i-sense

EPSRC IRC in Early Warning Sensing Systems for Infectious Diseases

Annual Report

2014/2015

Foreword

Working for research excellence and global health benefits

In 2015, the threats of Ebola and antimicrobial resistance offer a stark reminder that the world urgently needs early warning systems to prevent the spread of deadly infections. Over the past 18 months, i-sense researchers have built the foundations of innovative digital sensing systems that aim to detect outbreaks of influenza, bacterial infection and HIV much earlier than ever before.

We are linking traditional public health efforts with millions of symptoms reported on the web, often before people visit their doctors. We are also engineering a new generation of mobile phone-connected diagnostic devices to help widen access to testing, for example to doctors' surgeries, care homes, remote villages in Africa and even to the home.

Research highlights this year include a collaboration with Google to improve the modelling underpinning their Flu Trends website, a mapping system to nowcast flu in the UK using Twitter, a crowd-sourcing project on self-testing with Flusurvey, innovative biomarker discovery tools for bacteria, novel capture ligands, advanced nanomaterials to transform the sensitivity of diagnostic tests and new 'apps' to connect self-tests with geo-located information.

From the outset we are working closely with potential end users of our technologies, including NHS clinicians, the public, patient groups, industry and Public Health England to ensure we build technologies that meet a clear need. Strong partnerships are central to our vision. In addition, a new ethics project into data privacy is under way to study the wider societal impact of our work to responsibly develop these technologies.

I'm also very proud of our brilliant team. The awards, fellowships, high impact publications (Science, Nature Nanotechnology), invited talks and advocacy work reflect a collective research excellence and commitment to impact across the five partner universities. Our Education Alliance's summer schools and training programmes are growing the skills of our bright young researchers, and our Partnership Resource workshops are creating national and international networks of excellence.

We hope you enjoy reading about our progress over the past year and our plans for the future, including a new partnership with the Wellcome Trust Africa Centre for Health and Population Studies. As the health needs of developed countries begin to coalesce with the traditionally unmet needs of developing countries, we have a remarkable opportunity to build better early warning systems for the common good.

Professor Rachel McKendry

About i-sense

The aim of i-sense is to detect outbreaks of infectious disease earlier than before to prevent pandemics.

We will achieve this by engineering a new generation of low-cost, early-warning sensing systems. These systems will exploit web information, such as search engine queries and social media posts, in combination with mobile phone-connected point-of-care diagnostics. Our research programme is focused on three areas of infectious disease: **Influenza**, **bacterial infection** and **HIV**.

In addition, we have a programme on the Systems Level Perspective of End-user Needs, as well as our Exploratory Projects, an Education Alliance and Partnership Resource Fund.

i-sense is a five year, £11M EPSRC funded Interdisciplinary Research Collaboration. It brings together a remarkably strong team of biochemists, chemists, physicists, engineers, computer scientists, microbiologists, clinicians and epidemiologists from across five university partners with Public Health England, the NHS and industry.

Newcastle University · UCL · Imperial College London · London School of Hygiene & Tropical Medicine · University of Surrey · Public Health England

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i-sense in numbers

Postdoctoral Research Associates employed by i-sense on core and exploratory projects

15 Research Associates

Leveraged funding
Total funding leveraged by i-sense members since launch

£8 Million

Publications
Including in Science and Nature Nanotechnology

15 Publications

Prizes

Prizes won by i-sense members this year included:

The European Life Science Research Group of the Year Award for the Stevens Group, Honorary Member of the Society of General Microbiology for Colin Harwood, George Macdonald Medal for Rosanna Peeling, Royal Society Rosalind Franklin Award for Rachel McKendry and a Marie Curie Fellowship for Research Associate Subinoy Rana.

Scientific poster awards went to Harriet Gliddon, Philip Howes, Valérian Turbé and Keith Flanagan. Sinziana Popescu, Katie Griffiths and their team won ACTION 2014 for their business idea, and the Stevens group team won Best Healthcare Business Plan at Biotechnology YES.

Influenza

Pandemic influenza is listed in the 2015 Cabinet Office National Risk Register as the most significant civil emergency risk to the UK population, prioritized above flooding and terrorist attacks. In comparison to circulating seasonal flu, emerging strains of influenza are of particular concern due to the potentially severe response. In 1918 'Spanish Flu' killed over 50 million people. In 2003 'Bird Flu', when transmitted to humans, resulted in death in 60% of cases.

The best approach to control any outbreak is to identify the source of infection at the earliest stage possible, using diagnostic testing as part of an early-warning system.

Mass gatherings

The risk of a disease outbreak originating at a mass gathering, such as a music festival or religious event such as the Hajj, is high. Professor Ingemar Cox of i-sense, has teamed up with Microsoft Research to develop a new method to alert to an outbreak using Internet data.

Twitter posts and Bing queries were extracted and a statistically significant appearance of a disease symptom was found in two of the nine festivals studied. The work demonstrated the feasibility of creating a public health surveillance system for mass gatherings based on Internet data.

The i-sense team are currently in the development stage of a map to nowcast flu-like-illness activity across the UK, based on geo-located Twitter data (see inset image).

Yom-Tov E, Borsa D, Cox IJ, McKendry RA, Detecting disease outbreaks in mass gatherings using Internet data. (2014) *J Med Internet Res*. 16(6) 154

Public health needs

In order to understand how and where our early-warning systems can bring maximum benefit, i-sense has partnered with government agency, Public Health England (PHE). Together with PHE's Richard Pebody, we are evaluating the potential impact of our technologies on diseases such as influenza, MRSA, *C. difficile* and HIV.

Professor Rosanna Peeling (LSHTM) led a study to review the limitations of current early-warning systems, define a "dare to dream" system and produce target product profiles. This work, involving interviews with infectious disease experts, GPs, clinicians and public health officials, will carry on throughout the coming year.

Tracking flu with Google.org

Google has pioneered the use of search queries to track the spread of influenza worldwide. Google Flu Trends, **www.google.org/flutrends**, uses millions of flu-related queries typed into their search engine each day, similar to 'I have a fever' and 'flu symptoms', to map flu activity in near real-time. Recently, the first generation of Flu Trends was reported to overestimate flu activity.

i-sense researcher, Dr Vasileios Lampos joined Google this year as a visiting researcher to improve their models.

Search query trends can be used in conjunction with other influenza surveillance systems, such as the networks of general practitioners used by Public Health England, to improve our understanding of flu activity. *The results of this collaboration have been submitted for publication.*

A biobarcode for flu using advanced nanoparticles

A low cost paper microfluidic test that resembles a barcode is being developed by i-sense researchers to detect multiple biomarkers of flu simultaneously. The test will be read out by the i-sense app, enabling testing of highly-multiplexed arrays on a single test strip, which would be impossible to read by eye.

i-sense researchers led by Professors Rachel McKendry and Robin Weiss are working on novel capture llama antibodies for immobilisation on paper, and are teaming up with Professor Molly Stevens' group at Imperial College London to employ nanomaterials, including quantum dots and metal nanoparticles to create highly sensitive tests.

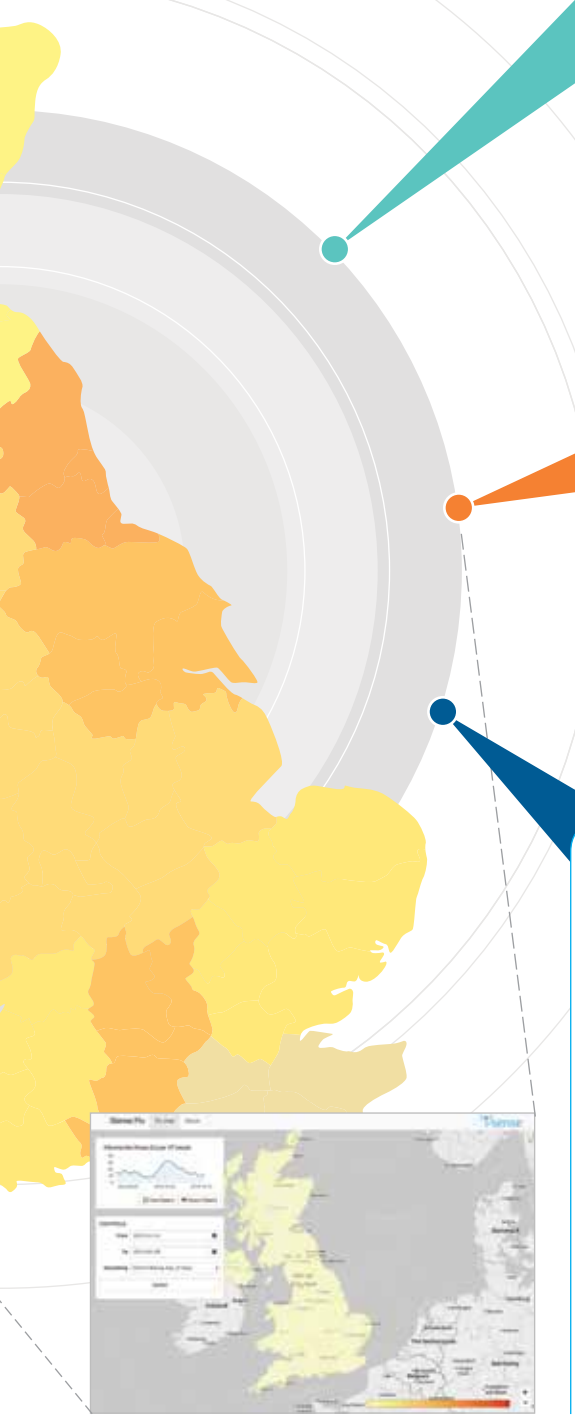
In a recent review published in the journal Science, i-sense researchers from Professor Molly Stevens' group at Imperial College London discuss the use of nanoparticles as advanced biological sensors, how their properties can deliver extremely sensitive detection and how this can be translated into commercial and clinical technologies.

Howes PD, Chandrawati R, Stevens MM Colloidal nanoparticles as advanced biological sensors. *Science* (2014) 346(6205):1247390.

Self-diagnose with your phone

Using a smartphone to photograph and analyse a flu test can give reliable and quantitative results within seconds, increasing the power of self-testing at home and in the community. The three key limitations of self-testing with a lateral flow test (similar to a pregnancy test) are that they have limited sensitivity, are qualitative and often misinterpreted, and the test is not connected – so the results are lost when the test is disposed of.

i-sense researchers led by Rachel McKendry are developing smartphone apps to overcome these limitations. The app links to the mobile phone camera to read-out results from commercial flu tests with high sensitivity and quantitative information. Results can be immediately sent to health care systems, with geo-located information, helping to identify flu 'hotspots' earlier than ever before.



(Image courtesy of London School of Hygiene and Tropical Medicine)

i-sense Flu

Traditional influenza surveillance uses cases reported to hospitals, GPs or NHS phone lines. Flusurvey, the UKs biggest crowd-sourced study of influenza, however, uses self-reporting from the public to monitor flu, with virtually no delays.

This year, for the first time and in collaboration with i-sense, **flusurvey.org.uk** volunteers have been offered a swab they can use at home, to confirm if their symptoms are caused by a flu virus. This pilot Exploratory Project led by Professor John Edmunds involves the swabs being analysed at a central laboratory. We hope in the future to be able to offer 'instant' self-testing with a disposable test.

Data such as this can be used to validate analysis of internet search data. Ultimately, identifying a particular virus is a crucial part of efforts to spot a potential pandemic.

Bacterial infections

Dame Sally Davies, the Chief Medical Officer for England called the threat of bacterial infections and antibiotic resistance a “ticking time bomb”. Her white paper highlights the need not only for new antibiotics but also early detection systems and diagnostic tests to improve antibiotic stewardship. 2014 also saw antibiotics voted as the topic of the £10M Longitude Prize, which will be awarded to those who develop a rapid bacterial diagnostic.

Current tests to identify a bacterial infection, for example *C. difficile*, E. *coli* and MRSA, can take up to several days. Patients therefore, tend to be administered a broad-spectrum antibiotic or mixture of different antibiotics as a ‘catch-all’ approach. Unfortunately, this inappropriate use of antibiotics can lead to the evolution of antibiotic resistance, which can result in a difficult or sometimes impossible to treat disease. Quick and simple, point-of-need diagnostics for the early detection of these infections are therefore desperately required to guide appropriate treatment.

Diagnosing bacterial infections

i-sense is developing a range of mobile phone-connected diagnostics, to detect and identify bacterial infection in the time it takes for a check-up in a doctors surgery or care home. Sensor technologies, including impedance-based lateral flow tests and MEMS are being integrated with low-power microelectronic chips for wireless signal transmission.

A range of novel capture molecules are being investigated, including peptide and DNA aptamers. The team has now brought in-house the capability to generate DNA aptamers, and are in the process of producing these for their first target, *E. coli*. The team is led by Professor Calum McNeil at Newcastle University, in partnership with the group of Professor Andreas Demosthenous at UCL who is working on wireless CMOS technology.

Cloud computing software

To help discover new biomarkers for bacterial diagnostics, two pieces of cutting-edge software are being developed that aim to take advantage of the huge amount of genetic data available for bacteria.

A new cloud-computing system, ‘Microbase’ and graph-based database ‘Entanglement’, has been written by members of the group of Professor Anil Wipat at Newcastle University. This software will be used to identify marker proteins on the surface of the bacteria, ‘bacterial fingerprints’, which will then guide the development of a range of capture molecules for the diagnostic sensors. Version 2.0 of the system is currently being tested and a web-based user interface is being developed (‘IDRIS’), to make the software accessible to other researchers.

Flanagan K, Cockell S, Harwood C, Hallinan J, Nakjang S, Lawry B, Wipat A. A distributed computational search strategy for the identification of diagnostics targets *J Integr Bioinform.* (2014) 11(2):242

Miniaturised and wireless

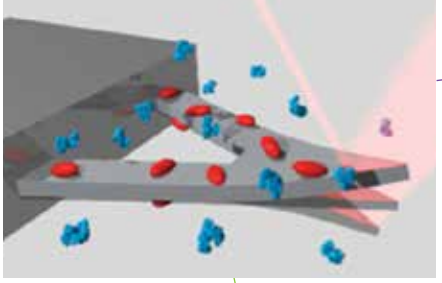
As part of the i-sense project, a tiny CMOS potentiostat is being developed to replace the large bench-top machine commonly used in the laboratory. This would be a significant step in the miniaturization of diagnostic devices that depend on electrical impedance signals.

A first-stage prototype of the chip has been constructed and is currently being evaluated. The tiny wireless chip is designed to be inexpensive, low power and of very small dimensions, suitable for use in a point-of-need diagnostic device.

Which antibiotic?

To enable an informed choice of antibiotic in the clinic, i-sense researchers are developing a diagnostic that works in minutes. Cantilevers, which resemble tiny diving boards, capture bacteria in the sample to be tested. A laser, bounced off the cantilever tip, is used to measure the vibrations produced by living bacteria. A selection of antibiotics can then be washed over the bacteria, and the antibiotic that successfully kills the bacteria (thus stopping the vibration) is selected to treat the infection.

The development of specialized coatings for the capture of the bacteria on the surface of the cantilever is a collaboration between UCL and Newcastle University.



R.A.McKendry, N.Kappeler, Sensors: Good vibrations for bad bacteria. *Nature Nanotech*. (2013) 8, 483-484.

HIV

HIV, a retrovirus transmitted through bodily fluid including blood, affects 34 million people worldwide. Initial symptoms can be flu-like, with the immune system significantly weakening over time. Without proper treatment, this leads to death. Most recently, the early detection and treatment of HIV has been shown crucially to achieve a ten-fold reduction in risk of death in the first year.

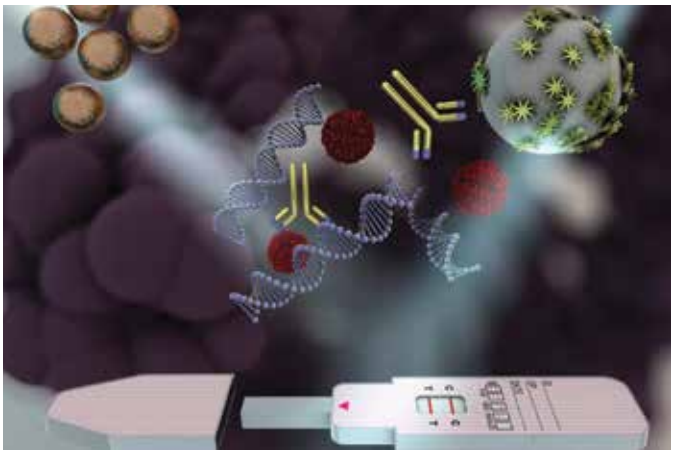
However, early detection in the community is problematic, as tests typically rely on antibody detection. These antibodies cannot be detected until approximately one to six months after exposure. Moreover, antibody detection is sometimes inaccurate, for example in infants, where their mothers' antibodies may cause false-positive results.

Optically active nanomaterials for diagnostics

Researchers are constantly discovering new molecular markers that can be used as an indicator of disease. However, these biomarkers often occur in very low concentrations in the body, such as HIV marker protein p24, and are therefore difficult to detect, requiring the development of ultrasensitive diagnostics.

At the nanoscale, unique and interesting phenomena often arise that are not observed in the bulk material, and it is these phenomena that can be exploited in the development of next-generation diagnostic tests.

i-sense researchers from Imperial College London and UCL are collaborating to develop ultrasensitive assays for the detection of HIV biomarker p24, useful in the early diagnosis of HIV. The Imperial team is using novel nanomaterials, such as gold nanostars, nanoparticles and quantum dots, to make their ultrasensitive colorimetric and fluorescence-based assays. The UCL team are investigating the use of novel llama antibodies as capture agents for the sensitive and robust detection of p24.



A next-generation HIV test

Diagnostics company OJ-Bio, **www.oj-bio.com**, are pioneering the development of innovative mobile phone-connected diagnostics, based on their surface acoustic wave technologies. Surface acoustic wave sensors are cheap, mass-produced sensors that are found in your mobile phone. *Professor Rachel McKendry's team at UCL* are working with OJ-Bio to develop next generation mobile diagnostics for the early detection of HIV. This research combines OJ-Bio's innovative microelectronics and telecommunications technology with UCL's novel capture coatings and modelling expertise, as well as a strong link to clinicians within UCL Partners.

i-sense events

Influenza workshop

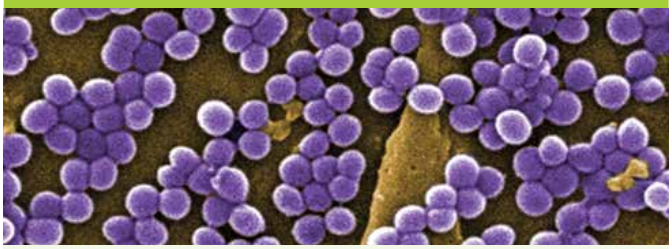
i-sense's first one day workshop was a powerful event that brought home the global risks and challenges of pandemic influenza, through talks and discussion from an international perspective.

120 experts in big data and mobile diagnostics met at the Institute of Materials for the workshop, entitled "New Frontiers in Digital Influenza Surveillance: Web Data and Mobile Phone-Connected Diagnostic Tests". Delegates included representatives from UCLA, Harvard, Columbia, Telefónica and molecular diagnostics company Cepheid.

Topics covered included mapping the effect of control measures during the Mexican pandemic, mobile phone-connected tests using microfluidics, nanomaterials and surface acoustic wave sensors, as well as the use of online data to identify disease outbreaks.

Outcomes of the workshop included a collaboration between i-sense and FluSurvey led by Professor John Edmunds from the London School of Hygiene and Tropical Medicine, see i-sense Flu p5. A collaboration with Google was initiated to work on their website Flu Trends, see article p4. The sold-out workshop was jointly organized by i-sense and the Infectious Disease Research Network (**www.idrn.org**).

Bacterial infections workshop



To ensure our bacterial identification systems are driven by clinical, public health and industry needs, i-sense organised a one-day workshop on "point of care systems for detection of bacterial infection".

The unique event saw thirty-one experts participate, with representation including hospital consultants in A&E, adult and paediatric infectious diseases and critical care, Public Health England, clinical microbiologists and the mobile diagnostics industry.

A lively open debate, described as 'inspiring' by delegates, has been used to define both the minimum, as well as aspirational requirements for an early-warning system.

An additional outcome of the workshop was an invitation for Newcastle University and other i-sense scientists to participate in a large-scale European Commission Horizon 2020 application with 21 other partner organisations, including Imperial. This project aims to increase diagnostic capability in the area of paediatric bacterial infection.

The meeting can be reviewed in the Newcastle University ReCap system at **https://goo.gl/LZ0QrW** and in summary on the i-sense website, **www.i-sense.org.uk**

Training young researchers

Based on a theme of enterprise, innovation and commercialisation, i-sense students and early career researchers met for the first annual Education Alliance summer school, held at Newcastle University.

The group was exposed to the journey from 'idea' to 'enterprise', touching on intellectual property, commercialisation models, business planning and finance. To start the day researchers were asked to give a three-minute presentation on their work, using only one slide and props. Next, participants were asked to discuss key societal challenges, then to create pseudo-companies to solve these challenges, leading to final group pitches at the end of the workshop. The programme was designed to complement i-sense research and help students gain confidence in their business and soft skills.

Thanks to Gareth Trainer, Assistant Director of Entrepreneurial Development at Newcastle University, and Dr Neil Keegan, who leads the Education Alliance for delivering and organising the event.

i-sense funded Exploratory Projects

Following a funding call for new partners, i-sense has launched four multidisciplinary, collaborative projects this year, focused on influenza, equating to £200k of investment.

Following a funding call for new partners, i-sense has launched four multi-disciplinary, collaborative projects this year, focused on influenza, equating to £200k of investment.

Two of the projects covered diagnostic assay development using novel materials. The group of Professor Steven Hilton from the London School of Pharmacy, has joined i-sense to work on novel sugar capture coatings for the detection of flu biomarkers with the McKendry and Stevens groups.

Professor Milo Shaffer of Imperial College and Professor Neal Skipper of UCL have joined i-sense in a new collaborative project with the McKendry Laboratory at UCL. This will investigate the use of novel nanomaterials, such as carbon nanotubes to increase the sensitivity of lateral flow tests for influenza.

A third collaboration launched this year and funded directly by i-sense is a project that is looking at how to build public trust in early-warning systems for influenza, and how to balance issues such as data privacy with the greater public good. This project is led by UCL Philosophy researcher Dr James Wilson.

As a fourth project i-sense funded the 2014-15 Flusurvey project to crowd source influenza activity – see page 5 for details.

i-sense will be providing funding for collaboration in future funding calls – keep your eye on the website for details: www.i-sense.org.uk

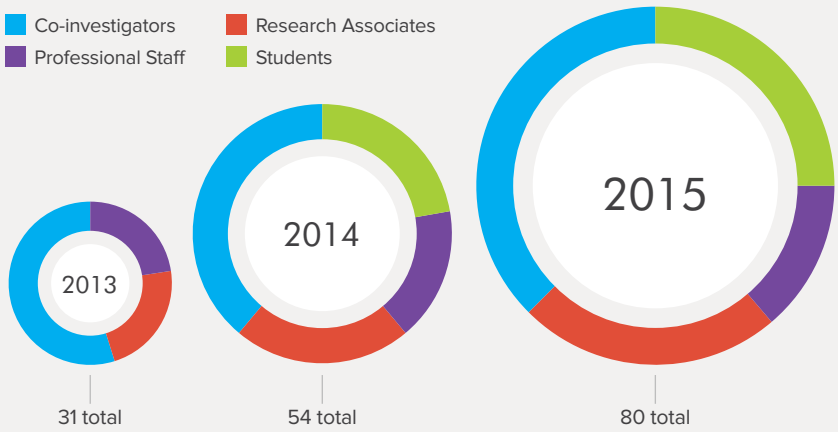
Talks

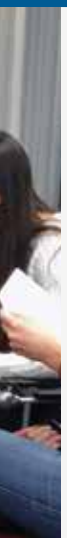
49 talks were given on i-sense research in the UK and internationally by i-sense members.

Highlights included Rosanna Peeling's Royal Society of Tropical Medicine and Hygiene Manson Christmas Lecture on 'Diagnostics in a Digital Age' and Rachel McKendry's TEDx Exeter talk entitled 'Going viral: The digital future of public health'.

12 Conference posters were presented internationally.

The i-sense network





Building skills:

60 courses to improve academic and business skills were attended by 18 researchers and students in 2014-15

Students in labs:

6 university and school students, including students from disadvantaged backgrounds were given internships in the i-sense hub laboratories in London

Industrial and training placements:

Vasileios Lampos (PDRA in Cox Group) was a visiting researcher at Google for six months developing new models for their Flu Trends website.

Valérian Turbé and Jennifer Brookes (student and PDRA in McKendry Group) visited the research laboratories of OJ-Bio and parent company Japan Radio Company for two weeks to understand the manufacture of surface acoustic wave devices.

Philip Howes (PDRA in Stevens group) was sponsored by the Royal Society of Chemistry and Wellcome Trust, to visit the Lawrence Berkeley National Laboratory Molecular Foundry for four months. Whilst there, he developed nanoparticle detection assays for the influenza virus.

Eleanor Gray (PDRA in McKendry Group) visited Mortimer Market Centre to meet a patient representative of the Bloomsbury Group of HIV patients, Chris Sandford. Eleanor also recently visited the Wellcome Trust Africa Centre for Health and Population Studies in Kwazulu Natal, South Africa to see point of care testing in rural clinics.

Funding

£250,000

Exploratory Projects funding awarded by i-sense in 2014

Leveraged funding

£4.5M in 2014

£3.5M in 2015

Over £8M total leveraged funding obtained through collaborative initiatives supported by i-sense and organized by i-sense investigators

Looking forward

The year ahead will see continued consolidation of our Core Research programme and the expansion of our Exploratory Project and Partnership Resource Fund schemes to grow the i-sense consortium and accelerate the delivery of products and practices to benefit patients and the public.

Up to £1M will be available to support new interdisciplinary Exploratory Projects in key areas, including: advanced microfluidics, smartphone connected optical devices, modelling diagnostic devices, data privacy and security, statistical methods to improve the early detection of outbreaks, design of smart human – computer interfaces for patient benefit and 5G mobile technologies for infectious diseases.

Our Partnership Resource Fund will support new initiatives to create test-beds to evaluate our technologies with NHS partners in the UK and the Africa Centre for Health and Population Studies in South Africa.

An industry workshop and match-funding opportunities will help to accelerate the development of products and practices to benefit patients and populations.

We are also committing to expand our public-patient initiatives over the next year, including focus groups with patients and the public, a new Facebook page and Flickr presence, outreach activities including interactive exhibits at local and national festivals, visits to local schools, and a national 'app' competition linked to the Royal Society Rosalind Franklin Award for Women in Science.

We are always open to new collaborations – for more information on how to join us please visit: **www.i-sense.org.uk**

Policy

In 2014/2015 i-sense researchers have been influencing policy in the following ways:

Professor Dame Anne Johnson attended meetings with the Department of Health and NHS England to discuss flu home testing and Professor Vincent Emery took part in roundtable discussions on the Ebola crisis.

Rachel McKendry met with Carlos Moedas, the European Commissioner for Research, Innovation and Science. i-sense was chosen for this showcase event during Commissioner Moedas' first visit to the UK, since being appointed.

i-sense was also selected to showcase EPSRC-funded research at their 'Science for a Successful Nation' event, with MPs and policy makers.

Professor Rosanna Peeling was selected as a judge to advise on the prestigious £10M Longtitude prize on Antibiotics, which aims to inspire the development of a rapid, point-of-care test kit for bacterial infections. Rachel McKendry and Rosanna Peeling continue to advise the Medical Research Council.

A policy briefing on 'Care.data and the Future of the NHS', written by i-sense researcher and UCL Philosophy Lecturer Dr James Wilson, can be found on the Discover Society Website: **www.discoversociety.org**

Communications

Website: i-sense launched its website **www.i-sense.org.uk** in October 2014 and it now has over 2800 unique visitors a month. You can visit the site for more information on the projects in this Annual Report, discussion on the diseases we study: influenza, bacterial infections and HIV, upcoming events, funding opportunities, interviews and news. You can also follow i-sense on Twitter **@isenseIRC**

Kailey Nolan, i-sense Communications and Administration Officer

i-sense corner: Kailey Nolan, i-sense Communications Officer has launched the regular feature on **www.i-sense.org.uk**, i-sense corner, interviewing key people of interest to the project. Recent interviewees have included Professor Deenan Pillay, Director of the Wellcome Trust Centre for Health and Population Studies, who highlights the challenge of resistance to antiretroviral treatment for HIV.

Plague Inc. creator James Vaughan discusses how a game can be used to educate and engage the public on disease control, emerging infections and antibiotic resistance. For the full interviews, including a recent interview with HIV patient representative Chris Sandford, see: **www.i-sense.org.uk**

Public engagement: The i-sense team recently secured funding for an i-sense stall at the UCL Festival of Engineering 2015 and a Biochemical Society Scientific Outreach Grant to engage with local schools. i-sense will also exhibit at the UCL 'Here East' Summer School, involving 250 school students.

Management Committee

Rachel McKendry, Professor of Biomedical Nanotechnology, UCL and Director of i-sense.

Tania Saxl, Strategic Operations Director and Deputy Director and of i-sense, UCL.

Ingemar Cox, Professor of Telecommunications, UCL Deputy Director and i-sense Flagship 2 lead (flu).

Rosanna Peeling, Professor & Chair of Diagnostics Research, London School of Hygiene and Tropical Medicine and i-sense Flagship 1 lead (system needs).

Calum McNeil, Professor of Biological Sensor Systems, Newcastle University Deputy Director and Flagship 3 lead (bacteria).

Vincent Emery, Pro Vice-Chancellor (International Relations) and Professor of Translational Virology, University of Surrey and i-sense Flagship 1 and Partnership Resource Fund lead.

Molly Stevens, Professor of Biomedical Materials and Regenerative Medicine, Imperial College London and i-sense Flagship 4 lead (HIV).

Anne Johnson, Professor of Infectious Disease Epidemiology, Chair and Vice-Dean, External Relations, UCL and i-sense Deputy Director

Richard Pebody, Head of Influenza and other respiratory viruses Section, Public Health England.

Deenan Pillay, Head of the Wellcome Trust Africa Centre for Health and Population Studies and i-sense Deputy Director.

Neil Keegan, Lecturer Institute of Cellular Medicine, Newcastle University and i-sense Education Alliance lead.

Advisory Board

David Heymann (Chair), Professor of Infectious Disease Epidemiology, London School of Hygiene and Tropical Medicine and Chair of Public Health England.

Patrick Maxwell, Regius Professor of Physic and Head of the School of Clinical Medicine, University of Cambridge.

Mark Welland, Professor of Nanotechnology, The Nanoscience Centre, University of Cambridge.

Andrew Eland, Engineering Director, Google.

Mike Short, Vice President, Telefónica Europe.

John Brownstein, Associate Professor of Pediatrics, Harvard Medical School, co-founder of HealthMap.

Christoph Gerber, Professor, Swiss Nanoscience Institute, University of Basel.

Peter Dobson, Professor and Director Begbroke Science Park, University of Oxford.

Ciara O'Sullivan, Research Professor Nanobiotechnology and Bioanalysis Universitat Rovira i Virgili.

Industrial and Clinical Partners

MOLOGIC

UCLPartners

Farr

NHS

NHS National Institute for Health Research

The Newcastle Upon Tyne Hospitals NHS Foundation Trust

ojbio

UCL Hospitals Biomedical Research Centre

Microsoft

Avacta

Telefónica

microdrop TECHNOLOGIES

Cepheid

Google

flusurvey.org.uk

AFRICA CENTRE

CAMBRIDGE LIFE SCIENCES

Saving lives and livelihoods

i-sense is working to protect patients and populations from the threat of infectious diseases. The development of early-warning systems for infectious diseases has the potential to bring major human and economic benefits.

Patients will benefit by gaining faster access to treatment and follow-up care.

Populations will benefit from the reduced spread of infection and antibiotic resistance.

The NHS and global healthcare providers will benefit from more cost-effective care, improved stewardship of antimicrobials and informed intervention programmes.

Public health will benefit from timely, targeted efforts to control disease spread.

We plan to grow the i-sense network into a national centre for excellence over the next five years and will bring in a broad range of disciplines and expertise to help us realise our vision.

We are always interested in discussing new opportunities for research collaboration.

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Annual report prepared by Dr Tania Saxl, Deputy Director and Strategic Operations Director, i-sense, UCL.

i-sense
EPSRC IRC in Early Warning Sensing Systems for Infectious Diseases