screening for diabetic retinopathy - where have we been …….and where are we now?

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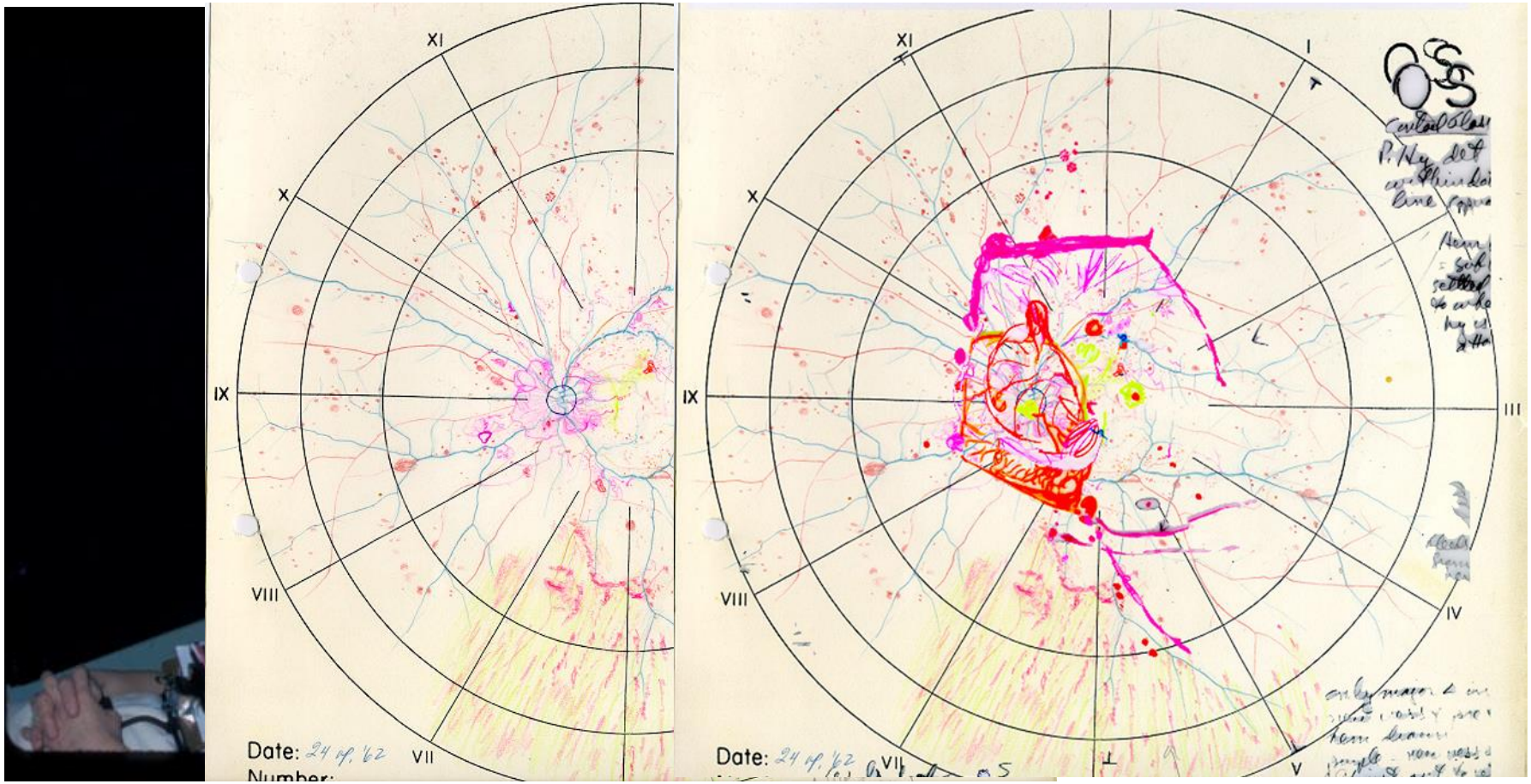
19th annual BARS conference 2019

plan

- development of grading /classification of diabetic retinopathy
- screening for diabetic retinopathy
- technology
- future developments
- conclusions

grading / classification of diabetic retinopathy

retinal drawing circa 1962



Hammersmith Hospital grading system

- 1967
- devised for assessment of patients undergoing pituitary ablation for DR
- standardised colour images
  - 5 features
  - haemorrhages / microaneurysms (HMa), new vessels, venous irregularities, hard exudates, fibrous retinitis proliferans

O’Hare Classification

- US Public Health Symposium on DR Treatment – identified need for standardisation
- group of 7 met at O’Hare Inn, Des Plaines, Illinois on 29 June 1968
- background DR (including venous beading), new vessels, vitreous haemorrhage, fibrovascular proliferation

Airlie Classification

- the group who had devised the O'Hare classification and other experts
- recommended assessment
  - (stereo) fundus photography- 4 fields + 1 optional
  - flourescein angiography
  - introduced cotton wool sp
    microvascular abnormalitie
    haemorrhage and macular

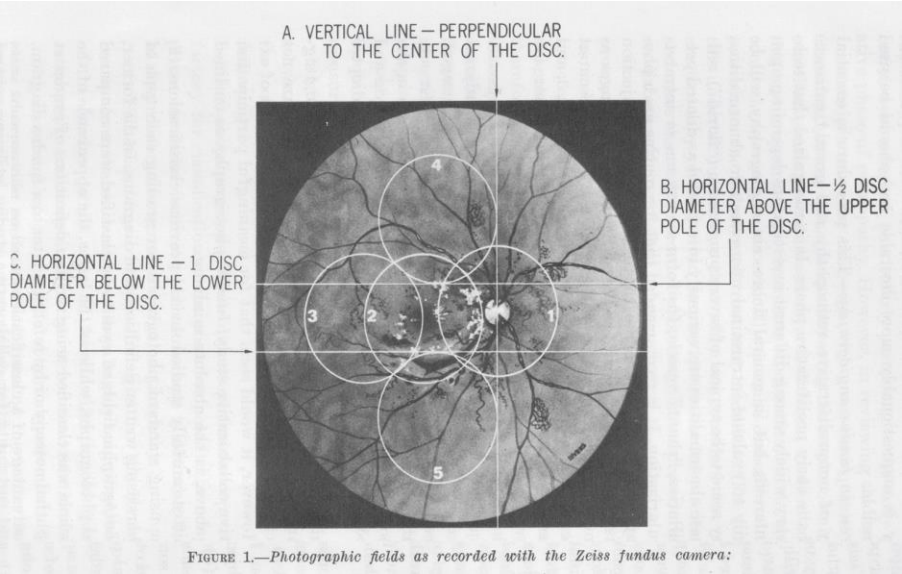


FIGURE 1.—*Photographic fields as recorded with the Zeiss fundus camera:*

Symposium on the Treatment of Diabetic Retinopathy, Airlie House, Warrenton, Virginia 29 Sep- 1 Oct 1968

Modified Airlie House Classification

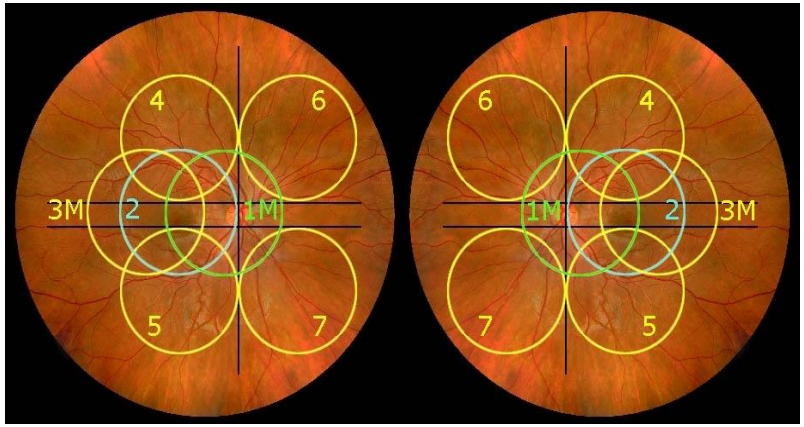
Diabetic Retinopathy Study (DRS)

- 1971 – 1975
- 1758 patients
- 7 fields
- standard photographs

ETDRS study

Early Treatment Diabetic Retinopathy Study (ETDRS)

- 1980-1985
- 3,700+ patients
- 7-field stereo 30° standard photographs
- developed a prognostic risk score - risk of development of proliferation / visual loss



Grading Diabetic Retinopathy from Stereoscopic Color Fundus Photographs – An Extension of the Modified Airlie House Classification. ETDRS Report Number 10. *Ophthalmology* 1991;**98**:786-806

Fundus Photographic Risk factors for Progression of diabetic Retinopathy. ETDRS Report Number 12. *Ophthalmology* 1991;**98**:823-833

mapping classifications

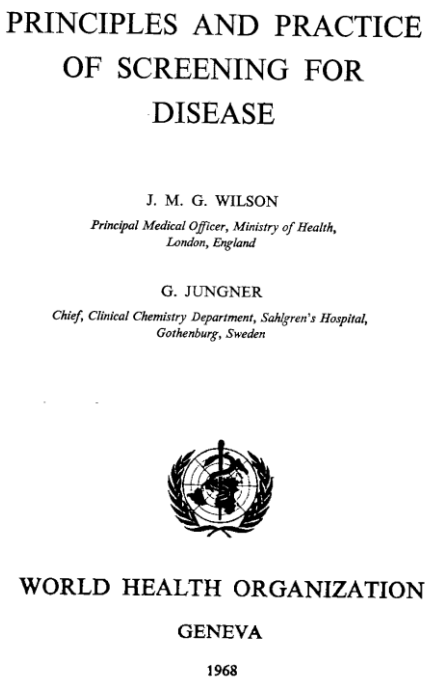
Feature specific grading	ETDRS	NDESP	LDES	Narrative	
no apparent retinopathy	10	R0	10	no retinopathy	
HMa only < ETDRS STD 2A	20/35	R1	20	background DR	mild NPDR
< 6 CWS	20/35	R1	30	mild preproliferative DR	mild NPDR
any of: HMa ≥ 2A in 1-3 quads ≥ 6 CWS I quad VB/VL/VR IRMA < ETDRS STD 8A	43/47	R2	40	moderate preproliferative DR	moderate NPDR
any of: 4 quads HMa ≥ 2A 2-4 quads VB/VL/VR ≥ 1 quad IRMA ≥ ETDRS STD 8A	53	R2	50	severe preproliferative DR (4:2:1 rule)	severe NPDR (4:2:1 rule)
inactivated NVD and/or NVE	61	R3s	60	stable treated DR	
FPD / FPE	61	R3s	60		mild PDR
any of: NVD < ETDRS STD 10A alone NVE <1/2 DA alone NVE ≥ 1/2 DA in absence of PRH/VH	65	R3a	60	proliferative DR	moderate PDR
any of: NVD ≥ 10A alone NVD ≥ 1/2DA + PRH/VH	71/75	R3a	70	PDR with high risk characteristics	high risk PDR
any of: VH precluding adequate fundus view traction retinal detachment	81/85	R3a	71/72	advanced PDR	advanced
ungradeable	90	U	90		

screening for diabetic retinopathy

Wilson and Jungner principles 1968

Key principles:

- the condition should be an important health problem
- the natural history of the disease should be understood
- there should be a treatment for the condition
- there should be a latent stage of the disease
- there should be an acceptable test
- there should be an agreed policy on whom to treat
- the total cost of finding a case should be economically balanced in relation to medical expenditure as a whole



PRINCIPLES AND PRACTICE OF SCREENING FOR DISEASE

J. M. G. WILSON

Principal Medical Officer, Ministry of Health, London, England

G. JUNGNER

Chief, Clinical Chemistry Department, Sahlgren's Hospital, Gothenburg, Sweden

WORLD HEALTH ORGANIZATION

GENEVA

1968

disadvantages

Day NE, Chamberlain J. Screening for breast cancer Eur J Cancer Clin Oncol. 1988

physical, psychological, economic

- over diagnosis - false +ve
- false reassurance - false -ve
- anxiety of positive tests
- economic costs – personal, societal

Remember

the person being screened is not a patient

relationship between health system and the patient is different in screening

St. Vincent Declaration 1989

general goal for people with diabetes

sustained improvement in health experience and life approaching normal expectation in quality and quantity

implement effective measures for the prevention of costly complications

reduce new blindness due to diabetes by one third or more in the next 5 years

St Vincent Declaration 1989

WORKSHOP REPORT DM

Diabetes Care and Research in Europe: The Saint Vincent Declaration

Representatives of Government Health Departments and patients organizations from all European countries met with diabetes experts under the aegis of the Regional Offices of the World Health Organization and the International Diabetes Federation in St Vincent, Italy on 10–12 October, 1989. They unanimously agreed upon the following recommendations and urged that they should be presented in all countries throughout Europe for implementation.

Diabetes mellitus is a major and growing European health problem, a problem at all ages and in all countries. It causes prolonged ill-health and early death. It threatens at least ten million European citizens.

It is within the power of national governments and health departments to create conditions in which a major reduction in this heavy burden of disease and death can be achieved. Countries should give formal recognition to the diabetes problem and deploy resources for its solution. Plans for the prevention, identification and treatment of diabetes and particularly its complications—blindness, renal failure, gangrene and amputation, aggravated coronary heart disease and stroke—should be formulated at local, national and European regional levels. Investment now will earn great dividends in reduction of human misery and in massive savings of human and material resources.

General goals and five-year targets listed below can be achieved by the organized activities of the medical services in active partnership with diabetic citizens, their families, friends and workmates and their organizations; in the management of their own diabetes and education for it; in the planning, provision and quality audit of health care; in national, regional and international organizations for disseminating information about health maintenance; in promoting and applying research.

General Goals for People—Children and Adults—with Diabetes

- Sustained improvement in health experience and a life approaching normal expectation in quality and quantity.
- Prevention and cure of diabetes and of its complications by intensifying research effort.

Five-year Targets

Elaborate, initiate and evaluate comprehensive programmes for detection and control of diabetes and of its complications with self-care and community support as major components.

Raise awareness in the population and among health care professionals of the present opportunities and the future needs for prevention of the complications of diabetes and of diabetes itself.

Organize training and teaching in diabetes management and care for people of all ages with diabetes, for their families, friends and working associates and for the health care team.

Ensure that care for children with diabetes is provided by individuals and teams specialized both in the management of diabetes and of children, and that families with a diabetic child get the necessary social, economic and emotional support.

Reinforce existing centres of excellence in diabetes care, education and research. Create new centres where the need and potential exist.

Promote independence, equity and self-sufficiency for all people with diabetes—children, adolescents, those in the working years of life, and the elderly.

Remove hindrances to the fullest possible integration of the diabetic citizen into society.

Implement effective measures for the prevention of costly complications.

- Reduce new blindness due to diabetes by one third or more.
- Reduce numbers of people entering end-stage diabetic renal failure by at least one third.
- Reduce by one half the rate of limb amputations for diabetic gangrene.
- Cut morbidity and mortality from coronary heart disease in the diabetic by vigorous programmes of risk factor reduction.
- Achieve pregnancy outcome in the diabetic woman that approximates that of the non-diabetic woman.

Establish monitoring and control systems using state of the art information technology for quality assurance of diabetes health care provision and for laboratory and technical procedures in diabetes diagnosis, treatment and self-management.

Promote European and international collaboration in programmes of diabetes research and development through national, regional and WHO agencies and in active partnership with diabetes patients organizations.

Take urgent action in the spirit of the WHO programme, 'Health for All' to establish joint machinery between WHO and IDF, European Region, to initiate, accelerate and facilitate the implementation of these recommendations.

At the conclusion of the St Vincent meeting, all those attending formally pledged themselves to strong and decisive action in seeking implementation of the recommendations on their return home.

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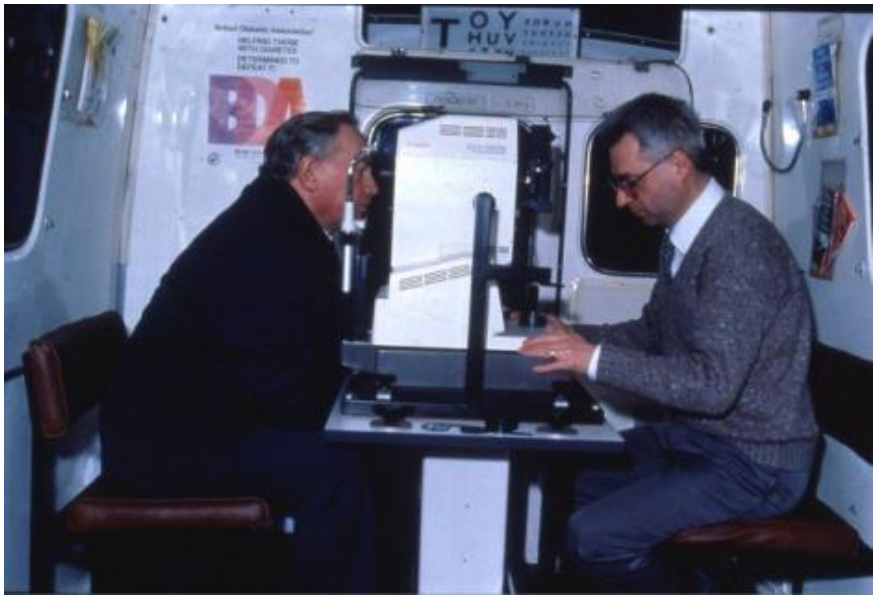
screening in the UK



Liverpool 1991 – one of 11 centres funded by BDA (now DUK) and Allied Dunbar

1996 – Bedford van sent to Africa

BARS 2001- today

preceded the National Programme!

Professor Roy Taylor and Lilian Lovelock

co-opted member for many years

Blackpool!

national screening for DR

national service framework for diabetes

- *NSF for diabetes – delivery strategy*
- *Planning and performance framework for 2003-6*

"by 2006, a minimum of 80% of people with diabetes to be offered screening for the early detection (and treatment if needed) of diabetic retinopathy as part of a systematic programme that meets national standard, rising to 100% coverage of those at risk of retinopathy by end 2007"

Glasgow workshop – RCOphth and NSC

Project advisory board- lead Peter Scanlon

Subcommittees

- Workforce, Training and Education
- Grading and Quality assurance
- Technology

screening qualification

NSF requires a competent workforce

- to protect the patient
- to protect the worker and employer
- a competence defines the knowledge, understanding and skill to perform a specific task
- individual competences are grouped into frameworks
- competences that have undergone 4 nations collaboration become National Occupational Standards (NOS)
- NOS inform the structure and content of education and training and related qualifications

Diabetic Retinopathy NOS

- Skills for Health
  - www.skillsforhealth.org.uk
- HC 1-10 - approved May 2005
- suite of qualifications in DR screening developed with NHSU, National Open College Network and City and Guilds
- Diploma in DR screening – imaging, grading and administration – City and Guilds

NHSU expert reference group

- Steve Aldington - Hammersmith grading centre
- John Talbot - RCOphth
- Grant Duncan - BARS
- Sue Blakeney - College of Optometrists
- Shirley Burnett - BARS
- Lindy Pullan - NHSU
- Judy Craven - NOCN
- Gurpreet Sathya Narayanan - C&G
- Deborah Broadbent - ENSPDR

Screening in Europe – the Liverpool Declaration 2005

European countries should

reduce the risk of visual impairment due to diabetic retinopathy by 2010 through:

- systematic programmes of screening reaching at least 80% of the population with diabetes
- using trained professionals and personnel
- universal access to laser therapy

follow up meetings

- Amsterdam 2008
- Gdansk 2011
- Manchester 2016
- www.drscreening.eu

Impact of DR screening

England and Wales

- after >50 years, DR no longer leading cause of certifiable blindness in working age people

Liew et al BMJ Open 2014

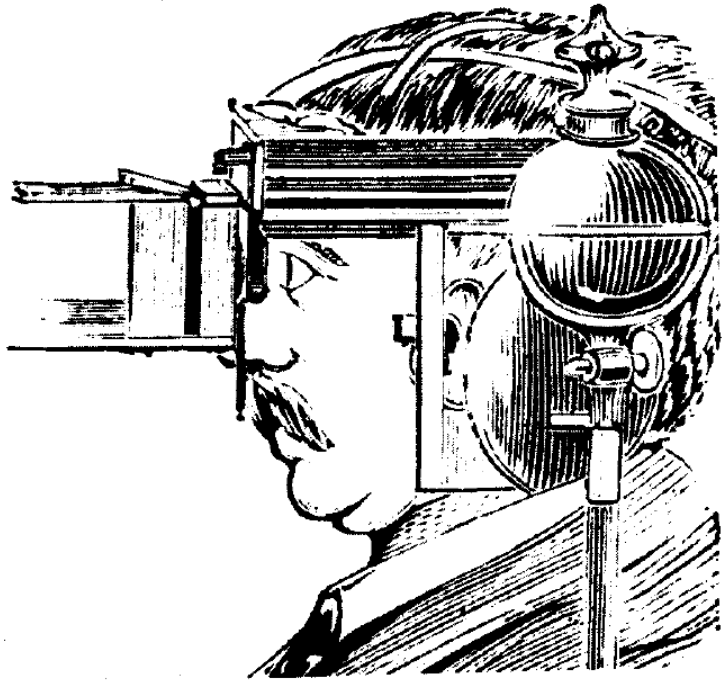
- 1999-2000 DR commonest cause of CVI (17.7%)
- 2009-2010 DR third commonest (14.1%)

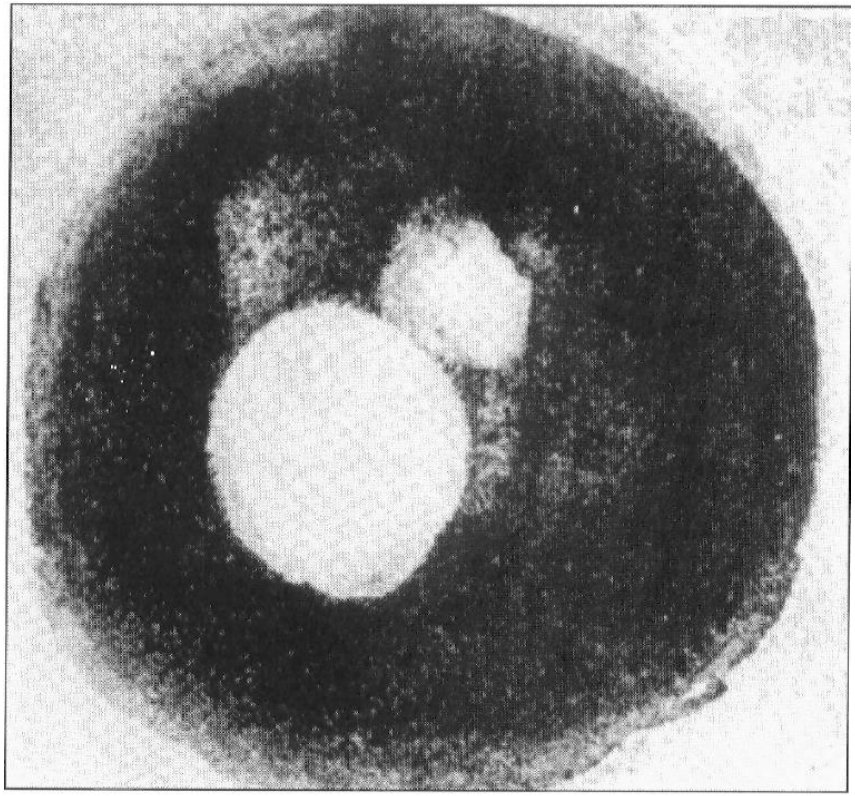
Quartilho, et al. Eye March 2016

- DR dropped to 4th commonest cause of registration

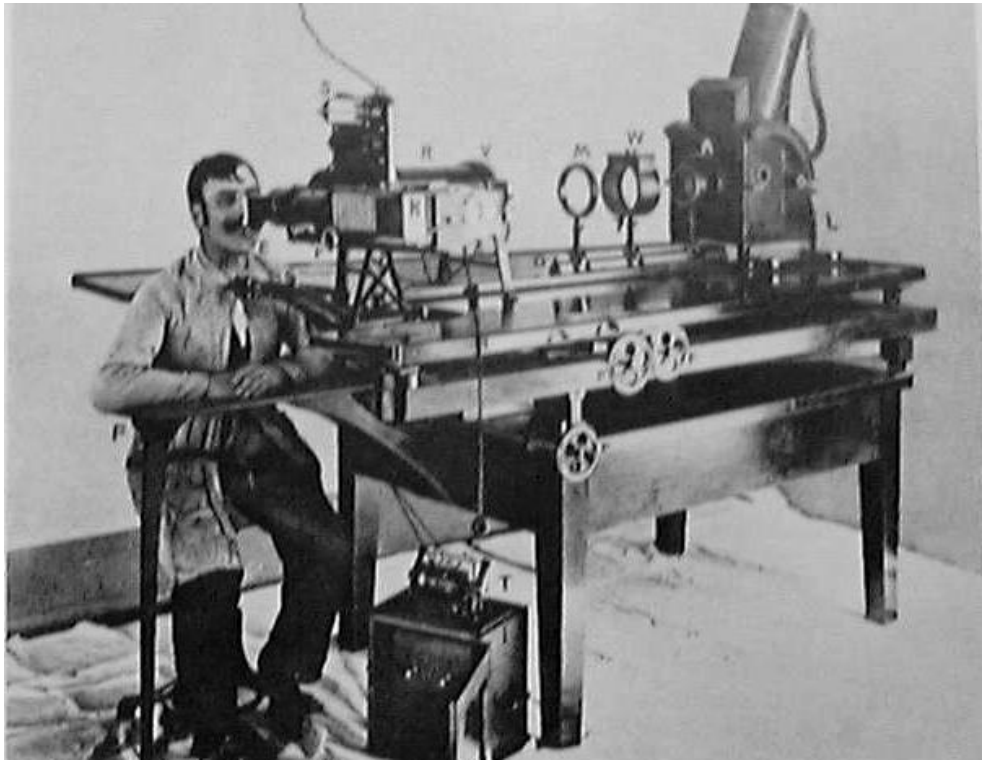
technology

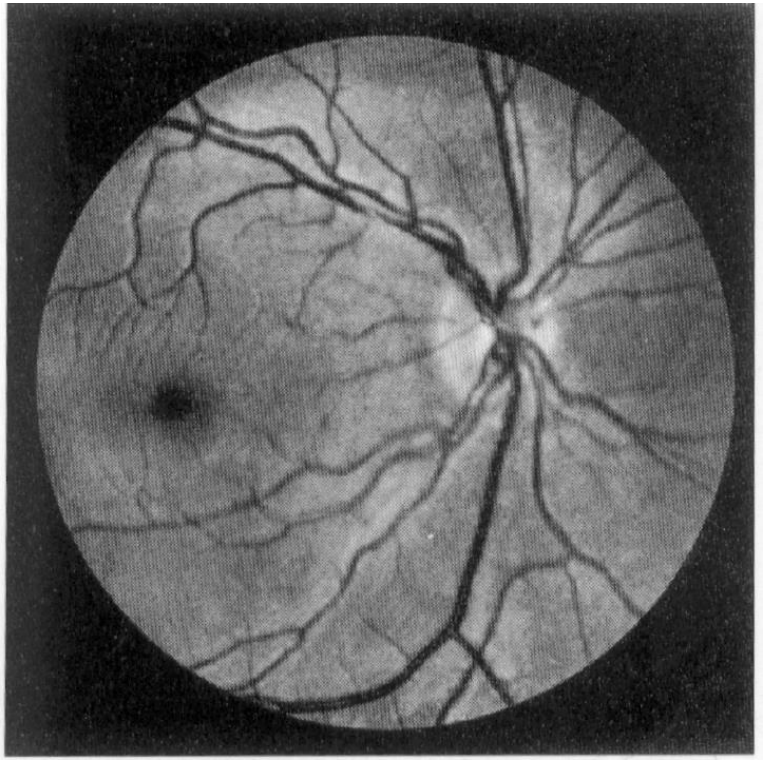
Jackman 1886



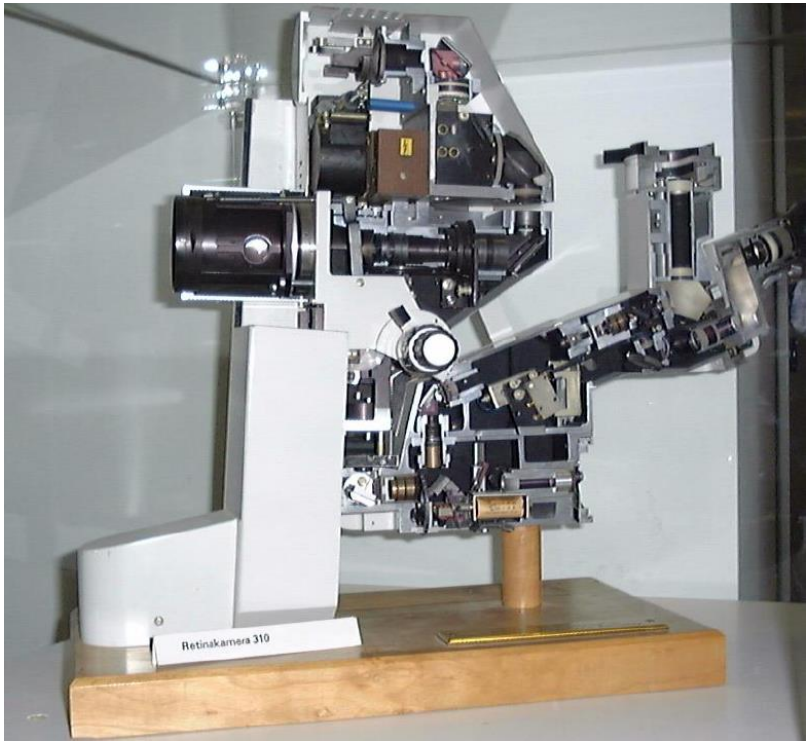


Dimmer 1901

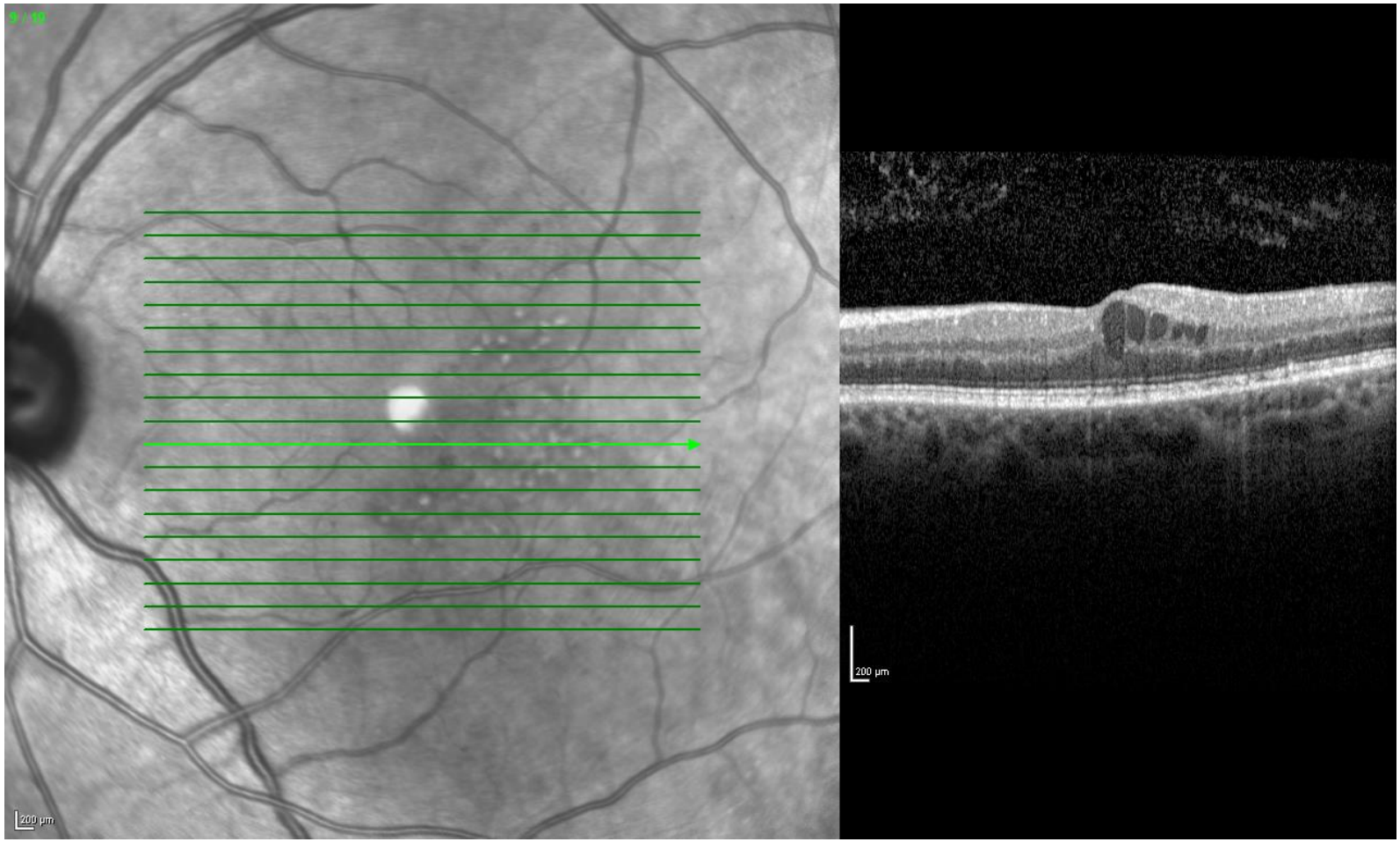




inside a fundus camera!

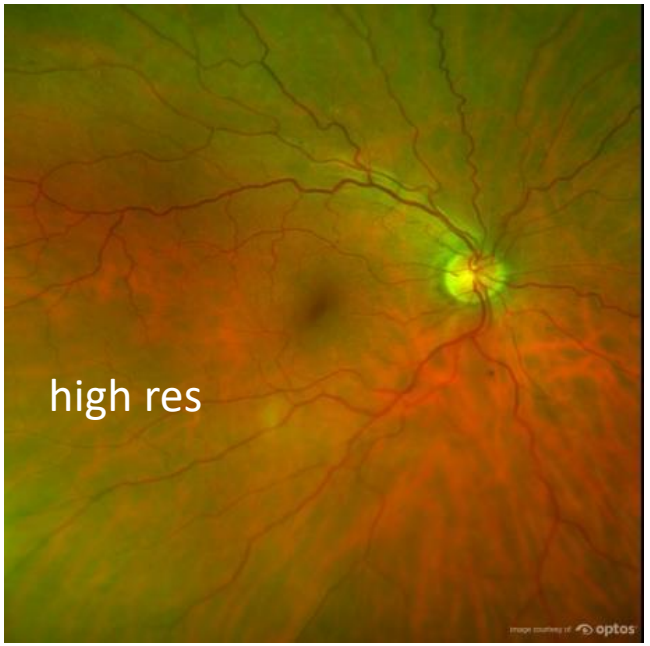


OCT

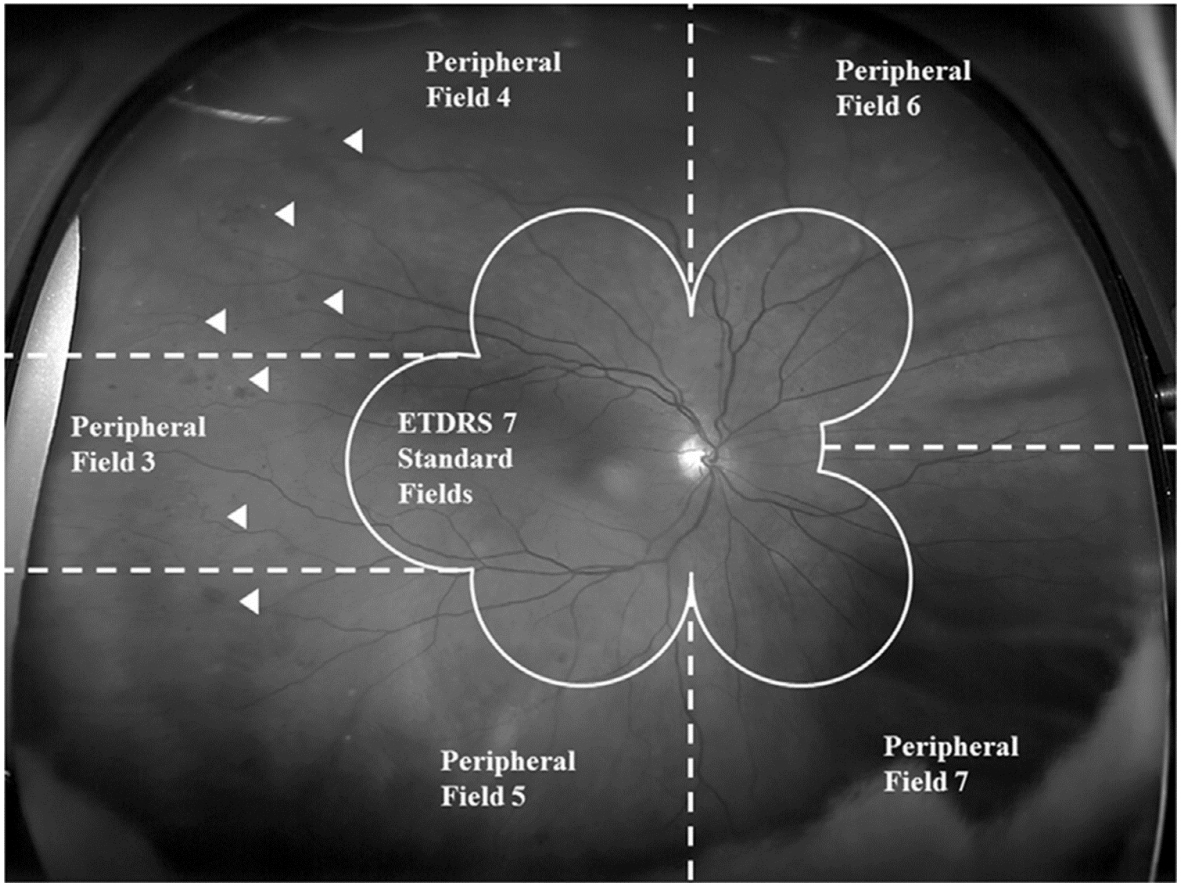


Optos

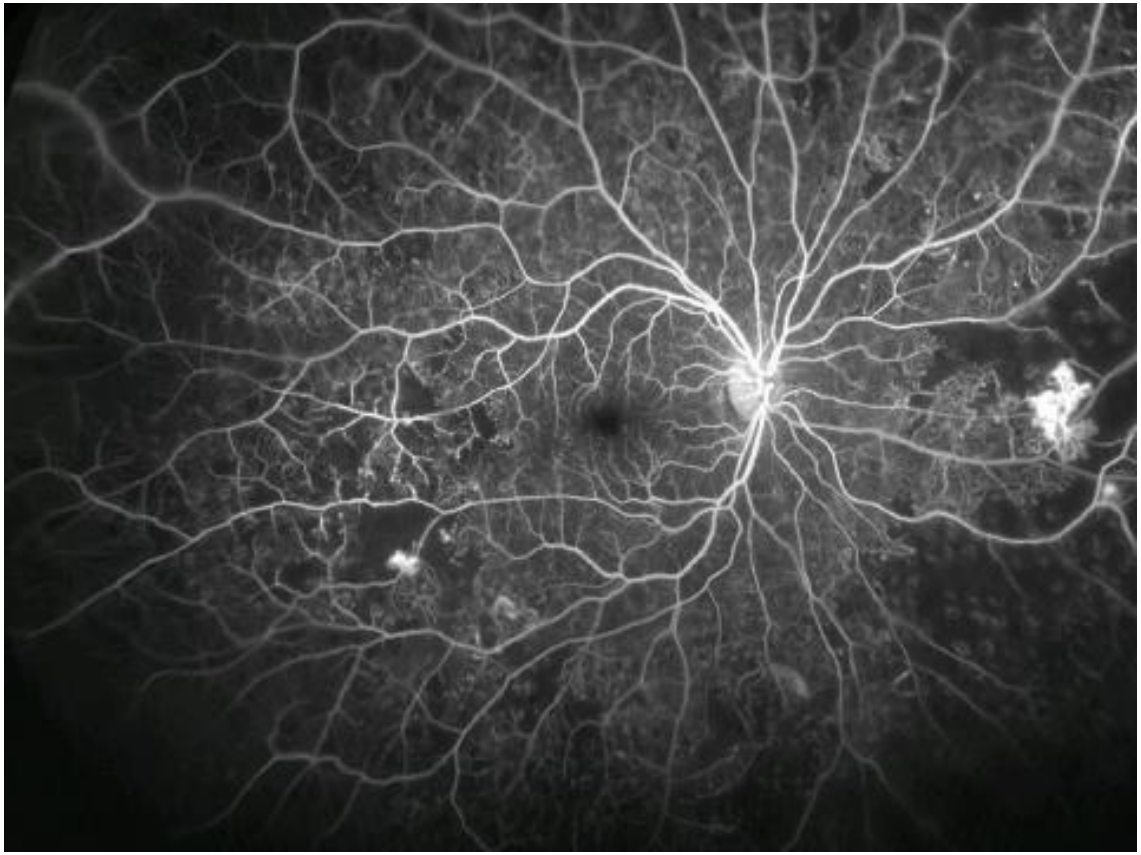
- 200Tx Optomap, California
- second generation: projection correction, steered view, pseudocolour
- previously unidentified peripheral NV



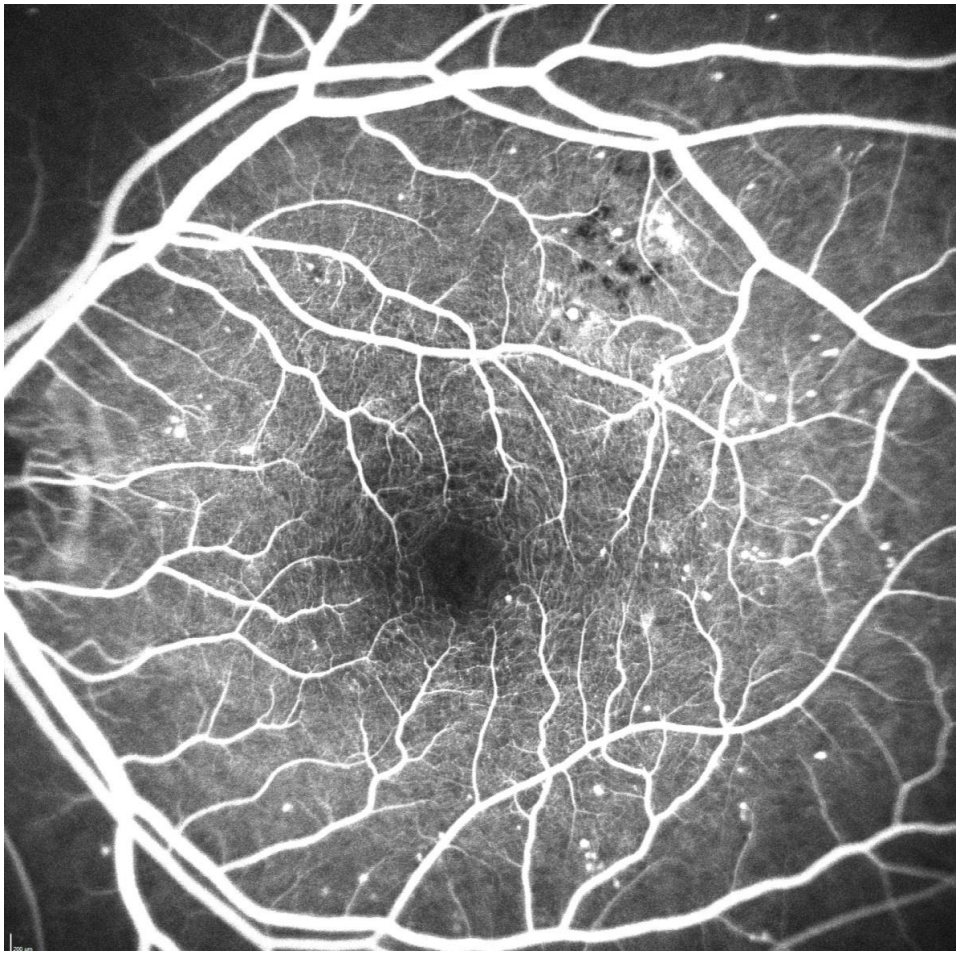
Optos

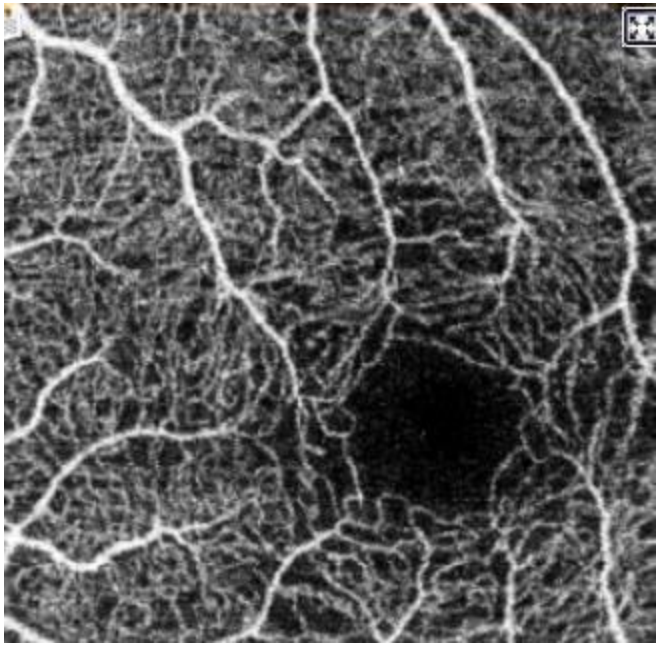

Peripheral
Field 4
Peripheral
Field 6
Peripheral
Field 3
ETDRS 7
Standard
Fields
Peripheral
Field 5
Peripheral
Field 7

FA guided laser



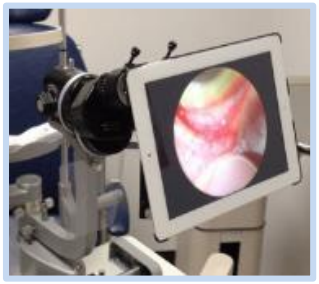
OCT angiography





into the future

portable / hand-held / smartphone-based imaging



EyecPhotoDO

Zarf iPhone Adapter

Orion SteadyPix Telescope Photoadapter

Magnifi

Keeler Portable Slit Lamp iPhone 4 Image Adapter

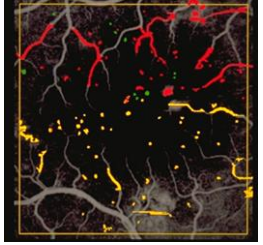
iExaminer

D-EYE

Peek Retina

39

automated grading



- commercial “traffic light” systems
  Retmarker EyeArt iGrading Idx-DR

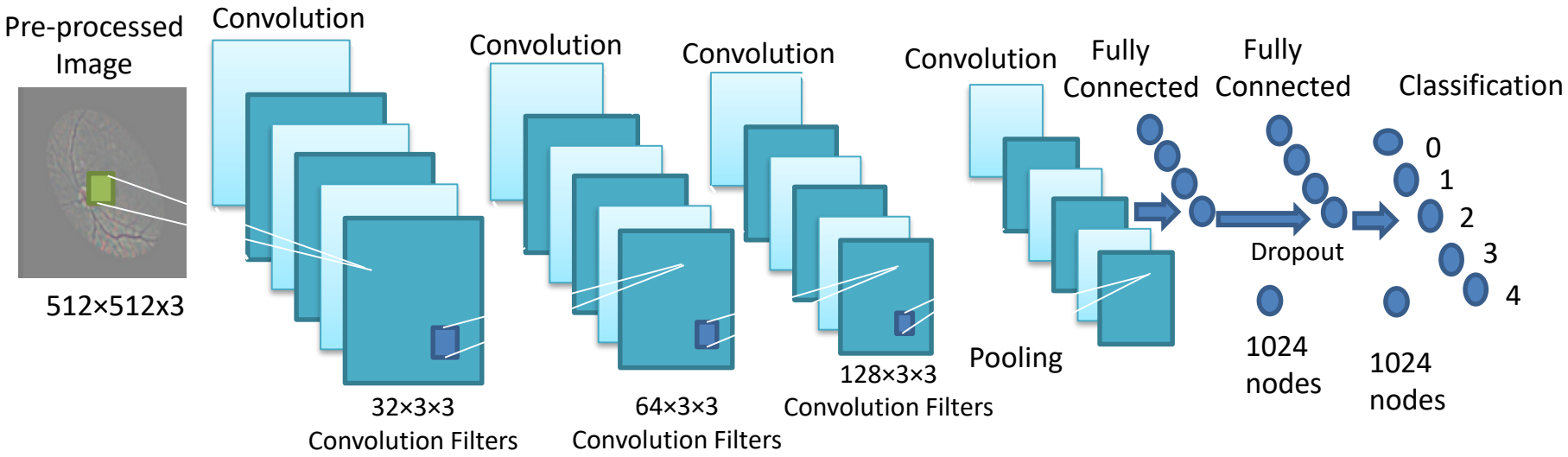
- others in development: VisionQuest, Singapore/Liverpool

- widespread support in Europe for disease/no disease grading

- EyeArt and Retmarker meet NDESP criteria

Tufnall

artificial intelligence – convolutional neural networks



CNNs were inspired by biological processes in that the connectivity pattern between neurons resembles the organization of the animal visual cortex.

CNNs have shared-weights architecture and translation invariance characteristics.

extending screen intervals

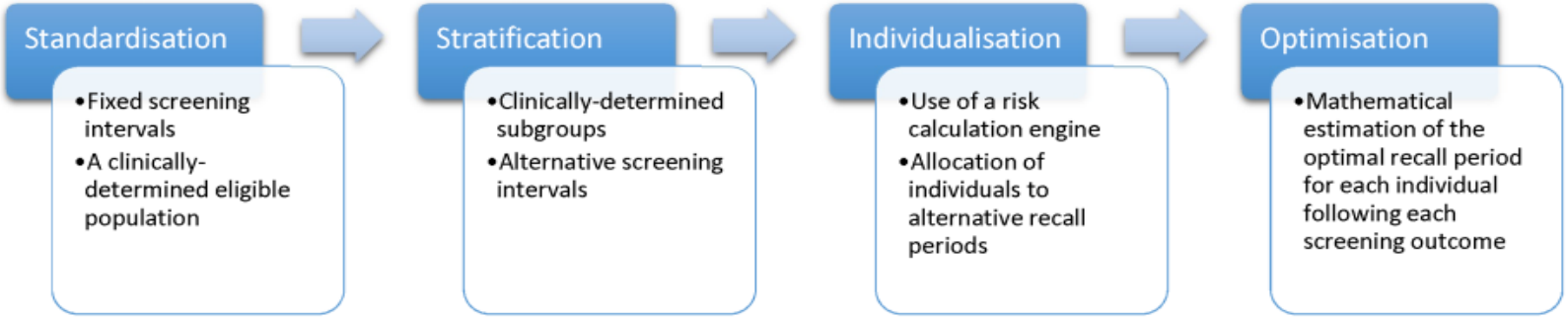
pros

- increasing prevalence of diabetes
  - 415 million people with diabetes world-wide
- scarce resources
- improve cost effectiveness
- improve patient journey

cons

- inadequacies around accuracy and consistency of grading and data collection
- no data in UK on safety
  - concerns re attendance / uptake of screening
  - concerns over effect on overall diabetes care

personalisation



fixed intervals

pragmatic / administrative / consensus / not evidence based

stratified screen intervals

differential care depending on allocation to a subgroup

individualised (personalised)

use of information about the individual and allocation to alternative recall dates based on their individual risk of developing referable retinopathy

variable number of systemic risk factors in addition to retinopathy levels and type of diabetes

optimisation

equity

ISDR – programme grant

NIHR Programme Grant for Applied Research

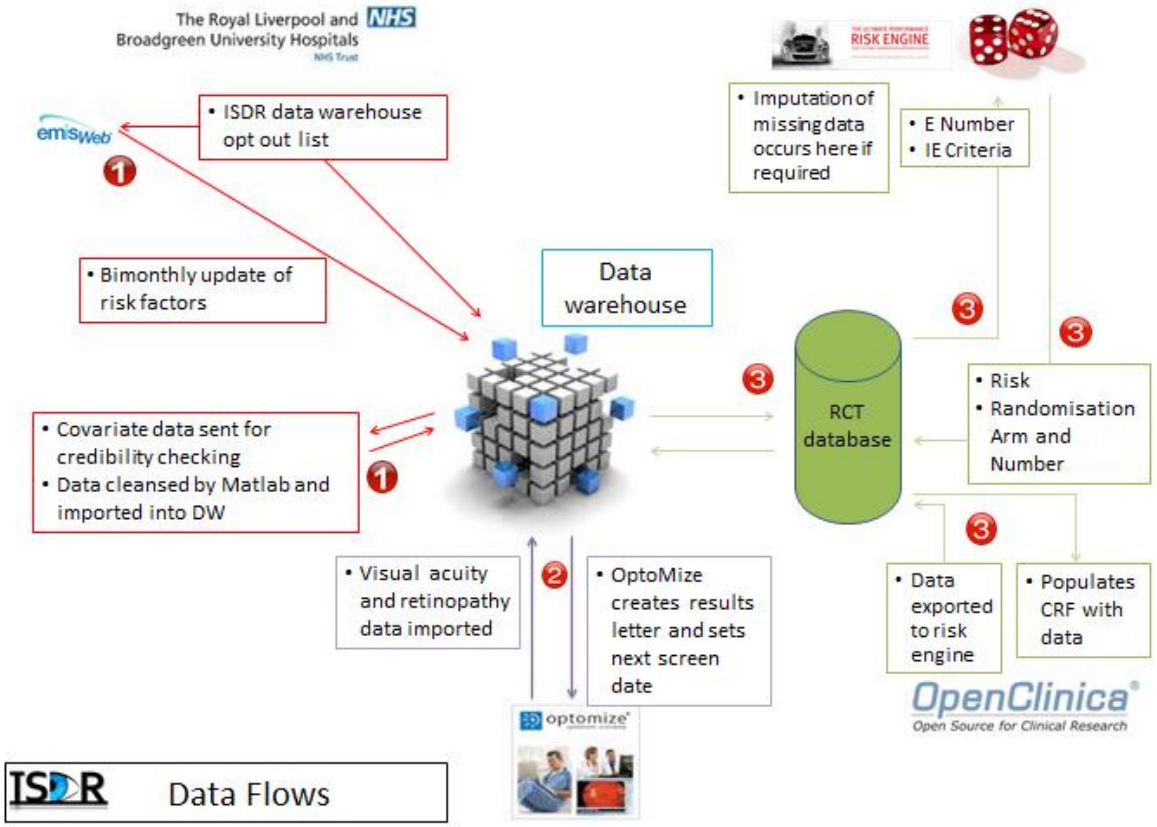
Introducing personalised risk based intervals in screening for diabetic retinopathy: development, implementation and assessment of safety, cost-effectiveness and patient experience (RP-PG-1210-12016)
2013-2019
£2.2m

Harding SP, Broadbent DM, Gabbay M, James M, Stratton I, Fisher AC, Vora JP, Roberts J, Byrne P, Garcia-Finana M, Williamson P, Seddon D, Moitt T.

SPH presenting results tomorrow

NHS
National Institute for Health Research

Individualised Screening for DR (ISDR)



in conclusion

screening is well established and is rolling out throughout the world

reasonable evidence of effectiveness but we need more evidence

burden of screen +ve and programme costs remains a challenge

- being addressed by digital surveillance and extended intervals
- technology will help in part

major problems for the next 10 years:

- in established screening programmes **non-attendance**
- in low/middle income countries **epidemic of diabetes**

how to eat an elephant…….

…….piece by piece!

acknowledgments

Liverpool Diabetic Eye Screening Programme:
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Trial Steering Committee
Gideon Smith, Helen Cooper, Vineeth Kumar, Alison Rowlands, Naveed Younis, Julia West, Heather Rogers

Independent Data Safety Monitoring Committee members
Chris Rogers, Nathalie Massat

Liverpool Clinical Commissioning Group:
Lisa Jones

Patient and Public Involvement Group:
John Collins, John Kelly, Peter Lees, Sandra Lees, Emily Doncaster, Betty Williams

thank you!