NHS Research Scotland Annual Conference

Parallel Sessions

Convergence: the future of health

NHS SCOTLAND
NHS RESEARCH SCOTLAND

proud to support 70 YEARS of the NHS in Scotland

Join the conversation @NHSResearchScot #NRSConf18

Convergence - Introduction

University of Strathclyde Engineering

Key points to consider;

- The Scottish Medtech Industry provides nearly half of the Life Sciences industrial activity in Scotland
- Digital technology plays an increasingly important role in addressing the challenges faced by health services around the world
- We need to ensure our health service continually evolves to meet new patterns of care, increased demand and opportunities arising from new treatment and technology
- Researchers from engineering, science, and maths are creating and participating in multidisciplinary medical projects in a bid to solve some of the biggest challenges
- Data mining, patient self management and digital home monitoring are just a few of the new streams of healthcare being enabled by convergence
- The potential to exploit technology and innovative solutions within our health and social care services should not be underestimated
- Business change is a major issue which can block the gains that could be made

University of Strathclyde Engineering

Professor Patricia Connolly
Strathclyde Institute of Medical Devices

What is a Medical Device ?

University of Strathclyde Engineering

Any instrument apparatus , appliance, material or other article ,whether used alone or in combination , including the software necessary for its proper application intended by the manufacturer to be used for human being for the purpose of:

- Diagnosis,prevention,monitoring,treatment or alleviation of disease,
- Diagnosis,monitoring, treatment,alleviation of or compensation for an injury or handicap,
- Investigation,replacement or modification of the anatomy or of a physiological process,
- Control of conception,

And which does not achieve its principal intended action in or on the human body by pharmacological, immunological or metabolic means, but which may be assisted in its function by such means

Predictions of convergence drove our early strategy in Strathclyde

University of Strathclyde Engineering

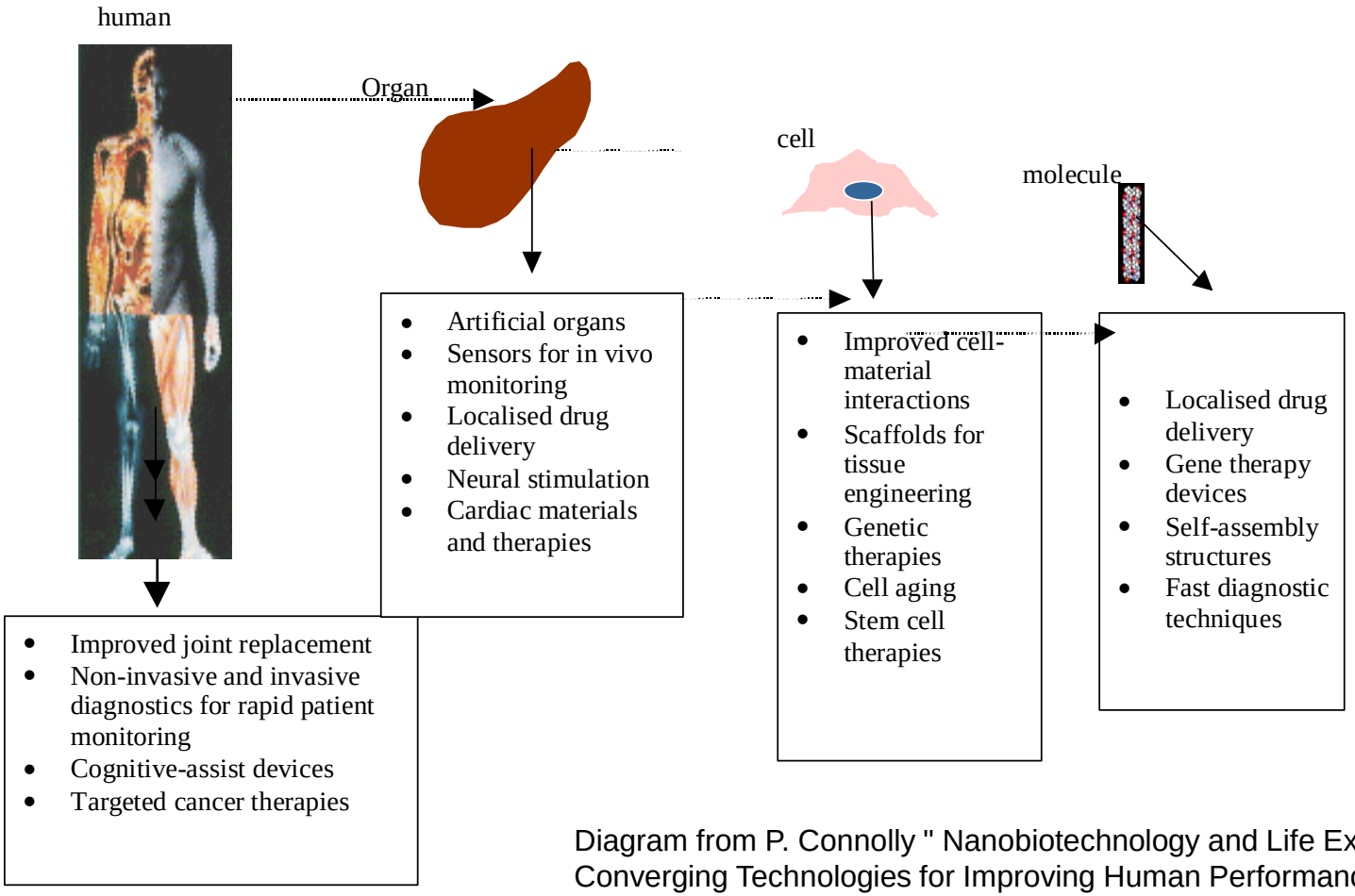


Diagram from P. Connolly " Nanobiotechnology and Life Extension", in Converging Technologies for Improving Human Performance, eds. M.C.Roco, W.S. Bainbridge, National Science Foundation, USA, June 2002.

Many opportunities exist for convergence. One area is home and self-monitoring

University of Strathclyde Engineering

Where are some of the opportunities?

- Devices that can measure parameters of clinical relevance
  - Devices for home use
  - Smaller, wearable devices
  - Non-invasive technologies
- Key monitoring needs lie in chronic diseases, hospital to home transfers and self-management
  - Diabetes, cardiac disease, hypertension
  - Hospital to Home devices e.g. ECG, Oxygen, Glucose , Wound Care

The wearable devices available today measure mainly physical parameters

University of Strathclyde Engineering

- A variety of companies are in the field of wearables or preparing to enter it such as Ihealth, Neumitra, Imec, Reebok, Nike
- Larger communications and consumer device companies are also entering the field
  - For example Google, Samsung, Apple

Most offerings are for activity sensors. The Apple Watch for example has physical monitoring on board

Other companies are offering physical parameter monitoring

University of Strathclyde Engineering

Mio and others have wearable heart rate and activity monitors

iHealth have a wearable blood pressure monitor

Spire have a wearable breath rate sensor that interacts with your smartphone to try and reduce stress through controlled breathing

A notable need – today's wearable glucose sensors are subcutaneous

University of Strathclyde Engineering

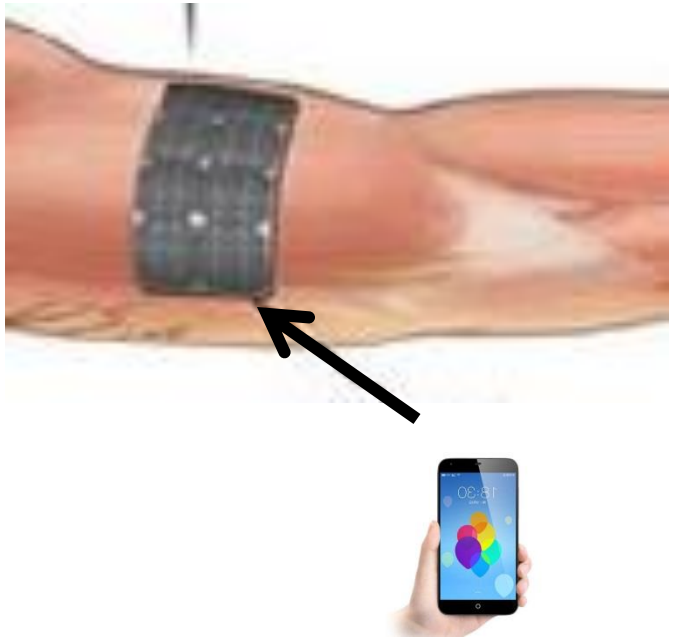
17

Dexcom

Abbot

We have 3 platform technologies from our Medical Diagnostics & Wearables group covering wearable and portable devices for home, hospital or consumer use, developed with multidisciplinary teams;

- WoundSense™. Wound monitoring and diagnostics for moisture, infection and dressing change control
- Cell and bacterial reagentless monitoring and detection for infection detection , urine, blood, lung etc
- Transdermal (wearable) sensors for glucose, lactate and hydration



Ohmedics

Ohmedics

University of Strathclyde

An Advanced Bioelectronics company developing and marketing products for the fast growing Medtech and Digital Health Care Markets

The company was spun out from the University of Strathclyde in 2009 and is partnered with this internationally leading university

The company is ISO 13485 certified and has a CE marked medical device already on the market

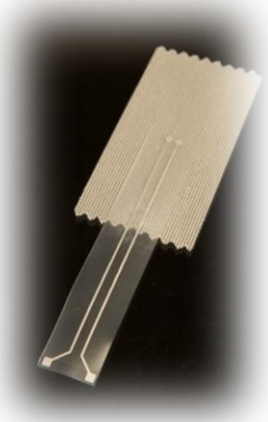
WoundSense

CHANGE THE PRACTICE NOT THE DRESSING

University of Strathclyde Engineering

‘In-Dressing’ real time monitoring for;

- Wound moisture –optimal dressing selection and healing
- Dressing change need - for home or hospital use by patients, carers and clinicians
- Pipeline product - real time ‘In-Dressing’ infection monitoring
- IP protected in the USA, Canada, EU, China, Japan



WoundSense

University of Strathclyde Engineering

WoundSense™ is the first ‘In – Dressing’ moisture sensor that can be used by patient, carer or clinician to establish when a wound dressing needs changed without disturbing the dressing.

CHANGE THE PRACTICE NOT THE DRESSING

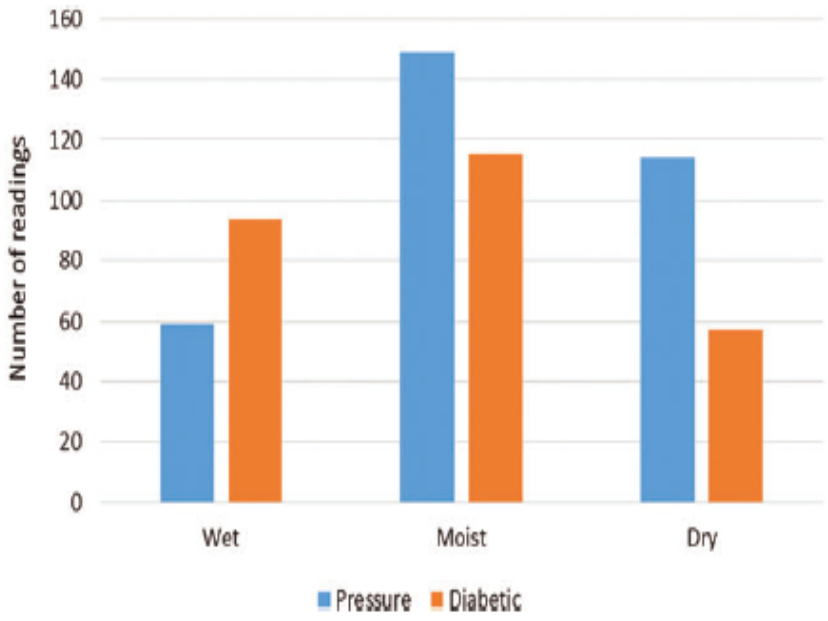
- Less patient discomfort
- Less dressing use
- Savings on staff time
- Avoiding disturbing the healing wound
- Reduces opportunistic infections

WoundSense

University of Strathclyde Engineering

In a major study we have shown that 45% of wound dressing changes in hospital are not required.

Our study of home wound dressing changes revealed that 43% of dressings were being changed when not required disturbing healing.



CHANGE THE PRACTICE NOT THE DRESSING

- Removing the need for one unnecessary home care dressing change per week for a chronic wound care patient saves a health system a minimum of **$500** in a six week treatment period and **6 hours** of community staff time **per patient**

£ $
¥ €

Device validation and use

University of Strathclyde Engineering

NHS Greater Glasgow and Clyde

NHS Lothian

NHS Nottinghamshire Healthcare NHS Foundation Trust

Queen Elizabeth Hospital Birmingham

Wythenshawe Hospital

حمد Hamad مؤسسة حمد الطبية Hamad Medical Corporation HEALTH · EDUCATION · RESEARCH صحة · تعليم · بحوث

Platform 2. Reagentless, infection monitoring technology with a granted patents for the Electrical Detection of Bacteria (including typing of such bacteria).

University of Strathclyde Engineering

The system uses reagentless, printed electrodes to identify presence of specific bacteria and is in development for ;

- Infection monitoring in wound dressings, funded by the UK research councils in conjunction with the Royal Hospital for Children, Glasgow.
- Detection of lung infection in patients, funded by Innovate UK and involving the Queen Elizabeth University Hospital, Glasgow.
- The technology could be used for detection of infection in urine or dialysate. We have results from research into abdominal surgical wound drains that show the technology can be applied in the abdominal region.
- Two published papers present some aspects of our approach that are in the public domain:
  - Identification and characterisation of Staphylococcus aureus on low cost screen printed carbon electrodes using impedance spectroscopy. A.C. Ward , A.J. Hannah, S.L. Kendrick, N.P. Tucker, G. MacGregor, P. Connolly, Biosensors and Bioelectronics 110 (2018) 65–70
  - Pseudomonas aeruginosa Can Be Detected in a Polymicrobial Competition Model Using Impedance Spectroscopy with a Novel Biosensor Andrew C. Ward, Patricia Connolly, Nicholas P. Tucker.

The Reagentless Infection Monitor : Principle of Operation

University of Strathclyde Engineering

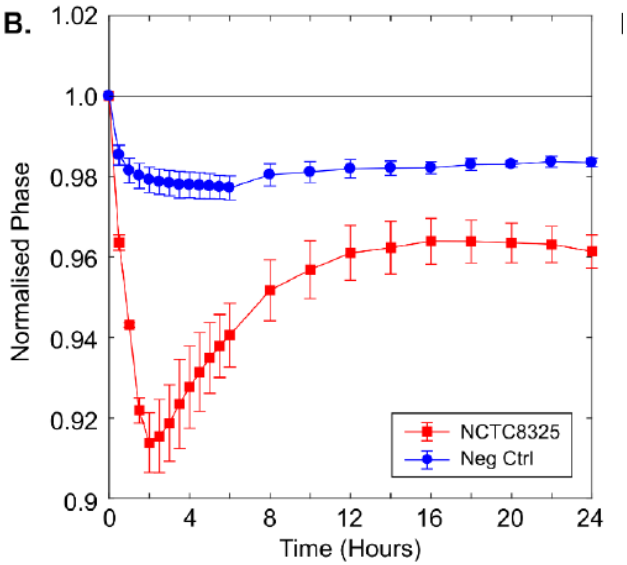
The IP-protected technology detects the presence of bacteria by Electrical Impedance Spectroscopy (EIS).

Electrodes used with the system can be permanent or screen printed (low cost).

Screen printing allows for electrodes of many shapes and sizes to be printed for different applications.

The key to the detection power of our system lies in the use of a ‘normalisation’ algorithm that compares impedance at time zero (electrodes just placed in environment) with impedance as time progresses.

Each type of bacteria has a unique EIS signature when analysed by our method.

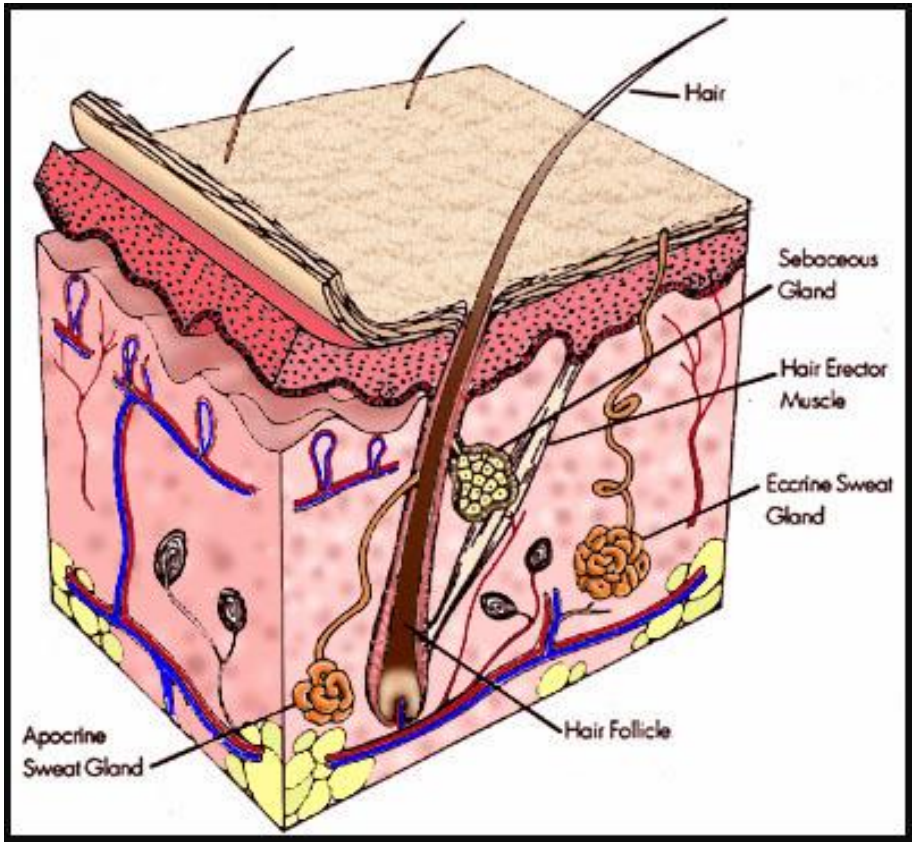


Staph Aureus growth tracked by patented, reagentless sensor in LB media.

Comparing the negative control and the bacterial environment mathematically leads to automatic recognitions of S.aureus.

Wearables sensors- Transdermal extraction of molecules as a route to diagnostics

University of Strathclyde Engineering



The skin structure. Transport routes in intact skin are (i)transcellular (ii) intercellular (iii) sweat glands (iv) hair follicles (v) artificially induced micropores

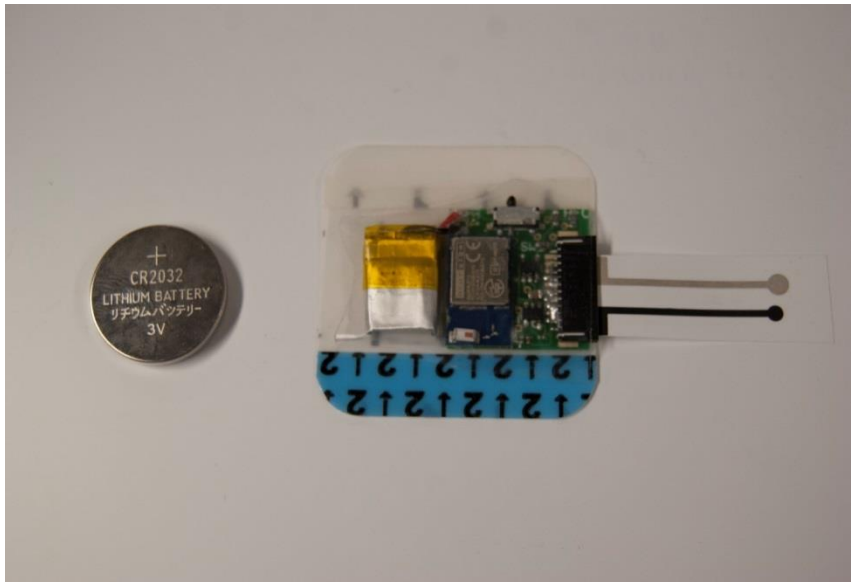
For many types of biosensors this can be a route to filtered, clean samples and avoids fouling

We have initial work completed on wearables patches for hydration and sports monitoring

University of Strathclyde Engineering

An example is blue tooth K+ sensors developed by - Dr Stephen Milne

- Bluetooth low energy transmission to smartphone android application
- Device sealed in polyethylene
- Device weighs 2.8g
- Full patch 39mm*39mm size
- Could be converted for hydration sensing

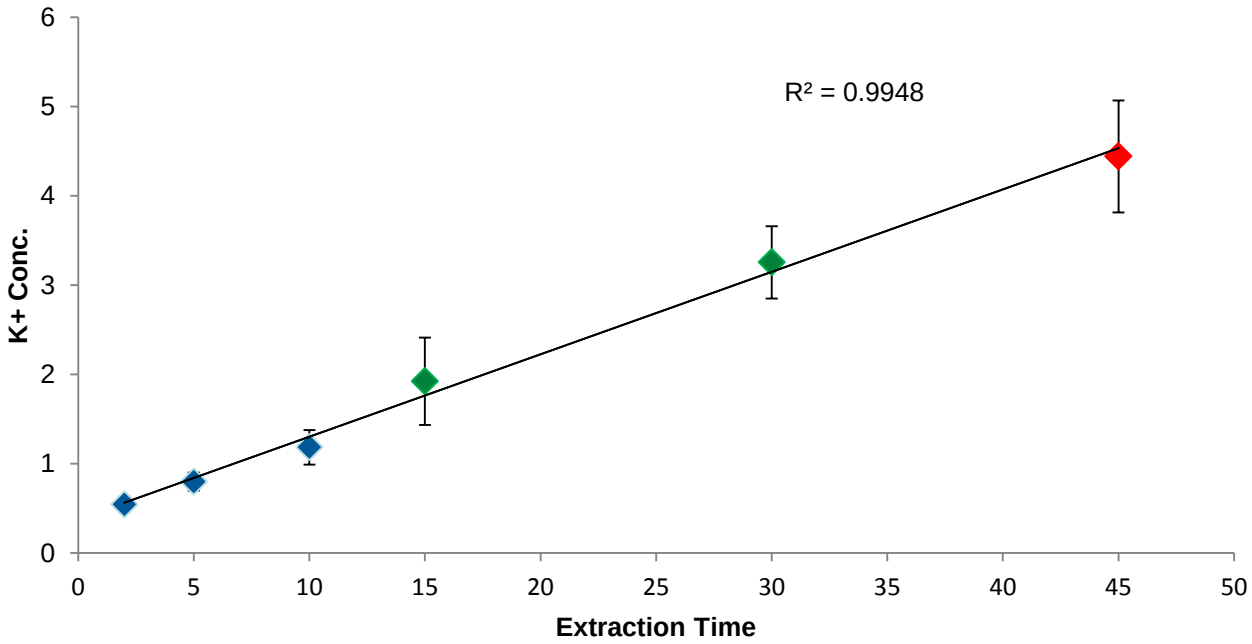


Top view of Bluetooth wearable sensor with scale given by CR2032 coin cell battery

We have results on transdermal extraction for a number of biological parameters of interest

University of Strathclyde Engineering

For example, this is the amount of potassium that flows across the skin with time in healthy volunteers and diabetics using our gel skin electrode



The blue markers show the extraction results for the 2, 5 and 10 minute study. The Green markers show the results for the 15 and 30 minute study. The red marker shows the average potassium value after 45 minutes of extraction in the diabetic group (n=13)

Transdermal diagnostics

University of Strathclyde Engineering

- We have extracted a number of molecules or ions across the skin
  - Glucose & lactate detection demonstrated. A short trial for glucose on 17 Type 2 diabetics has been completed
  - Vitamins , Vitamin C and Vitamin D detected
  - Electrolytes detected

- The sensor technology <u>will not need blood based sample calibration</u>.

- A Wearable Hydration sensor, bluetoothed to a mobile phone, is in development for clinical trials

- Transdermal glucose, lactate & electrolyte sensors are in development with Royal Hospital for Children, Glasgow, funded by the Gates Foundation.

Transdermal patches can monitor neonates and adults

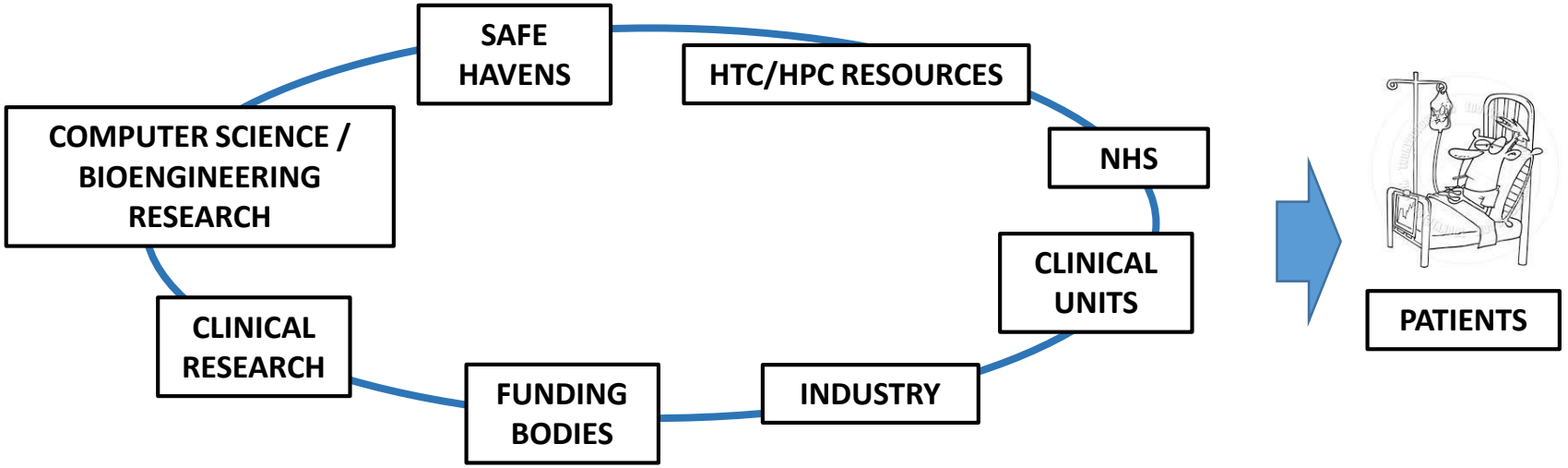
VAMPIRE: mining the eye for biomarkers, achieving effective interdisciplinarity

Emanuele Trucco

VAMPIRE project
Computer Vision and Image Processing group
Computing, School of Science and Engineering
University of Dundee
UK

A VISION FOR SCOTLAND

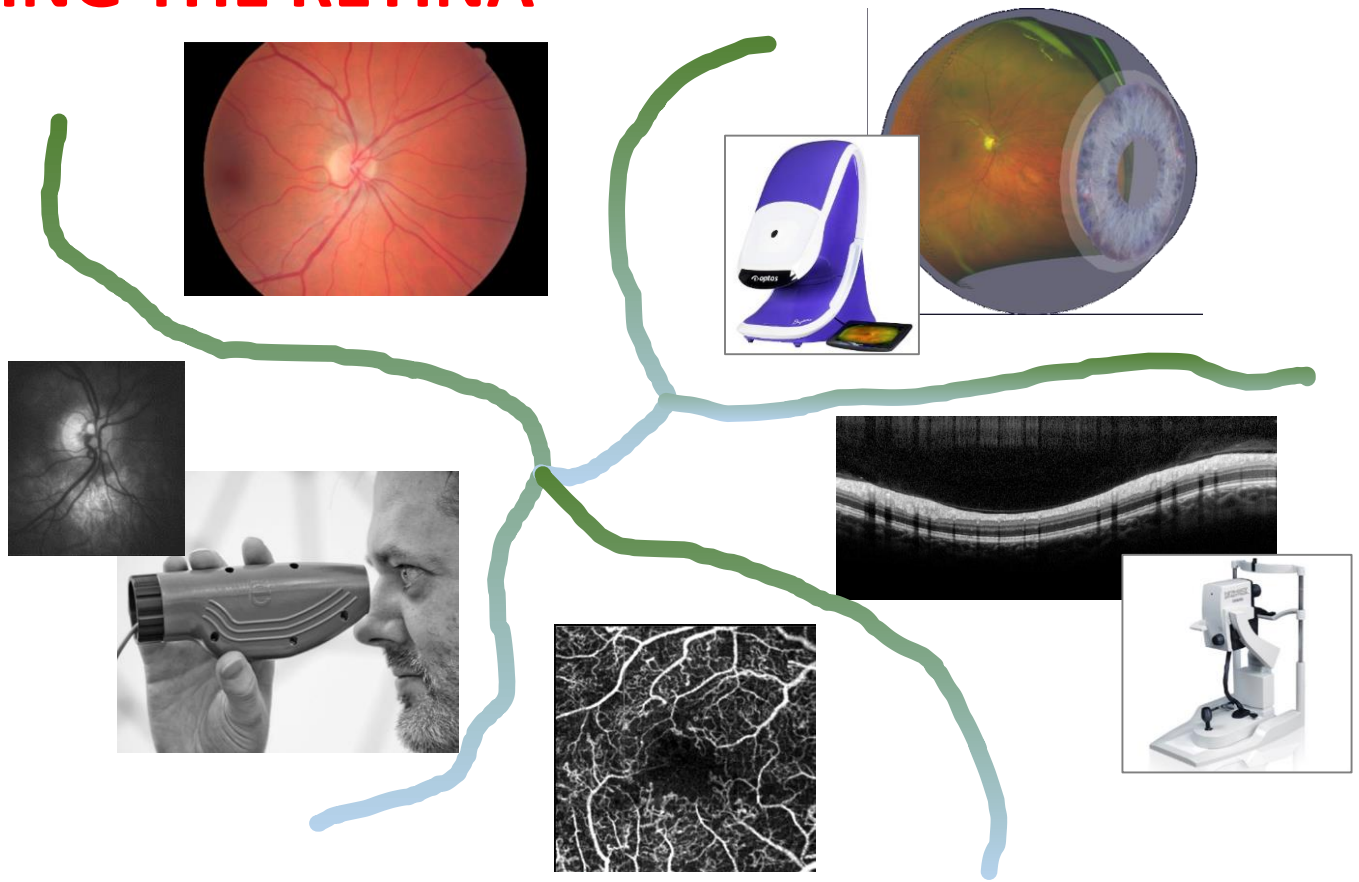
AN ECOSYSTEM FOR TRANSLATION-ORIENTED COMPUTATIONAL OPHTHALMOLOGY



University of Dundee

DUNDEE

IMAGING THE RETINA



RETINAL BIOMARKERS: PREDICTING RISK - and more…

British Journal of Ophthalmology

Home / Archive / Volume 101, Issue 7

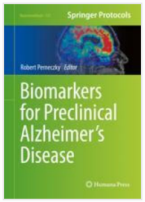
Retinal microvascular network geometry and cognitive abilities in community-dwelling older people: The Lothian Birth Cohort 1936 study

Sarah McGrory[1], Adele M Taylor[2], Mirna Kirin[3], Janie Corley[2], Alison Pattie[2], Simon R Cox[2, 4, 5], Baljean Dhillon[1], Joanna M Wardlaw[1, 4, 5], Fergus N Doubal[1], John M Starr[4, 6], Emanuele Trucco[7], Thomas J MacGillivray[1, 8], Ian J Deary[2, 4]

iovs investigative ophthalmology & visual science an ARVO journal

Ultra-Widefield Ophthalmic Imaging for Biomarker Discovery in Hypertension

Gavin Robertson; Tunde Peto; Michelle Williams; Baljean Dhillon; Graeme Houston; David Newby; Edwin J R van Beek; Emanuele Trucco; Alan Fleming; Jano Van Hemert; Tom J MacGillivray



Biomarkers for Preclinical Alzheimer's Disease pp 199-212 | Cite as

Retinal Imaging in Early Alzheimer's Disease

Authors Authors and affiliations

Tom MacGillivray, Sarah McGrory, Tom Pearson, James Cameron

BJR

REVIEW ARTICLE

Retinal imaging as a source of biomarkers for diagnosis, characterization and prognosis of chronic illness or long-term conditions

[1,2]T J MACGILLIVRAY, MSc, PhD, [3]E TRUCCO PhD, FRSA, [4]J R CAMERON MSc, FRCOphth, [5]B DHILLON BM BS, FRCS, [6]J G HOUSTON MD, FRCR and [1]E J R VAN BEEK MD, FRCR

[1]Vampire Project, Clinical Research Imaging Centre, University of Edinburgh, Edinburgh, UK
[2]Wellcome Trust Clinical Research Facility, University of Edinburgh, Edinburgh, UK
[3]Vampire Project, School of Computing, University of Dundee, Dundee, UK
[4]The Anne Rowling Regenerative Neurology Clinic, University of Edinburgh, Edinburgh, UK
[5]Vampire Project, Princess Alexandra Eye Pavilion, NHS Lothian, Edinburgh, UK
[6]Medical Research Institute, University of Dundee, Dundee, UK

University of Dundee

DUNDEE

VAMPIRE

VESSEL ASSESSMENT and MEASUREMENT PLATFORM for IMAGES of the RETINA

- **RESEARCH**: DELIVER EFFECTIVE, ADVANCED IMAGE AND DATA ANALYSIS SOFTWARE TOOLS SUPPORTING CLINICAL EYE-RELATED RESEARCH

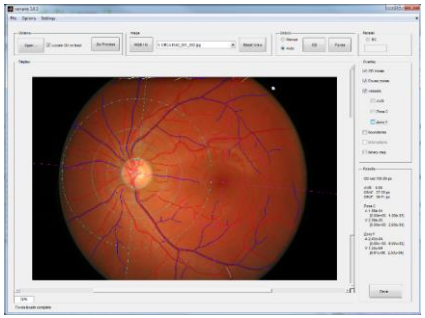
- **TRAINING**: SPECIALISTS OF IMAGE AND DATA ANALYSIS IN AN INTERDISCIPLINARY ENVIRONMENT

- **TRANSLATION**: MAKE A DIFFERENCE TO HEALTHCARE

University of Dundee

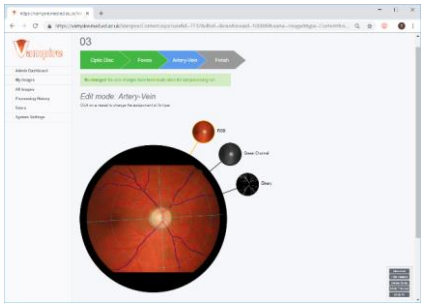
DUNDEE

VAMPIRE 3.1 SEMI-AUTOMATIC TOOL



VAMPIRE 3.1 (desktop)

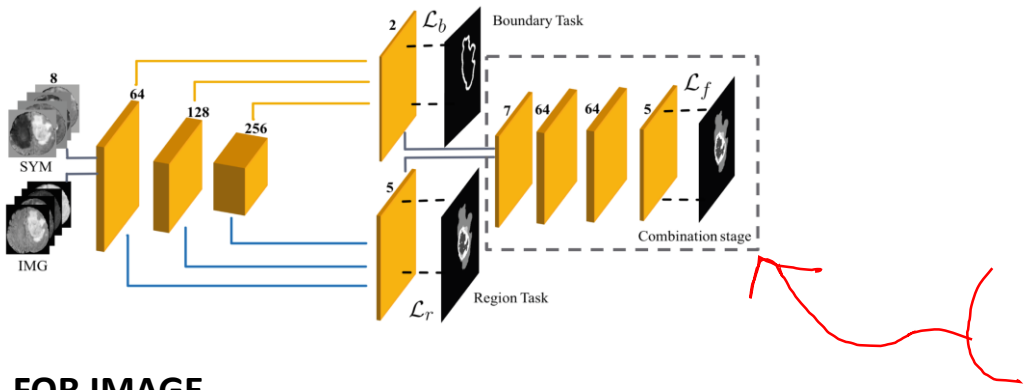
- 151 morphometry measurements of the retinal vasculature per image
- Include width-related, tortuosity, bifurcations, fractal dimension
- By zone, vascular tree, vessel
- Semi-automatic



VAMPIRE WEB (remote terminal)

- Same measurements as VAMPIRE 3.1
- Less operation intervention

DEEP LEARNING CVIP / VAMPIRE



FOR IMAGE ANALYSIS

- **Segmentation**
- **Classification**
- **Detection**

FOR DATA ANALYSIS

- **Discovery**
- **Representation**

RECENT INTERNATIONAL CHALLENGES WON BY CVIP + COLLABS

- MICCAI ISIC 2018 skin cancer classification (Task 3, Diagnostics)
- MICCAI 2017 white matter hyperintensities segmentation
- MICCAI 2015 abnormality detection in gastroscopic images
- MICCAI 2015 early Barrett cancer detection

R Annunziata, E Trucco: *Accelerating Convolutional Sparse Coding for Curvilinear Structures Segmentation by Refining SCIRD-TS Filter Banks*. IEEE Trans on Medical Imaging, vol 35 no 11, Nov 2016, pp 2381-2392.

S Manivannan, WQ Li, J Zhang, E Trucco, S McKenna: *Structure Prediction for Gland Segmentation with Hand-Crafted and Deep Convolutional Features,* IEEE Trans on Medical Imaging, vol 37 no 1, Jan 2018, pp 210-221.

H. Shen, R. Wang, J. Zhang, S. J. McKenna, *Boundary-Aware Fully Convolutional Network for Brain Tumor Segmentation*, MICCAI 2017.

S Manivannan and E Trucco: *Subcategory Classifiers for Multiple-Instance Learning and Its Application to Retinal Nerve Fiber Layer Visibility Classification*. IEEE Trans on Medical Imaging, vol 36 no 5, May 2017.

McNeil, A., Degano, G., Poole, I., Houston, G., Trucco, E. *Comparison of automatic vessel segmentation techniques for whole body magnetic resonance angiography with limited ground truth data*. Medical Image Understanding and Analysis - 21st Annual Conference, MIUA 2017.

... etc

University of Dundee

DUNDEE

EXAMPLE: RETINA - MACE

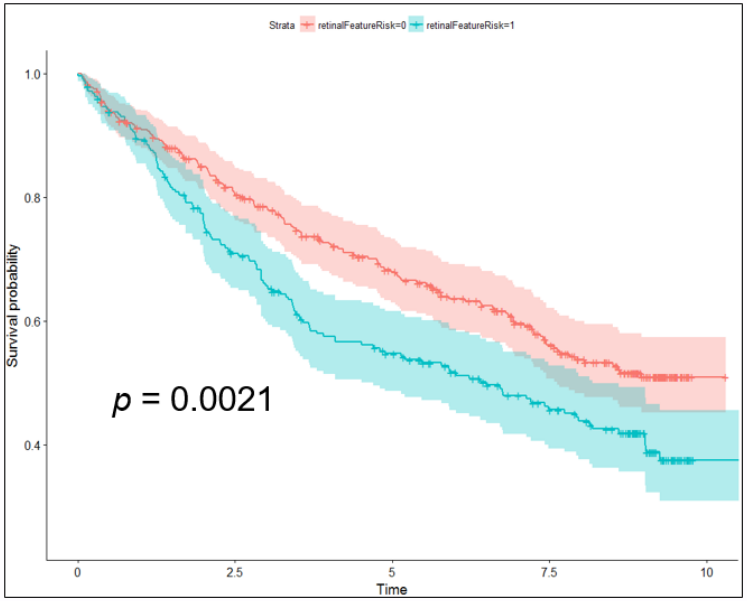
MACE RISK STRATIFICATION FROM RETINAL VASCULATURE IN ELDERLY DIABETIC PATIENTS

AE Fetit[1], S Hogg[1], R Wang[1], A Doney[2], GJ McKay[3], SJ McKenna[1], E Trucco[1]

[1]VAMPIRE/CVIP, Computing, School of Science and Engineering, University of Dundee, Dundee, UK; [2]Ninewells Hospital and Medical School, School of Medicine, University of Dundee, Dundee, UK; [3]Centre for Public Health, Queen's University Belfast, Belfast, UK.

Group	MACE	No MACE
Sex: female (male)	143 (134)	163 (160)
Mean age at scan in years	80.15	79.49
Median age at scan in years	79.14	78.62
Mean time between scan and end point, in years	3.22	6.90
Median time between scan and end point, in years	2.64	8.26

Feature	Coef	z	p
Retinal score	0.84198	2.27	0.0233
Diastolic blood pressure	-0.01279	-0.50	0.6193
Systolic blood pressure	0.00968	0.39	0.6964
Corrected dbp	-0.00825	-0.34	0.7332
Corrected sbp	-0.01618	-0.61	0.5412
# of blood pressure lowering drugs	0.22074	1.58	0.1144
Glycated haemoglobin	0.13104	2.42	0.0155
Cholesterol levels	-0.01201	-0.14	0.8850
High-density lipoprotein	-0.11295	-0.54	0.5877
Triglycerides	0.14340	2.51	0.0121
ApoE-4 presence	0.07092	0.56	0.5770
Sex	-0.05457	-0.42	0.6778
Age at scan	0.04402	3.11	0.0019




Ahmed Fetit


Alex Doney


Gareth MacKay


Stephen McKenna

EXAMPLE: RETINA - DIABETES COMPLICATIONS

Retinal microvascular parameter (per unit increase)	Unadjusted β eGFR (95% CI)	p	Adjusted β eGFR (95% CI)	p
Calibre				
Central retinal arteriolar equivalent	−0.47 (−0.87, −0.07)	0.02	−0.38 (−0.80, 0.05)	0.08
Central retinal venular equivalent	−0.30 (−0.60, 0.00)	0.05	−0.27 (−0.58, 0.05)	0.10
Arteriovenous ratio	−3.32 (−21.81, 15.16)	0.72	−0.52 (−19.64, 18.60)	0.96
Fractal dimension				
Arteriolar	−18.41 (−36.92, 0.10)	0.05	−17.64 (−36.71, 1.44)	0.07
Venular	−3.74 (−22.79, 15.31)	0.70	−3.46 (−23.36, 16.43)	0.73
No. of First branches in zone C				
Arteriolar	−0.67 (−1.63, 0.30)	0.17	−0.50 (−1.50, 0.49)	0.32
Venular	0.66 (−0.43, 1.75)	0.24	0.82 (−0.31, 1.95)	0.15
Tortuosity				
[a]Arteriolar	−0.01 (−2.66, 2.65)	1.00	−0.01 (−2.75, 2.73)	0.99
[a]Venular	−3.20 (−6.73, 0.32)	0.08	−2.22 (−5.86, 1.43)	0.23

Table 4. Linear regression models testing cross-sectional associations between follow-up eGFR and follow-up RVP. Follow-up eGFR and follow-up RVP, adjusted for age, gender, systolic blood pressure at follow-up, and HbA_{1c} at follow-up. 95% CI: 95% confidence interval. [a]Tortuosity variables were log transformed before linear regression to produce normal distribution.

The results of this study suggest that retinal vascular calibre, fractal dimension, tortuosity, and number of first vascular branches surrounding the optic disc are not predictive of eGFR decline over a 3 year follow-up in this white population with type 2 diabetes.

SCIENTIFIC REPORTS

OPEN

Received: 21 November 2017
Accepted: 22 February 2018
Published online: 02 March 2018

Retinal microvascular parameters are not associated with reduced renal function in a study of individuals with type 2 diabetes

Gareth J. McKay[1], Euan N. Paterson[1], Alexander P. Maxwell[1], Christopher C. Cardwell[1], Ruixuan Wang[2], Stephen Hogg[2], Thomas J. MacGillivray[3], Emanuele Trucco[2] & Alexander S. Doney[4]

GODARTS, n = 1,068


Alex Doney


Tom MacGillivray


Gareth MacKay


Stephen Hogg

EXAMPLE: RETINA - COGNITIVE DECLINE

Table 2 Characteristics of the study population (% prevalence and mean values)

Participant characteristics	N (%)/M (SD)	Min	Max
Age	72.5 (0.7)	70.9	74.1
Sex			
Male	352 (51.5)		
Female	331 (48.5)		
Presence or history of disease			
Hypertension	322 (47.1)		
Diabetes	62 (9.1)		
CVD	189 (27.7)		
Stroke	38 (5.6)		
Smoking status			
Current smoker	54 (7.9)		
Ex-smoker	308 (45.1)		
Never smoked	321 (47.0)		
APOE status			
e4 allele present	184 (26.9)		
No e4 allele	465 (68.1)		
Visual acuity (left)	0.4 (0.3)	−0.1	1.3
Visual acuity (right)	0.4 (0.3)	−0.1	1.4
HADS depression	2.5 (2.1)	0	13
Years of education	10.8 (1.1)	9	14
Social class	2.3 (0.9)		
I	134 (19.6)		
II	261 (38.2)		
IIIN	142 (20.8)		
IIIM	109 (16.0)		
IV	22 (3.2)		
V	5 (0.7)		

Visual acuity in logMAR units. Social classes are categorised as follows: I (professional occupations); II (managerial and technical occupations); IIIN (non-manual skilled occupations); IIIM (manual skilled occupations); IV (partly skilled occupations); V (unskilled occupations).
APOE, apolipoprotein E; CVD, cardiovascular disease; HADS, Hospital Anxiety and Depression Scale.

LBC 1936

n = 683

Age 11

Centre for Cognitive Ageing and Cognitive Epidemiology

EPSRC Engineering and Physical Sciences Research Council

Bal Dhillon

Ian Deary

Fergus Doubal

Joanna Wardlaw

BJO Online First, published on October 17, 2016 as 10.1136/bjophthalmol-2016-309017
Clinical science

OPEN ACCESS

Retinal microvascular network geometry and cognitive abilities in community-dwelling older people: The Lothian Birth Cohort 1936 study

Sarah McGrory,[1] Adele M Taylor,[2] Mirna Kirin,[3] Janie Corley,[2] Alison Pattie,[2] Simon R Cox,[2,4,5] Baljean Dhillon,[1] Joanna M Wardlaw,[1,4,5] Fergus N Doubal,[1] John M Starr,[4,6] Emanuele Trucco,[7] Thomas J MacGillivray,[1,8] Ian J Deary[2,4]

University of Dundee

CVIP DUNDEE

RETINA - DEMENTIA

- Importance of retinal parameters in classifying dementia.
- GoDARTS, n =1,742.
- Regularized logistic regression.

- 500 Bootstraps
- Lasso + λ_{min}

Feature vector	Average classification error across bootstraps	95% confidence intervals of classification error
Multiscale Features	37%	30% - 43%
Local Quadrant Features	38%	32% - 44%
Global Features	39%	33% - 45%
Age only classifier (no regularisation)	37%	32% - 43%
Multiscale Textural Features + Age	**33%**	**28% - 39%**

- **Textural features match the performance of Age, the single strongest predictor for the data set.**
- **Using the textural features alongside Age improves prediction performance.**

Retinal Biomarker Discovery for Dementia in an Elderly Diabetic Population

Ahmed Fetit, Siyamalan Manivannan, Sarah McGrory, Lucia Ballerini, Alexander Doney, Thomas J. MacGillivray, Ian J. Deary, Joanna M. Wardlaw, Fergus Doubal, Gareth J. McKay, Stephen McKenna, Emanuele Trucco

Alzheimers Dement (Amst). 2016 Dec 2;6:91-107. doi: 10.1016/j.dadm.2016.11.001. eCollection 2017.

The application of retinal fundus camera imaging in dementia: A systematic review.

McGrory S[1], Cameron JR[2], Pellegrini E[1], Warren C[3], Doubal FN[1], Deary IJ[4], Dhillon B[1], Wardlaw JM[5], Trucco E[6], MacGillivray TJ[7].

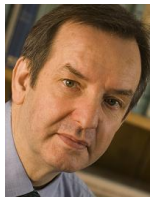
Ophthalmic Res. 2018 May; 59(4): 182–192. PMCID: PMC5985743
Published online 2018 Apr 5. doi: 10.1159/000487053 PMID: 29621759

Peripheral Retinal Imaging Biomarkers for Alzheimer's Disease: A Pilot Study

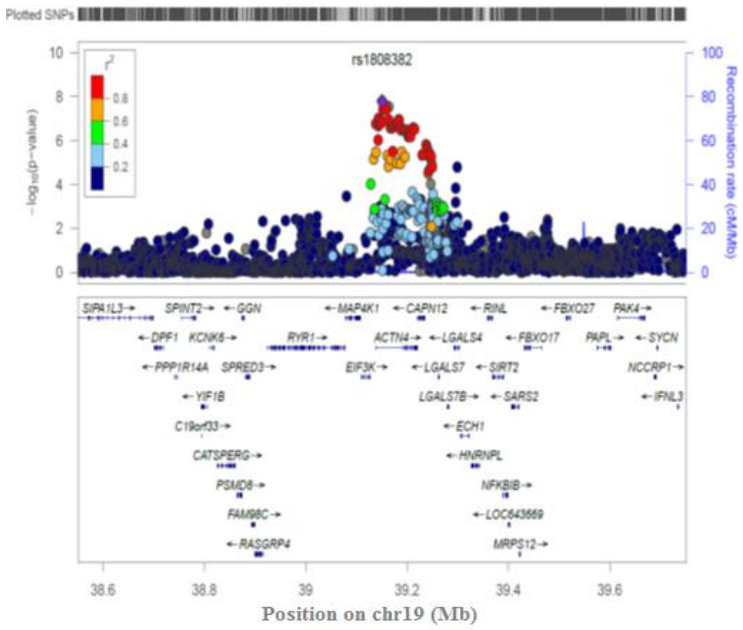
Lajos Csincsik,[a,b] Thomas J. MacGillivray,[c,d] Erin Flynn,[a,e] Enrico Pellegrini,[c,f] Giorgos Papanastasiou,[d] Neda Barzegar-Befroei,[b] Adrienne Csutak,[b,g] Alan C. Bird,[b] Craig W. Ritchie,[h] Tunde Peto,[a,i] and Imre Lengyel[a,b,*]


Imre Lengyel

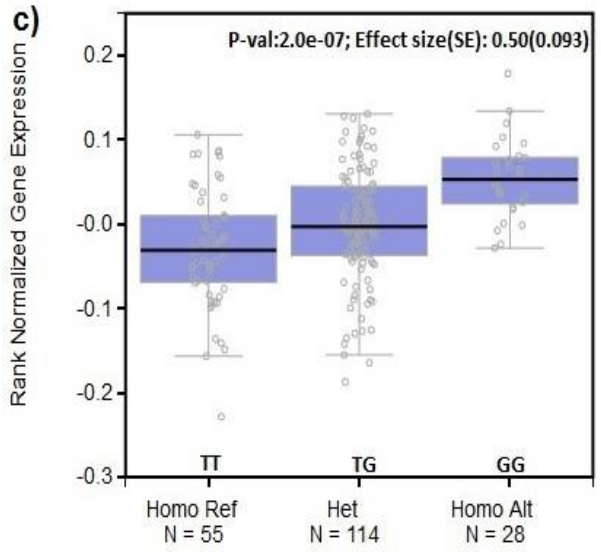

Joanna Wardlaw


Ian Deary

Retinal venular tortuosity : novel loci at 19q13 near *ACTN4/CAPN12*



rs1808382 is correlated with *CAPN12* expression in artery aorta



Slide courtesy of Dr A Veluchamy and Dr Alex Doney, Division of Molecular and Clinical Medicine, Univ of Dundee

CONCLUSION: KEY MESSAGES

- VISION: AN ECOSYSTEM FOR TRANSLATION-ORIENTED COMPUTATIONAL OPHTHALMOLOGY …

- … and VAMPIRE CONTRIBUTIONS:
  - CONCRETE PLATFORM BRINGING TOGETHER ALL ECOSYSTEM PLAYERS
  - IMAGE AND DATA ANALYSIS
  - RETINAL BIOMARKERS FOR SYSTEMIC CONDITIONS

WITH HUGE THANKS TO …

CVIP / VAMPIRE DUNDEE

Dr Shazia Akbar
Dr Hind Azegrouz, SNCCR, Spain
Dr Roberto Annunziata, UCL
Dr Lucia Ballerini, UoEdinburgh
Dr Colin Buchanan, UoEdinburgh
Jyothsna Divy Mohammananda
Tianjun Huang
Dr Wenqi Li, UCL
Prof Stephen MacKenna
Andrew McNeil
Dr Siyamalan Mannivannan
Dr Muthu Mookiah
Dr Enrico Pellegrini, OPTOS plc
Dr Adria Perez Rovira, UoRotterdam
Haocheng Shen
Mohammed Syed
Prof Roy Wang, Chendu
Kris Zutis, NHS Tayside

VAMPIRE EDINBURGH

Dr Tom MacGillivray
Dr Sarah McGrory
Emma Pead
Tom Pearson
Dr Devanjali Relan
Dr Gavin Robertson, OPTOS plc

CLINICAL/SCIENTIFIC COLLABS

Dr James Cameron, UoEdinburgh, NHS
Prof Christophe Chiquet, UoGrenoble, France
Prof Ian Deary, UoEdinburgh , CCACE
Dr Alex Doney, NHS Tayside
Prof Bal Dhillon,
Dr Fergus Doubal, UoEdinburgh, NHS
Dr Sharon Fekrat, Duke Univ, USA
Prof Paul Foster, UCL Moorfields
Dr Pedram Hamrah, Harvard Med School, US
Dr Ruth Hogg, QUB, NHS
Prof Graeme Houston, NHS Tayside, UoDundee
Dr Jean Pierre Hubschman, UCLA Jules Stein Eye Inst, USA
Dr Ahmad Kheirkah, Harvard Med School, USA
Dr Gareth MacKay, QUB,
Dr Danny Mitry, UCL Moorfields
Dr Tunde Peto, QUB / UCL Moorfields
Prof Axel Pries, Charite` Hosp, D
Prof Joanna Wardlaw, UoEdinburgh
…

MAIN INDUSTRIAL COLLABS

OPTOS plc
Toshiba MV Edinburgh
Epipole plc
NIDEK Technologies

COMPUTER SCIENCE COLLABS

Prof Xinjian Chen, China
Prof Luca Giancardo, Univ Texas, US
Prof Andrea Giachetti, UoVerona, I
Prof Andrew Hunter, UoLincoln
Prof Jiang (Jimmy) Liu, Chin Acad Sci
Dr Damon Wong, A*STAR Singapore
Dr Carmen Lupascu, UoPalermo, I
Prof Giovanni Montana, Warwick University, UK
Prof Mimmo Tegolo, UoPalermo, I
Jeff Wigdahl, UoPadova, I
Prof Alessandro Verri, UoGenova, I
Prof Tien Yin Wong, Singapore
Dr Frank Wu, Baidu, China

THANK YOU !

vampire.computing.dundee.ac.uk

e.trucco@dundee.ac.uk

t.j.macgillivray@ed.ac.uk



Proteus: : Team Science & Moving Together

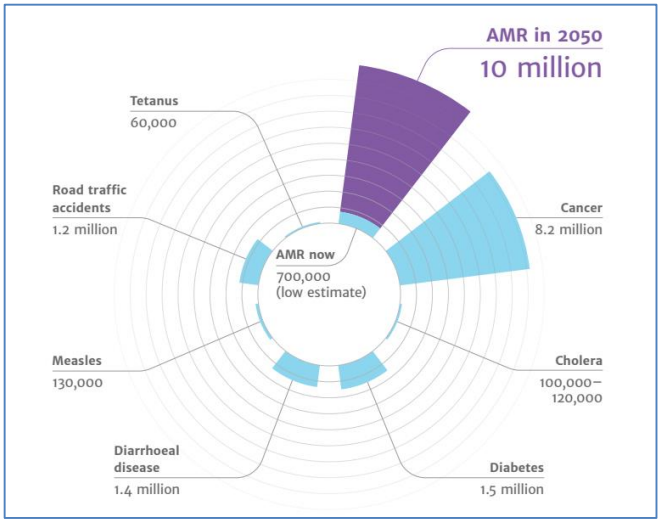
Prof Kev Dhaliwal

Centre for Inflammation Research , Queen's Medical Research Institute

Edinburgh BioQuarter

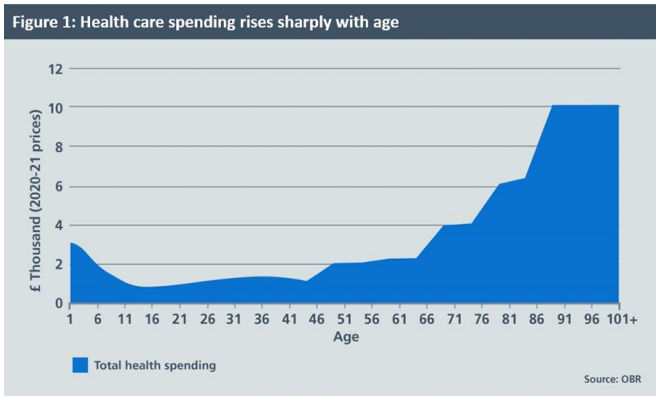
Overwhelming Global Healthcare Challenges

- **Antimicrobial Resistance**



"Resistant TB endangers the health and security of every country...the day will soon come when we are facing the international spread of an incurable airborne disease" - Paul Jensen (Director of Policy and Strategy for The International Alliance Against TB).

- **Ageing & Unhealthy Population**



Cancers
Dementia
Cardiovascular Disease
Smoking Related Lung Disease

What do We Want to Do?

Prevent

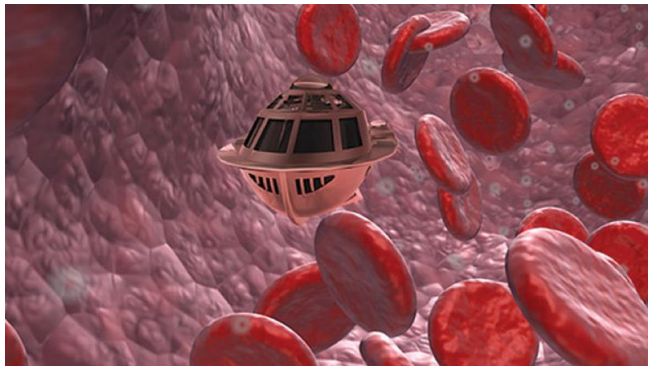
Diagnose Early

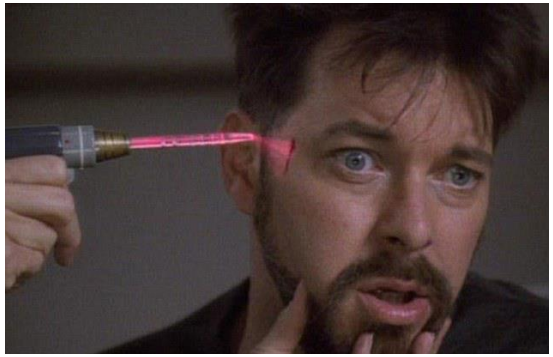
Treat Smartly and Quickly

Improve Quality of Life

Technology is Accelerating Like Never Before in Human History

Seeing into the Future From the Past





Healthcare Delivery Is Changing

Now Imagine – What If ?

- What if we brought together and mixed the engineers, physicists , mathematicians , biologists, regulatory staff, ethics experts , patients and clinicians in the same place?
- What if we spoke each others languages?
- What if we fought disease and not each other ?
- What if we embraced global health as THE priority?
- Interventional Biophotonics…..... Fusing across Data, Radiomics, Robotics, Sensing, Imaging, Therapy

Clinical Uncertainty

Pneumonia

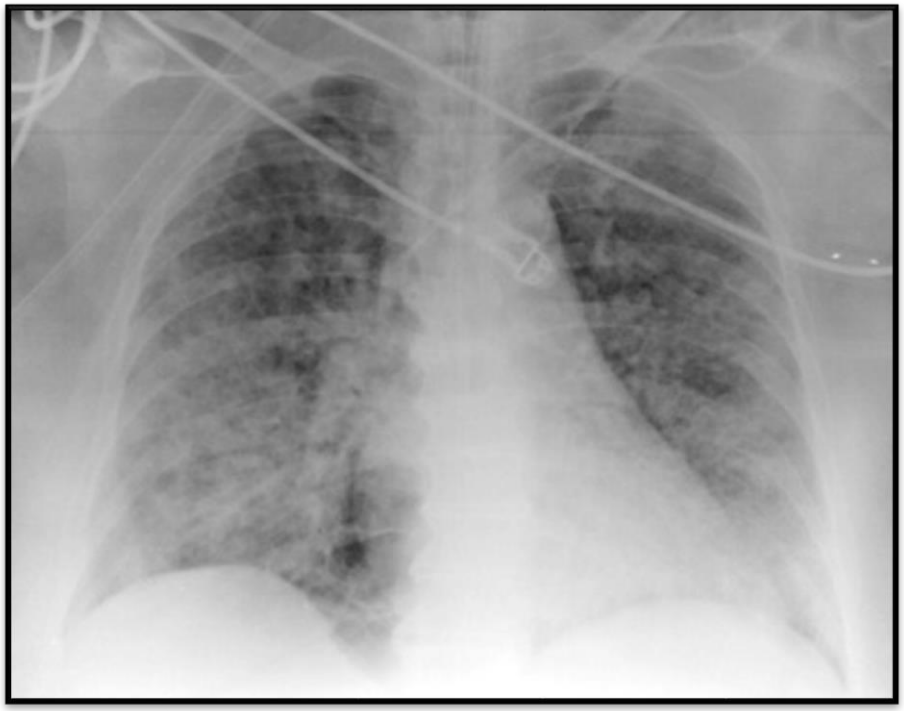
Cardiac failure

Alveolar Collapse

Sterile Inflammation

Embolism

Systemic Sepsis



Haemorrhage

Non-cardiogenic oedema

Aspiration

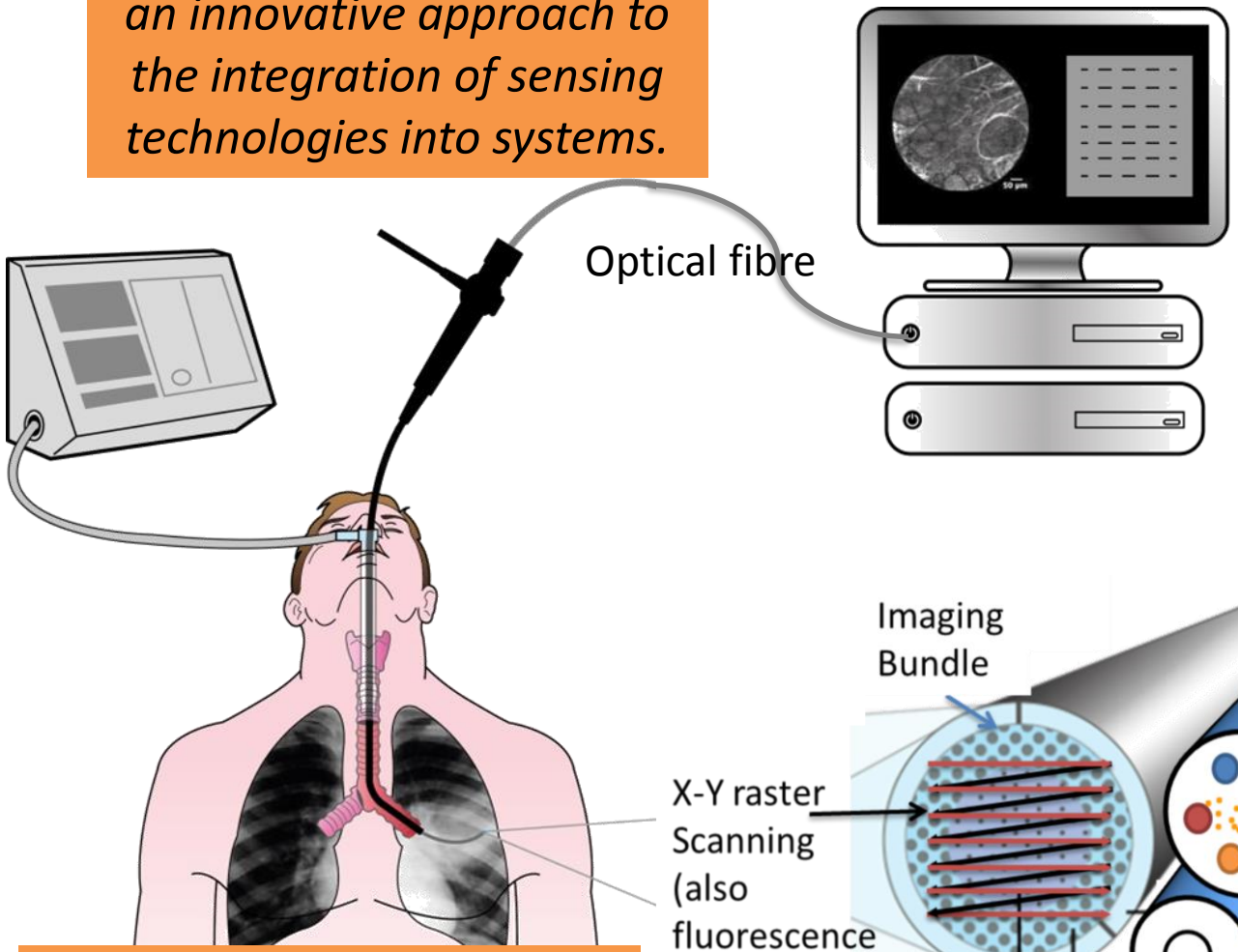
Drug induced

Massive transfusion

Fibrosis

System & Integration

an innovative approach to the integration of sensing technologies into systems.

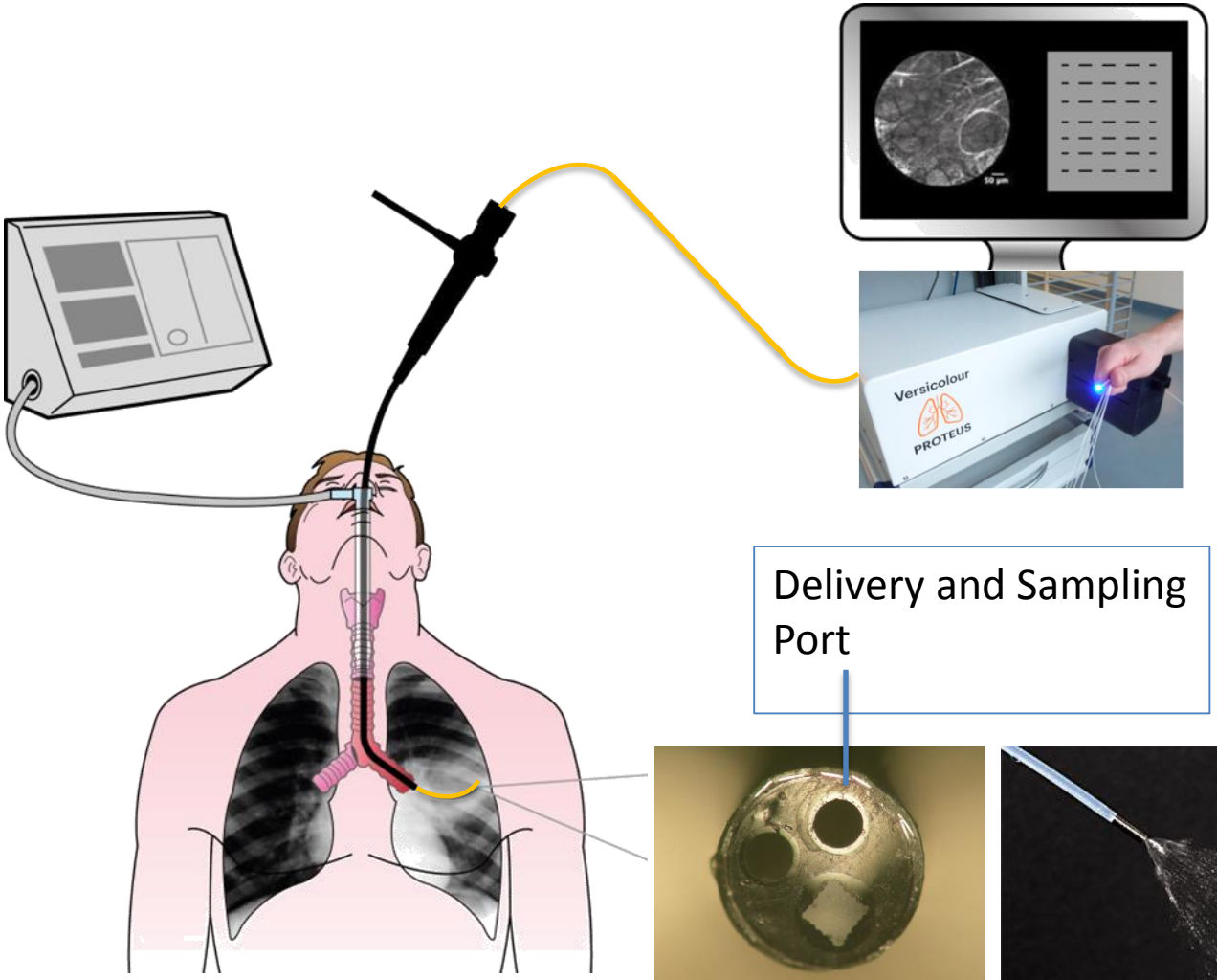


data integration and conversion to information for decision making

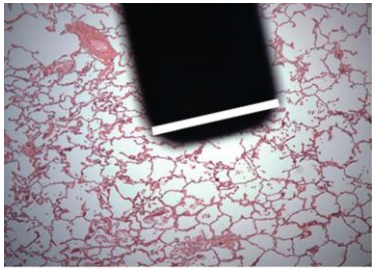
Novel sensors (Probes and reporters)

detect and measure in real-time

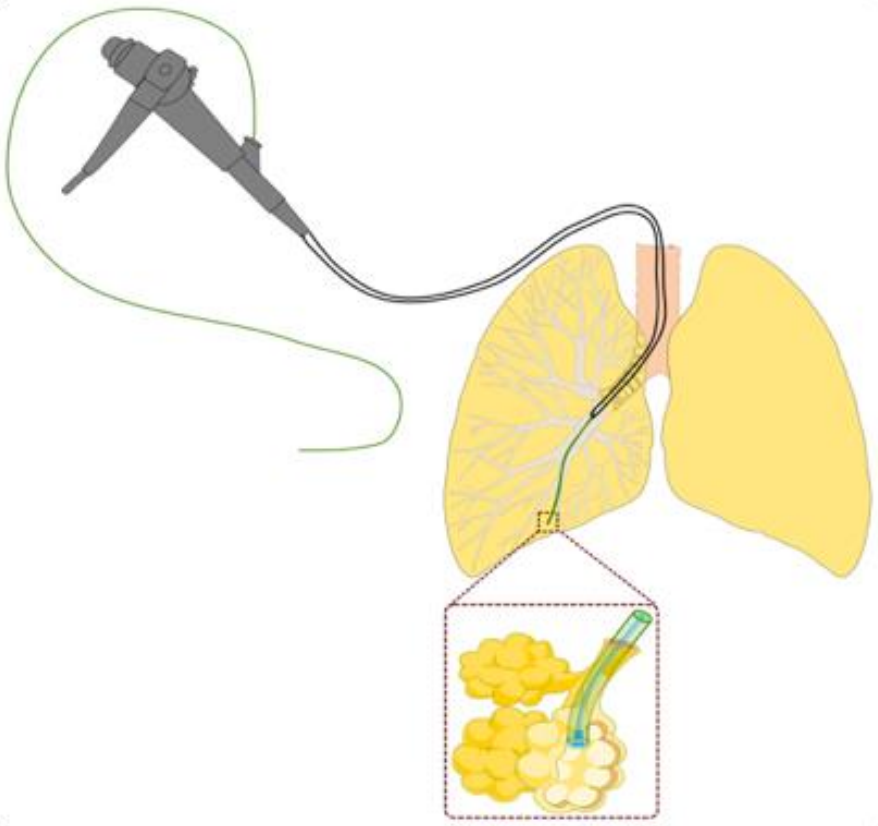
Simple Solution- Molecular Alveoscopy

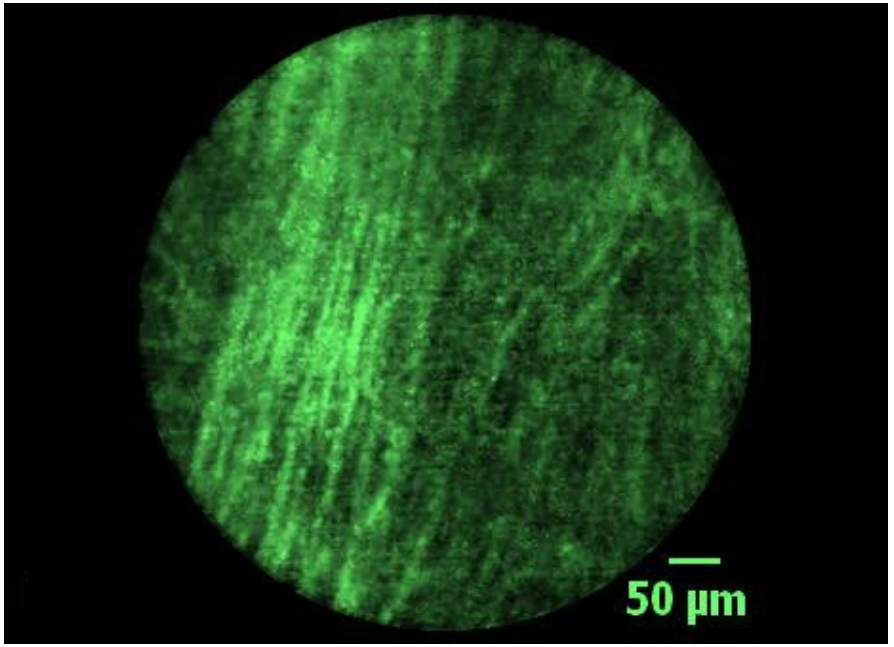


Delivery and Sampling Port

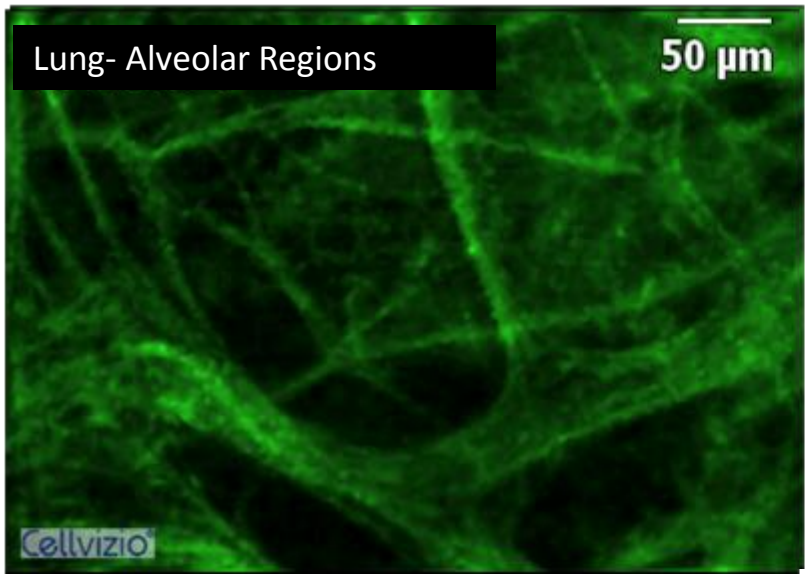


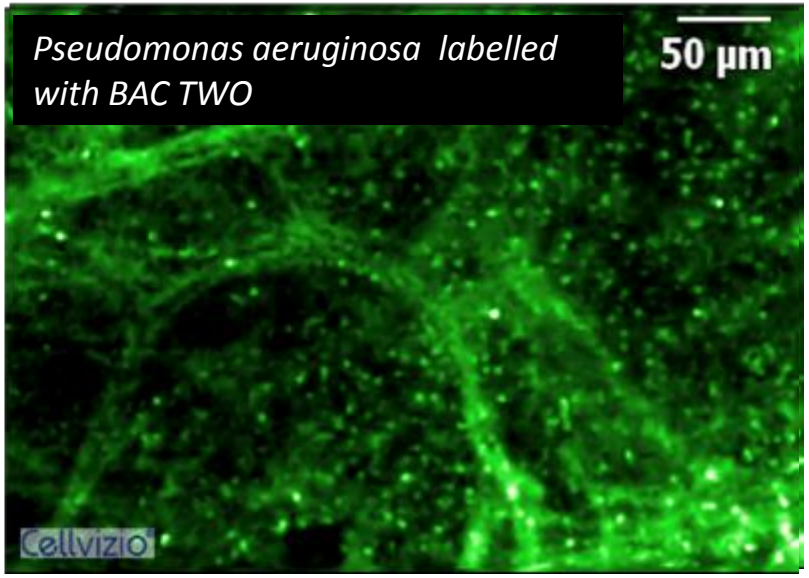
How Does It Work 1: Alveoscopy

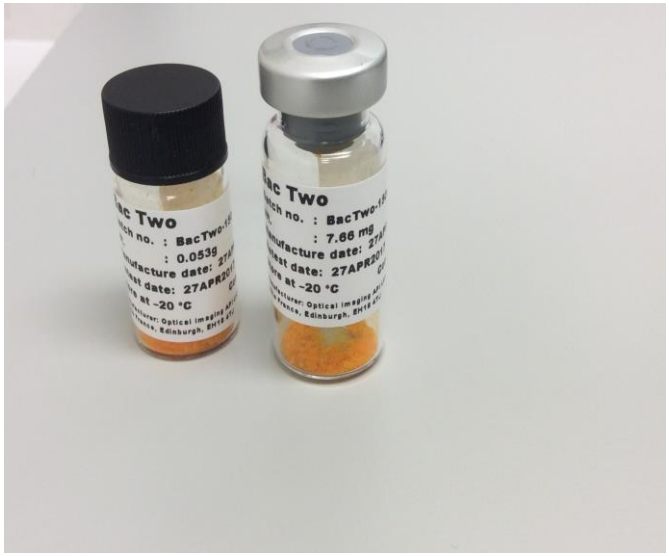


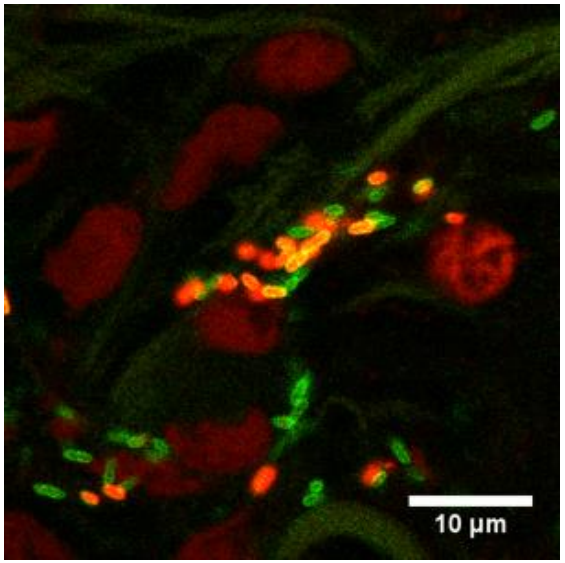


How Does It Work 2: Target Labelling

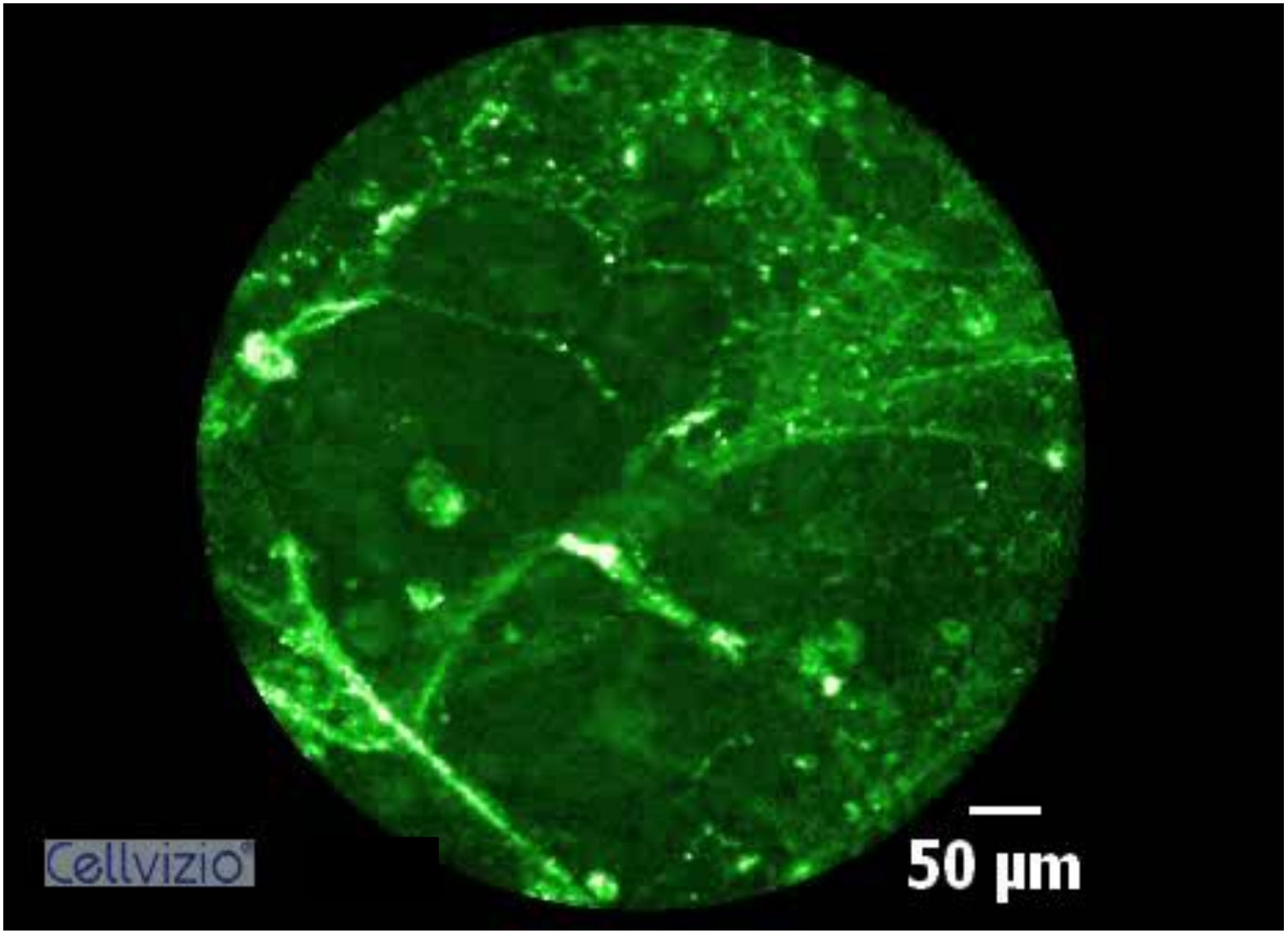








In Intensive Care



Where Are We Today?

2011----------2017 2018----------2022

Technology Concepts & Development **First-in-human** **Validation Clinical Studies**

Technology Developed

- SmartProbes
- Imaging System
- Image Analysis
- Fibres

To date, rapid and safe

- 65 patients imaged in Edinburgh
- 19 in ICU- all mechanically ventilated
- Average duration of procedure: 8 minutes, 3-5 passes
- No IMP related adverse events

Team Science Across Disciplines

PROTEUS

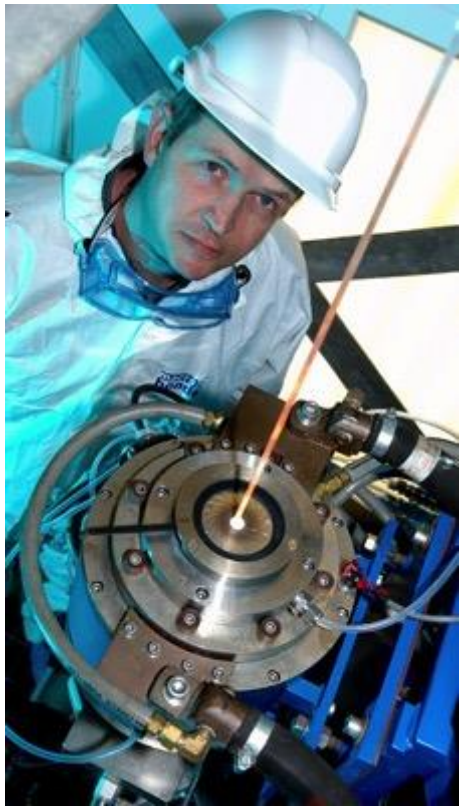
EPSRC Interdisciplinary Research Collaboration

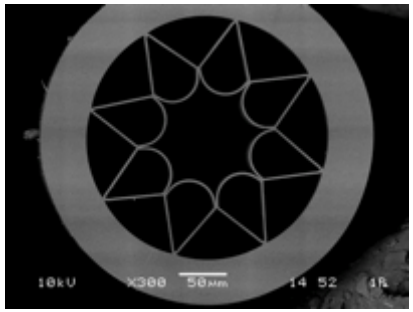
THE UNIVERSITY OF EDINBURGH

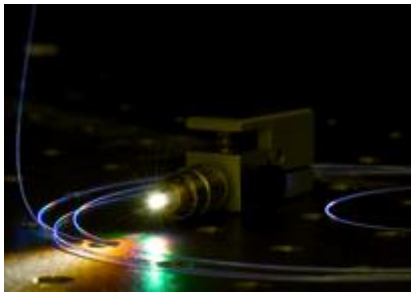
HERIOT WATT UNIVERSITY

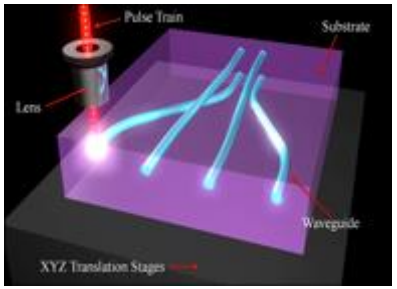
UNIVERSITY OF BATH

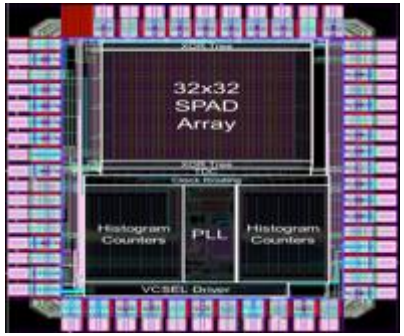
Glass to Man

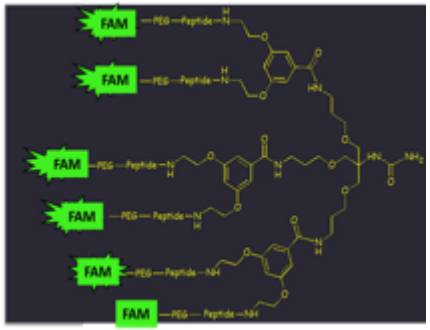


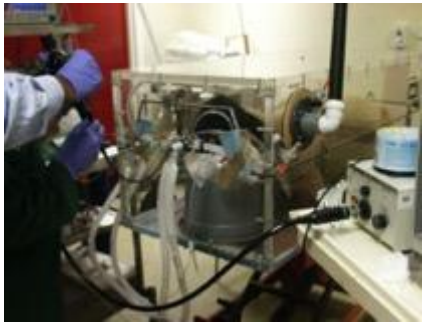

10kV
X300
50µm
14 52

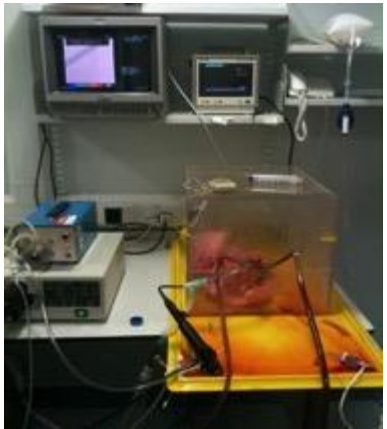



Pulse Train
Substrate
Lens
Waveguide
XYZ Translation Stages

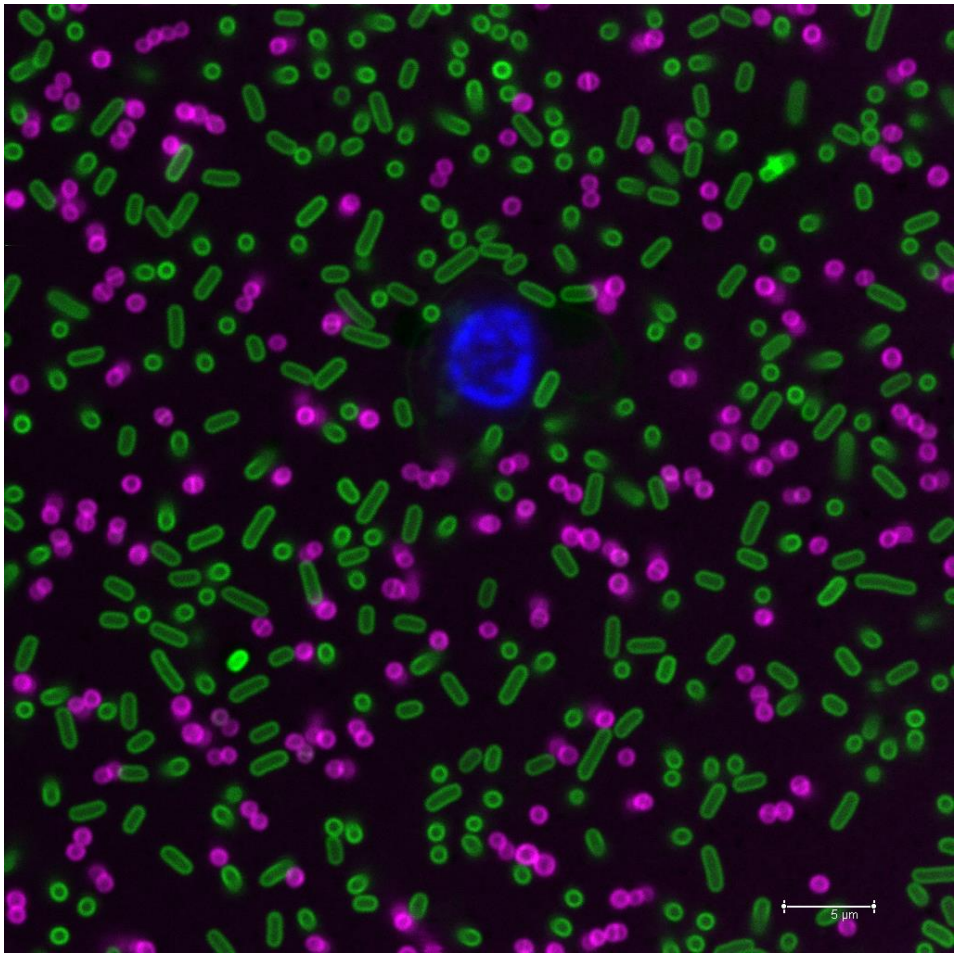

32x32
SPAD
Array
Histogram
Counters
PLL
Histogram
Counters
VCSEL Driver


FAM
FAM
FAM
FAM
FAM
FAM





Beautiful Molecules



Learning Through Translation

EPSRC Pioneering research and skills

wellcome trust Strategic Award

MRC Medical Research Council

MARIE CURIE ACTIONS

• **Neutrophil Activation**	**Phase 2**	**Q1 2016**
• **Macrophage polarisation**	**Lead optimising**	
• **Bacteria**	**Phase 2**	**Q4 2018**
• **Fungi**	**Phase 1**	**Q1 2016**
• **Fibrogenesis**	**Phase 1**	**Q4 2016**
• **Malignant Matrix**	**Phase 1**	**Q4 2016**
• **Versicolour Device**	**Phase 1**	**Q4 2015**

- Respiratory Critical Care
- Lung Cancer
- Immunotherapy
- Lung Transplantation
- Pulmonary Fibrosis
- Intraoperative applications

Working with India & Malawi

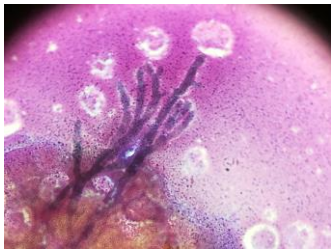
ARAVIND EYE CARE SYSTEM
Run by Govel Trust

Entrance to AEH outpatient block, Madurai, India.

- Probes now being tested in India
- Visit to Aravind Eye Hospital

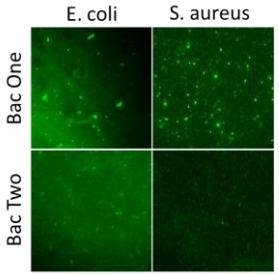

Myself and the microbiology team at Aravind.

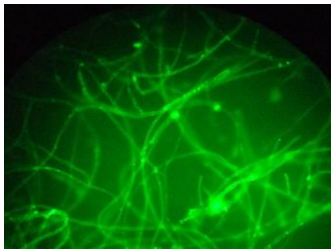

Current diagnostics for corneal infection are invasive and require specialists at the hospital.




Innovative, high throughput four-patient tandem cataract surgery developed at AEH.

Entrance to Aurolabs and their corporate social responsibility pledge.

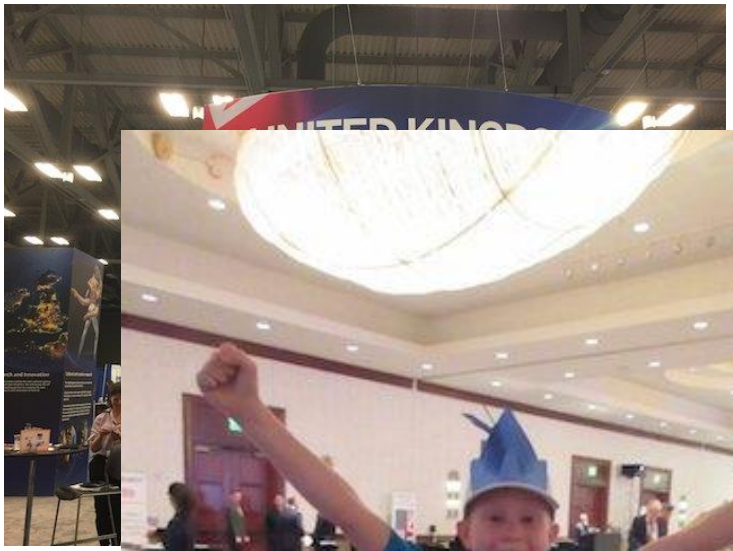




Testing of Bac One

AAAS Annual Meeting

PROTEUS

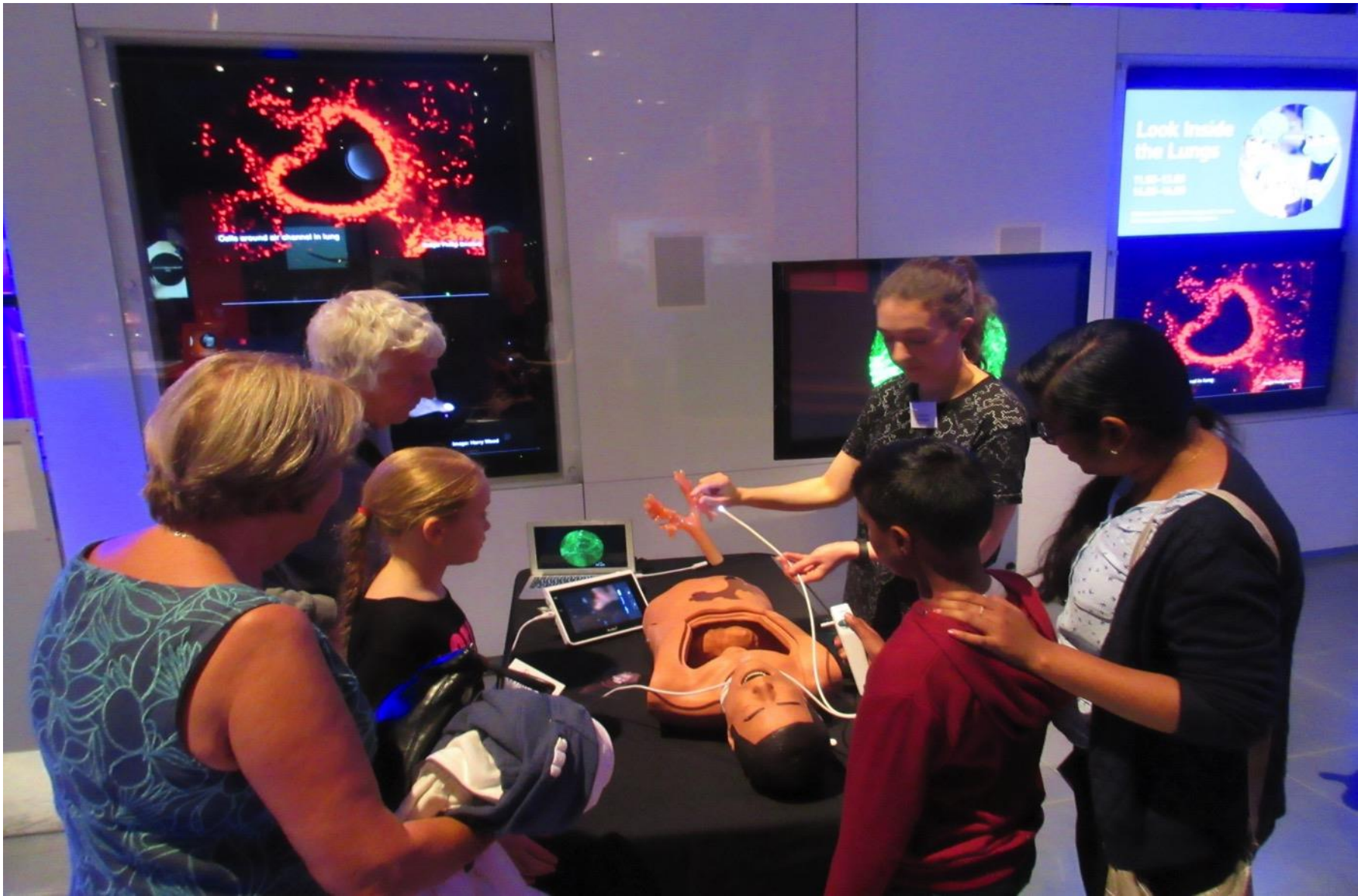


The Proteus Research Pod

PROTEUS

The London Science Museum

PROTEUS



The Edinburgh International Science Festival

PROTEUS

In Rwanda

PROTEUS

Having Fun

PROTEUS

Concept to Translation: Where Are We?

- DISTANT PAST

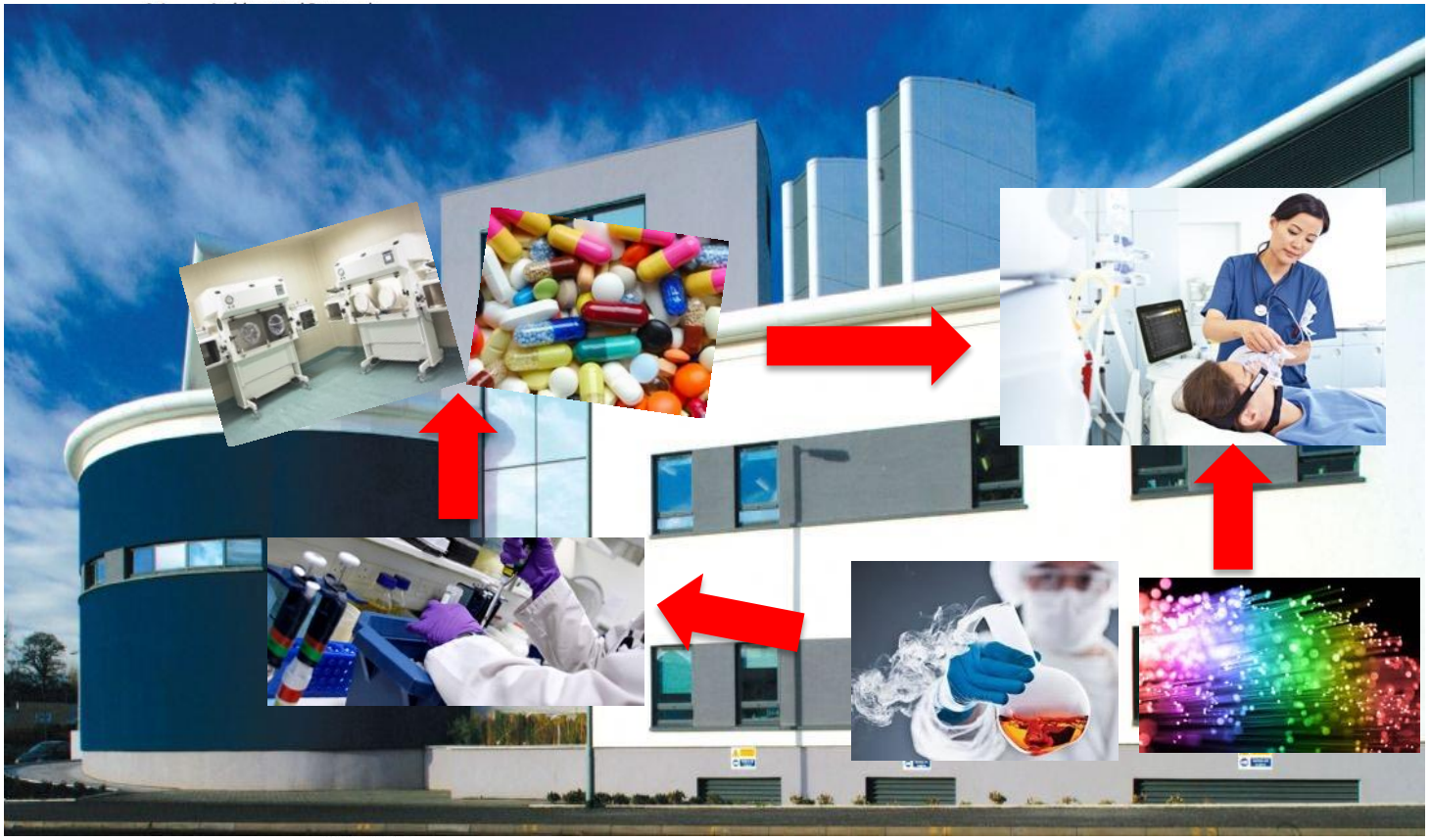
- RECENT PAST

+

Where Do We Want to Go?

- FUTURE

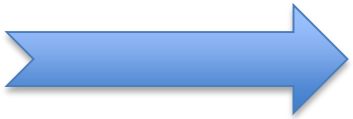
QMRI: Joined Up Vision



The “Push” and the “Pull” for **Interventional Biophotonics-Healthcare Technology Accelerator Facility**

Engineering & Physical Sciences

Clinical Faculty & Medical School

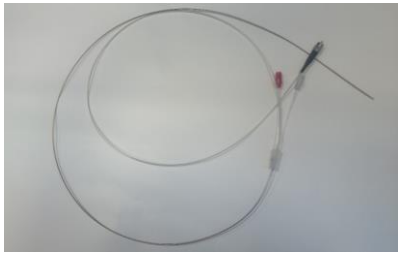


CiC Portfolio: Interventional Biophotonics

The “Push” and the “Pull” Quality Management Systems

Technology Innovation Hub

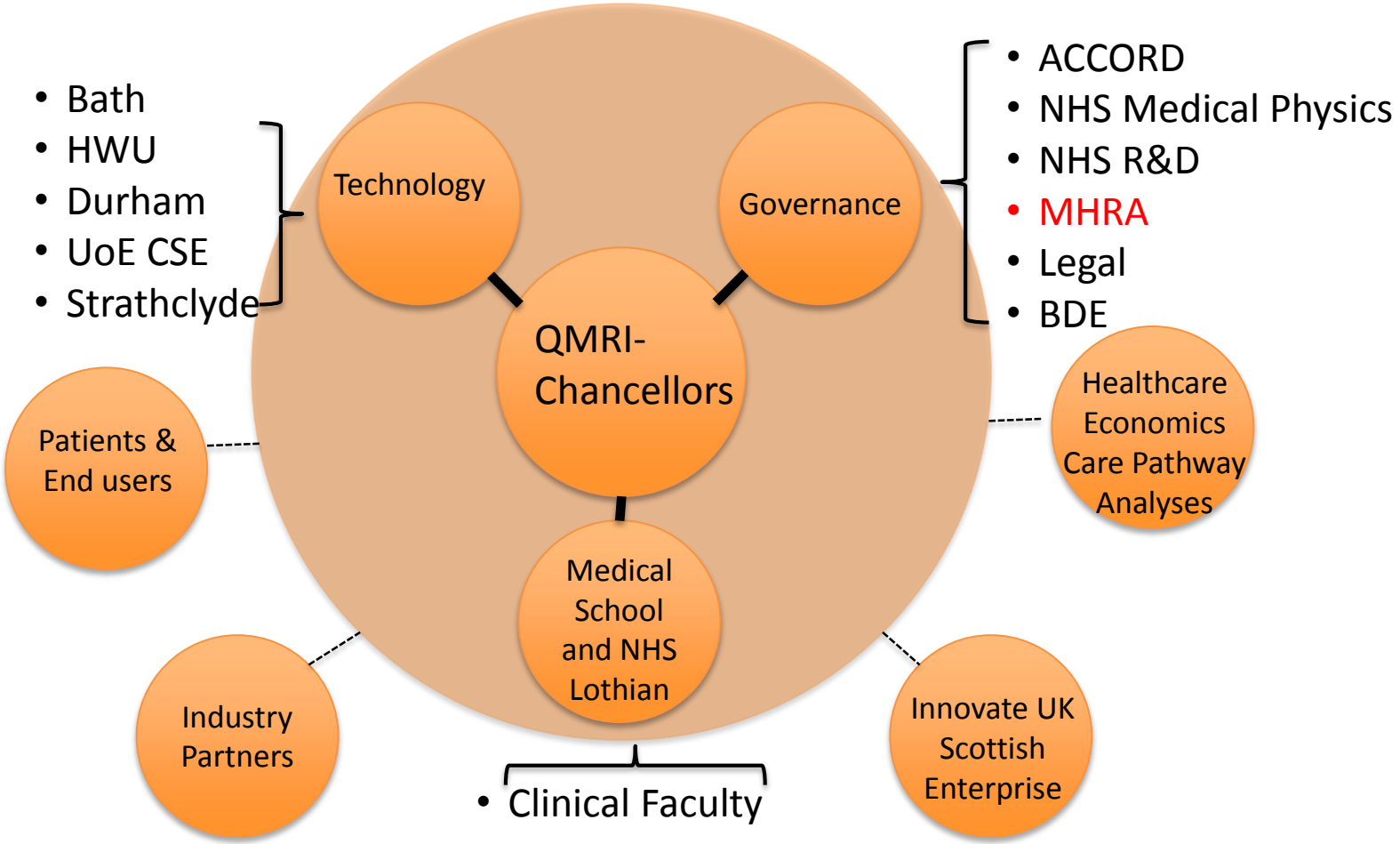
- Technology Integration to Deliver Technology that can be Evaluated
- ***Innovate & Develop***



Expediting The Pathway

- A one-stop shop for interventional biophotonics
- Inception, translation and commercialisation
- Removing traditional barriers, creating opportunities, catalysing innovation and expediting impact
- Implementing translational technology focussed activities in parallel with clinical studies to accelerate “bedside to bench” innovation

Key Interactions



Key Capabilities/Networks

- Oversight by professional technology consultancy (PA) and commercialisation experts (California Life Sciences Institute)
- Flexible lab space operating as UK-wide ‘R&D’ resource.
- Clinical expert faculty ***from all NHS specialties***
- Experienced clinical project managers
- Embedded quality management systems
- Trial design methodology and statistics
- Production engineers, chemists and software engineers with ethos and experience of translation.
- Direct liaison with MHRA

Summary

- Interventional Biophotonics – A Bright Future at the Bedside
- TEAM TEAM TEAM

accord

THE UNIVERSITY OF EDINBURGH

NHS Lothian

Academic and Clinical Central Office for Research and Development

EPSRC

Pioneering research and skills

MRC Medical Research Council

wellcome

Powered by CARB-X

Questions

NHS SCOTLAND
NHS RESEARCH SCOTLAND

proud to support 70 YEARS of the NHS in Scotland