

Screening for Diabetic Retinopathy in Europe Impact of New Technologies

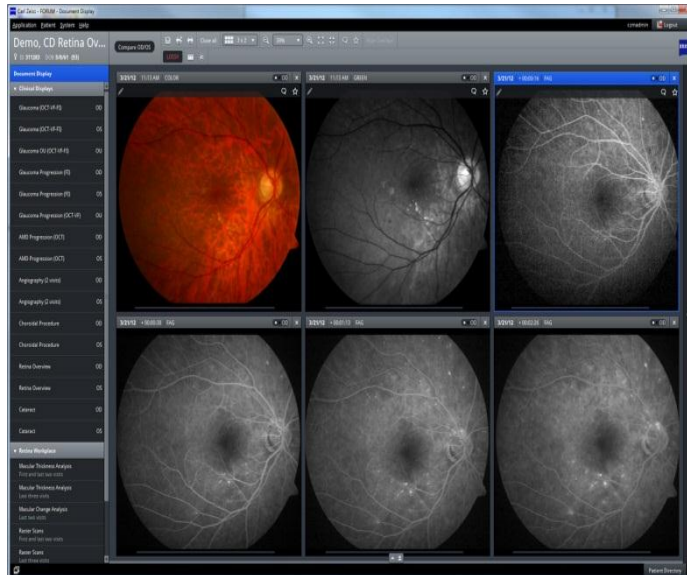
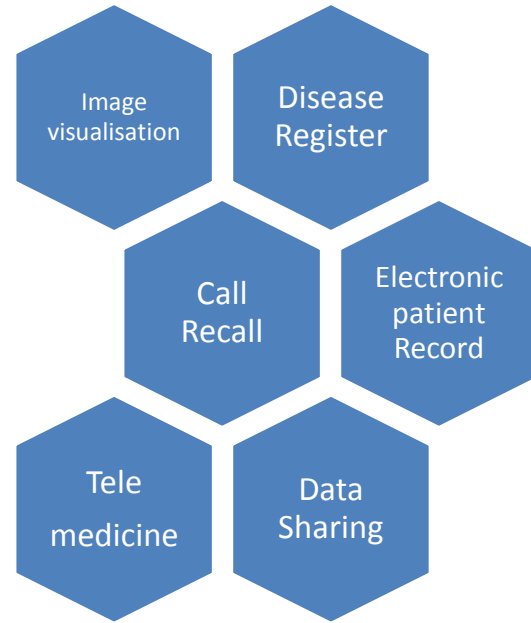
Software developments

Dr Sam Philip, MBBS,MD,MD,FRCP

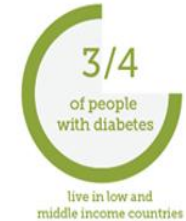
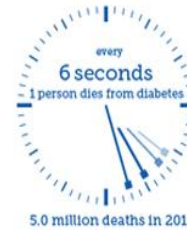
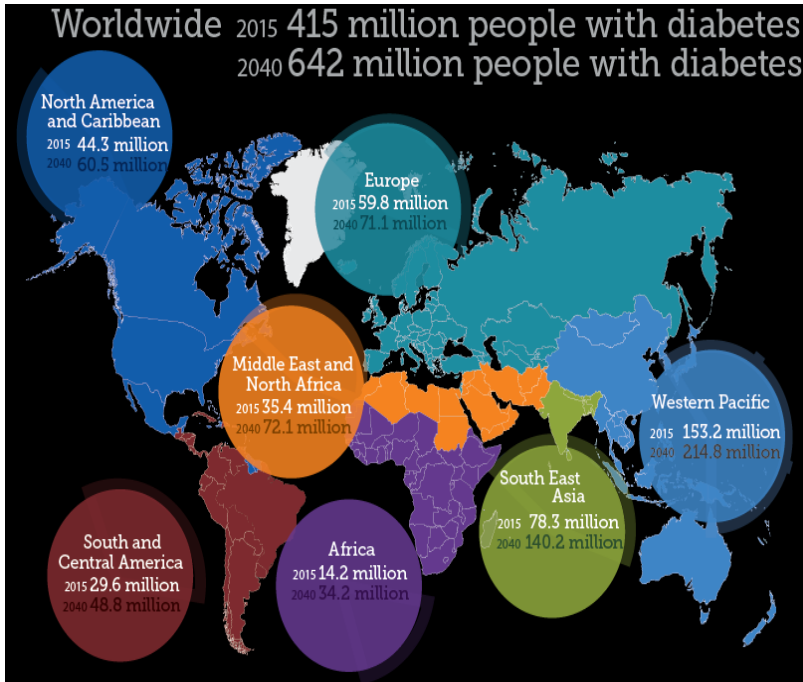
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Honorary senior lecturer, University of Aberdeen

23rd June 2016



Why adopt these new technologies.....



Ensure all eligible patients are Screened at recommended intervals

Improve access and uptake of screening in remote and rural areas, among young people

Decrease cost of screening

Improve Work satisfaction for retinal grading staff

2015

2040



One in 11 adults has diabetes



One in 10 adults will have diabetes



One in two adults with diabetes is undiagnosed

Topics for discussion: Software developments

- **Should automated grading be routinely implemented within systematic screening programmes?**
- **Is there a role for feature based automated grading or is disease / no disease grading the best that can be achieved ?**
- **Which locations in Europe require remote imaging and use telemedicine in screening for Diabetic eye disease?**
- **Is there a role for risk prediction algorithms for developing personalised Screening intervals?**

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Automated grading

[Rev Epidemiol Sante Publique. 1984;32\(3-4\):254-61.](#)

Automatic detection of microaneurysms in diabetic fluorescein angiography.

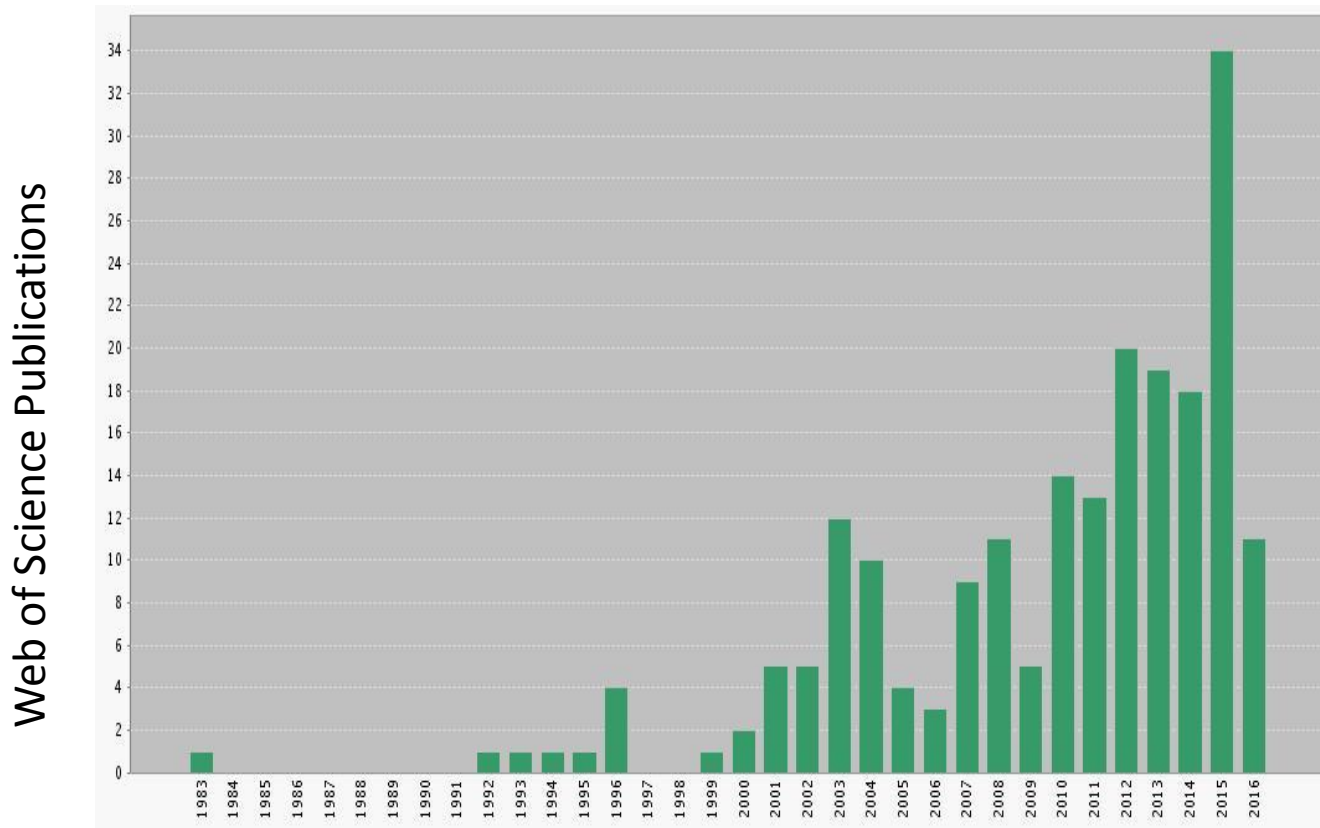
[Baudoin CE](#), [Lay BJ](#), [Klein JC](#).

Abstract

A computerized method for the detection of microaneurysms (MA) in fluorescein angiograms is proposed, using the concepts of mathematical morphology. The MA which are almost circular particles, are extracted from the image by performing different "top-hat transformations". Some particles, however, may then be detected inside the nonhomogeneous vessels, and it is necessary to be able to extract the vascular net. The MA which present fuzzy boundaries (due to the leakage of fluorescein) are the most difficult to extract. The algorithm has been tested on 25 angiograms, with 1 045 MA analysed. A comparison between the automatic counting procedure and three manual methods of counting has been made to prove the robustness of the proposed method.

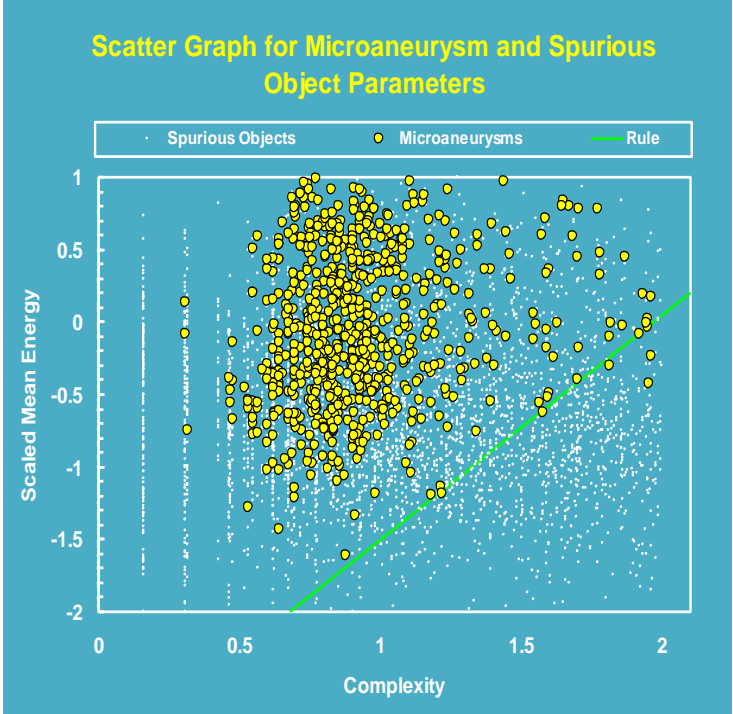
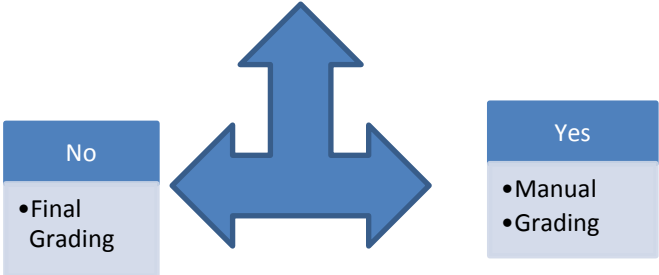
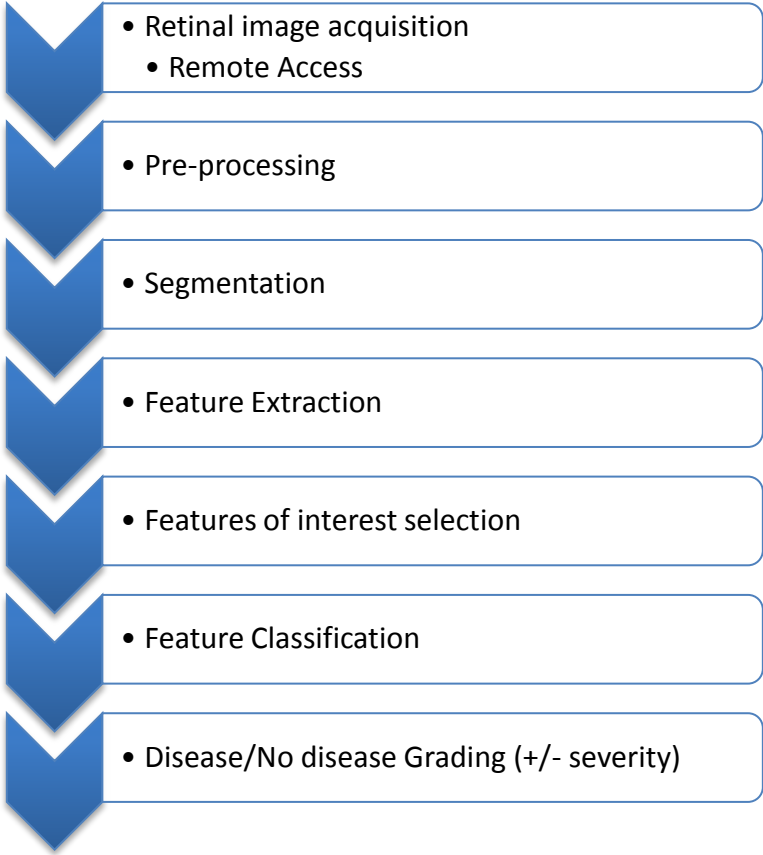
PMID: 6522738 [PubMed - indexed for MEDLINE]

Automated grading



Steady growth in interest.....

Automated grading



Automated DR detection methods.

Authors	Features	Methods (Dataset size)	Salient feature	Performance measure
Two class classification				
Gamer et al. [116]	Pixel intensity	NN (301)	Statistical threshold tuning	Sensitivity-88.40%, specificity-83.50%
Osareh et al. [154]	HEM, MA, hard exudates and cottonwool spots	FCM (142)	Precisely detect's exudates	Accuracy-90.10%
Larsen et al. [156]	Red lesions	DR Visibility threshold (260)	Adjustable visibility thresholding	Sensitivity-96.70%, specificity-71.40%
Sinthanayothin et al. [30]	HEM, MA, and hard exudates	NN (767)	Real time screening	Sensitivity-80.21%, specificity-70.66%
Hansen et al. [160]	Red lesions	DR Visibility threshold (83)	With and without pupil dilation	Sensitivity-97%, specificity-75%
Usher et al. [31]	HEM, MA, hard exudates and cottonwool spots	NN (1273)	Detects maculopathy also	Sensitivity-95.10%, specificity-46.30%
Abramoff et al. [27]	Web-based questionnaire, visual acuity measurement	EyeCheck software (1676)	Telediagnosis system	Interrater agreement-0.93
Neubauer et al. [155]	Retinal thickness	RTA (61)	RTA used for telescreening of DR	Sensitivity-93% (PDR)
Jelinek et al. [159]	MA	Waikato automated MA detector (543)	Color non-mydratic images can be analyzed	Sensitivity-85%, specificity-90%
Kahai et al. [153]	MA	statistical learning (143)	Less computational time (10 ns)	Sensitivity-100%, specificity-67%
Philip et al. [19]	MA and HEM	Wilson score and kappa statistic (527)	Adaptable to local imaging methods and equipments	Accuracy-99.1%
Aptel et al. [152]	HEM, MA, hard exudates and cottonwool spots	Kappa analysis (158)	Three-field strategy without pupil dilation	Degree of agreement-0.82 (single), 0.90 (three), 0.90 (mydriasis), 0.95 (non-mydriasis)
Suthammanas et al. [29]	Exudates	DR telescreening system (100)	Can handle images from various hospitals	Accuracy-92.52%
Agurto et al. [157]	AM-FM features	Distance metrics (376)	Rapid retraining	ROC-0.98
Abramoff et al. [161]	MA, HEM, exudates, and CWS	k-NN classifier (16,770)	It can discard poor quality images	AUC-0.839
Dupas et al. [162]	MA, HEM, and exudates	k-NN classifier (761)	It can able to detect ME	Sensitivity-83.9%, specificity-72.7%
Quellec et al. [33]	Optimal filter frame work	k-NN (67)	Detects drusen and Stargardt's disease flecks also	AUC-0.927
Reza and Eswaran [7]	Hard exudates, CWS, and large plaque of hard exudates	Rule based classifier (20)	Accurate grading of NPDR lesions	Accuracy-97%
Kevin Noronha et al. [158]	Wavelet energy features	SVM (240)	DRRI	Accuracy-99.17%, sensitivity-99.17%, specificity-99.17%
Three class classification				
Lee et al. [163]	HEM, MA, exudates and CWS	NN (430)	High reproducibility	Normal-82.60% Non-Proliferative Diabetic Retinopathy-82.60% Proliferative Diabetic Retinopathy-88.30%
Nayak et al. [3]	Exudates, area of bloodvessel, and contrast	NN (140)	Texture and morphological features	Sensitivity-90% Specificity-100% Accuracy-93%
Mookiah et al. [80]	Blood vessels and exudates area, bifurcation points, global texture and entropies	GA optimized PNN classifier (156)	PNN tuning by GA and Particle Swarm Optimization (PSO)	Sensitivity-96.27%, specificity-96.08%, accuracy-96.15%
Four class classification				
Yun et al. [164]	Perimeter of the blood vessels	NN (124)	Morphological features	Sensitivity-90%, specificity-100%, accuracy-84%
Acharya et al. [165]	Co-occurrence matrix and run length matrix	SVM (238)	DRRI	Sensitivity-98.9%, specificity-89.5%, accuracy-100%
Five class classification				
Acharya et al. [166]	Higher Order Spectra (HOS)	SVM (300)	Non-linear features	Sensitivity-82.50%, specificity-88.90%, accuracy-82%
Acharya et al. [167]	Blood vessel area, exudates, MA, and MA	SVM (331)	Morphological features	Sensitivity-82%, specificity-86%, accuracy-85.9%

Computer-aided diagnosis of diabetic retinopathy: A review

Muthu Rama Krishnan Mookiah^{a,*}, U. Rajendra Acharya^{a,b}, Chua Kuang Chua^a, Choo Min Lim^a, E.Y.K. Ng^c, Augustinus Laude^d





Accurately Identify Referable DR Patients in Minutes

With No Human Grading Needed



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IGRADING™ PLATFORM- DIABETIC RETINOPATHY SCREENING SOFTWARE

The IGrading platform is an CE-accredited innovation that can help reduce the risk of blindness by detecting early incidences of diabetic retinopathy. The product is the result of a collaboration with the University of Aberdeen, SHIL and NHS Grampian and commercial partner Medalytix Ltd.

The IGrading system utilises automated computer algorithms to assess image quality and detect early signs of diabetic retinopathy, allowing a cost-effective and immediate alternative to the manual grading process. The programme works by rapidly scanning digital photos taken of the eyes of people with diabetes. It hunts for tiny blood spots - microaneurysms - which are the earliest signs of diabetic retinopathy. Use of IGrading allows separation of those patients whose images have no problem and can be recalled in one year, from those with a problem, whose images need to be reviewed by a trained person or ophthalmologist.

<http://www.shil.co.uk/>

Retmarker Screening Biomarker Medisoft Other Products News

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RetmarkerDR RetmarkerDR is a biomarker for Diabetic Retinopathy progression in a mild non-proliferative stage, predicting sight threatening Diabetic Retinopathy through the quantification of microaneurysms turnover ratios, namely for Clinically Significant Macular Edema.

There is a FREE Trial of RetmarkerDR available for download that entitles each user to install the software and process 20 free analysis (sets of images).

DOWNLOAD FREE TRIAL VERSION


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According to our research, where we analysed different type 2 diabetic patients (with non-proliferative retinopathy), Microaneurysm Turnover was a key factor for the classification in different phenotypes and appears to be a good predictor of progression to Clinically Significant Macular Edema (CSME).

Professor Conceição Lobo, Leading ophthalmologist and researcher from the University Hospital of Coimbra, Portugal



<http://www.retmarker.com/>



Retinopathy online challenge: automatic detection of microaneurysms in digital color fundus photographs

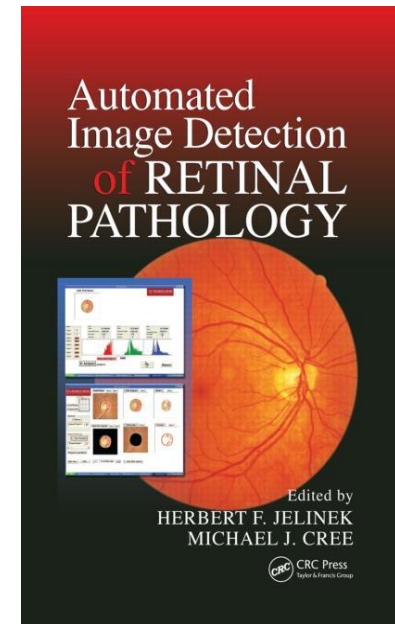
Meindert Niemeijer, Bram Van Ginneken, Michael J. Cree, Atsushi Mizutani, Gwénoél Quéléec, Clara I. Sanchez, Bob Zhang, Roberto Hornero, Mathieu Lamard, Chisako Muramatsu, et al.

Detailed Project Description: Can automated Diabetic Retinopathy Image Assessment software replace one or more steps of manual imaging grading and is this cost-effective for the English National Screening Programme?

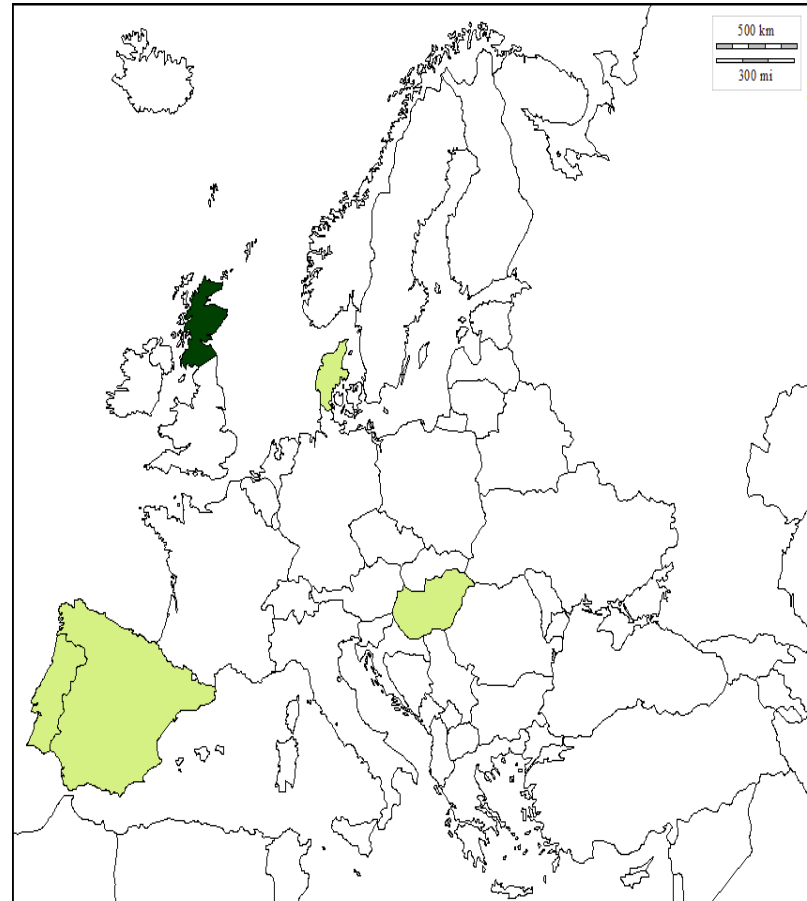
HTA Priority Area: 11/21 - Automated reading of retinal photography in diabetic eye screening

Lead applicant: Adnan Tufail

Co-applicants: Ms Catherine Egan, Dr Alicja Rudnicka, Dr Christopher Owen, Ms Clare Bailey, Dr Caroline Rudisill, Dr Paul Taylor



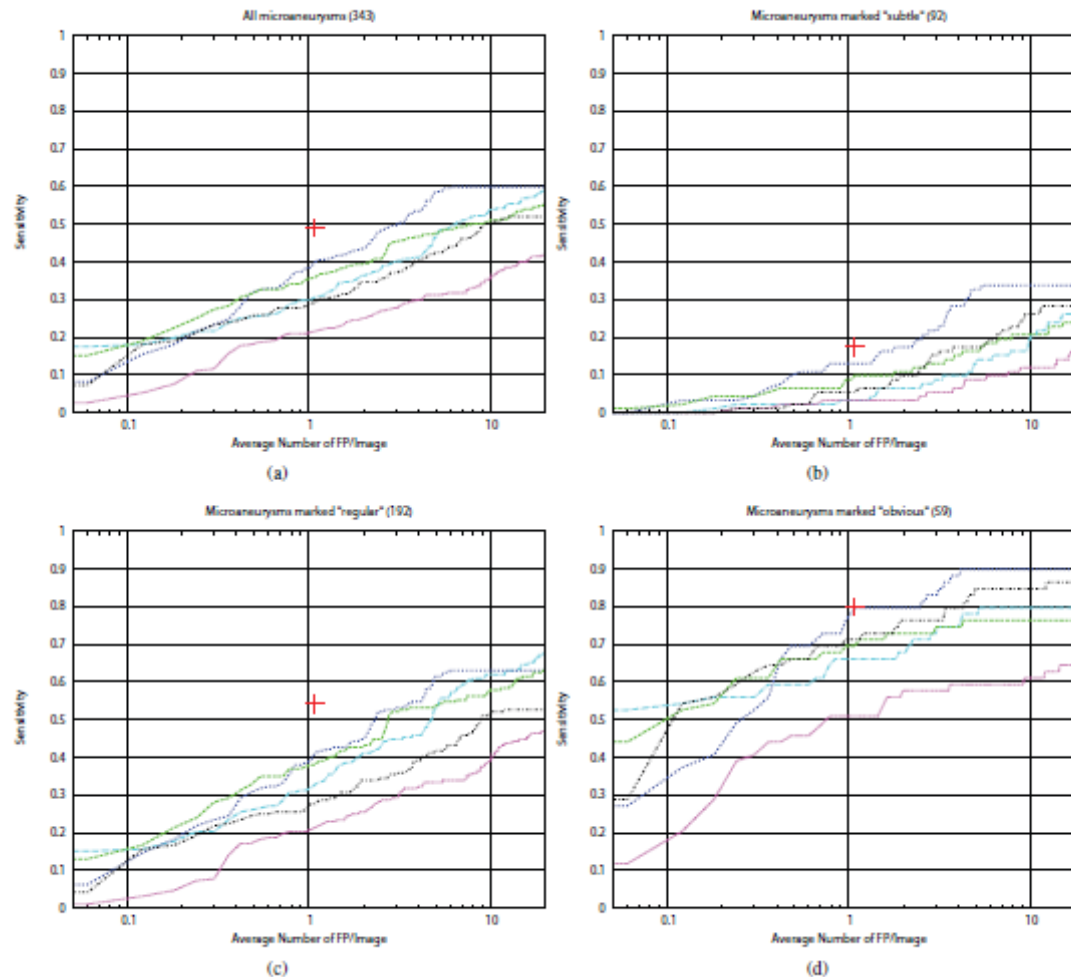
Automated Retinal Screening : Current Uptake



Topics for discussion: Software developments

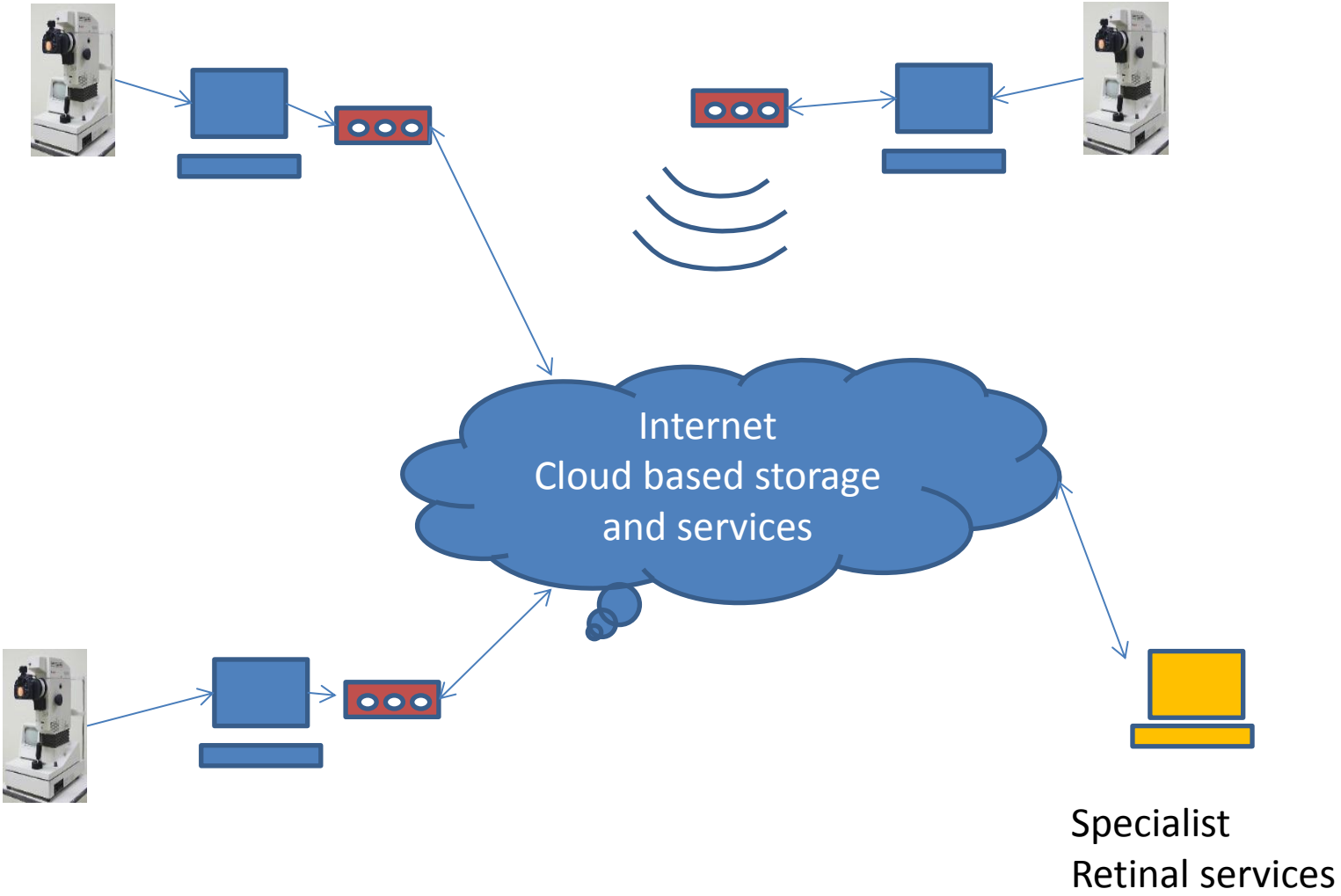
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Automated performance



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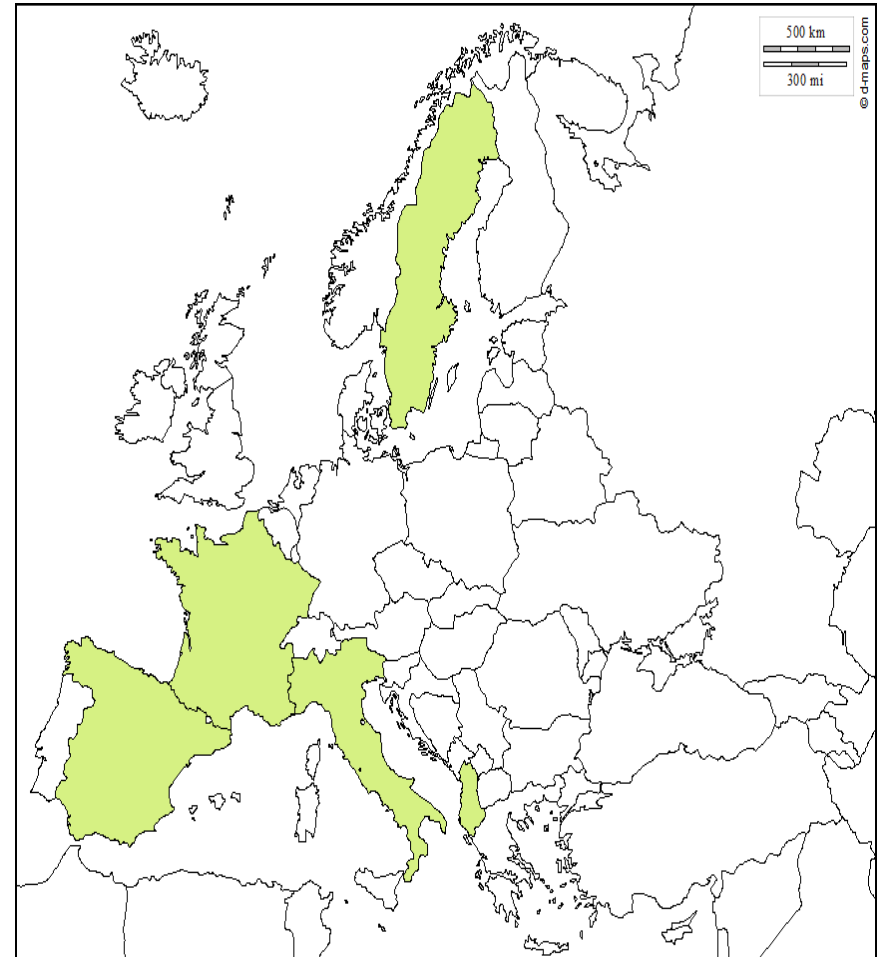


Telemedicine: Current Uptake

potential to improve the regular annual evaluation for diabetic retinopathy

Cost to service
Cost to patient
Improved uptake

The organization of the network around a central reading centre serves to guarantee quality control.



[Diabetes Metab.](#) 2008 Jun;34(3):227-34. doi: 10.1016/j.diabet.2007.12.006. Epub 2008 May 9.

OPHDIAT: a telemedical network screening system for diabetic retinopathy in the Ile-de-France.

[Massin P¹](#), [Chabouis A](#), [Erginay A](#), [Viens-Bitker C](#), [Lecleire-Collet A](#), [Meas T](#), [Guillausseau PJ](#), [Choupot G](#), [André B](#), [Denormandie P](#).

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Table 1 Number and incidence (%) of individuals who develop R2 (preproliferative retinopathy), R3A (active proliferative retinopathy), M1 (diabetic maculopathy) or any of R2, R3A or M1, split up by sex and type of diabetes

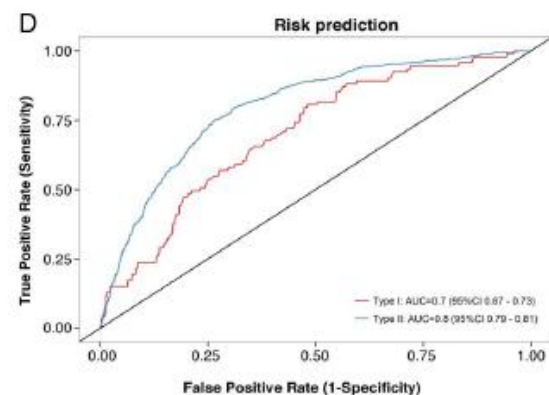
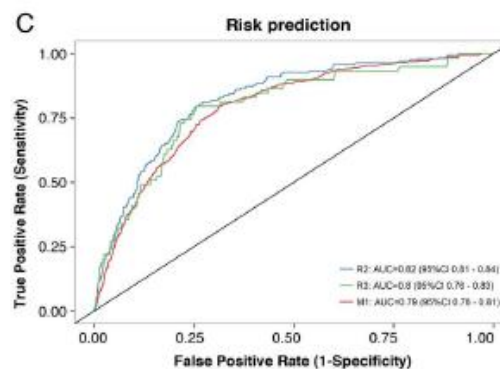
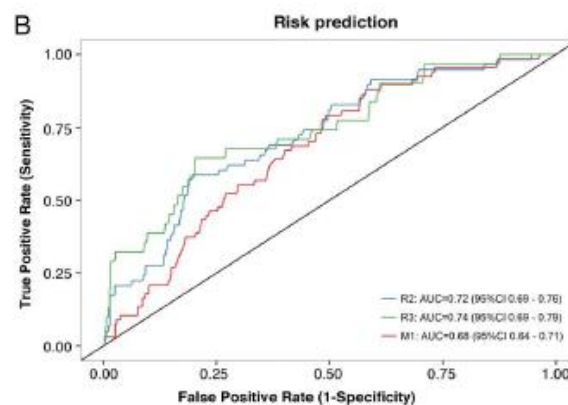
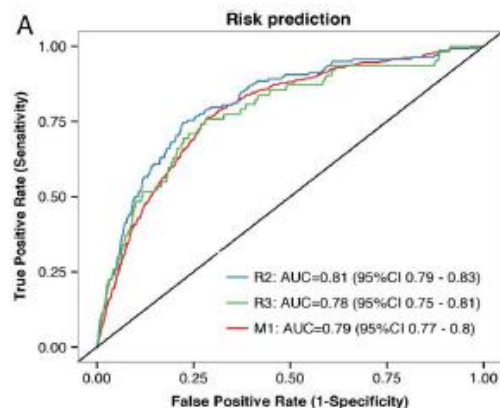
	Type I		Type II	
	annual	biennial	annual	biennial
Men (%)	252 (51.9)		5211 (56.6)	
Total (%)	486 (5.0)		9201 (95.0)	
	annual	biennial	annual	biennial
Men				
Developed R2 (%)	22 (8.7)	35 (13.9)	69 (1.3)	110 (2.1)
Developed R3A (%)	15 (6.0)	17 (6.7)	25 (0.5)	45 (0.9)
Developed M1 (%)	23 (9.1)	36 (14.3)	114 (2.2)	216 (4.1)
Developed any above (%)	41 (16.3)	52 (20.6)	153 (2.9)	259 (5.0)
Women				
Developed R2 (%)	15 (6.4)	23 (9.8)	32 (0.8)	56 (1.4)
Developed R3A (%)	11 (4.7)	14 (6.0)	9 (0.2)	14 (0.4)
Developed M1 (%)	17 (7.3)	31 (13.2)	89 (2.2)	153 (3.8)
Developed any above (%)	30 (12.8)	41 (17.5)	107 (2.7)	179 (4.5)

The results are shown for annual incidence (1 year) and biennial incidence (2 years).

Type of Diabetes
Duration of diabetes
HbA1c M
Mean blood glucose
Blood pressure
presence and grade of retinopathy

Individualised risk assessment for diabetic retinopathy and optimisation of screening intervals: a scientific approach to reducing healthcare costs

S H Lund,¹ T Aspelund,^{1,2} P Kirby,³ G Russell,³ S Einarsson,² O Palsson,² E Stefánsson^{1,2}



Individualised risk assessment with 2 year ceiling on screening intervals may be a pragmatic next step in diabetic retinopathy screening in UK, in that safety is maximised and cost reduced by about 40%.

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