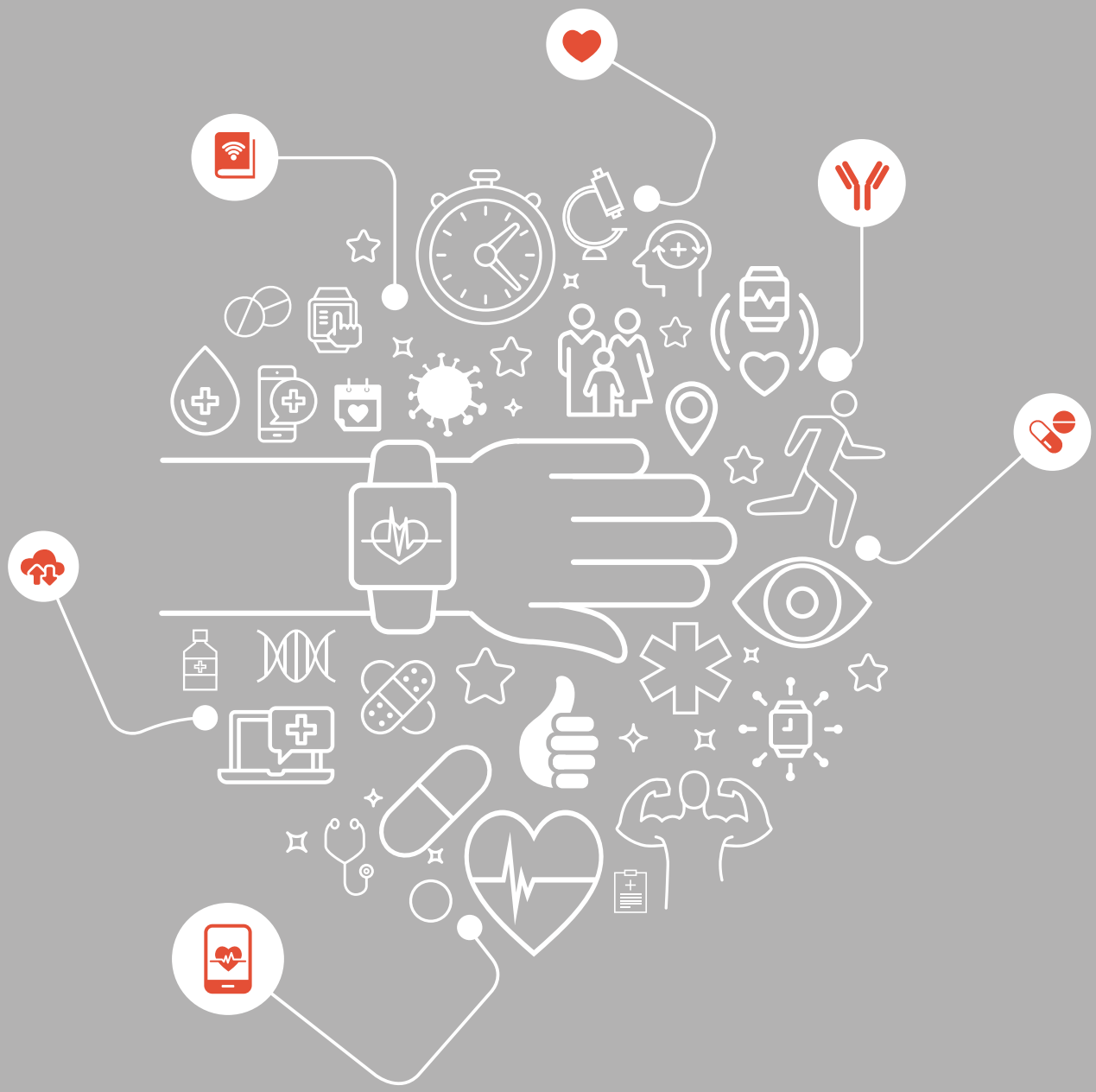
Precision Medicine and Digital Health

Technology Showcase
Oxford 2017



Oxford Biomedical Research Centre

NHS National Institute for Health Research

Oxford Academic Health Science Network

Oxford University Innovation

University of Oxford

Oxford Academic Health Science Centre
WORLD-CLASS PARTNERSHIPS BRINGING RESEARCH TO LIFE

Programme

Said Business School (SBS) Foyer

12:00 – 13:00 Registration, lunch, and exhibition

Nelson Mandela Lecture Theatre

13:00 – 14:00 Welcome Lectures

Professor Keith Channon - Director, NIHR Oxford Biomedical Research Centre

Dr Matt Perkins - CEO, Oxford University Innovation

Dr Nick Scott-Ram - Director of Commercial Development, Oxford AHSN

Dr Manuel Pinuela - CBO, Drayson Technologies
Mapping the Personal Health Space

Dr Nigel Pitchford - Chief Investment Officer, Touchstone Innovations
What works..?

Parallel Sessions

Nelson Mandela Lecture Theatre

14:00 – 15:15 Stream 1

Digital Technologies

Theme A. Wearable Technologies and Monitoring Devices

Plenary: Professor Lionel Tarassenko - Professor of Electrical Engineering, University of Oxford
Wearables: from consumer devices to healthcare products?

Speaker: Professor Maarten de Vos - Associate Professor in Engineering Science, University of Oxford
Inobtrusive monitoring of sleep and circadian rhythms at home

Speaker: Dr Tim Bonnici - Clinical lecturer, The Institute of Biomedical Engineering (IBME)
SEND A digital patient safety system

Speaker: Dr Karl Surmacz - Principal Data Scientist at McLaren Applied Technologies
Real-world data-driven dynamic patient engagement

Speaker: Dr Alessandro Guazzi, CEO Sentimoto
Mens sana in corpore sano: measurement and prevention in social care

Rhodes Trust Lecture Theatre

14:00 – 15:15 Stream 2

Precision Medicine

Theme A. In vitro Diagnostics for Personalized Medicine

Plenary: Professor Anna Schuh - Associate Professor and Director for Molecular Diagnostics
Development, validation and implementation of precision diagnostics for blood cancers and solid tumours in the NHS

Speaker: Dr Ian Campbell - Director - Health and Life Sciences, Innovate UK
Driving productivity and economic growth in health and life sciences

Speaker: Professor Michael Simpson - Co Head of Science, Genomics Plc
Genomics, big data and better health

Speaker: Dr Gordon Sanghera - CEO, Oxford Nanopore Technologies
Power in your pocket: taking real time DNA information out of the lab towards the point of care

Speaker: Dr Graham Speight – Oxford Gene Technology
Targeted NGS Panels Towards Precision Medicine in Oncology

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Said Business School (SBS) Foyer

15:15 – 16:00 Afternoon Break, Refreshments, Exhibition and Networking

Parallel Sessions

Nelson Mandela Lecture Theatre

16:00 – 17:15 Stream 1

Digital Technologies

Theme B. Pathway Reconfiguration

Plenary: Mr Peter Knight - Chief Information and Digital Officer, Oxford University Hospitals NHS Foundation Trust
Strategic Digital Health Solutions for Pathway Innovations

Speaker: Seán Wetherall - Oneview Healthcare PLC
Digital Pathways – Transforming Healthcare

Speaker: Dr Nick de Pennington - Specialist Registrar, Oxford University Hospitals & Health Innovation Lead/Director of The Hill
Healthcare conversations, two digital solutions…

Speaker: Professor Helen Dawes - Faculty of Health and Life Sciences, Oxford Brookes University.
Gait crashers, monitoring activity and movement in the wild

Speaker: Dr Dario Salvi - PostDoc researcher at University of Oxford
Mobile phone-based six-minute walk test

Rhodes Trust Lecture Theatre

16:00 – 17:15 Stream 2

Precision Medicine

Theme B. Targeted Therapeutics

Plenary: Professor Chris Chamberlain - VP Head Experimental Medicine and Diagnostics, UCB
The molecular deconstruction of disease: a route to better targeted therapy

Speaker: Professor Ian Pavord - Professor of Respiratory Medicine, University of Oxford
Precision management of airways disease

Speaker: Dr Wen Hwa Lee - Director of the Disease Foundations Network programme
Open Science accelerating identification of novel targets for therapeutics at the Structural Genomics Consortium.

Speaker: Professor Paresh Vyas – Professor of Haematology, University of Oxford
Tracking cancer through treatment to improve outcome – using Acute Myeloid Leukaemia as an exemplar: opportunities and challenges for the NHS

Speaker: Professor Ahmed Ahmed – Professor of Gynaecological Oncology, University of Oxford
Targeting SIK2 to prevent ovarian cancer metastasis

Nelson Mandela Lecture Theatre

17:15 – 18:00 Expert Panel Discussion and closing remarks

Chair: Professor Keith Channon - Director, NIHR Oxford Biomedical Research Centre

Panel: Mr Peter Knight - Chief Information and Digital Officer, Oxford University Hospitals

Professor Gary Ford - CEO, Oxford AHSN

Professor Chris Chamberlain - VP Head Experimental Medicine and Diagnostics, UCB

Professor Hugh Watkins - Radcliffe Professor of Cardiovascular Medicine, University of Oxford

Said Business School (SBS) Foyer

18:00 – 18:30 Drinks and Networking

Comments from Sponsoring Organisations

Dr Vasiliki Kiparoglou
Head of Clinical Research Operations
NIHR Oxford Biomedical Research Centre
Oxford University Hospitals NHS Foundation Trust

The NIHR Biomedical Research Centre, Oxford (Oxford BRC) is a partnership that brings together the research expertise of the University of Oxford and the clinical skills of Oxford University Hospitals NHS Foundation Trust. The aim is to support the translation and innovation of basic scientific developments into clinical benefits for patients. Precision Medicine and Digital Health offer huge potential for improving the delivery and management of care and are the focus of many Oxford BRC funded research projects. Based at the Oxford University Hospitals, the Oxford BRC is part of the Government's initiative run by NIHR to reinforce the position of the UK as a global leader in healthcare related research. The Oxford BRC brings research from bench to the bedside. We initiate medical innovations keeping healthcare delivery and patient benefit central. The Oxford BRC supports one of the largest clinical trial portfolios in the UK and has a successful 10 year track-record of taking discoveries from the laboratory into the clinic.

Oxford Biomedical Research Centre
NHS National Institute for Health Research

Dr Matt Perkins
Chief Executive Officer
Oxford Innovation

With rapidly changing demographics and continually emerging threats and challenges, Oxford's contribution to shaping the future of healthcare has never been more important.

In order to generate the greatest impact from the ideas and technologies coming out of Oxford, it is critical that Oxford University Innovation (OUI) is there to support and engage with our researchers and clinicians. At OUI, we work hard to bring Oxford's best ideas to bear benefit for society. Each year, we see around 400 ideas come from the full breadth of research activities at the University and Hospitals.

Named global Technology Transfer Office of the Year, OUI produced 21 companies based on University intellectual property in 2016. As of 2015, we have created over 150 spinouts with a combined annual turnover of £600m, providing 1,886 jobs and adding £1.2bn to the global economy.

This is all made possible by our highly skilled, passionate people at OUI bringing together world-leading Oxford University and Oxford University Hospital Trust academics with our powerful network of academic leaders, industry experts, consultants and service providers. This is why supporting the NIHR Oxford BRC and the Oxford AHSN through events like this are imperative both for Oxford and the wider world.

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Dr Nick Scott-Ram
Director of Commercial Development
Oxford AHSN

Over the last year, the landscape for the health and life sciences industry has dramatically changed. The Government has been developing a new industrial strategy, while the NHS continues to face challenges around capacity, an ageing population, and the rising costs of healthcare. Innovation has, and will continue to play an important role in delivering better care to patients and this year's theme is focused on Precision Medicine and Digital Health, where an exciting intersection between patient stratification and improved patient tracking presents new opportunities for innovators and system change through effective adoption. The canvas is broad, covering the whole pathway from early warning of disease through to effective diagnosis and improved treatment, through to more targeted disease management and recovery. The close working relationship between the University of Oxford, Oxford University Innovation, the Oxford Biomedical Research Centre, the Oxford AHSC and the Oxford AHSN means that there is a viable and connected runway from concept through to adoption across the ecosystem

Dr Glenn Wells
Chief Operating Officer, Oxford Academic Health Science Centre

The Oxford Academic Health Science Centre partnership harnesses the strengths and aligns the resources of its partners to drive world class research, patient care and education. The partnership has created an integrated research environment where the best research can be translated, applied and evaluated for patient benefit.

The six interconnected Themes of the AHSC bring together the expertise and established programmes of the partners which contribute in different ways to achieve the acceleration and realisation of patient benefit from research to address major healthcare challenges.

The AHSC partnership hosts two NHS Global Digital Exemplars alongside the recently opened Big Data Institute creating an ideal environment to foster and develop digital health innovation and support the partner organisations roles in supporting national initiatives such as Genomics England.

Oxford Academic Health Science Centre
WORLD-CLASS PARTNERSHIPS BRINGING RESEARCH TO LIFE

Angela Hobbs
Managing Director
Triteq

Triteq is an innovative product design, development & technology consultancy made up of talented teams of brilliant people working together to produce incredible products for a rapidly changing world. Our award winning designs are found in hospitals, homes, offices, manufacturing plants, construction sites, airplanes, laboratories and retail outlets all around the world. We have an exemplary track record in medical product design and have supported many start-ups through each stage of the development process. We listen, ask the right questions and deliver results on time. With a team of fifty in our Hungerford office, plus our sales and marketing team in Oxford, we can respond effectively to our client's needs. It is impossible to be aware of every single challenge, across an extensive range of industry sectors; our strength is knowing how to manage the process for successful outcomes. I look forward to hearing from you at the event.

About Sponsoring Organisations

Oxford Academic Health Science Network

The Oxford Academic Health Science Network is licensed by NHS England and covers a population of 3.3 million living in Berkshire, Buckinghamshire, Milton Keynes, Oxfordshire and Bedfordshire. Our vision is Best health for our population and prosperity for our region, which is delivered by bringing together universities, industry and the NHS to improve prosperity in our region through rapid clinical innovation adoption. We have four objectives:

- Focus on the needs of patients and local populations
- Speed up adoption of innovation into practice to improve clinical outcomes
- Build a culture of partnership and collaboration
- Create wealth through co-development, testing, evaluation and early adoption of new products and services.

Oxford University Innovation (OUI) commercialises the research and expertise of the University of Oxford and its researchers. We provide access to technology through intellectual property licensing, spinout company formation and material sales, and to academic expertise through Consulting Services.

OUI is the highest university patent filer in the UK and is ranked 1st in the UK for university spinouts, having created over 160 new companies since 1988. In the last reported financial year we completed more than 50 deals from licensing and consulting every month. OUI is active in regional, national and international networks that support entrepreneurs and innovators. Oxentia, our innovation management consultancy, works with university, government and industrial clients from offices around the world.

Oxford Biomedical Research Centre — NHS National Institute for Health Research

The NIHR Biomedical Research Centre Oxford, is based at the Oxford University Hospitals NHS Foundation Trust and run in partnership with the University of Oxford. It was one of five centres funded by the NIHR in 2007 through a competitively awarded grant of £57m over five years. In April 2012, as a recognition for its outstanding contribution to healthcare research it was awarded £95.5m to 2017 and in September 2016 was awarded £113.7m for 2017 to 2022 to support translational research. Biomedical Research Centres are part of the Government's initiative to translate basic scientific developments into clinical benefits for patients reinforcing the position of the UK as a global leader in healthcare research.

Oxford Academic Health Science Centre
WORLD-CLASS PARTNERSHIPS BRINGING RESEARCH TO LIFE

The Oxford Academic Health Science Centre is one of six accredited AHSCs in England. It is a partnership of Oxford University Hospitals Foundation Trust, Oxford Health Foundation Trust, University of Oxford and Oxford Brookes University. The goals of the OxAHSC are to:

- Cultivate an integrated and coordinated health research environment
- Succeed in the acceleration and realisation of patient benefit from research to address major healthcare challenges
- Achieve excellence in research, health education and in patient care
- Drive economic growth in partnerships with industry
- Drive innovation and entrepreneurship

triteq

What do Triteq do? In short, they make products happen. You go to Triteq with an idea or concept; they research it, design it; prototype it; and then help get your product to market. The company supports start-ups to develop ideas from concept through to manufacture and every stage in-between and work alongside established companies on creating and redesigning existing products too. Triteq work to the highest standards – including British Standards Institution ISO13485, 9001 and 14001 – and has helped many of their clients achieve CE Marking for their products. The strength of Triteq is in its people.

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Welcome Lectures

Professor Keith Channon
Director
NIHR Oxford Biomedical Research Centre

Keith Channon is Director of NIHR Oxford Biomedical Research Centre, which he has directed since 2010. Honorary Consultant Cardiologist at the John Radcliffe Hospital, Field Marshall Earl Alexander Professor of Cardiovascular Medicine., Director of R&D, Oxford University Hospitals and Associate Head, Medical Sciences Division for Clinical Research, University of Oxford.

Keith trained in cardiology in Manchester, Oxford and Duke University before returning to Oxford in 2000 where he now co-directs Oxford's British Heart Foundation Centre of Research Excellence. Keith was Chairman of the British Atherosclerosis Society, and is an NIHR Senior Investigator and a Fellow of the Academy of Medical Sciences.

Positions and honours include the British Heart Foundation Clinician Scientist Fellowship, Fellow of the European Society of Cardiology, elected to Medical Sciences Board, University of Oxford, elected Fellow of the Academy of Medical Sciences, NIHR Senior Investigator award, John French Lecture, British Atherosclerosis Society, Strickland-Goodall Lecture & Medal, British Cardiovascular Society and William Harvey Award, University of London.

Dr Matt Perkins
Chief Executive Officer
Oxford University Innovation Limited

Dr Matt Perkins joined Oxford University Innovation (OUI), the research commercialisation arm of Oxford University, in October 2016 during a time of both great change and growth for the company. During 2016, OUI's spinout company rate doubled, while the wider innovation ecosystem around Oxford continues to evolve rapidly. As OUI's Chief Executive Officer, Dr Perkins is responsible for guiding OUI through these changing times, to achieve an even greater impact and to pioneer ways in which OUI can continue to enhance its offer to the University and the surrounding ecosystem.

Earlier roles include President of Space Imaging at e2v, Group CEO at Surrey Satellite Technology Limited, and various technical and management positions in Filtronic Comtek.

Matt is a Fellow of the Royal Academy of Engineering and has a BSc and PhD in electronic and electrical engineering from the University of Leeds.

Dr Nick Scott-Ram MBE
Director of Commercial Development
Oxford AHSN

Nick is Director of Commercial Development at the Oxford Academic Health Science Network where he is responsible for working with industry, the NHS and academic partners to commercialise new innovations in the digital, medtech, diagnostics, and pharmaceutical sectors. His focus is on building partnerships to support the adoption of new technologies into the NHS.

Nick has over 25 years' experience in commercial and business development in the life sciences sector. He has an MA in Natural Sciences and a PhD in the Philosophy of Science from Cambridge University. After leaving university he set up a vaccine company before working in blue chip life science companies such as PowderJect Pharmaceuticals where he was VP Corporate Affairs, responsible for strategy and government affairs. He has also had extensive experience as a consultant, specialising in strategy and corporate finance support working with public and private sector clients. From 2006-11 he was a special industry consultant to the BioIndustry Association working on pharmaceutical pricing and uptake. He played a leading role in representing the life sciences industry position on the drafting and passage of the Biotechnology Patents Directive through the European Parliament in the 1990s. He was awarded the MBE for services to biotechnology in 2001. He is a Director at the Oxford Martin School.

Welcome Lectures continued

Dr Manuel Pinuela
Chief Business Officer
Drayson Technologies

Manuel was born in Mexico City, Mexico, in 1983. He received his BSc degree in Electrical and Electronic Engineering from the National Autonomous University of Mexico (UNAM) in 2007, where he received the Gabino Barreda Medal, awarded to the highest GPA of his class (summa cum laude). From 2006 to 2008 he joined Actif Power, a start-up technology company in Mexico City, where he designed patented switched mode power supplies and solar lighting systems. During his work at Actif Power he supervised manufacturing and developed client relationships in Mexico.

From 2008 to 2009 Manuel worked for Thermon Manufacturing Company and Washington Division of URS in Houston, USA where he held electronic design and project engineer roles for the oil and gas industry in the US and Latin America. He was also involved in social projects with Engineers without Borders and the Mexican Government to provide solar lighting and potable water systems to poor rural communities in Mexico.

In 2009 he started his PhD in Electrical Electronic Engineering at Imperial College London developing systems for inductive power transfer and ambient RF energy harvesting. Both technologies have won awards in international conferences and are published in IEEE journals. He was awarded a Design London Fellowship by the Imperial College Business School and the Royal College of Art to turn his research into a successful spinout.

In 2011 Manuel was a finalist at the Imperial College Business Plan Competition and was selected from 250 ventures for a pre-development plan at the RCA's Business Incubator.

After more than five years of developing new technologies and as co-founder of Drayson Technologies, Manuel believes that technologies such as wireless energy and machine learning will improve our lives and completely modify the way we interact with the environment that surrounds us.

Dr Nigel Pitchford
Chief Investment Officer
Touchstone Innovations

Nigel is the Chief Investment Officer and is responsible for Innovation's investment activities. He joined Innovations in January 2012. He was previously a Partner at DFJ Esprit, and prior to that spent 12 years at 3i, becoming a Partner in 2006, and ultimately leading the venture team's healthcare activities across Europe and the US. As well as sitting on the board of Touchstone Innovations plc, Nigel is also a board member of Veryan Medical, Abzena, Oxular and Nexeon.

During his venture career he has been responsible for leading investment rounds into Domantis (sold to GSK for $454m), Apatech (sold to Baxter for $330m), Arakis (sold to Sosei Pharma for $187m), Horizon Discovery (AIM: HZD) and Oxford Immunotec (NASDAQ: OXFD), amongst others. He has also served on the boards of EUSA Pharma (sold to Jazz for $700m) and HBI (sold to Meda AB for $282m).

Nigel studied chemistry at the University of Oxford, before completing a PhD at the University of Durham. His research activities included rational drug design and saw him join the Cambridge Crystallographic Data Centre (CCDC) in 1994, where he spent two years working on new product design and projects for pharmaceutical company clients. He completed an MBA at Warwick Business School, before joining 3i in 1997.

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Stream 1
Digital Technologies

Theme A. Wearable Technologies and monitoring devices.

Professor Lionel Tarassenko
Professor of Electrical Engineering
University of Oxford

Professor Lionel Tarassenko is Professor of Electrical Engineering at the University of Oxford. He was the driving force behind the creation of the Institute of Biomedical Engineering, which he directed from its opening in April 2008 to October 2012. He is a Fellow of the Royal Academy of Engineering (2000), and a Fellow of the Academy of Medical Sciences (2013). He was made a CBE for services to engineering in 2012.

In 1996, he received a British Computer Society Medal for his work on analysis of sleep disorders. His work on mobile phones for healthcare was awarded the E-health 2005 Innovation Award for "best device to empower patients". He received the 2006 Silver Medal of the Royal Academy of Engineering for his contribution to British engineering leading to market exploitation and he won the Institute of Engineering & Technology IT Award, also in 2006. In 2010, he gave the Vodafone lecture on m-health at the Royal Academy of Engineering and the Centenary Lecture on Biomedical Engineering at the Indian Institute of Science in Bangalore. He received the 2015 Martin Black Prize for the best paper in Physiological Measurement.

Professor Tarassenko is a world-leading expert in the application of signal processing and machine learning to medical systems, with a strong track record in translation to clinical medicine. He is the author of 210 journal papers, 180 conference papers and 3 books. He holds 30 granted patents and has founded four University spin-out companies, all in the med tech sector. He is also a Director of the University of Oxford's technology transfer company, Oxford University Innovation. He is the current Head of the Department of Engineering Science and a member of the University Council, the University of Oxford's governing body.

Professor Maarten De Vos
Associate Professor IBME
University of Oxford

Maarten De Vos is Associate Professor at the IBME, in the University of Oxford, following a Junior Professorship at the University of Oldenburg, Germany. His academic work focuses on innovative biomedical monitoring and signal analysis, in particular the derivation of biosignatures of patient health from data acquired via wearable sensors and the incorporation of smart analytics into unobtrusive systems.

He has a strong interest in translational research and consults for different digital health and medical innovation companies. His pioneering research in the field of mobile real-life brain-monitoring led to the formation of mBrainTrain, which he supported with scientific advise and which has won several prizes for their mobile EEG innovation. His work on neonatal brain monitoring also achieved impact in patient care through the Neoguard implementation project. After successful completion of the Biodesign faculty training at Stanford University, he started and directs the Oxford Biodesign programme. Most recently, he co-founded Circadian Therapeutics, an Oxford spin-out aiming to revolutionise circadian measurement and modulation.

Stream 1 continued
Digital Technologies

Theme A. Wearable Technologies and Monitoring Devices.

Dr Tim Bonnici
Clinical lecturer
The Institute of Biomedical Engineering (IBME)

Tim's clinical specialities are Intensive Care and Acute Medicine. He combines his clinical work with research into using novel technologies to support clinical decision making. He is currently completing a PhD which examines how wearable sensors, clinical informatics and machine learning can be integrated to alert clinicians to impending patient deterioration.

Dr Karl Surmacz
Principal Data Scientist
at McLaren Applied
Technologies

After completing PhD in Physics from University of Oxford, Karl joined McLaren Racing in 2008 as a Race Strategist. Karl spent four years providing real-time decision support to the race team, as well as developing tools and models to aid decision-making. Karl also spent a further two years as a Control Systems engineer, building statistical models to improve car system performance and reliability. Karl joined McLaren Applied Technologies in 2013 and, alongside helping to deliver customer projects, helped to grow an Analytics team. Karl now acts as technical lead for a Modelling and Decision Sciences team, which consists of simulation engineer and data scientists. His main technical area of interest remains mathematical modelling of complex systems, specifically statistical machine learning. He has acted as a technical lead on projects across McLaren Applied Technologies' industry portfolio, including on projects forming part of the company's relationship with Oxford University Medical School.

Dr Alessandro Guazzi
Chief Executive Officer
Sentimoto

Alessandro read Physics at Imperial College and obtained his DPhil in Biomedical Engineering at the University of Oxford. Alongside three doctoral colleagues, he founded Sentimoto in 2013, with the aim of becoming the first company to tackle behavioural diagnosis and automated social prescription, focusing on the needs of older adults. Alessandro acts as CEO at Sentimoto, which has since completed an InnovateUK project with Bupa to work on passive monitoring of social withdrawal, as well as winning a number of awards, including Best Startup at the London Wearable Tech Show and the Wolfson Innovate Prize, and featuring in the Observer's New Radicals list.

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Stream 2
Precision Medicine

Theme A. *In vitro* Diagnostics for Personalized Medicine.

Professor Anna Schuh
Associate Professor of
Molecular Diagnostics
University of Oxford

Professor Anna Schuh is the Director of Molecular Diagnostics at the University of Oxford and an honorary consultant haematologist. She has participated as a principle or chief investigator in over 30 early or late phase clinical trials in chronic lymphocytic leukaemia. A number of these led to subsequent NICE approvals and have changed clinical practice in the UK and worldwide.
As the Director of the Oxford NIHR Molecular Diagnostics Centre (MDC), she receives grants from the NIHR, Wellcome Trust, Technology Strategy Board and Bloodwise. Her primary research interest is with the development, evaluation and implementation of new technologies for precision diagnostics with a particular focus on genomics. She leads the Genomics England Clinical Interpretation Partnership for Haematological Malignancies on behalf of the NCRN clinical investigators and has authored or co-authored over 80 peer-reviewed publications in the last five years.

Dr Ian Campbell
Director for Health
and Life Sciences
Innovate UK

Dr Ian Campbell is an experienced executive in life sciences and the diagnostics sector. In October 2016 Ian took up the post of Director for Health and Life Sciences at Innovate UK. Prior to that, he most recently served as Chief Executive of Arquer Diagnostics, a company developing and commercialising immunoassay tests for cancers of the urinogenitary tract.

Previously he served as Chief Executive of Imperial College spin-out company Molecular Vision, developing a disposable, quantitative point-of-care diagnostic platform, before being acquired by Abingdon Health in 2012. Ian has also served as Commercial Director with Bespak Europe. Ian has a strong scientific background, gaining his PhD at the University of Glasgow.

Professor Michael Simpson
Co Head of Science
Genomics plc

Michael is Co-Head of Science at Genomics plc and Professor of Genetics at King's College London. His academic research is centred on the discovery of novel genetic determinants of human disease, with a particular focus on rare diseases and common complex diseases of the skin. Michael's early career focused on understanding the genetic basis of recessive diseases identified at elevated frequency in the Old Order Amish. With the advent of next generation sequencing his research group has extensively utilised exome sequencing approaches to identify genes that are recurrently the site of mutation in unrelated individuals with rare phenotypes, his team has contributed to the discovery over 30 new genes involved in the pathogenesis of rare diseases. At Genomics plc Michael co-leads the science team who are building robust scalable analytical systems to generate biological insight from large scale human genomic and phenotypic datasets.

Stream 2 continued
Precision Medicine

Theme A. *In vitro* Diagnostics for Personalized Medicine.

Dr Gordon Sanghera
Chief Executive Officer
Oxford Nanopore Technologies

Gordon Sanghera was co-founder of Oxford Nanopore, together with Hagan Bayley and IP Group. He was appointed CEO in June 2005. He brings over 20 years' experience in the design, development and global launch of disruptive platform sensor technologies.

Dr Sanghera's PhD in bioelectronics sensing was followed by a career at MediSense an Oxford spin-out that delivered a new generation glucose technology to the market. Following the acquisition of MediSense by Abbott Laboratories Dr Sanghera held both UK and US VP and Director-level positions, including VP World Wide Marketing, Research Director and Manufacturing Process Development Director. Before its acquisition by Abbott, Gordon led the R&D of Medisense Inc. where he was instrumental in the launch of several generations of blood glucose bio-electronic systems for the consumer and hospital medical markets. He has also developed and validated production processes to meet with the regulatory requirements for USA and Europe.

Gordon has a PhD in bio-electronic technology and a degree in Chemistry.

Dr Graham Speight
R&D Director
Oxford Gene Technology (OGT)

Dr. Graham Speight (PhD) is R&D Director at Oxford Gene Technology (OGT). He has a PhD in human genetics and prior to joining OGT he held positions in pharmaceutical companies and managed a core cancer genomic facility. He joined OGT over 10 years ago, and has previously managed the service laboratory as well as the oncology biomarker development team. Currently, he has overall responsibility for the R&D and product development for oncology. The main focus is the development of highly specific hybridisation-based capture panels for next-generation sequencing. These panels can be used in precision medicine for research into predisposition, diagnosis, prognosis, and therapy selection.

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Stream 1
Digital Technologies

Theme B. Pathway Reconfiguration.

Mr Peter Knight
Chief Information and Digital Officer, Oxford University Hospitals NHS Foundation Trust

Before taking up the newly created role of Chief Information and Digital Officer and being appointed as a Senior Fellow of Health Informatics at Oxford University, Peter was Deputy Director at the Department of Health for Research Contracting, Information Intelligence and Stakeholder Engagement working for the Chief Medical Office Professor Dame Sally Davies.

Prior to joining the Department of Health in 2007, Peter was the Executive who led the introduction of Cerner at the Winchester and Eastleigh NHS Trust, among his other operational and board responsibilities. Winchester was subsequently merged with North Hampshire Hospital Foundation Trust in 2014.

Peter will build on significant recent investment in the Trust's technology infrastructure to help transform healthcare, research and education in Oxfordshire.

Seán Wetherall
Futurist
Oneview Healthcare PLC

Sean Wetherall is a Futurist and lean start-up rapid prototyping practitioner. With over 25 years' experience in mobile product design and solutions delivery all over the world. He focuses on user centric software design. He believes simple design is always better. A proponent of digital transformation through optimised digital workflows that simplify the clinical delivery of care. Digital Pathways represent an unprecedented opportunity to optimise the delivery of healthcare services placing the patient at the centre of care.

Dr Nick de Pennington
Digital Health Innovation Lead
Oxford University Hospitals
and founder Ufonia Limited

Nick studied medicine at Cambridge and Oxford. He completed specialist training in Neurosurgery and has over 15 years frontline clinical experience in the NHS. His recently created role at OUHFT aims to both promote the identification of digital health needs and ideas from those working in Oxford healthcare; as well as creating the environment for new products and solutions to be tested within the organisation. He has a particular interest in supporting value-based healthcare projects. He is co-founder and Director of TheHill, Oxford Academic Health Science Centre's digital health innovation lab. He is also founder and CEO of Ufonia, a startup based in Oxford University Innovation's Incubator.

Stream 1 continued
Digital Technologies

Theme B. Pathway Reconfiguration.

Professor Helen Dawes
Faculty of Health and Life Sciences Oxford Brookes University

Prof. Helen Dawes directs the Centre for Movement and Occupational Rehabilitation Sciences (MORES), Oxford Brookes University is a movement scientist and physiotherapist leading a multidisciplinary team of 25 researchers. Her team and research is currently funded by Research Councils including the EPSRC, the NIHR, Charities and the EU. She works closely with key stakeholders including clinicians, industry and users to develop monitoring and therapeutic rehabilitation interventions using commercially available and affordable systems. She has 113 publications, two patents, and has established a spinout company (CDD) and social enterprise to translate her research. She has developed tools to monitor gait in adults and children with neurological and neuromuscular conditions. Her group is currently monitoring the gait and movement using single sensor systems of more than 40,000 adults and children worldwide alongside clinical data including data on people at risk of developing and at different stages of diabetes. She is also developing systems to monitor fatigue and movement in long-term conditions using mobile phone/watch Apps.

Dr Dario Salvi
PostDoc researcher
at University of Oxford

Dario Salvi obtained his MSc in Telecommunications Engineering from the Universita degli Studi di Napoli Federico II, Italy, in 2004. Soon after he joined the Consorzio Interuniversitario Nazionale per l'Informatica (CINI), Naples, where he did research in the area of computer networks. In 2005 he joined the Life Supporting Technologies group at the Universidad Politécnica de Madrid (UPM), Madrid, Spain. In UPM he worked as researcher in EU funded projects in the areas of personalised health systems and ambient assisted living. In 2014 he received the PhD degree in biomedical engineering from the same University.

At the end of 2014 Dario joined the Institute of Biomedical Engineering of the University of Oxford as Post Doctoral Research Assistant where he collaborates with Professor Lionel Tarassenko. His interests include SW platforms for e/m/p-Health and ambient assisted living, indoor localization and persuasive computing.

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Stream 2
Precision Medicine

Theme B. Targeted Therapeutics.

Professor Chris Chamberlain
VP Head Experimental Medicine and Diagnostics UCB Trust

Chris Chamberlain has been head of Experimental Medicine and Diagnostics at UCB since 2013, with responsibility for ensuring the effective use of biomarkers and in vitro diagnostics across the UCB clinical portfolio. These efforts look to deliver both earliest proof of concept for investigational therapies and the appropriate use of molecular taxonomy and related mechanistic insights best to target such therapies in later development and use. Chris is a specialist registered physician and a chartered scientist within the UK and has extensive experience across the pharmaceutical industry, he has previously worked at SmithKline Beecham, Roche and AstraZeneca. Chris is Project co-coordinator for PRECISESADS, a large collaborative European study for the discovery of new molecular taxonomy in systemic auto-immune disease (www.precisesads.eu).

Professor Ian Pavord
Professor of Respiratory Medicine
University of Oxford

Ian D Pavord, MA DM FRCP FERS FMedSci is Professor of Respiratory Medicine at the University of Oxford and Honorary Consultant Physician at the Oxford University Hospitals. He is a member of congregation at the University of Oxford and a Professorial Fellow of St Edmund Hall. He was a Consultant Physician from 1995 and Honorary Professor of Medicine from 2005 to 2013 at the Institute for Lung Health, Glenfield Hospital, University Hospitals of Leicester NHS Trust. He was elected an NIHR Senior Investigator in 2011, a Fellow of the European Respiratory Society in 2014 and a Fellow of the Academy of Medical Science in 2015.

He has a research interest in the clinical aspects of inflammatory airway diseases and he has pioneered the use of non-invasive measures of airway inflammation in the assessment of these conditions. He has identified a number of clinically important phenotypes of inflammatory airway disease and has played a lead role in the clinical development of three of the most promising new treatments for severe airway disease.

Professor Pavord was co-editor of Thorax from 2010-2015, Chief Medical Officer of Asthma UK from 2008-14 and Associate Editor of the American Journal of Respiratory and Critical Care Medicine from 2005-10. He is the author of more than 320 publications including 6 in the New England Journal of Medicine and 11 in the Lancet. He gave the Cournand Lecture at the 2004 European Respiratory Society meeting, the second UK based researcher to have been given this honour.

Stream 2 continued
Precision Medicine

Theme B. Targeted Therapeutics.

Dr Wen Hwa Lee
Director of the Disease Foundations Network programme at the Structural Genomics Consortium

Wen Hwa Lee ('Lee'), from the University of Oxford, is the Director of the Disease Foundations Network at the Structural Genomics Consortium (SGC – www.thesgc.org) – a Global reference for pre-competitive, Open Science drug discovery, creating and openly sharing outputs in the absence of patents. Since 2004 Lee has been working with multiple institutions and stakeholders to establish strategic joint research programmes with the SGC and its international partners (academia, industry, governments, charities) to create novel Open Science models for drug discovery. He also led the establishment a new SGC laboratory in Brazil. Presently Lee is creating Open Science frameworks with disease foundations to integrate and accelerate patient-driven research efforts for drug discovery. Lee also co-directs an Oxford Martin School programme to quantify the economic impact of open science efforts for development of novel treatments and medicines (http://www.oxfordmartin.ox.ac.uk/research/programmes/affordable-medicines).

Professor Paresh Vyas
Professor of Haematology
University of Oxford

Professor of Haematology at Oxford University. He studied medicine at Cambridge then Oxford. After completing his medical and haematology training in London. He did his PhD with Professor Higgs and Professor Sir Weatherall at the MRC Molecular Haematology Unit, Oxford and did a three years doing a post-doctoral fellowship with Professor Orkin at Harvard University. He is a research active Consultant Haematologist with a clinical practice in myeloid disorders (MDS, AML and MPD) and allogeneic stem cell transplant in Oxford and the MRC Molecular Haematology Unit, Weatherall Institute of Molecular Medicine, University of Oxford. His research focuses on molecular and cellular biology of AML and MDS with specific interest in purification and therapeutic targeting of myeloid preleukaemic and leukaemic stem cells. He studies single cell biology in both normal and leukaemic haemopoiesis.

He is on the UK AML and MDS clinical trial groups. He is co-Lead of the Oxford BRC Haematology Theme, is on the Board of NHSBT, vice-chair of the MRC Clinical Training Panel, Translational Lead for the UK Therapy Acceleration Program. He works with Celgene on the IDH inhibitor program and is global lead for the AML-005 study.

Professor Ahmed Ahmed
Professor of Gynaecological Oncology
University of Oxford

Professor Ahmed Ahmed Consultant Gynaecological Oncology Surgeon, Director of the Ovarian Cancer Cell Laboratory at the Weatherall Institute of Molecular Medicine.

Prof. Ahmed's research focuses on personalization of therapy to circumvent drug resistance in cancer. Our group is interested in investigating the mechanistic basis of ovarian cancer development, progression and resistance to therapy. We are interested in understanding the key initiating factors that determine how precursor cells develop into tumours and how such tumours evolve under therapeutic selection. Our aim is to translate such understanding into early detection methods for women who are at high risk of ovarian cancer and to develop novel therapeutic approaches to prevent recurrence of ovarian cancers following primary treatment. We combine novel surgical techniques in prospective clinical trials with mechanistic laboratory investigations to achieve our goals.

Expert Panel Discussion and closing remarks

Chair: Professor Keith Channon
Director
NIHR Oxford Biomedical Research Centre

Keith Channon is Director of NIHR Oxford Biomedical Research Centre, which he has directed since 2010. Honorary Consultant Cardiologist at the John Radcliffe Hospital, Field Marshall Earl Alexander Professor of Cardiovascular Medicine., Director of R&D, Oxford University Hospitals and Associate Head, Medical Sciences Division for Clinical Research, University of Oxford.

Keith trained in cardiology in Manchester, Oxford and Duke University before returning to Oxford in 2000 where he now co-directs Oxford's British Heart Foundation Centre of Research Excellence. Keith was Chairman of the British Atherosclerosis Society, and is an NIHR Senior Investigator and a Fellow of the Academy of Medical Sciences.

Positions and honours include the British Heart Foundation Clinician Scientist Fellowship, Fellow of the European Society of Cardiology, elected to Medical Sciences Board, University of Oxford, elected Fellow of the Academy of Medical Sciences, NIHR Senior Investigator award, John French Lecture, British Atherosclerosis Society, Strickland-Goodall Lecture & Medal, British Cardiovascular Society and William Harvey Award, University of London.

Panel: Mr Peter Knight
Chief Information
and Digital Officer
Oxford University Hospitals

Before taking up the newly created role of Chief Information and Digital Officer and being appointed as a Senior Fellow of Health Informatics at Oxford University, Peter was Deputy Director at the Department of Health for Research Contracting, Information Intelligence and Stakeholder Engagement working for the Chief Medical Office Professor Dame Sally Davies.

Prior to joining the Department of Health in 2007, Peter was the Executive who led the introduction of Cerner at the Winchester and Eastleigh NHS Trust, among his other operational and board responsibilities. Winchester was subsequently merged with North Hampshire Hospital Foundation Trust in 2014.

Peter will build on significant recent investment in the Trust's technology infrastructure to help transform healthcare, research and education in Oxfordshire.

Panel: Professor Gary Ford
CEO
Oxford AHSN

Professor Ford is Chief Executive of the Oxford Academic Health Science Network, Visiting Professor of Clinical Pharmacology at Oxford University and Consultant Stroke Physician at Oxford University Hospitals NHS Foundation Trust. He held a Clinical Pharmacology Fellowship at Stanford University. His research interests are on the impact of ageing on drug responsiveness with a focus on acute stroke therapies. He held the Jacobson Chair of Clinical Pharmacology at Newcastle University from 2007-2013. He has been involved in service innovations in UK stroke care in the last 20 years including developing the first thrombolysis protocol for acute stroke in England. He developed the Face Arm Speech Test now used to increase public and professional awareness of stroke. In 2005 he was appointed Director of the National Institute for Health Research Stroke Research Network and awarded a CBE in the 2013 New Year Honours List for services to research in stroke medicine.

Expert Panel Discussion and closing remarks continued

Panel: Professor Chris Chamberlain

VP Head Experimental Medicine and Diagnostics
UCB

Chris Chamberlain has been head of Experimental Medicine and Diagnostics at UCB since 2013, with responsibility for ensuring the effective use of biomarkers and in vitro diagnostics across the UCB clinical portfolio. These efforts look to deliver both earliest proof of concept for investigational therapies and the appropriate use of molecular taxonomy and related mechanistic insights best to target such therapies in later development and use. Chris is a specialist registered physician and a chartered scientist within the UK and has extensive experience across the pharmaceutical industry, he has previously worked at SmithKline Beecham, Roche and AstraZeneca. Chris is Project co-coordinator for PRECISESADS, a large collaborative European study for the discovery of new molecular taxonomy in systemic auto-immune disease (www.precisesads.eu).

Panel: Professor Hugh Watkins

Radcliffe Professor of Cardiovascular Medicine
University of Oxford

Hugh Watkins is Radcliffe Professor of Medicine and Head of the Radcliffe Department of Medicine, and the Director of the British Heart Foundation Centre of Research Excellence, at the University of Oxford.

Professor Watkins researches the molecular genetic basis of cardiovascular disease. He works on both rare inherited diseases, such as cardiomyopathy, where genetic advances now underpin diagnosis and new approaches to therapy, and common diseases such as coronary artery disease where the goal is to use newly identified common genetic variants to define novel therapeutic targets. He is a Fellow of the Royal Society and a Fellow of the Academy of Medical Sciences.

Precision
Medicine
and Digital
Health

Targeted Next Generation Sequencing

Assessing only relevant genes provides a cost-effective, useful tool for oncologists.

Cancer is a genetic disease. Understanding the precise nature of the genetic damage in each patient's own cancer can provide extremely useful information for research and even informing decisions about treatment choices – so-called "precision medicine".

Developments in precision medicine in oncology have led to a situation where often several different kinds of genetic tests have to be performed on a given biopsy specimen to check for the variety of genetic aberrations found in apparently similar tumours. This arises because similar tumours under the light microscope may contain a number of different mutations across a number of different genes, making these supplementary test(s) necessary to fully understand the tumour make up beyond its simple morphology. Searching for the full range of pathogenic mutations can be very important not only in research, but also in terms of actual diagnosis, understanding prognosis and for informing treatment choices (Table 1). This process, which today requires a number of different techniques (eg PCR, FISH, IHC), is expensive, resource and time consuming, and may not even be possible if only small pieces of tumour tissue are available.

Tumour Type	Detection Technology	Mutations	Reason
Lung Cancer	Sequencing	EGFR, KRAS, BRAF, MET (exon 14 skipping), ERBB2. (ALK, ROS1, RET)	Treatment Choices. (Kinase inhibitors, mutation specific).
	FISH or sequencing	ALK, ROS1 and RET rearrangements	Treatment Choices. (Kinase inhibitors, mutation specific).
Colorectal Cancer	Sequencing	KRAS, NRAS	Treatment Choices. (Utility of antiEGFR MAbs).
		BRAF (with loss of MLH1)	Prognosis. (Also to identify sporadic "mismatch repair".)
	IHC or other methods	MLH1, MSH2, MSH6, PMS2	Diagnosis of Lynch Syndrome/ dMMR.

Next Generation Sequencing (NGS) can identify many possible important aberrations in one experiment. The technology involves identifying the tumour sequence (base by base) and comparing it to known sequences in the normal human (reference) genome. Targeted sequencing refers to experiments in which pre-specified parts of the genome (eg panels of a few key genes or parts of genes) are "enriched" from the total genome focussing on specific regions of interest and sequenced in great detail. NGS for oncology samples must be robust to the processes of sample collection and handling including preservation in FFPE and ideally must be capable of detecting all the various forms of genetic aberration: point mutations, small insertions and deletions, copy number variations and structural alterations (translocations, inversions etc.).

Oxford Gene Technology has developed and commercialised customisable next generation sequencing panels (and associated software) that deliver reproducible and robust genetic information from oncology samples detecting mutations with a high degree of accuracy.

Robert L Holland
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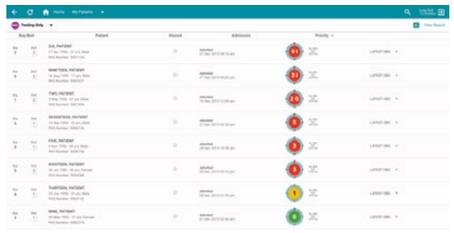
SEND

A digital patient safety system.

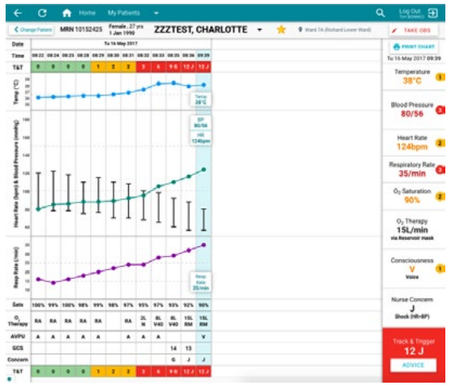
SEND is a system for digitally recording and reviewing vital signs. It automatically calculates an Early Warning Score every time new vital signs are entered to help staff easily identify patients who need urgent intervention.

In the UK alone, there are around 10,000 avoidable in-hospital deaths each year. The majority of cardiac arrests in hospital are preceded by a period of clinical deterioration, defined by abnormalities in patients' vital signs (heart rate, respiratory rate, blood pressure, temperature, arterial oxygen saturations and level of consciousness). Traditionally these have been recorded on paper charts, which can be inaccurate or illegible and are only accessible at the patient bedside.

The SEND system replaces the paper charts with a highly intuitive digital system that brings all the advantages of digital data storage whilst retaining the speed and usability of paper charting. Developed by a multidisciplinary team of clinicians, engineers and human factors scientists, the solution comprises a software application containing an Early Warning Score algorithm developed using machine learning techniques, and a customised hardware platform for fast, ergonomic data entry.



The ward overview screen, showing patients listed in order of priority for review.



A patient chart showing clinical deterioration. When the vital signs flag red the patient's care should be escalated

SEND improves safety at multiple levels in the healthcare system. At the bedside it helps clinical staff identify abnormal vital signs and act appropriately. At a ward level it provides senior clinicians with a real-time overview of patient sickness. At an organisational level it provides real-time auditing of clinical practice and data for clinical governance.

The research origins of SEND have strongly informed its development and future potential. Not only have we undertaken clinical trials to study the effectiveness of SEND but it also provides hospitals with a valuable data resource for research and innovation.

SEND is currently operational across all adult wards in all 4 hospitals of the Oxford University Hospitals Foundation Trust (OUHFT). It is used to record 150,000 observation sets every month. In a clinical trial SEND was found to be 30% faster than charting using pen and paper. Since the start of roll-out in 2014 over 16 million vital signs have been stored in the SEND database. These are being actively used in Oxford to develop next-generation Early Warning Scores and improve patient safety.

The SEND data entry hardware, comprising of a tablet, barcode scanner and bespoke roll stand capable of mounting most common vital signs monitors.

Peter Watkinson
Associate Professor
Nuffield Department of Clinical Neuroscience, University of Oxford

Lionel Tarassenko
Head of Department
Department of Engineering
University of Oxford

Timothy Bonnici
Academic Clinical Lecturer
Nuffield Department of Medicine
University of Oxford

Unobtrusive and automated sleep monitoring

Using the lightweight cEEGrid platform for accurate sleep staging.

Changing sleep patterns is considered a reliable marker for a large range of illnesses, from arthritis to schizophrenia. However, sleep monitoring is cumbersome and expensive, creating the need for a reliable but convenient alternative.

Sleep quality directly impacts general health. Changes in how we sleep can cause, and be caused by, a long list of illnesses.

However, the golden standard, the polysomnogram (PSG), involves electrodes spread over the whole upper body, requiring time consuming setup and expensive equipment, as well as inconvenience to the patient. This makes sleep measurements unfeasible in many cases where it could help diagnosis or treatment, and when it is used, it is often far less than what would be optimal.

A lightweight platform

The cEEGrid platform is a lightweight EEG array, which is attached around the ears using simple adhesives. This makes it highly promising as a method for performing a standard EEG measurement. The attachment of a set of electrodes at once is quicker than the current standard clinical practice of placing one electrode at a time. The cEEGrid also has the potential to be attached at home, without expert assistance. This capability would enable a real revolution in the study and treatment of a long range of chronic illnesses, in which repeated, longitudinal measurements of sleep are needed.

Comparison to current standard

Based on pilot data, we have shown that the cEEGrid contains similar information about sleep as conventional scalp electrodes (used in the PSG). The next, ongoing, step is a larger scale study, investigating the feasibility of clinical sleep measurements using cEEGrid instead of PSG.

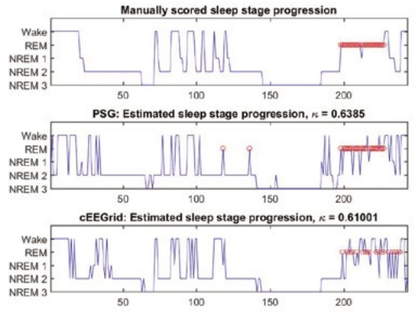


Figure 2: Comparison of estimated sleep stage progression with an automated processing pipeline. Top: expert estimates based on PSG data. Middle: Automatic estimation using PSG data. Bottom: Same algorithm used on cEEGrid data.

Figure 1: The cEEGrid array. For better signal quality, an array can be placed around each ear. The cEEGrids interphase over bluetooth with a smart phone, that stores the recording.

Kaare Mikkelsen
Post Doc at Institute for Biomedical Engineering,University of Oxford

Maarten De Vos
Associate Professor IBME
University of Oxford

PepGen: Peptide drug delivery platform technology

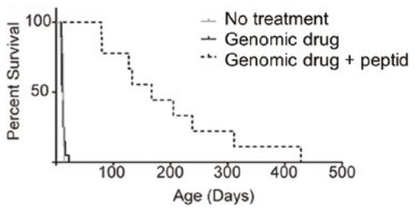
Delivery is the major barrier to the development of genomic precision medicine for human disease. We have developed a highly advanced peptide platform technology for the effective delivery of genomic medicine.

Genomic medicine (e.g. oligonucleotides, siRNAs and gene editing) is a dynamic and active field. The effects of antisense oligonucleotides (AONs) have been shown in multiple clinical trials, however due to the poor delivery of these drugs to target tissues, clinical benefit has been marginal and thus regulatory approval has proved difficult. This has left an urgent unmet need for AON therapies that are more efficacious.

Drug delivery platform technology

A highly productive collaboration stretching over ten years between Prof Matthew Wood at the University of Oxford and Dr Michael Gait at the MRC Laboratory of Molecular Biology in Cambridge has led to the development of a drug delivery platform technology that dramatically increases the efficacy of AON therapeutics.

This propriety peptide-based delivery platform has been developed with an initial focus on enhancing AON delivery for the treatment of neuromuscular diseases yet its applicability is far wider reaching with pre-clinical work in the pipeline for neurodegeneration, inflammation and oncology targets.



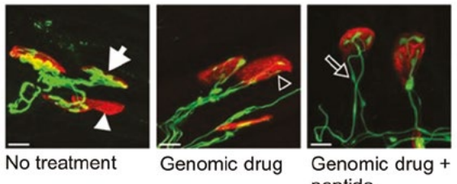
Peptide drug delivery platform significantly enhances survival in model of spinal muscular atrophy.

Neuromuscular disease

A wealth of pre-clinical work has been generated demonstrating the ability of this peptide-based platform technology to significantly enhance the delivery of AONs in two key neuromuscular diseases; Duchenne muscular dystrophy (DMD) and spinal muscular atrophy (SMA). These targets are clinically validated and commercially de-risked with data showing functional therapeutic benefits likely to translate into preventing or delaying disease progression.

Broad and robust patent position

Alongside the development of this technology we've built a unique intellectual property portfolio and working with Dr Ruth Barrett from Oxford University Innovations, are now seeking to commercialise this.



Morphological disease hallmark reduced following treatment with peptide drug delivery platform in model of spinal muscular atrophy.

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Matthew Wood, Prof.
Department of Physiology
Anatomy and Genetics
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Big Data: delivering the digital medical revolution

Work within this theme aims to deliver an integrated, modular, sustainable and extensible informatics approach that facilitates delivering personalised medicine, by translating laboratory research into patient treatments. We are taking a 3 way approach to the themes mission:-

Clinical Informatics

Develop and deploy secure, interoperable methods, tools, and systems for acquisition, integration, and sharing of health data (including medical records, patient-reports, sensors, imaging, 'omics, and other biological data), and for controlled information exchange among academic and NHS organisations.

Information Governance

Develop, deliver and evaluate an ethically robust governance framework (with appropriate informatics tools and services) for capture, application and management of consents; information sharing; and transparency within and across organisations.

Big Data analytics

Develop methods for analysis of large, heterogeneous biomedical datasets, including scalable methods for evaluating phenotype and joint analysis of high-dimensional, longitudinal biological and clinical data.

Our projects include:

- Oesophageal cancer: Understanding the influence of molecular pathology and response to checkpoint blocking immunotherapy on clinical progression of early oesophageal cancer
- Chronic disease: Digital Health approaches to management of chronic disease using EHR, smartphone-enabled sensors/cameras, EHR and machine learning
- Inflammatory bowel disease: Development of clinically applicable algorithms for patient stratification in inflammatory bowel disease
- Atrial fibrillation: Assessing the impact of (often silent) atrial fibrillation on cardiovascular, stroke, and vascular dementia diseases
- Drug-resistant infections: Using combined clinical and genomic data to identify emergence of infection threats

Global Digital Exemplar

Oxford Health NHS Foundation Trust and Oxford University Hospital NHS Foundation Trust within the AHSC partnership have been designated as Global Digital Exemplars to champion the use of digital technology to drive radical improvements in the care of patients and are paving the way in the use of digital technology in the NHS, embracing digital health on a daily basis to support patient care.

Oxford Health initiatives have included offering patients remote consultations using video conferencing facilities such as Skype and FaceTime, electronic patient notes available via iPad from anywhere at any time, signposting to online wellbeing and mental health therapies and using and recommending apps such as True Colours to support patients' self-management and recovery.

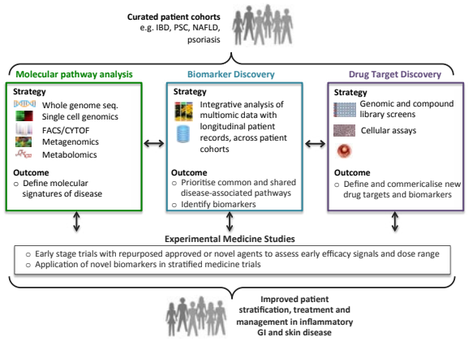
The exemplar has allowed Oxford University Hospitals to accelerate the opportunities that digital technology offers, in line with the ambition of the NHS to be 'paper-free at the point of care. The Trust has been acknowledged to be one of the most advanced NHS trusts for implementing electronic patient records (EPR), with over 1.2 million daily transactions via EPR. Administering more than 20,000 drugs every day using electronic prescribing and medicines administration, and having recently introduced a new state-of-the-art digital imaging system.

SEND, state of the art patient monitoring

Martin Landray
Professor of Medicine and Epidemiology and Deputy Director of the Big Data Institute

Modulating immune response for patient benefit

Work within this theme integrates cutting edge, multi-disciplinary basic science with first-rate clinical research. The close physical and intellectual collaboration between clinical and academic researchers provides an innovative, fast-paced, evolving approach to translational medicine that results in significant advances in patient treatment and care.



We are taking a multi-disciplinary approach to the mission.

1. Molecular pathway analysis: Using state-of-the-art technologies, including single cell genomics, CyTOF and whole genome sequencing we are identifying the underlying molecular causes of disease. These molecular signatures will improve patient stratification and optimise treatment options.

2. Biomarker discovery: Our academics and clinicians work closely with patients. Using clinical samples we can identify molecular markers of disease that can be exploited to facilitate patient stratification.

3. Drug target discovery: We are screening existing drugs and novel compounds for their ability to modify disease pathways. In vitro and cellular assays will combine with computational analysis to define new drug targets.

These three approaches will lead to Experimental Medicine Studies including early clinical trials to assess drug efficacy, the utilisation of biomarkers to identify the patients most likely to benefit from a particular therapy and the improved stratification and treatment of patient cohorts.

True Colours

The stratification of patients to ensure the most appropriate and effective treatment regimens are followed is a key aim of our theme. The Gastro-Enterology and Mucosal Immunity NIHR Oxford-BRC theme is proving instrumental in this area. Using molecular pathway analysis, biomarker and drug discovery and experimental medicine, inflammatory disorders can be classified to ensure that the patients receive the right treatment at the right time.

Professor Simon Travis at the TGU is leading a programme of real-time data collection in ulcerative colitis to relate fluctuations in disease activity with the biology of the disease. TrueColours-ulcerative colitis (TCUC) is a comprehensive real-time web-based programme for patients with UC. It monitors multiple parameters via electronic questionnaires: symptoms, quality of life (QoL), outcomes (eg emergency department visits) and demographics. Medications are entered and personalised treatment guidance formulated. This information, graphically displayed on a traffic light system, is available to the patient and clinical team via the TCUC website (https://ouh.truecolours.nhs.uk/ibd/en/), and is housed on a secure National Health Service server. Proteomic and metabolomics analysis of serial biological samples collected over 6 months from patients is planned.

Paul Klenerman,
Sidney Truelove Professor
of Gastroenterology

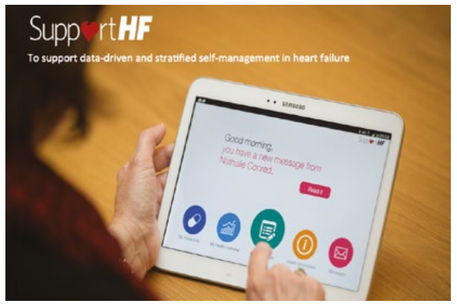
Managing the epidemic of chronic disease

Advances in medicine over the past few decades have led to an unprecedented increase in life expectancy and reduction in major disabilities. However, these achievements have also contributed to a rise in often poorly understood chronic conditions and their co-occurrence among individuals. This trend together with growing public expectations from medicine and healthcare, has generated new challenges for patients, clinicians, researchers and health policy makers in managing the burden of chronic disease and multi-morbidity. The theme builds on Big Data and Digital Technologies to advance the science and management of chronic diseases.

Deep Medicine programme

Researchers at the George Institute UK, have collaborated with the Oxford Martin School at the University of Oxford on a major new programme looking at how machine intelligence can be used to treat chronic disease.

The recently funded programme on Deep Medicine (http://deepmedicine.medsci.ox.ac.uk/) is led by a core team of interdisciplinary researchers who work together towards the common goal of advancing "data science" in medicine and healthcare. By aligning their goals, Deep Medicine is developing a Big (Health) Data analytics platform that will bring together the silos of traditional research methods and datasets, and will employ a powerful High-Performance Computing (HPC) infrastructure for extracting insights from medical data. Deep Medicine has already accessed some of the largest and most complex biomedical datasets that have ever been collected and is applying state-of-the-art machine intelligence algorithms and statistical methods to them to generate insights into complex disease patterns and risk trajectories in a replicable and scalable way. The clusters of new correlations and previously unknown associations will lead to new insights to direct research and transform healthcare delivery.



SUPPORT-HF programme

An exemplary project is the SUPPORT-HF programme (http://supporthf.org/), which aims to support patients with chronic heart failure to manage their conditions better at home. After several years of system design and usability testing, the project is now at the trial stage. About 200 patients from across the UK have been randomised into the trial, which now tests the hypothesis that centrally supported and data driven approaches to chronic disease management can reduce the gap between evidence and practice.

Kazem Rahimi,
Associate Professor of Cardiovascular Medicine, University of Oxford, Deputy Director, The George Institute for Global Health, James Martin Fellow in Healthcare Innovation, Oxford Martin School Honorary Consultant Cardiologist
Oxford University Hospitals NHS Trust

Stephen MacMahon
Head of the George Institute for Global Health and Professor of Medicine
University of Oxford

Mobile phone-based six-minute walk test

The six-minute walk test (6MWT) consists of walking as far as one can in six minutes. This simple test is a standard way for measuring exercise capacity in patients with cardiopulmonary disease. It is also used as a parameter for optimising the use of expensive treatments.

The problem:

6MWT are performed in hospitals to assess how patients are, and their response to treatment. However many factors on the day of the test can affect patients performance, including tiredness or stress. The test requires two physiologists and it can be difficult to find a quiet corridor in a hospital to perform the test

The solution:

We are developing an “app” to allow patients to easily perform the 6MWT at home (indoors or outdoors).

The app will send the results of the tests to a website accessible by the doctors under strict data protection rules. The quality and the reliability of the measurement is expected to be better than the hospital-based one.

The future:

Patients will be able to assess their physical condition more comfortably and as often as they want. Their treatment will be improved thanks to more reliable and frequent data.

Currently, we are testing this system in the clinic for pulmonary hypertension in the JR hospital.

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Precision
Medicine
and Digital
Health

New methods for stratifying airway disease

New BRC-supported technology promises to distinguish between different respiratory pathologies.

A new medical device has been developed by University of Oxford researchers supported by the Oxford Biomedical Research Centre (BRC). Data from this device, used with a computational model, can quantify lung inhomogeneity.

All lungs, young or old, healthy or diseased, have some degree of inhomogeneity – the distribution of fresh gas entering the lungs with each breath does not match perfectly with the distribution of the blood perfusing the lungs. It has long been known that different diseases affect the distributions of gas and blood flow in different ways, but previous methods measuring these distributions are invasive, time-consuming, and/or insensitive to early disease.

Researchers at the University of Oxford have devised a simple, quick, and non-invasive test that makes use of a new medical device that has been under development for the last 10 years. All that is required is a 15-minute period breathing through a mouthpiece (see fig 1). This can be a standalone test, or included as part of routine lung-function tests.

Data from these tests are then used with a computational model, also developed with support from the Oxford BRC. The model generates several numerical parameters that describe the patient’s lungs; this includes how inhomogeneous the lungs are with regard to air flow, blood flow, and ‘deadspace’ (airways that do not exchange gas with the blood).

The research team have already demonstrated that the model can distinguish between young participants, older participants, and patients with Chronic Obstructive Pulmonary Disease (COPD) (see fig 2). They are now working to sub-classify (stratify) patients with different forms of COPD. Specifically, lungs with emphysema, and lungs with small airways inflammation should show differences in deadspace and compliance distributions and the research team is hopeful of finding promising results.

This new technology, simple patient procedure, and novel computational model could lead to the application of precision medicine to diagnose early-stage lung disease and refine treatment decisions.

Fig 1) Participant breathing through Molecular Flow Sensor.

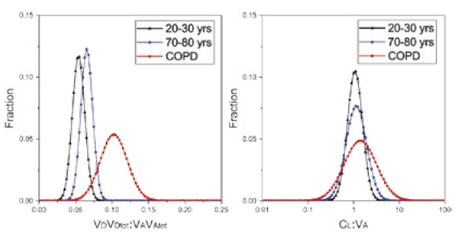


Fig 2) Distributions generated by the computational model for three participant groups (young participants, older participants, and patients with COPD). Left panel shows distribution of deadspace; right panel shows distribution of lung compliance. Lower, wider distributions correspond to less effective gas exchange within the lungs.

The Molecular Flow Sensor (MFS) Project Team
Institute of Biomedical Engineering
dario.salvi@eng.ox.ac.uk

Oxford Acute Referral System (OARS)

An electronic system to manage the referral of patients to specialist hospital services.

The process of complex-patient referral can be unstructured and inefficient leading to suboptimal care. OUH has developed OARS which enables transparent, real-time sharing of clinical knowledge, between teams across a care network.

Patients who require urgent or emergency care from specialist (tertiary) hospital services are often the most unwell individuals the organisation cares for. Their care is challenging:

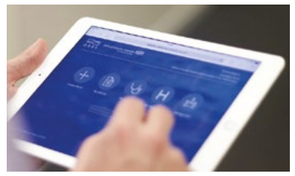
- They are referred from many different institutions, covering a large population, over a wide geographical area.
- Multiple members of different teams are involved in their care and accurate decision-making requires the synthesis of numerous different factors in each case.
- The capacity to provide specialist care is limited, resources are expensive and outcomes are often time-critical.

Despite (or perhaps, because of) these features, the process of acute specialist referrals has typically been conducted via repeated telephone calls with limited data capture. OUH identified the opportunity to improve the quality and efficiency of specialist clinical services by digitising this acute referral pathway.

A vital aspect of this project was the involvement of the Quality, Reliability, Safety and Teamwork Unit of the Nuffield Department of Surgical Sciences, University of Oxford. Their academic Human Factors research team helped lead a user-centered design process that involving widespread stakeholder engagement.

Ethnographic research and design-thinking approaches identified that other electronic referral systems that simply passed a referral from one individual to another did not fit the existing process. A new system would need recapitulate the to-and-fro of repeated voice conversations that were the basis of the existing process.

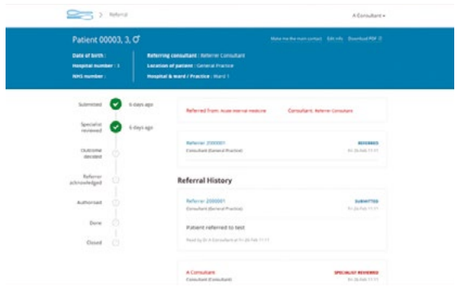
The system was developed and deployed in partnership between a local SME, OUH and the University of Oxford.



OARS being used on a tablet

OARS went live in the Department of Neurosurgery in April 2016. Over the first year of use 3000 healthcare workers registered and over 5500 referrals have been managed by the system. During 2017 OARS will be rolled-out into further specialties in Oxford and opportunities to extend its use into other institutions will be explored.

Further information can be found at http://www.ouh.nhs.uk/services/oars/default.aspx



The referral 'conversation'

Oxford University Hospitals NHS
NHS Foundation Trust

NUFFIELD DEPARTMENT OF SURGICAL SCIENCES

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Selfies to help diagnose rare diseases

Facial recognition for aiding diagnoses of rare diseases by diagnostically relevant phenotyping.

Minerva & Me is a public engagement in science effort to allow people to share photographs and selfies with researchers. From this computer vision and machine learning models can be developed to aid diagnosis of rare diseases.

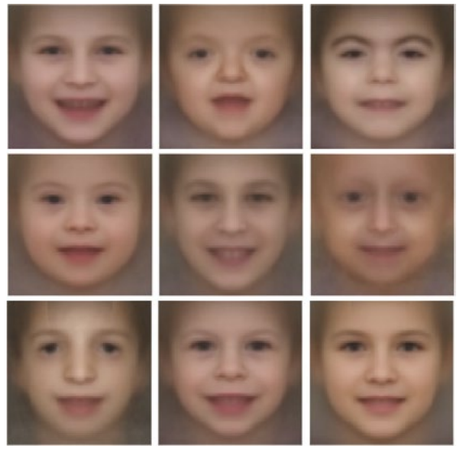
Rare diseases are collectively common, with estimates of up to 8% of the population having some type of rare disease. The clinical pathway and patient journey to get a diagnosis is frequently costly and protracted, often taking several years.

We are developing facial recognition-like approaches to produce models to aid diagnosis of rare diseases. This holds great promise as a clinical genetics tool around the world by bringing together and identifying ultra-rare diseases and conditions. However, this is a big data problem – which can only be addressed through training with broad representations of people with different diagnoses, and variation in ancestry, age and clinical settings.

To make this possible we have formed a research consortium with the purpose of allowing research collaboration and data sharing, the Minerva Consortium. The purpose is to allow a healthy competition and development of basic research into approaches.

Minerva & Me is a research web portal, designed to allow families and patients with rare diseases to participate and help drive this research forward. Through this portal it is possible to share family photographs and control how these can be used in research projects.

Minerva & Me is hosted on secure University of Oxford servers and is controlled by an Advisory Board with patient group, clinician, data security and legal representatives. At the core of the design of Minerva & Me is that participants retain control of their own data and how that data is used in research. Participants can always change the way their data can be used, or delete the data entirely if they so choose. The hope is that Minerva & Me will be a growing resource hub for patients to participate with their medical information and photographs in research projects into rare diseases.



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Theranostic nanoparticles

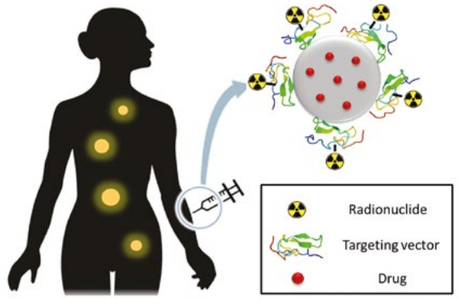
Cancer imaging and treatment.

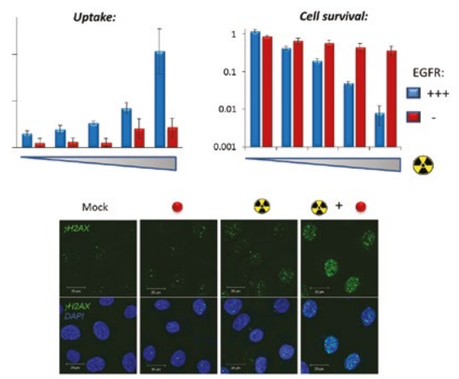
Development of new therapeutic combinations for targeted drug delivery to sites of disease

Oncology, including the treatment of cancers of unmet need such as those of the oesophagus and pancreas, remains centred around the systemic administration of highly cytotoxic drugs such as cisplatin, usually employed in combination with radiotherapy. However, the toxicity associated with conventional chemotherapy agents severely restricts their use. Although technical advances have enabled highly precise delivery of therapeutic radiation, exposure of surrounding healthy tissue still limits the dose that can be administered to a cancer.

To address this, a multi-disciplinary research team led by Professor Katherine Vallis (Oncology) and Professor Robert Carlisle (Bioengineering) aims to develop nanoparticle-based dual therapeutic/imaging systems - “theranostics” - for cancer treatment. These drug delivery vehicles combine both a radiopharmaceutical suitable for PET/SPECT imaging and a complimentary small molecule agent as the therapeutic payload within. Cancer specific uptake is achieved by targeting receptors over-expressed by cancer – but crucially not healthy - cells. As a lead candidate we have developed nanoparticles for the synchronous targeted delivery of the radionuclide Indium-111, a SPECT imaging agent which also generates DNA double-strand breaks, and a novel ruthenium-based radiosensitizing compound, Ru1. This has been tested in oesophageal cancer cells that over-express the membrane receptor, epidermal growth factor receptor.

Working side-by-side with Theragnostics, we aim to streamline the production of radiolabelled nanoparticles employing good manufacturing practice (GMP) to develop a radiolabelled nanoparticle kit with optimised yields, minimising loss of reagents and improving preparation efficiency to a level suitable for clinical application. As all components of this system: targeting ligand, payload and radionuclide, may be varied, specific functionalities may be introduced and tailored to specific tumours. Thus our strategy enables patient-specific treatment and promotes the desirable goal of personalised medicine. Further developmental work and pre-clinical studies are ongoing.





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Oxford Biodesign

Devising innovative technology-based solution for healthcare needs.

In the UK, every 10 seconds someone experiences a potentially life-threatening asthma attack, every 8 minutes someone is hospitalised and every 8 hours someone dies due to asthma. These numbers, worst since 2003, demonstrate the increasing severity of the problem and unmet need for an effective solution. asthma attacks cause significant disruption in daily activities, panic, trauma, and even deaths. Moreover, the vast majority of these asthma attacks are preventable.

The NHS spends about £1 billion each year caring for people with asthma, while the unplanned expenditure due to emergency visits and hospitalisations alone costs the EU over €5 billion a year. The lack of reliable monitoring mechanisms leaves clinicians in the dark about their patients’ condition when they are out of the clinic or hospital, making it very difficult to provide optimum treatment.

We are developing an innovative monitoring device with integrated analytics that can track objective markers of disease severity in asthma patients, empowering them to self-manage their asthma and enable timely intervention before their condition worsens considerably. The system, designed to achieve high-compliance, high-quality monitoring for long term use, would include clinicians and adaptive algorithms in the process to deliver optimal personalised asthma care.

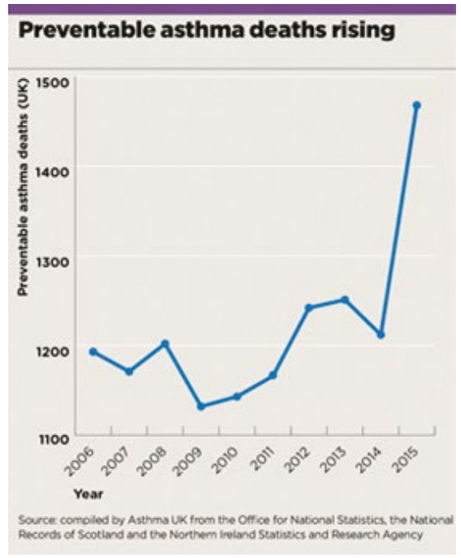
What do patients and healthcare professionals want from asthma technology?

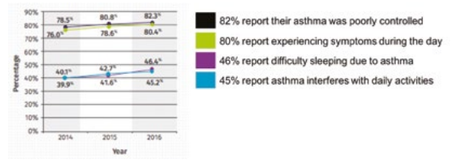
In 2015 Asthma UK asked patients and healthcare professionals for their views on what they would like from an mHealth system.[30]

Nearly three-quarters of patients wanted to see an mHealth device that would help them monitor their asthma. In addition, nearly half suggested they would value a system which could be used as part of their asthma action plan and tell them if changes to asthma medication have improved their asthma and when to seek medical attention.

Over three-quarters of healthcare professionals said they would value an mHealth system that would monitor patients’ asthma symptoms over time and provide patients with an asthma action plan.

With our combined expertise in clinical practice, electrical engineering, signal processing and machine learning, we are geared up to deliver clinically effective and commercial scalable solutions for patients, clinicians and payers of healthcare.





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Precision Medicine and Digital Health

Mapping the personal health space

Understanding the health of a patient in the context of their environment.

As a healthcare Internet of Things company, we understand the health of a patient in the context of their environment and generate actionable information and discoveries that improve health and reduce costs.

Drayson Technologies is a healthcare IoT company addressing major global health problems. Chronic disease is the single biggest driver of ballooning healthcare costs (CDC, 2012) and air pollution is the biggest environmental health risk and a major cause of chronic disease exacerbations (WHO, Urban Air Quality Database, 2016).

We adopt a holistic patient approach to the development of digital pharmaceuticals that fuses health and environmental monitoring data across the whole care pathway from hospital to home.

Environmental monitoring

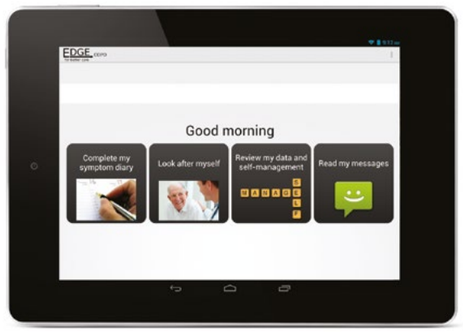
- CleanSpace™ is the world's most comprehensive air pollution monitoring platform. This IoT sensor network uses machine-learning and connected smart sensors to create hyper-local air pollution information to enable people to "see the air they breathe" and to help enterprises and municipalities improve air quality.

Health monitoring

- Drayson Technologies, Oxford University and Oxford University Hospitals (OUH) NHS Foundation Trust have signed an agreement to collaborate on the development, testing and future commercialisation of three clinically validated digital health products arising from research undertaken by engineers and doctors at Oxford University and the OUH Trust.
- SEND, GDm-health, EDGE-COPD are digital health products that use machine learning artificial intelligence software, to analyse data and provide decision support and patient safety information to both patients and healthcare professionals. The products have undergone significant clinical testing and validation involving over 100,000 patients and generated over 20 million data records to date. Results suggest that these technologies could deliver significant improvements in patient health outcomes and reduction in costs for the NHS.

Our expertise in regulated diagnostic and therapeutic product development and marketing combined with expertise in digital health sensor networking, wireless technology, Big Data and machine learning enables us to create effective new care pathways for the diagnostic and treatment of chronic disease.

CleanSpace is the world's most comprehensive air pollution monitoring platform.



EDGE (COPD management)

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Precision Medicine and Digital Health

In Silico Prediction of Drug Effects on Human Ventricular Electrophysiology

Using the Virtual Assay Software and Comparison to In Vitro Data.

- **Electrophysiological cardiotoxicity** is an important cause of drug withdrawal from the market
- **Inter-subject variability** is the key to explain the different responses to diseases and drug action

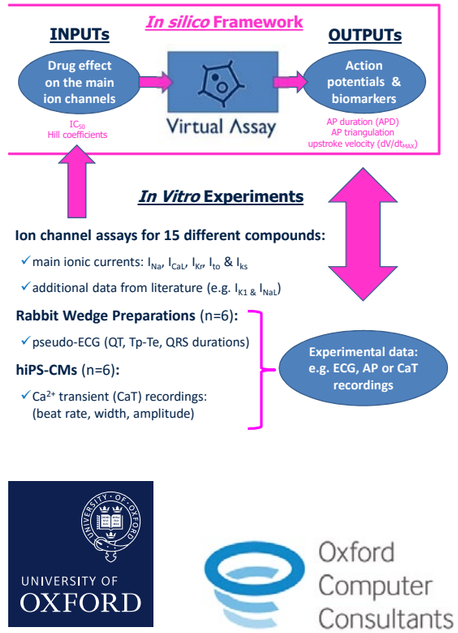
  ✓**"Who, When and Why?"** people may be at risk
- ***In Silico* models** constitute a new frontier for the assessment of drug cardiotoxicity

  ✓Help in the **translation from animal to human**

  ✓**Identify causes of cardiotoxicity**

  ***In Silico* models** are included in the **Comprehensive in vitro Proarrhythmia Assay (CIPA):**

  ✓novel safety screening proposal based on in vitro and *in silico* cellular cardiac electrophysiology predictions (Sager et al. AHJ. 2014)



Conclusions

- Virtual Assay Software constitutes a user-friendly powerful *in silico* tool for safety pharmacology assessment
- *In silico* predictions with Virtual Assay are in overall agreement with rabbit wedge and hiPS invitrocalcium measurements
- *In silico* human cell populations are able to reproduce inter-cellular variability in drug responses, not captured by a single action potential model
- *In silico* human cell populations identify key factor determining inter-subject variability in cardiotoxic response

UNIVERSITY OF OXFORD

Oxford Computer Consultants

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Precision Medicine and Digital Health

Autonomous speech-based monitoring of health at scale

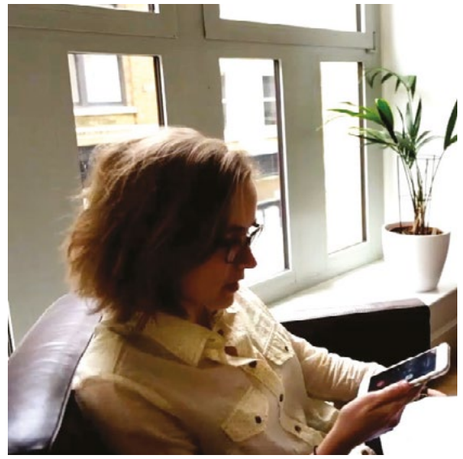
Ufonia is an Oxford University Innovation start-up company that is developing voice chat-bot systems that can monitor individuals' health and wellness across entire patient populations.

ufonia

Ufonia's initial product supports people with long-term conditions ('chronic diseases'), such as diabetes, asthma and heart failure. These patients account for 70% of health and social care expenditure. Throughout the world this sector of healthcare faces the greatest challenge from increasing demand. Forthcoming 'accountable care systems' will incentivise providers to more intensively monitor these patients. But, the additional workforce capacity to do so, does not exist. Ufonia is developing products to meet these needs. It is an automated system, delivered via a telephone, that can engage entire patient populations without the need for specific software, devices or training.

Further market opportunities exist for Ufonia to provide new and effective engagement channels for secondary care, research, pharmaceutical, medical device and insurance providers.

Ufonia has been supported by funding from the Science and Technology Facilities Councils' Harwell HealthTec Cluster and Hartree, High Performance Computing Centre, plus IBM Watson.



A user talking to the system

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Science & Technology Facilities Council

Harwell

IBM Watson

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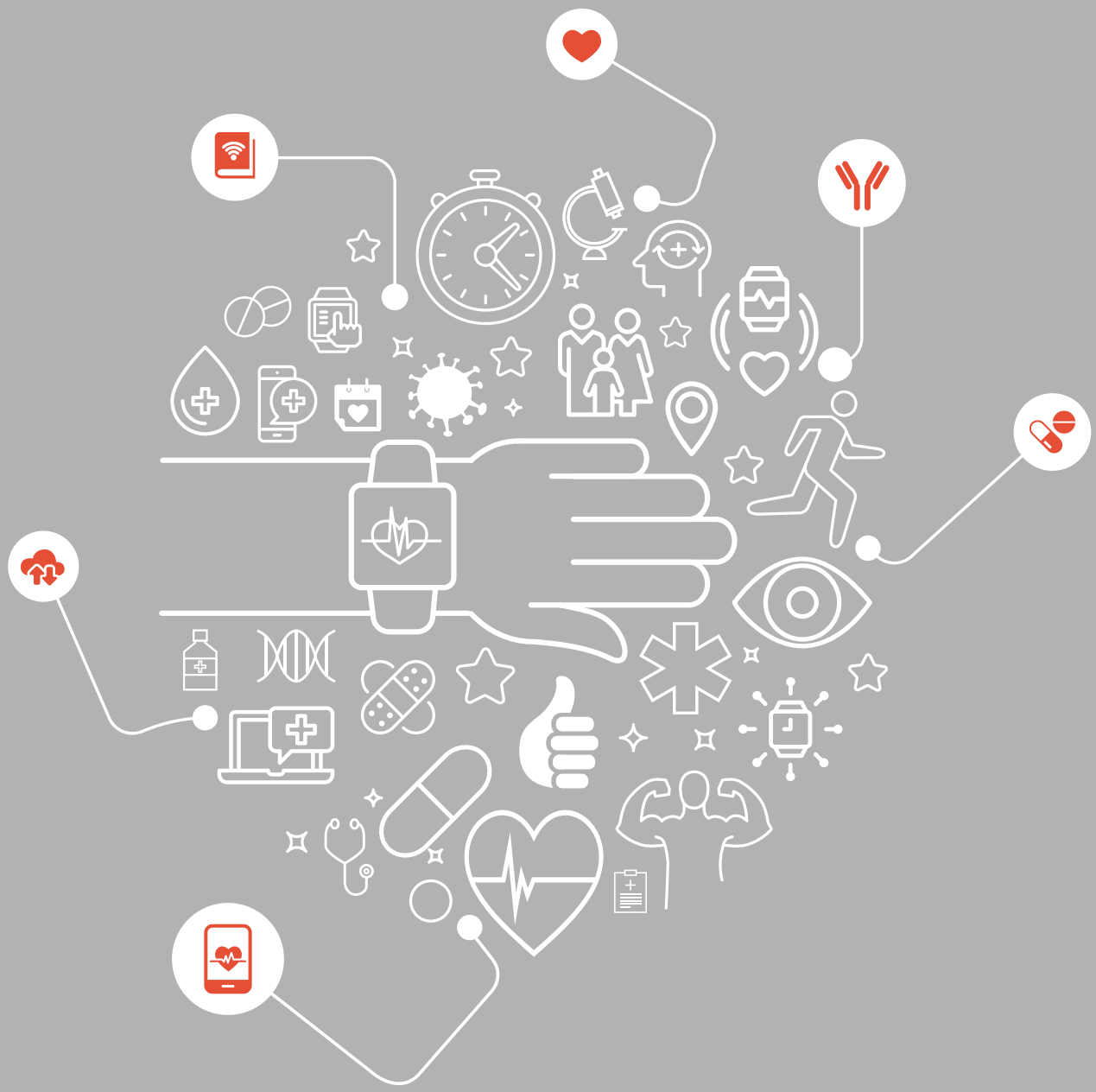

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NHS National Institute for Health Research

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