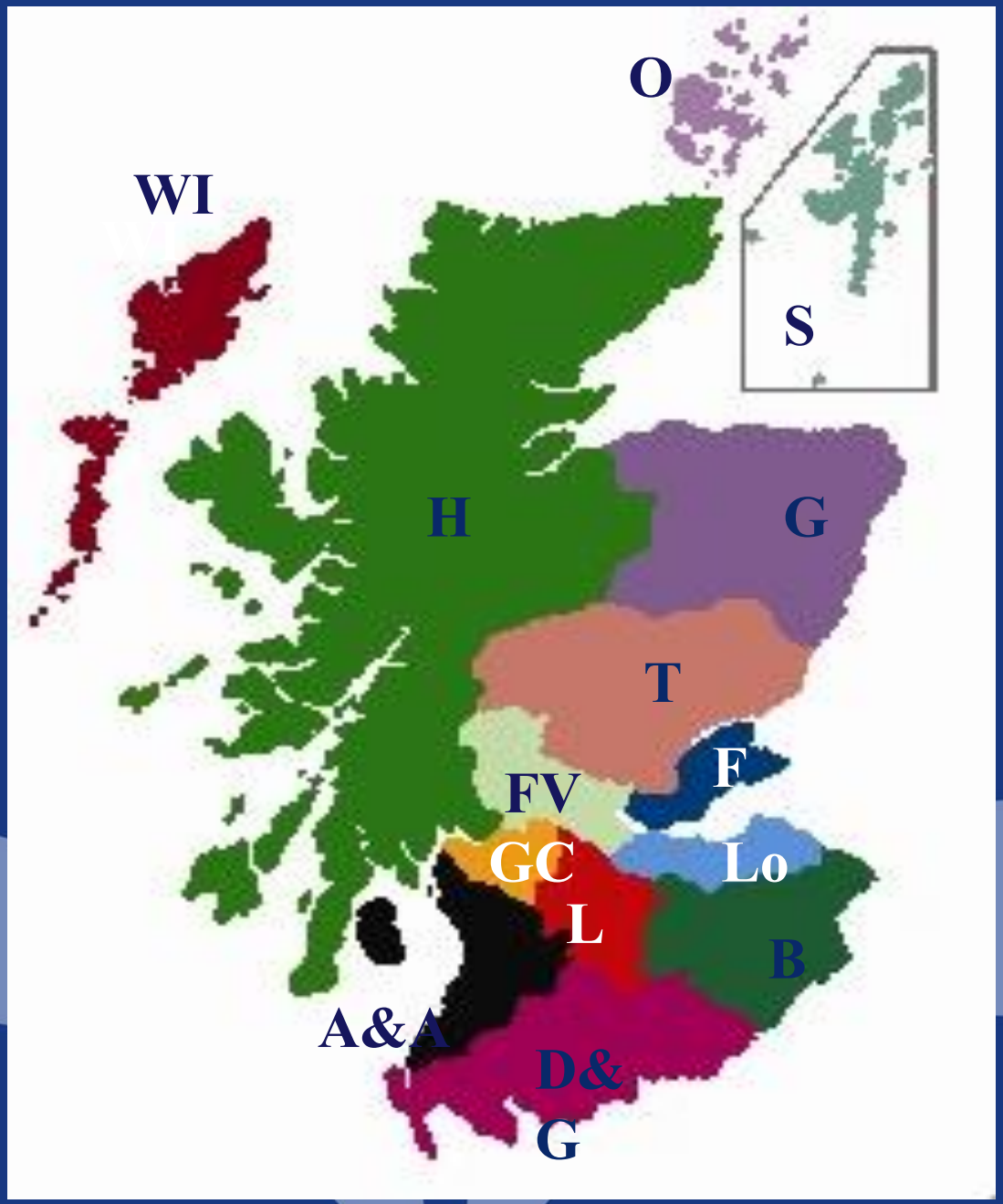


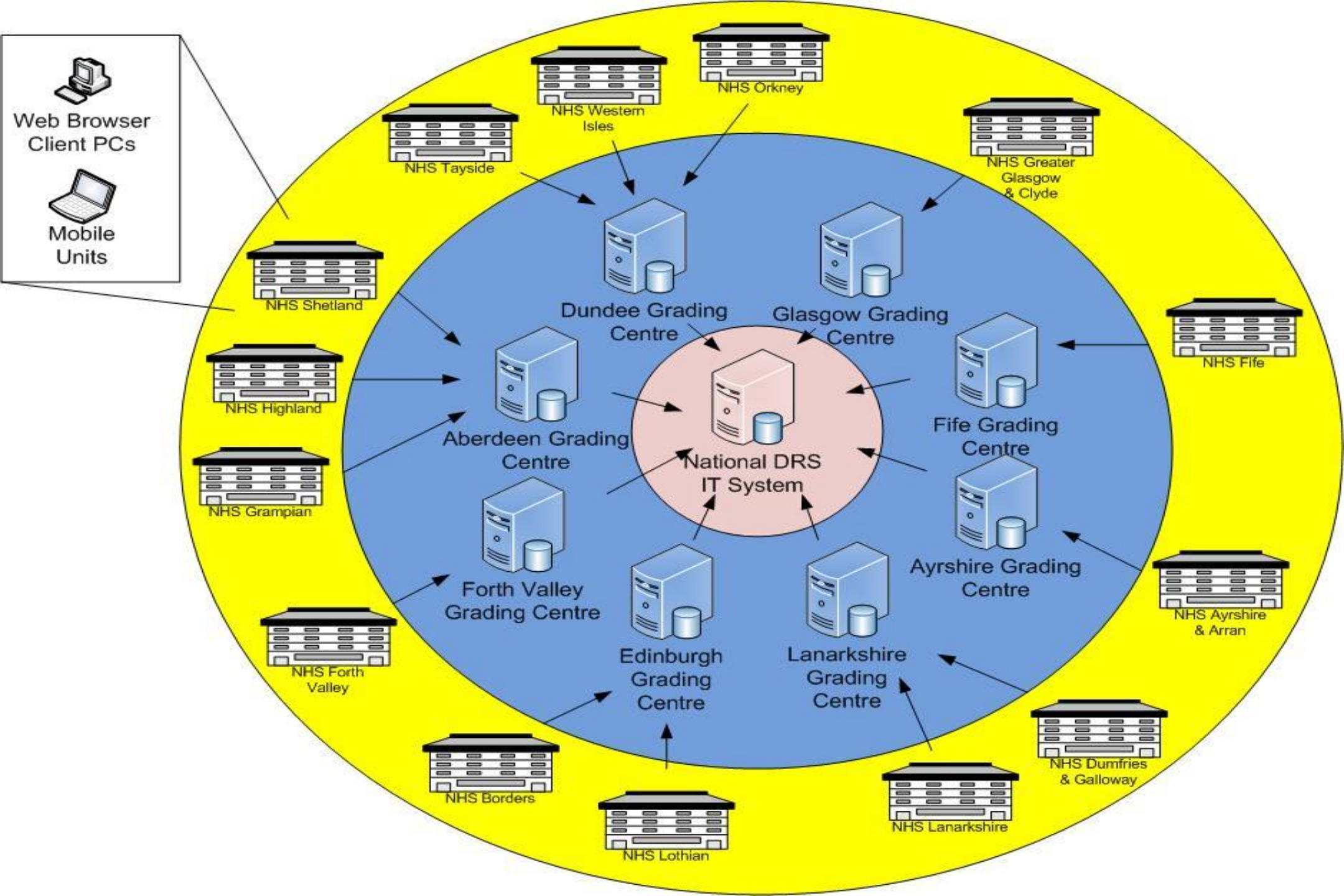
NHS SCOTLAND

Mike Black
National Coordinator
Diabetic Eye Screening Programme Scotland

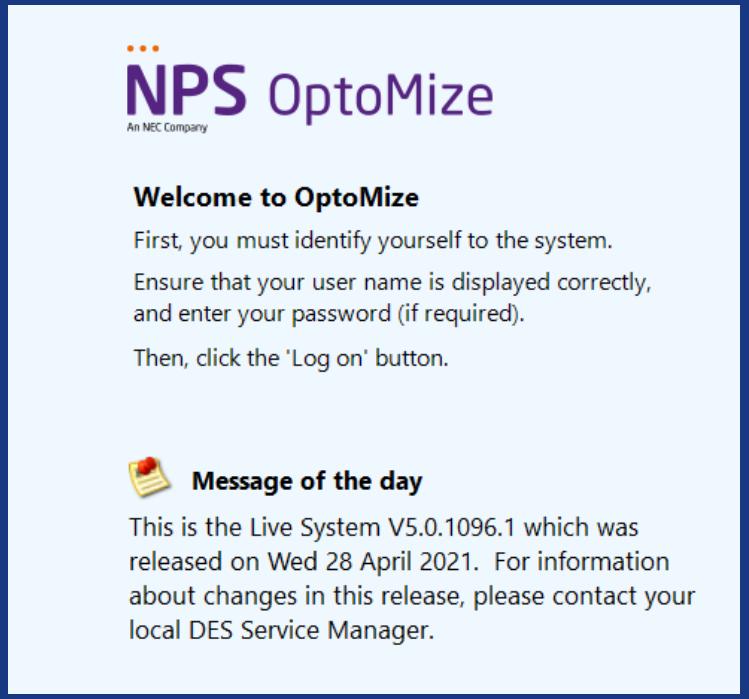


NHS SCOTLAND

Ayrshire & Arran (A&A)
Borders (B)
Dumfries & Galloway (D&G)
Fife (F)
Forth Valley (FV)
Grampian (G)
Greater Glasgow & Clyde (GC)
Highland (H)
Lanarkshire (L)
Lothian (Lo)
Orkney (O)
Shetland (S)
Tayside (T)
Western Isles (WI)


Web Browser Client PCs
Mobile Units
NHS Orkney
NHS Western Isles
NHS Tayside
NHS Greater Glasgow & Clyde
NHS Shetland
NHS Highland
NHS Grampian
NHS Fife
NHS Forth Valley
NHS Ayrshire & Arran
NHS Borders
NHS Lothian
NHS Lanarkshire
NHS Dumfries & Galloway
Dundee Grading Centre
Glasgow Grading Centre
Aberdeen Grading Centre
National DRS IT System
Fife Grading Centre
Forth Valley Grading Centre
Ayrshire Grading Centre
Edinburgh Grading Centre
Lanarkshire Grading Centre

IT system



- Tailored for Scotland
- Implemented in 2020
- Interfaces with SCI-Diabetes, Auto-grader, virtual mail etc.
- Internal Quality Assurance for grading.
- 5.5 million Fundus images – available for research etc.

Programme in Sept 21

- Total diabetic population = 352,802
  Eligible = 299,278
- Uptake ~ 80% (Pre Covid)
- Referral rate to HES ~ 4.0 % (Pre Covid)
  - However ~ 60% of these were M2 (MO) non treatable referrals ☹
  - Hence the introduction of OCT for DES in Scotland – this also includes a Visual Acuity threshold of 6/9.5 Snellen (LogMar 0.2)
  - Screening intervals at 2 years for low risk patients. (RO/MO x 2) introduced in Jan 21.

Scottish DES grading

Health Board: All Health Boards [Global]

Encounter kind: Fundus Screening

VA threshold option: Below VA threshold — **At or below Snellen 6/9.5 or LogMAR 0.2 (or VA not measured)**

Show matrix for pregnant patients: No

Valid | Warning | Invalid

	R0M0	R1M0	R1M1	R4iM0	R4iM1	R2M0	R2M1	R6	R1M2	R4iM2	R2M2	R3M0	R3M1	R3M2	R4M0	R4M1	R4M2
Fundus 12 months	Valid	Valid	Valid	Valid	Valid	Warning	Warning	Warning	Warning	Warning	Warning	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid
Fundus 6 months	Invalid	Invalid	Warning	Warning	Warning	Valid	Valid	Warning	Warning	Warning	Warning	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid
Fundus 3 months (pregnant)	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid
Refer to slit lamp	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Valid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid
Refer to ophthalmology for DR	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Warning	Valid	Valid	Valid	Valid	Valid	Valid	Warning	Warning	Warning
Refer to ophthalmology urgent for DR	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Warning	Warning	Warning	Warning	Warning	Warning	Warning	Valid	Valid	Valid
For OCT surveillance scan	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Valid	Valid	Valid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid
Repeat photography	Warning	Warning	Warning	Warning	Warning	Warning	Warning	Valid	Warning	Warning	Warning	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid

- We have 20 of these outcome/decision matrixes for Fundus, Slit Lamp, OCT, pregnant, above/below the VA threshold.

Scottish DES grading

Health Board: All Health Boards [Global]

Encounter kind: Slit Lamp Biomicroscopy

VA threshold option: Above VA threshold — **Above Snellen 6/9.5 or LogMAR 0.2**

Show matrix for pregnant patients: Yes

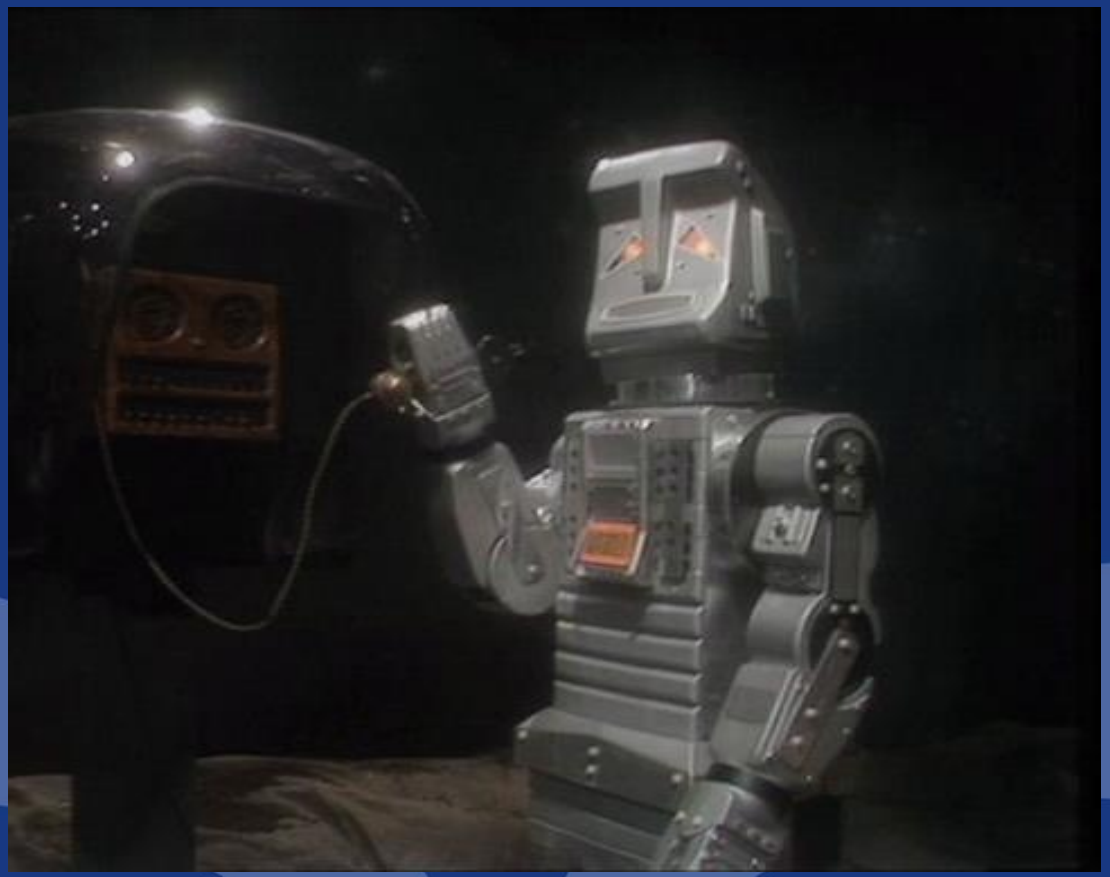
Valid | Warning | Invalid

	R0M0	R1M0	R1M1	R4iM0	R4iM1	R2M0	R2M1	R6	R1M2	R4iM2	R2M2	R3M0	R3M1	R3M2	R4M0	R4M1	R4M2
Fundus 12 months	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid
Fundus 6 months	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid
Fundus 3 months (pregnant)	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Warning	Valid	Valid	Valid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid
Slit lamp 12 months	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid
Slit lamp 6 months	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid
Slit lamp 3 months (pregnant)	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Warning	Valid	Valid	Valid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid
Technical failure	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Valid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid
Refer to ophthalmology for DR	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Warning	Warning	Warning	Warning	Valid	Valid	Valid	Warning	Warning	Warning
Refer to ophthalmology urgent for DR	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Warning	Warning	Warning	Warning	Warning	Warning	Warning	Valid	Valid	Valid
For OCT surveillance scan	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Warning	Warning	Warning	Warning	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid
Re-examine in fundus	Warning	Warning	Warning	Warning	Warning	Warning	Warning	Invalid	Warning	Warning	Warning	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid
Re-examine in slit lamp	Warning	Warning	Warning	Warning	Warning	Warning	Warning	Invalid	Warning	Warning	Warning	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid

Automated grading

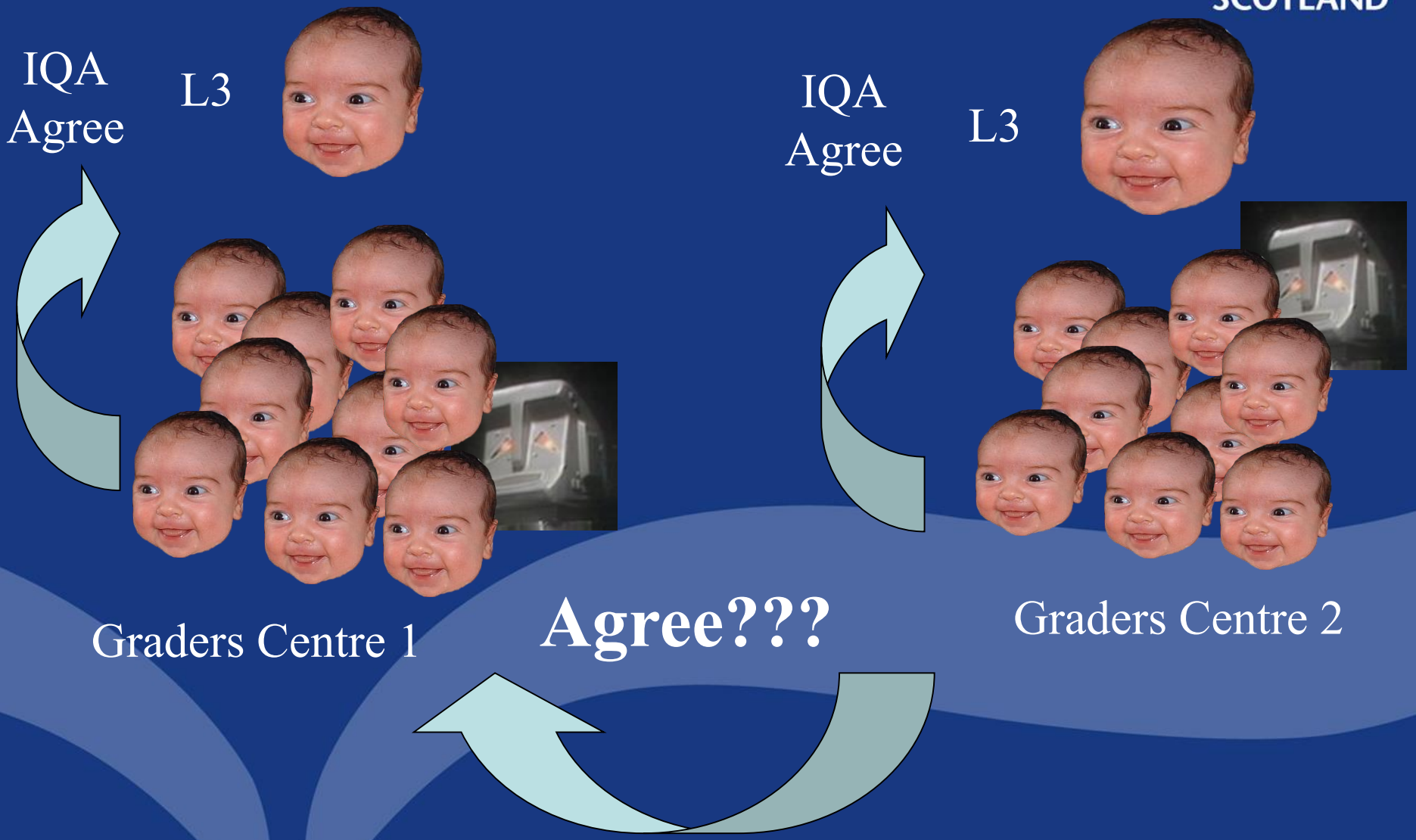
- Automated grading (iGrading M)
  - Detects micro-aneurysms in digital eye images
  - Technical Failure **or** No Disease Detected **or** Disease Detected
  - Cost effective and resilient and reduces manual grading
  - ~40% specificity and ~95% sensitivity for MA
  - not a true automated-grader – its a micro-aneurysm detector!
  - Hard worker – 600+ patients per day, 360 days per annum
  - Not AI but it does re-calibrate itself to null camera artefacts
  - Relatively 'simple' system but effective and cheap
  - Completes the work of 7 to 10 grading staff
  - Operates as a cautious but also very accurate L1 grader working at the bottom of the grading workload triangle
  - iGrading M – currently owned and operated exclusively by NHS Scotland

(what does it look like) Auto-grader

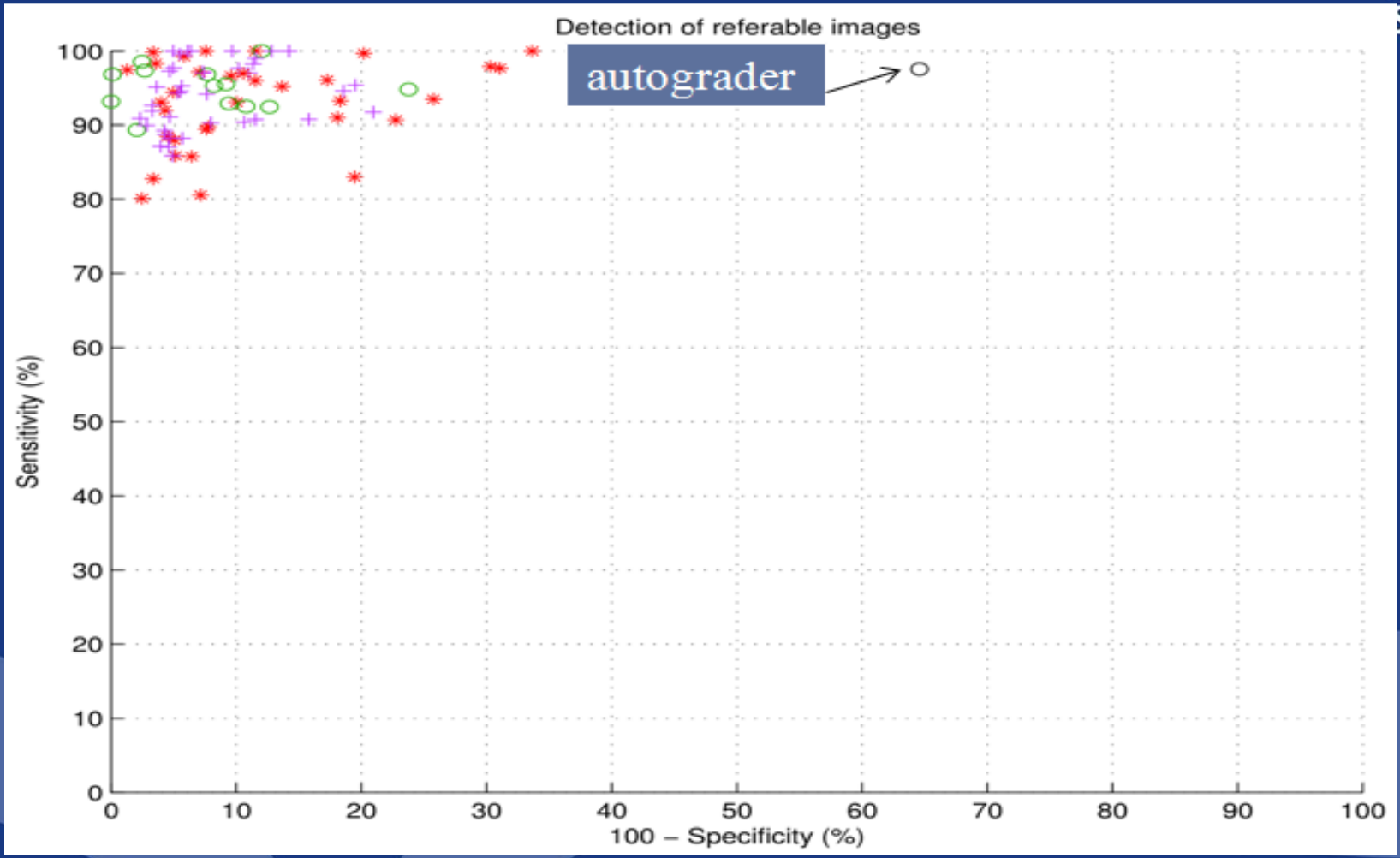


"I think you ought to know…. I'm feeling very depressed .....nobody liked me“

External Quality Assurance - EQA

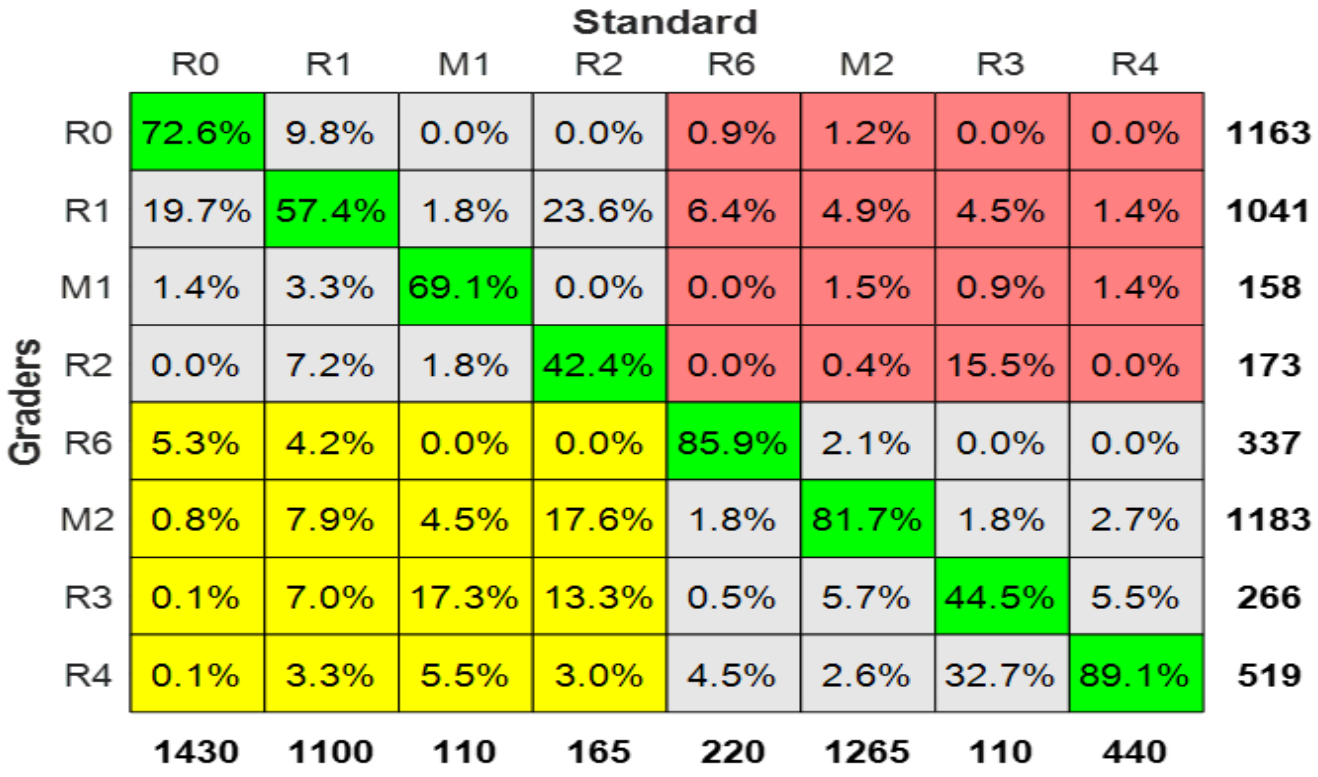


External Quality Assurance



Source: Scottish DRS EQA System, Dr K.A. Goatman, University of Aberdeen

External Quality Assurance



Graders \ Standard	R0	R1	M1	R2	R6	M2	R3	R4	
R0	72.6%	9.8%	0.0%	0.0%	0.9%	1.2%	0.0%	0.0%	**1163**
R1	19.7%	57.4%	1.8%	23.6%	6.4%	4.9%	4.5%	1.4%	**1041**
M1	1.4%	3.3%	69.1%	0.0%	0.0%	1.5%	0.9%	1.4%	**158**
R2	0.0%	7.2%	1.8%	42.4%	0.0%	0.4%	15.5%	0.0%	**173**
R6	5.3%	4.2%	0.0%	0.0%	85.9%	2.1%	0.0%	0.0%	**337**
M2	0.8%	7.9%	4.5%	17.6%	1.8%	81.7%	1.8%	2.7%	**1183**
R3	0.1%	7.0%	17.3%	13.3%	0.5%	5.7%	44.5%	5.5%	**266**
R4	0.1%	3.3%	5.5%	3.0%	4.5%	2.6%	32.7%	89.1%	**519**
	1430	**1100**	**110**	**165**	**220**	**1265**	**110**	**440**	

Figure 7 – Table showing how images of each grade (where the grades along the top show the most serious retinopathy or maculopathy grade according to the standard) were graded. The columns show the distribution of each standard grading, and sum to 100%. The leading diagonal, shown in green, indicates exact agreement between the standard and the graders. The bottom left-hand corner (shown in yellow) indicates "over-grading" according to the standard, and the top right-hand corner (shown in red) indicates "under-grading". The numbers in bold at the end of the rows and columns show the total number of grades in that row or column.

SCI-Diabetes system

- National diabetes management system in Scotland used by all diabetes Healthcare professionals and GPs.
- Feature rich with extensive reporting capability.
- Paediatrics, pharmacy, foot screening, DES, weight, BMI, smoking status, HbA1c, Lab results.....etc
- Interfaces with all GP practices in Scotland.
- Feeds and receives data to/from DES system. Also it connects to the national patient register (CHI) so we know when patients move or arrive/leave Scotland.
- Newly diagnosed patients electronically referred to DES overnight. DES are usually the first service to contact patients. (*new patients are our highest risk cohort)
- See - https://www.sci-diabetes.scot.nhs.uk/

What next ?

- The University of Edinburgh have provided a risk analysis and prediction tool as part of a research project in 2019. This is helping us to risk stratify our lowest risk cohorts.
- This tool is being used to consider our options for the temporary introduction of ‘tolerance’ levels to screening intervals for our lowest risk participants. We need to manage the queue….
- See –
  - https://diabepi.shinyapps.io/ScreeningIntervals/
  - https://www.research.ed.ac.uk/en/publications/use-of-personalised-risk-based-screening-schedules-to-optimise-wo/persons/

DR Screening Schedules and Risk Prediction | Instructions | Predicted Screening Schedules | Practical Schedules | Cohort Specification

Type 1 Diabetes

Interval for no prior DR

1 [12] 120

1 13 25 37 49 61 73 85 97 109 120

Interval for mild prior DR

1 [27] 120

1 13 25 37 49 61 73 85 97 109 120

Interval for moderate prior DR

1 [19] 120

1 13 25 37 49 61 73 85 97 109 120

Type 2 Diabetes

Interval for no prior DR

1 [56] 120

1 13 25 37 49 61 73 85 97 109 120

Interval for no prior DR

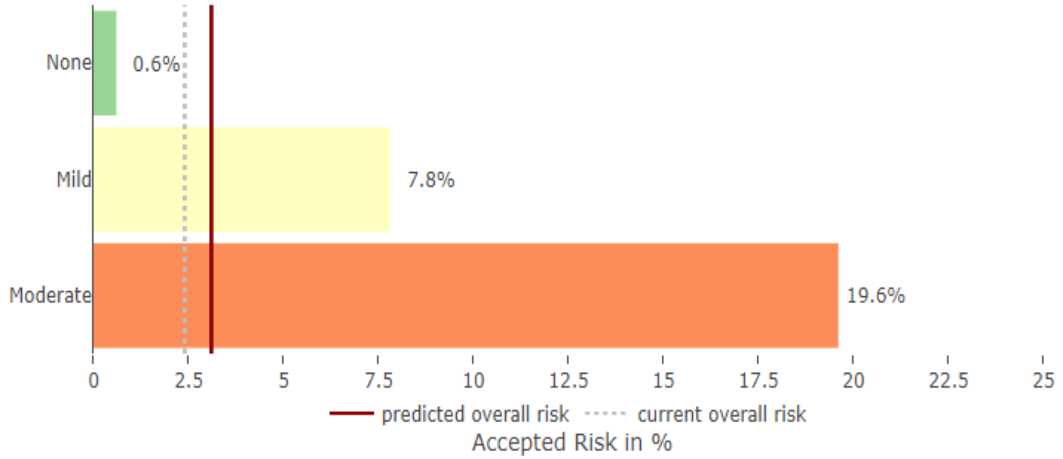
1 [25] 120

1 13 25 37 49 61 73 85 97 109 120

Type 1 Diabetes

Selected Intervals:

no prior DR: 12 months, mild prior DR: 27 months, moderate prior DR: 19 months



Overall Risk

3.1%

Workload Change

-27.9%

14399 Screens Overall

Sojourn Time Change

2.3

in months

Type 2 Diabetes

Selected Intervals:

no prior DR: 56 months, mild prior DR: 25 months, moderate prior DR: 14 months

What next 2 ?

- Recovery from Covid pause and backlog – high risk patients seen first with lower risk patients seen later.
- Electronic interfaces with Ophthalmology (HES) departments for referral from and discharge back to HES
- Interface to the ‘Open Eyes’ EPR project for digital images repository – OCT, HES, Optometry.
- Patient booking service online – book or change appointments via a website and App
- Reporting - SQL for ad-hoc reporting ongoing developments along with dashboards for users.
- MDR compliance for the auto-grader
- Wider development of risk based screening intervals based on other clinical factors as recorded in SCI-Diabetes

NHS SCOTLAND

References

- Br J Ophthalmology 2010;94:1606-1610. doi:10.1136/bjo.2009.176784 – *Automated grading for Diabetic retinopathy: a large-scale audit using arbitration by clinical experts*. Alan D Fleming, Keith A Goatman, Sam Philip, Gordon J Prescott, Peter F Sharp, John A Olson

  Should automated grading of retinal photographs be used in the Scottish Diabetic Retinopathy Screening Service. Prof Norman Waugh, MB ChB, DA, MRCP(UK), MPH, FRCP(Edin) FFHM.

- Costs and consequences of automated algorithms versus manual grading for the detection of referable diabetic retinopathy. G S Scotland, P McNamee, A D Fleming, K A Goatman, S Philip, G J Prescott, P F Sharp, G J Williams, W Wykes, G P Leese, J A Olson.

- **External Quality Assurance for image grading in the Scottish diabetic retinopathy screening programme**

  Keith A. Goatman, Sam Philip, Alan D. Fleming, Roderick D. Harvey, Kenneth K. Swa, Caroline Styles, Mike Black, Lee Neville, Peter F. Sharp and John A. Olson.

  For *Diabetic Medicine*

- Questions