i-sense

Annual Report 2021

Engineering and Physical Sciences Research Council

Cover illustrated by Dr Da Huang, i-sense McKendry group, UCL

Working together to track, test, and treat infectious diseases

i-sense researchers are engineering a new generation of tools and technologies to track, test, and treat infectious diseases. These systems will be agile and rapidly adaptable to different diseases, antimicrobial resistant strains and different countries.

Track

We use self-reported symptoms via social media and web searches to help track outbreaks of infectious disease, potentially before people visit their doctor and in resource-limited settings.

Our AI algorithms for influenza surveillance have been adopted by Public Health England to include in their weekly and annual influenza surveillance reports. This is one of the first examples of AI being adopted by Public Health England.

During COVID-19, our team built a surveillance tool to track the prevalence of the virus in the community, based on web search data from Google, which has also been adopted by Public Health England for surveillance.

Test

We are building smartphone-connected diagnostic tests to support front-line healthcare workers and self-testing, with real-time data linkage capabilities.

Our low-cost device prototypes include a point-of-care test that uses ultra-sensitive nanomaterials to detect the early stages of HIV, and a multiplexed test for Ebola serology. Our portable mHealth tools and protocols have been adopted for quality assurance of HIV rapid tests by the Africa Health Research Institute, supporting healthcare workers and the local community by reducing the risk of false test results.

Through the COVID-19 pandemic, our researchers have been adapting our diagnostic tests to help in the response to the virus.

Treat

We are creating online care pathways and visualisation tools to link patients to treatment and map disease ‘hot spots’ to help inform health interventions.

Our mobile app, co-created with the Africa Health Research Institute, has been piloted with 30 participants in a local health clinic demonstrating the feasibility and acceptability of self-testing and linkage to care using mHealth technologies.

Our data dashboards, co-created with Africa Health Research Institute, were used in a HIV Treatment as Prevention trial and adopted for service delivery of the population health intervention platform.

Contents

Our year in review

Welcome to our 2021 Annual report, a year that has been shaped by the ongoing global COVID-19 pandemic. I would like to start by extending a huge thank you to our team who have worked incredibly hard over the last year, under quite difficult circumstances. I am very proud to share this year's report, full of inspiring research and achievements.

Our 'Track' flagship, led by Prof Ingemar Cox, continues to work with Google and Microsoft to monitor outbreaks in populations using online search queries. These COVID-19 machine learning models are shared with Public Health England as part of their weekly/monthly surveillance reports. The data offers an early warning signal of cases on average 17 days in advance (Lampos et al *Nature Digital Medicine* 2021). The team have also started new research using Facebook data to understand vaccine hesitancy.

In our 'Test' flagship, Prof Molly Stevens led a successful £2.9M Wellcome Trust grant proposal to develop point-of-care tests for diagnosing cholera in stool and in water. Her team are also translating their very exciting nanozyme assay through a new venture called Zyme Biosciences. The i-sense teams at Newcastle University and the University of Strathclyde have been working together to develop SERS-based point of care tests for *C. difficile*.

Building on our recent paper in *Nature* on spin-enhanced nanodiamond biosensing, my own team have secured funding for next stage translation. We are also delighted to see our research using machine algorithms to interpret lateral flow tests published in the journal *Nature Medicine*. This is an important i-sense collaboration with AHRI, and an amazing image was featured on the front cover of the journal, designed by Dr Da Huang. The models were shared with the Imperial REACT study for COVID-19 serosurveillance in the UK.

I am also very proud of the members of my group who have taken up secondments to support national and international COVID-19 public health responses. Jobie Budd and Dounia Cherkaoui were seconded to the Joint Biosecurity Centre, and Dr Polina Brangel has an extended secondment to the World Health Organization.

Other highlights include a £2.5M NIHR Programme Grant for Applied Research to Prof Claudia Estcourt, and our collaboration with Prof Eleni Nastouli who leads the Advanced Pathogen Diagnostic unit at UCLH to monitor the severity of emerging COVID variants using sequencing and hospital data (Frampton et al *Lancet Infectious Diseases* 2021). The £1.4M SAFER collaboration with i-sense is also investigating COVID-19 in NHS hospital healthcare workers.

Erin Manning, our Communications Manager, has led the i-sense Q&A series bringing together 25 experts from around the world. Furthermore, in July 2021 we held an i-sense strategy meeting with a broad range of experts to reflect on the key learnings from the pandemic and future research priorities for i-sense.

I hope you enjoy reading more about our exciting research and developments from the past year. Please do get in touch if you are interested in collaborating!

Yours sincerely,

R. H. McKendry

Professor of Biomedical Nanotechnology at UCL and Director of i-sense

i-sense in numbers 2021

More than 20 talks and presentations
including an online networking event with Royal Society of Chemistry (Prof Rachel McKendry), The 25th Intl Conference on Miniaturized Systems for Chemistry and Life Sciences (Sara Carvalho), STI & HIV World Congress 2021 (Prof Claudia Estcourt), Biosensors 2021 (Dr Ben Miller, Dr Da Huang, Dounia Cherkaoui), Healthcare Engineering Science Showcase (Dr Karen Lloyd) and more.

10 events
including virtual Q&A sessions, internal conference, Strategy meeting, and Education Alliance workshop.

More than £5M in funding
including next steps UCL Discovery-to-Use translational funding to translate in- novations in nanodiamonds in point of care lateral flow tests (Prof Rachel McKendry and Dr Ben Miller), Wellcome Trust funding to develop point of care tests for cholera (Prof Molly Ste- vens), and NIHR programme grant for online care pathways (Prof Claudia Estcourt and Prof Pam Sonnenberg).

More than 100 media appearances
including in the Guardian, BBC Radio 4, Times, Sky News, New York Post, Evening Standard, Wall Street Journal, and Economist.

13 publications
Including in *Nature Medicine, Lancet Infectious Diseases, PLoS Neglected Tropical Diseases, Biosensors and Bioelectronics, Wiley Online Library* and more.

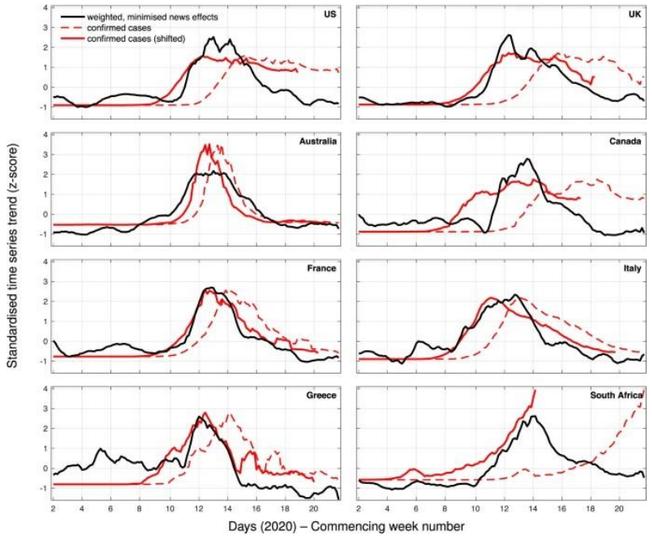
01

Our research highlights

Track Flagship
Research highlight

Online search activity can help predict peaks in COVID-19 cases

Research led by Prof Ingemar Cox and Dr Vasileios Lampos in collaboration with Harvard University, UK Health Security Agency (UKHSA; formerly Public Health England), Microsoft Research, Bar-Ilan University and UCL's Institute for Global Health, shows that online search activity can be used as a complementary data source for developing public health surveillance methods for novel infectious diseases, such as COVID-19.



Comparison between online search scores with minimised news media effects (black line) and confirmed cases (dashed red line), as well as confirmed cases shifted back (red line) such that their correlation with the online search scores is maximised
First published in *Nature Digital Medicine*

In their Nature Digital Medicine publication, the team used COVID-19's symptom profile from existing epidemiological reports to develop models of its prevalence by looking at symptom-related searches through Google. The data allows experts to predict a peak in cases on average 17 days in advance.

They then recalibrated these models to reduce public interest bias, that is, the effect media coverage has on online searches. This enabled them to predict a peak in cases when applied to COVID-19.

Academics developed the uncalibrated model by choosing search terms relating to COVID-19 symptoms, identified by the NHS and PHE. The terms were weighted according to their ratio of occurrence in confirmed COVID-19 cases.

Their model provided useful insights, including early warnings for COVID-19 prevalence increase and decrease, showcasing disease burden as well as the effects of non-pharmaceutical interventions.

The calibrated version, which took news coverage into account, enabled academics to provide UKHSA with weekly updates to more accurately predict surges in the UK. You can view the historical data and more up-to-date daily estimates of this model at https://covid.cs.ucl.ac.uk/

This work has also shown that this approach works on different countries irrespective of cultural, socioeconomic and climate differences. Their analysis was also among the first to find an association between COVID-19 incidence and searches about the symptoms of loss of sense of smell and skin rash.

The team is confident that these non-traditional data sets and methodologies will continue to be integrated in conventional epidemiological systems, and always in a privacy-preserving manner.

Acknowledgements: Dr Vasileios Lampos, Dr Maimuna S. Majumder, Dr Elad Yom-Tov, Dr Michael Edelstein, Dr Simon Moura, Dr Yohhei Hamada, Dr Molebogeng X. Rangaka, Prof Rachel A. McKendry, and Prof Ingemar J. Cox

View the paper

Track Flagship
In brief

Estimating vaccine hesitancy

The i-sense team (David Guzman, Dr Vasileios Lampos, and Prof Ingemar J. Cox) have expanded their work on syndromic surveillance to look at COVID-19 vaccine sentiment based on Facebook users. This project is a collaboration between UCL, Microsoft Research, and Bar-Ilan University. This work uses a series of sponsored posts (ads) with different calls to action to try to estimate vaccine hesitancy in a population. All ads lead to the same NHS advice page. Although this research is at an early stage, the team has obtained promising results.

Search data helps understand effects of public health interventions

In an attempt to reduce the burden of alcohol-related ill health in Scotland, the government implemented minimum unit pricing (MUP) of alcohol on 1 May 2018. The move meant that retail stores could not sell alcohol at a price lower than 50p per unit (10ml) of alcohol.

In a study led by Prof David Leon (LSHTM), in collaboration with i-sense researchers, web search activity was analysed over the months prior to the implementation of MUP and over nine months following the change.

The team collected data from eight alcohol-related topics searched by Bing users during this time, both in Scotland and England. They investigated whether the change in MUPs was reflected in search engine queries that could suggest interest in the policy or change in behaviour. They wanted to understand if the change in Scotland saw an increase in online purchases of alcohol from across the board in England.

They were able to capture signals of interest in the public health interventions and saw some interest in cross-border purchases of alcohol. They also saw that the overall queries about alcohol in Scotland and England mirrored their relative burden of alcohol consumption.

Acknowledgements: Prof David A. Leon, Dr Elad Yom-Tov, Prof Dame Anne M. Johnson, Prof Mark Petticrew, Dr Elizabeth Williamson, Dr Vasileios Lampos, and Prof Ingemar J. Cox

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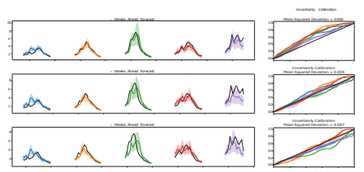
Estimating uncertainty in disease prevalence estimates



Research led by i-sense PhD student, Michael Morris, looks at understanding uncertainty when applying Neural Networks to the task of forecasting influenza-like illness (ILI) rates.

The team has previously been using web search activity to estimate the prevalence of ILI in a population, while traditional surveillance methods generally focus on syndromic, clinical and demographic data. Traditional models usually make certain assumptions that may not be true, and hence can be prone to errors when these assumptions do not hold. Web search activity streams could help make more educated assumptions or provide an independent forecasting estimate for a disease trajectory.

Importantly, forecasts are only useful when they have an associated estimate of uncertainty. The i-sense team has developed a Bayesian Neural Network that accounts for two types of uncertainty, one arising by the choice of model parameters, and another based on the potential sampling biases or errors in the data.

They have found that combining these two methods results in a better estimation of uncertainty without compromising forecasting performance when the forecast horizon windows are equal to 14 or 21 days ahead.

Acknowledgements: Michael Morris, Peter Hayes, Prof Ingemar J. Cox, Dr Vasileios Lampos

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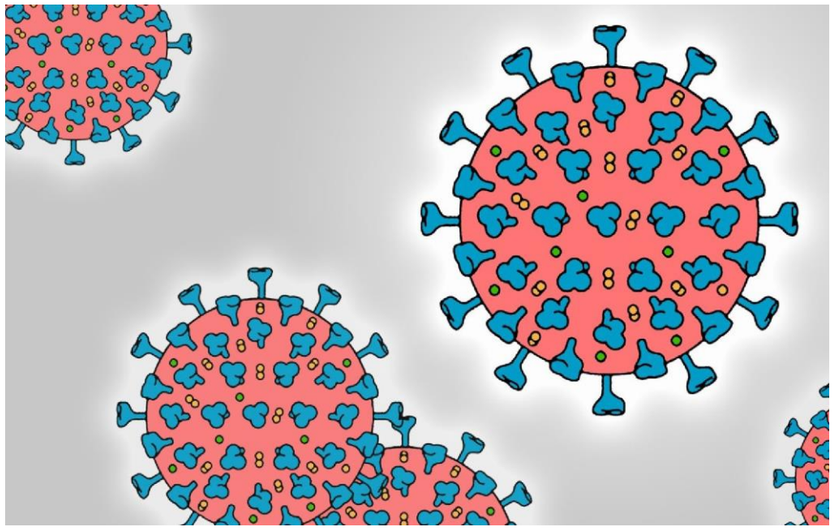
Test Flagship
Research highlight

Rapid isothermal amplification diagnostic test to detect multiple COVID genes

Researchers in the McKendry group at UCL have developed a rapid nucleic acid amplification test (NAAT) using recombinase polymerase amplification (RPA) that simultaneously detects multiple genes of COVID-19 to ensure that the test is still accurate, even when variants occur.



COVID-19 virus
Illustrated by Dr Da Huang, i-sense McKendry group, UCL

This approach offers an alternative to standard lab-based polymer chain reaction (PCR) tests, which require a thermocycler for temperate control and takes a relatively long time to result.

Isothermal molecular assays have emerged as a promising technology, given the faster turnaround time and minimal equipment compared to gold standard laboratory PCR methods. RPA is a method of isothermal amplification, meaning that it is performed at constant temperature (~37-39˚C), in this case at a much lower temperature than PCR. Therefore, it requires minimal equipment to perform, making testing more widely accessible. In addition, the assay developed by the i-sense team takes a shorter time to result.

Using multi-gene detection is crucial as a mutation in the S gene of the B.1.1.7 variant led to 'S gene target failure' in some molecular tests earlier in the pandemic. These positive cases might have been missed if PCR tests were not looking at multiple genes to confirm the presence of the virus.

The test was designed with two alternative readout methods: real-time fluorescence and a simple dipstick. The choice of two readout approaches aims to make the test more accessible in different settings. The fluorescence method was designed to be read by a portable reader, whilst the dipstick method can be read visually by eye, making it easier to deploy.

The assay used model samples and tested specificity against a range of common seasonal respiratory viruses. The assay showed it may be compatible with saliva samples, which is ideal as it is a non-invasive method for sample collection and is approved by the World Health Organization for COVID-19 testing.

Clinical validation with patient samples is underway, in collaboration with University College London Hospital, including a wide range of samples identified as SARS-CoV-2 variants. By adapting the test in the future to include other gene targets, it could be used to identify different variants, without the need for sequencing.

Acknowledgements: Dounia Cherkaoui, Dr Da Huang, Dr Benjamin S. Miller, Dr Valérian Turbé, Dr Judith Heaney, Prof Eleni Nastouli, and Prof Rachel A. McKendry.

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Test Flagship
Research highlight

Detecting drug resistance for Tuberculosis (TB)

Researchers at UCL and AHRI have developed a new way of diagnosing drug resistant tuberculosis (TB) in a shorter time, with less equipment, and for a lower price than current methods.

Current methods of TB drug resistant testing take weeks and cannot detect the full range of potential drug resistant mutations within the TB genome.

The team have proposed a new, simple workflow, published in *Microbiology Spectrum*, which first increases the amount of TB DNA without the need for costly equipment. This is done by using recombinase polymerase amplification (RPA) to perform targeted isothermal amplification of three regions within the *M. tuberculosis* genome.

Next the DNA is put into a portable sequencing device called a MinION. The MinION 'reads' the DNA for changes that may indicate if the TB strain is drug resistant.

Nanopore sequencing using the MinION proved to have identical predictions of drug resistance to whole genome sequencing methods and produced results in around 90 minutes.

The portability of RPA combined with a MinION sequencer means it can be performed outside of centralised laboratory conditions, and at less than £100 per sample it does not require extra steps from expensive equipment, which are barriers to deployment in resource-limited settings.

This proposed workflow could play an important role in helping to address the challenges of drug resistant TB and also increase access to testing.

Acknowledgements: Dr Harriet D. Gliddon, Dr Dan Frampton, Vanisha Munsamy, Dr Jude Heaney, Thomas Pataillot-Meakin, Prof Eleni Nastouli, Prof Alexander S. Pym, Prof Adrie JC Steyn, Prof Deenan Pillay, Prof Rachel A. McKendry.

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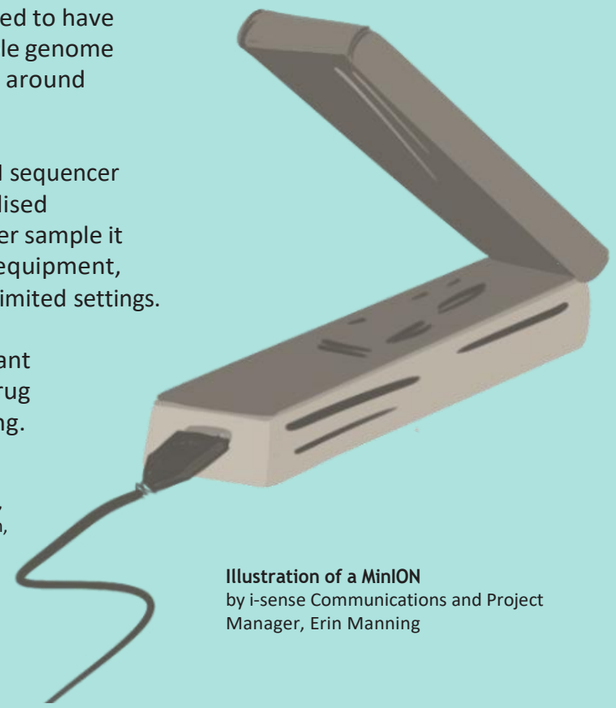

Illustration of a MinION
by i-sense Communications and Project Manager, Erin Manning

Testing in community setting
Image credit to Africa Health Research Institute (AHRI)

Test Flagship
Research highlight

AI app could help diagnose HIV more accurately

Pioneering technology developed by UCL and Africa Health Research Institute (AHRI) researchers could transform the ability to accurately interpret HIV test results, particularly in low- and middle-income countries.

The team used deep learning algorithms to improve health workers' ability to diagnose HIV using lateral flow tests in rural South Africa. Their findings, published in *Nature Medicine*, involve the first and largest study of field-acquired HIV test results, which have applied machine learning to help classify them as positive or negative.

An app was developed that can read test results from an image taken by end users on a mobile device. The study examined whether an AI app could support HIV testing decisions made by fieldworkers, nurses and community health workers. A team of more than 60 trained field workers at AHRI first helped build a library of more than 11,000 images of HIV tests taken in various conditions in the field in KwaZulu-Natal, South Africa.

The UCL team then used these images as training data for their machine-learning algorithm. They compared how accurately the algorithm classified images as either negative or positive, versus users interpreting test results by eye.

A pilot field study of five users of varying experience (ranging from nurses to newly trained community health workers) involved them using the mobile app to record their interpretation of 40 HIV test results, as well as capture a picture of the tests to be read automatically by the machine learning classifier. All participants were able to use the app without training.

The machine learning classifier was able to reduce errors in reading RDTs, correctly classifying RDT images with 98.9% accuracy overall, compared to traditional interpretation of the tests by eye (92.1%).

The team now plan a larger evaluation study to assess the performance of the system, with users of differing ages, gender and levels of digital literacy.

Acknowledgements: Dr Valérian Turbé, Carina Herbst, Thobeka Mngomezulu, Dr Sepehr Meshkinfamfard, Nondumiso Dlamini, Thembani Mhlongo, Theresa Smit, Valeriia Cherepanova, Koki Shimada, Jobie Budd, Nestor Arsenov, Steven Gray, Prof Deenan Pillay, Dr Kobus Herbst, Prof Maryam Shahmanesh, Prof Rachel A. McKendry.

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Test Flagship
Research highlight

Mosquito mobility helps record growing insecticide resistance

Pyrethroid-impregnated mosquito nets are estimated to have saved seven million lives but control of the malarial mosquito vector is threatened by resistance to these chemicals. A simple, robust and rapid measurement of resistance would be useful.

Researchers at UCL have demonstrated the potential of an invertebrate automated phenotypic platform (INVAPP) assay, originally developed for studies on nematode models of human disease and human nematode pathogens (Partridge et al, *Int J Parasitol: Drugs and Drug Resistance*), has proved useful in rapid detection of resistance of mosquito larvae to commonly used insecticides.

The mosquito research, led by Prof David Sattelle's team in collaboration with Prof Rachel McKendry's team and Dr Gareth Lycett's group at Liverpool School of Tropical Medicine (Buckingham et al, *PLOS Neglected Tropical Diseases*), shows the ability to track insecticide actions and resistance by measuring motility of larvae.

Currently deployed methods are labour intensive and end-point determination can be subject to investigator fatigue. The UCL and Liverpool collaborators have developed a fast, robust assay in 96 well plates, thereby increasing throughput. They demonstrated how imaging the swimming larvae allows the quantification of pixel variance as a proxy for larval motility.

Adding an insecticide and tracking the rate of reduction in motility enables differentiation between resistant and susceptible strains. They also showed in pilot experiments that the method could be adapted for use with a smartphone camera.

This research paves the way for the development of a smartphone app that could be used to detect resistance with potential for field application in communities around the world.

Acknowledgements: Dr Steven D. Buckingham, Dr Frederick A. Partridge, Dr Beth C. Poulton, Dr Benjamin S. Miller, Prof Rachel A. McKendry, Dr Gareth J. Lycett, and Prof David B. Sattelle.

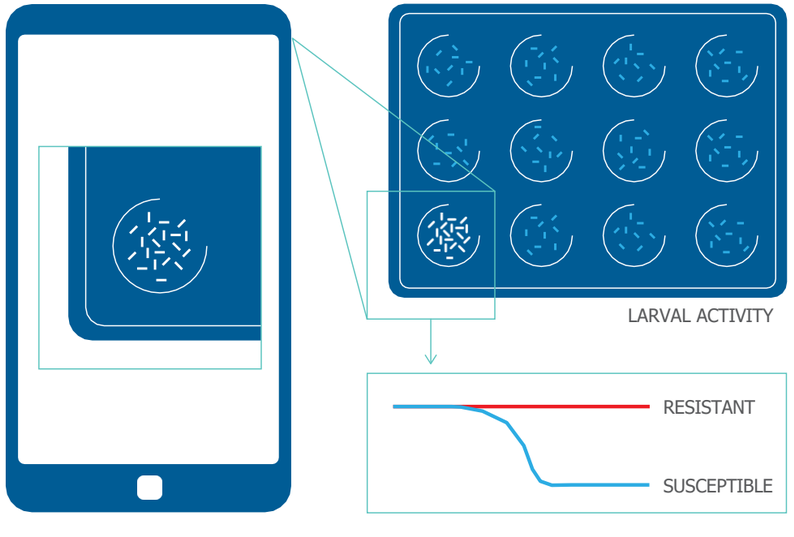

Illustration of imaging larvae activity in well plate using phone camera
Illustrated by Diva Creativ

Test Flagship
Research highlight

Chemically functionalised gold nanoparticles for diagnostics

Nanoparticles have found use across many emerging tools and technologies; most notable for i-sense researchers is their use in point-of-care diagnostics.

Gold nanoparticles (AuNPs) are particularly useful because of their optical density, meaning they can be seen by the naked eye, even at very low quantities.

Gold nanoparticles produce a red colour, which is what is visible on the test and control lines of a lateral flow test. They are also easy to produce and cheap to manufacture.

Researchers within Prof Molly Stevens' team at Imperial College have published research in *Nanoscale*, looking at improving the functionality of gold nanoparticles in diagnostics through surface modification. As gold nanoparticles are highly reactive they are prone to fouling, and therefore modifying their surface allows bet- ter binding to the surface of the AuNPs via a carrier.

To do this the team have combined a chemically modified idealised protein and added it to the surface of the gold nanoparticles. This acts as a scaffold for the nanoparticle, protecting its surface. The protein chosen was bovine serum albumin (BSA) as it has suitable chemical properties, binds well to gold surfaces, and is cheap and commercially available. The process is generalisable, allowing for the introduction of multiple unique chemical functionalities and more control over functionalisation.

Acknowledgements: Dr Daniel A. Richards, Dr Michael R. Thomas, Peter A. Szijj, James Foote, Yiyun Chen, João C. F. Nogueira, Prof Vijay Chudasama, and Prof Molly M. Stevens.

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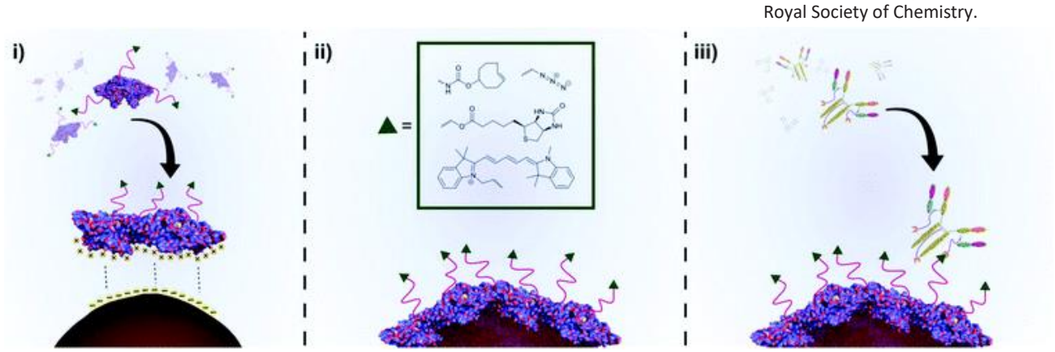
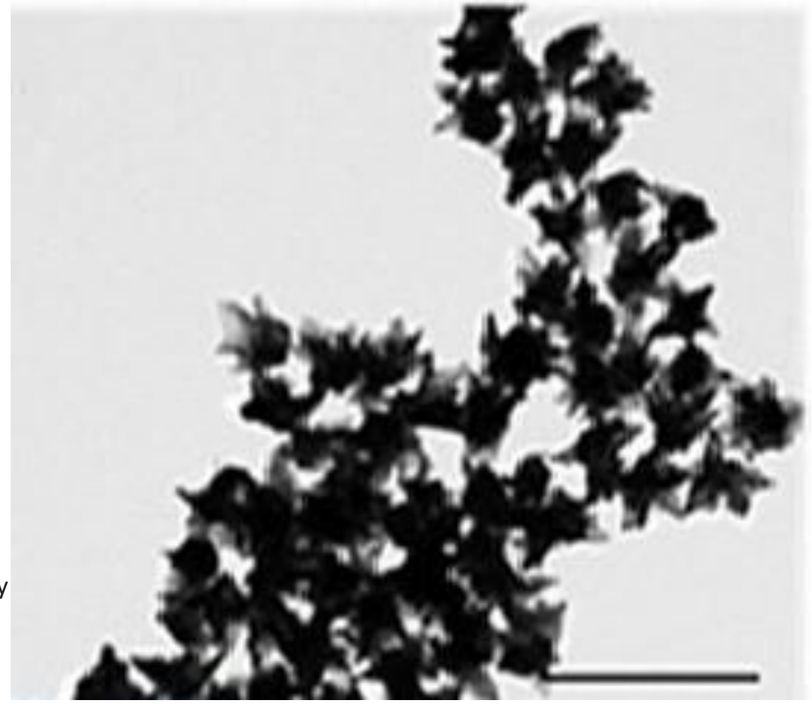
An illustration of the preparation of functional BSA coated AuNPs and subsequent conjugation to a disease-specific antibody

Reproduced from *Nanoscale, 2021,13, 11921-11931* with permission from the Royal Society of Chemistry.



TEM image showing native gold nanostars

Part of figure first published in *Angewandte Chemie,* Volume 60, Issue 18, April 2021, Pages 9891-9896



Test Flagship
In brief

Surface etching of gold nanostars for immunoassays

The optical properties of gold nanoparticles can change depending on their size, shape and morphology. By adding biosensors to gold nanoparticles, researchers have been able to better control their growth, making them more sensitive.

i-sense researchers in Prof Molly Stevens' group at Imperial have published research in *Angewandte Chemie* on the development of a more controlled signal from gold nanoparticles through a method known as surface etching. They have shown that reshaping the size and shape of the tips of gold nanostars to spherical gold nanoparticles through iodide-induced surface etching, they are able to get a more rapid and sensitive optical signal. The team further developed this method into a platform for plasmonic immunoassays, and have shown that using magnetic beads and click chemistry can amplify the signal and increase the sensitivity of the assay.

Acknowledgements: Prof Yunlei Xianyu, Prof Yiyang Lin, Dr Qu Chen, Alexis Belessiotis-Richards, Prof Molly M. Stevens, and Dr Michael R. Thomas.

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Test Flagship
Award

Zyme Biosciences make finals of WE Innovate

Members of the Stevens group have been working on a venture called Zyme Biosciences.

The Zyme Biosciences venture, led by Dr Marta Broto Aviles, have been working on a product called QwikZyme. QwikZyme is a small, user-friendly device that utilises novel nanomaterials to detect a range of disease biomarkers. The team have optimised the assay to detect proteins in SARS-CoV-2, and they believe the test could be expanded to detect non-communicable diseases in the future.

This work made it to the final of the Imperial WE Innovate 2021 scheme, which is led by the Imperial Enterprise Lab and provides a platform to showcase the incredible progress being made in women's entrepreneurship at Imperial. The team also won the Lauren Dennis People's Choice award, receiving over half the vote, and an award for Engineers in Business.

Test Flagship
Research highlight

Coupling lateral flow testing with SERS for rapid detection of *C. difficile*

The i-sense team at Newcastle University and the University of Strathclyde have been working together to develop an early point-of-care diagnostic test for *Clostridium difficile (C. difficile)*.

C. difficile is a bacterial infection that affects the bowel and can be deadly due to its high toxicity and increasing antibiotic resistance. Therefore, the early, rapid and accurate diagnosis of *C. difficile* infection is essential for appropriate medical intervention and to initiate infectious control measures, such as cleaning and quarantine.

The team have developed an ultra-sensitive test for *C. difficile* that is easy to use, cheap to manufacture and is quick to give a result. They have done this by developing a lateral flow test, coupled with surface-enhanced Raman scattering (SERS) detection.

The new platform is a duplex test that looks for two key biomarkers - surface layer protein A (SlpA) and toxin B (ToxB) - on separate test lines, and can be performed in 20 minutes. The benefit of a duplex test means it could be more accurate in *C. difficile* diagnosis.

Using a handheld Ramen spectrometer also increases the sensitivity of the test readout, which is a limiting factor when performed by the naked eye. It also means that the test can be carried out at a patient's bed- side, without complex lab-based equipment.

Future research will use clinical samples to evaluate the accuracy of the test, replacing the current synthetic samples.

Acknowledgements: Dr Waleed Hassanain, Dr Julia Spoors, Dr Christopher Johnson, Dr Neil Keegan, Prof Karen Faulds, and Prof Duncan Graham.

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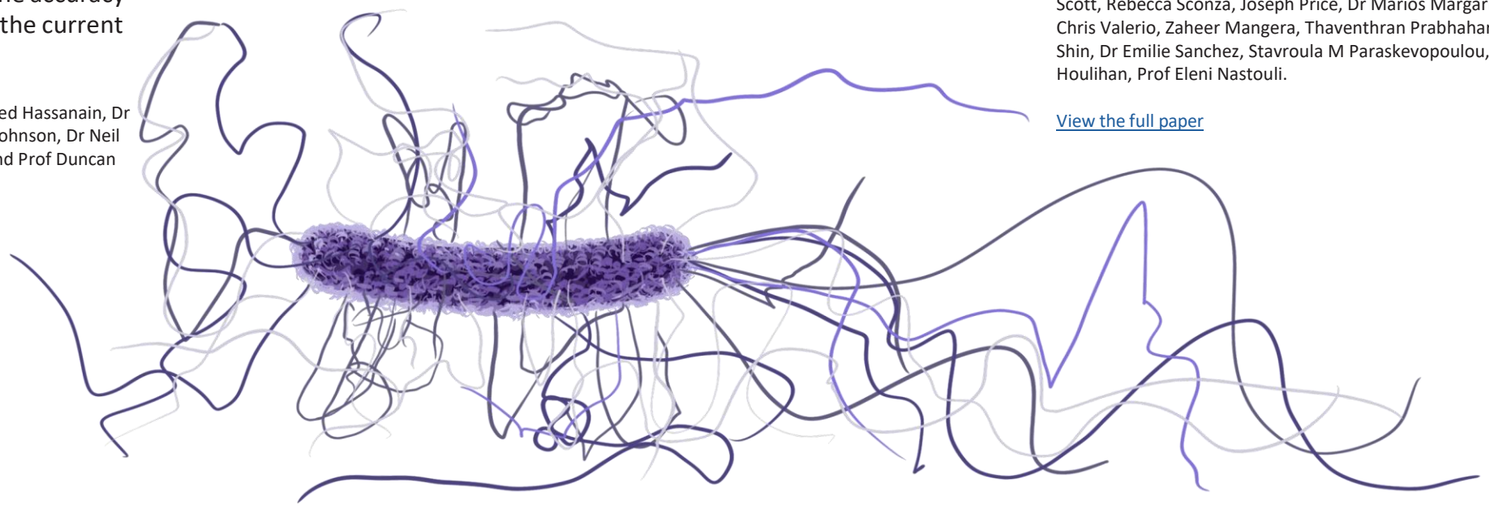

Illustration of *C. difficile* bacteria
Illustrated by i-sense Communications and Project Manager, Erin Manning

Treat Flagship
Research highlight

B.1.1.7 does not increase disease severity

An observational study of patients at UCLH and North Middlesex University Hospital, published in *The Lancet Infectious Diseases*, suggests that the B.1.1.7 variant of COVID-19 is not associated with more severe illness and death, but appears to lead to higher virus load.

The study, led by Dr Eleni Nastouli of UCLH and UCL Great Ormond Street Institute of Child Health, in collaboration with researchers at the Advanced Pathogen Diagnostics Unit and i-sense, spanned the period between November and December 2020. This was a critical time when both the original and B.1.1.7 variants were circulating in London, the vaccination programme was starting, and before a significant surge in cases in early 2021 caused a strain on the NHS.

The authors compared illness severity in people with and without B.1.1.7 and calculated viral load. Among 341 patients who had COVID-19 test swabs sequenced, 58% (198/341) had B.1.1.7 and 42% (143/341) had a non-B.1.1.7 infection (two patients' data were excluded from further analysis). No evidence of an association between the variant and increased disease severity was detected.

To gain insights into the transmissibility of B.1.1.7, the authors used data generated by PCR testing of patient swabs to predict their viral load. The data analysed indicated that B.1.1.7 samples tended to contain more virus than non-B.1.1.7 swabs.

Acknowledgements: Dr Dan Frampton, Dr Tommy Rampling, Aidan Cross, Dr Heather Bailey, Dr Judith Heaney, Matthew Byott, Rebecca Scott, Rebecca Sconza, Joseph Price, Dr Marios Margaritis, Malin Bergstrom, Dr Moira J. Spyer, Patricia B Miralhes, Dr Paul Grant, Stuart Kirk, Chris Valerio, Zaheer Mangera, Thaventhran Prabhahar, Dr Jeronimo Moreno-Cuesta, Dr Nish Arulkumaran, Prof Mervyn Singer, Gee Yen Shin, Dr Emilie Sanchez, Stavroula M Paraskevopoulou, Prof Deenan Pillay, Prof Rachel A. McKendry, Mariyam Mirfenderesky, Dr Catherine F. Houlihan, Prof Eleni Nastouli.

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Treat Flagship
In brief

Tracking COVID-19 among NHS staff

The SAFER study is a £1.4M Medical Research Council funded programme of research, led by Prof Eleni Nastouli, investigating COVID-19 in hospital healthcare workers.

The SAFER study recruited 200 frontline healthcare staff in a variety of roles across UCL hospital between 26 March and 8 April 2020 and 900 staff since January 2021.

Results from the initial 200 cohort in the first pandemic wave showed that 25% of healthcare staff tested during this period had already had the infection. A further 20% tested positive after the first month documenting high infection rates in frontline staff at the beginning of the pandemic.

The information from our study has been helping to improve the evidence-base for the protection of patients and staff and was key in highlighting the role of asymptomatic infection guiding the national policy for routine staff testing.

The SAFER team with i-sense researchers, led by Dr Ed Manley, are further analysing staff movement data and infection risk and are planning a study with wearables trying to understand better factors associated with infection acquisition.

Acknowledgment: Catherine F. Houlihan, Nina Vora, Thomas Byrne, Dan Lewer, Gavin Kelly, Dr Judith Heaney, Sonia Gandhi, Moira J. Spyer, Rupert Beale, Peter Cherepanov, David Moore, Richard Gilson, Steve Gamblin, George Kassiotis, Laura E McCoy, Charles Swanton, Prof Andrew Hayward, and Prof Eleni Nastouli.

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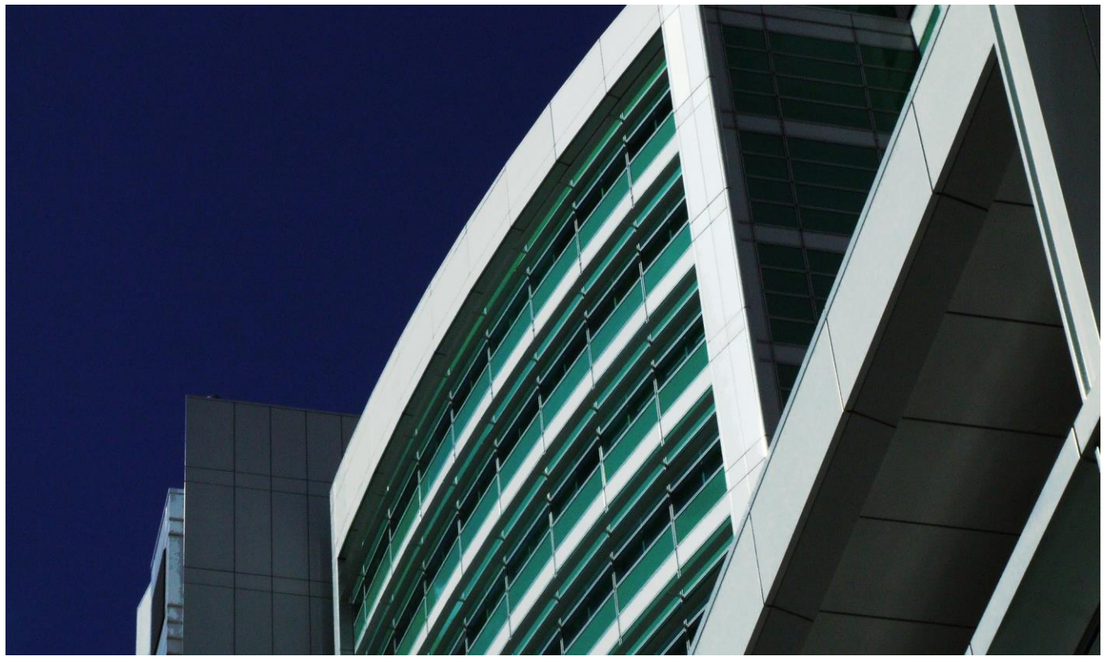
University College London Hospital
Credit Stewart Black, Flickr



Treat Flagship
Funding

Digital revolution for people with sexually transmitted infections

Prof Estcourt, as Principal Investigator, has been awarded a £2.5M National Institute for Health Research (NIHR) Programme Grant for Applied Research to lead the project entitled 'Improving care for people with Sexually Transmitted Infections and their sex partners in a digital NHS'.

She is joined by a team from University College London, University of Strathclyde, University of Birmingham, Barts Health NHS Trust, NHS Greater Glasgow and Clyde, West Sussex NHS Foundation Trust, Camden and Islington Council, and Cen- tral and North West London NHS Foundation Trust where the programme will be hosted.

People who test positive for chlamydia through home self-sampling will be given confidential access to a previously developed eSexual Health Clinic app. The team developed the eSexual Health Clinic with initial funding from UKCRC as part of the eSTI consortium. Further funding from i-sense EPSRC IRC enabled them to develop it further including the addition of pathways to support people who are testing for HIV at home using HIV self-tests or self-sampling kits.

The eSexual Health Clinic contains a unique-to-the-NHS online automated clinical consultation and electronic prescribing algorithm for people with chlamydia, the UK's most common STI. Patients will receive an electronic prescription to their phone and so they can pop into their local pharmacy to collect their antibiotics or get them sent straight to their home.

The platform could provide considerable health gains for people with STIs and could be applied across the NHS for many other health conditions, but it now needs full scale evaluation.

Acknowledgements: Prof Claudia Estcourt, Dr Andrew Winter, Dr Jo Gibbs, Dr Karen Lloyd, Dr John Saunders, Dr Vanessa Apea, Jonathan O'Sullivan, Merle Symonds, Caroline Ward, Prof Andrew Copas, Prof Ann Blandford, Prof Jonathan Ross, Prof Pam Sonnenberg, Prof Paul Flowers, Prof Tracy Roberts, and Roos van Greevenbroek.

Treat Flagship
In brief

iSHOP HIV online care pathway

After spending 2020 focussing on the analysis of qualitative interview data, this year the team at UCL have focussed on dissemination of findings and the translation of these findings to inform ongoing optimisation across the eSexual Health Clinic online pathways, including for the Chlamydia study led by Prof Claudia Estcourt (above).

Roos van Greevenbroek, one of the pre-trial qualitative study leads who has a background in Human-Computer Interaction (HCI) and is working with Prof Ann Blandford, has conducted a further HCI-focussed thematic analysis of the iSHOP transcripts to inform the optimisation of the Online Chlamydia Pathway. While iSHOP participants were interviewed about using eSexual Health Clinic's Online HIV Pathway, many of their problems and needs when using the system were not only related to HIV self-testing and self-sampling.

For example, data from iSHOP has informed the development of possible user requirements related to logging in and answering questions during an online consultation, supporting the development of a qualitative interview guide to query these needs with both service users and healthcare professionals who may be future users of the eSexual Health Clinic.

The team working on iSHOP are finalising a manuscript on the barriers and facilitators of trust in i-reader in the HIV self-testing pathway.

02

Communication

Communication and engagement highlights

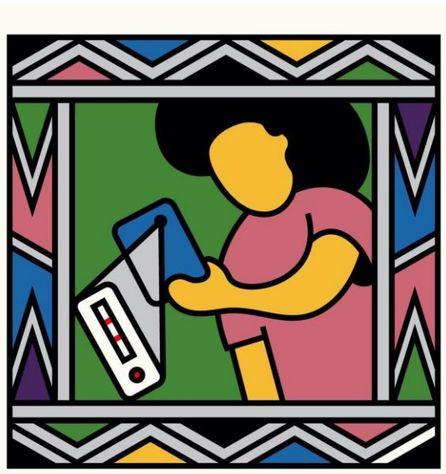
i-sense Q&A series continues

In August 2020, i-sense Communications and Project Manager, Erin Manning, developed and led our first ever Q&A series. Since then we've had a series of 11 Q&As with more than 25 speakers from the World Health Organization, the Health Foundation, GSMA, NHS England, National Voices, Harvard Medical School, Public Health England and more. Speakers have joined us from all across the world. The aim of the Q&A series is to offer the opportunity for our i-sense cohort to speak to and learn from experts working in infectious disease surveillance, testing, treatment and beyond.

Watch our Q&As

Communications bursaries

This year, we launched our first ever i-sense Communications and Engagement bursaries, supporting our researchers to design and implement their own projects to support their work. Three applicants were funded at £3000 per project, including Dr Da Huang who will be creating a series of images and infographics for researchers across i-sense to use in their presentations and funding applications, Dr Leah Frenette who will be working with an agency to develop a video on 'how a lateral flow test works', and an artist in residence, Dr Remi Picone, who will be working with Prof Rachel McKendry to create a public engagement piece that brings together science and art.



Nature Medicine front cover

i-sense Postdoc in the McKendry group, Dr Da Huang's, design for a *Nature Medicine* front covered was selected and appeared on Volume 27 Issue 7, July 2021. The cover was designed for the i-sense publication 'Deep learning for HIV field tests' led by Dr Valérian Turbé and Prof Rachel McKendry.

View full issue

Patient engagement with Positive East

Dr Harriet Gliddon, an i-sense Postdoc in the McKendry group at UCL, held a consultation with people who are living with HIV to understand how i-sense research developing a rapid test for HIV viral load could be used by individuals in the home and link them to digital healthcare systems. The findings are now published in a MedRxiv paper titled 'Current attitudes towards HIV viral load self-testing: thematic analysis of a consultation with potential end-users'.

View the paper

Strategy meeting

In July we held our i-sense Strategy meeting to hear from experts about their key learnings from the pandemic. The aim of the meeting was to develop a roadmap for future i-sense research, focused on the theme of digital and diagnostic needs for a post-COVID world. We had a number of speakers join across two panels, including Prof Pete Dobson (Ox- ford), Emma Rourke (ONS), Dr Daniela Paolotti (ISI Foundation), Dr Elad Yom-Tov (Microsoft Research), Dr Jo Gibbs (UCL), Prof Ed Manley (University of Leeds), Helen Dent (BIVDA), Tom Salusbury (JBC), and Dr Christina Atchison (Imperial – REACT study).

10
events
including virtual Q&A sessions, internal conference, Strategy meeting, and Education Alliance workshop.

social media
140K Tweet impressions
15% increase in Twitter followers
65,000 + unique page views on i-sense.org.uk, including covid.i- sense.org.uk

More than
100
media appearances
including in the Guardian, BBC Radio 4, Times, Sky News, New York Post, Evening Standard, Wall Street Journal, and Economist.

Education and training in lockdown

On 23 and 25 February, i-sense researchers and support staff across UCL, Imperial, Newcastle University, and the University of Strathclyde joined our first virtual careers workshop. The session was facilitated by coaching expert, Gill Burt, who worked with the i-sense team to help map out their career goals and ambitions. The team completed surveys and activities to help them identify their values and benefited from breakout sessions and group discussions about how their values may affect their career goals.

"The careers session gave me an excuse to carve out time to reflect on my own goals and values. Gill made it feel like an in-person session by providing materials for hands-on activities and concept visualisation."

– Dr Leah Frenette, Postdoc, Stevens Group, Imperial College London

"I enjoyed the Careers Day. During the session, I learnt that I'm enthusiastic about pushing boundaries and learning, but also recognise that I would like to improve on my communication with other people."

– Dr Da Huang, Postdoc, McKendry group, UCL

"Personally, the tools provided in the workshop will enable me to actively pursue career opportunities that align with my goals through strategic investment in my own strengths and lesser strengths."

– Dr Simon Pedersen, Postdoc, Stevens Group, Imperial College London

"When you are trying to decide your career goals and ambitions, it is crucial to start understanding yourself. This workshop really helped me take time to think about myself and my next steps."

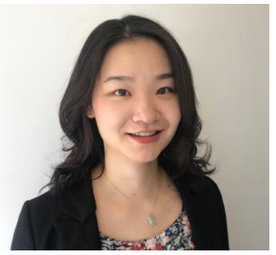
– Dr Marta Broto Aviles, Postdoc, Stevens Group, Imperial College London

New beginnings

Secondments and new opportunities

Dr Mengdie Zhuang

Lecturer in Data Science, the University of Sheffield



Dr Noah Fongwen

Head of Innovation Hub at Africa CDC

Dounia Cherkaoui

Research Analyst at UK Department of Health and Social Care

Dr Judith Healey

Assay and Process Development Scientist, Health Services Laboratories

Dr Polina Brangel

Technical Officer at World Health Organization (Secondment)

Dr Valérian Turbé

Research Associate at Clinton Health Access Initiative, Inc.

Erin Manning

Communications and Engagement Officer at Islington Council

Dr Julia Spoors

Infectious Diseases Facility (CL3) Manager at Newcastle University

Dr Dan Frampton

Senior Bioinformatician, GenPAx

Key talks, presentations, awards and recognition

There has been lots to celebrate this year. Below are just a few of the achievements from the i-sense cohort:

Prof Molly Stevens

Awarded the FEBS/EMBO Women in Science Award 2021 for her continued innovation in bioengineering research that addresses key problems in regenerative medicine and biosensing.

The Institute of Engineering and Technology (IET) have recognised Molly Stevens in their 2020 Achievement Awards.

Secured a prestigious Chair in Emerging Technologies by the Royal Academy of Engineering.

Secured £2.9M in funding from Wellcome Trust to develop point-of-care tests for diagnosing cholera

Prof Maryam Shahmanesh

Awarded NIHR Global Health Professorship.

Prof Rachel McKendry

Presented i-sense at the WHO roundtable for academia on early warning systems, and the G20 Digital Economy Taskforce workshop on digital connectivity and the COVID-19 Response.

Led the development of ultra-sensitive quantum nanodiamond labels to detect viruses, published in *Nature*. The team have secured next steps Discovery-to-Use translational funding to develop the technology and are in discussions with several potential partners (Cambridge Consultants, Abingdon Health, Hamamatsu).

Prof Claudia Estcourt

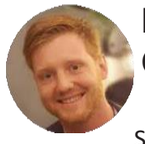
Awarded a £2.5M National Institute for Health Research (NIHR) Programme Grant for Applied Research to lead the project entitled 'Improving care for people with Sexually Transmitted Infections and their sex partners in a digital NHS'.

A/Prof Vasileios Lampos

Promoted to Associate Professor at UCL Department for Computer Science.

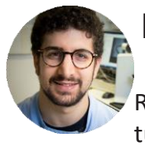
Dr Simon Vilms Pedersen

Awarded the International Postdoc fellowship from Independent Research Fund Denmark (IRFD). Simon's research focuses on designing and building miniature Raman-readers for diagnostics tests, deployed at the Point of Need.



Dr John Goertz

Selected to participate in Techcelerate, a programme which supports early career researchers to test out their business ideas and bring the benefits back to their laboratory.



Dr Ben Miller

Received UCL Institute of Healthcare Engineering Impact Fellow award.

Publications

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03
People and partners

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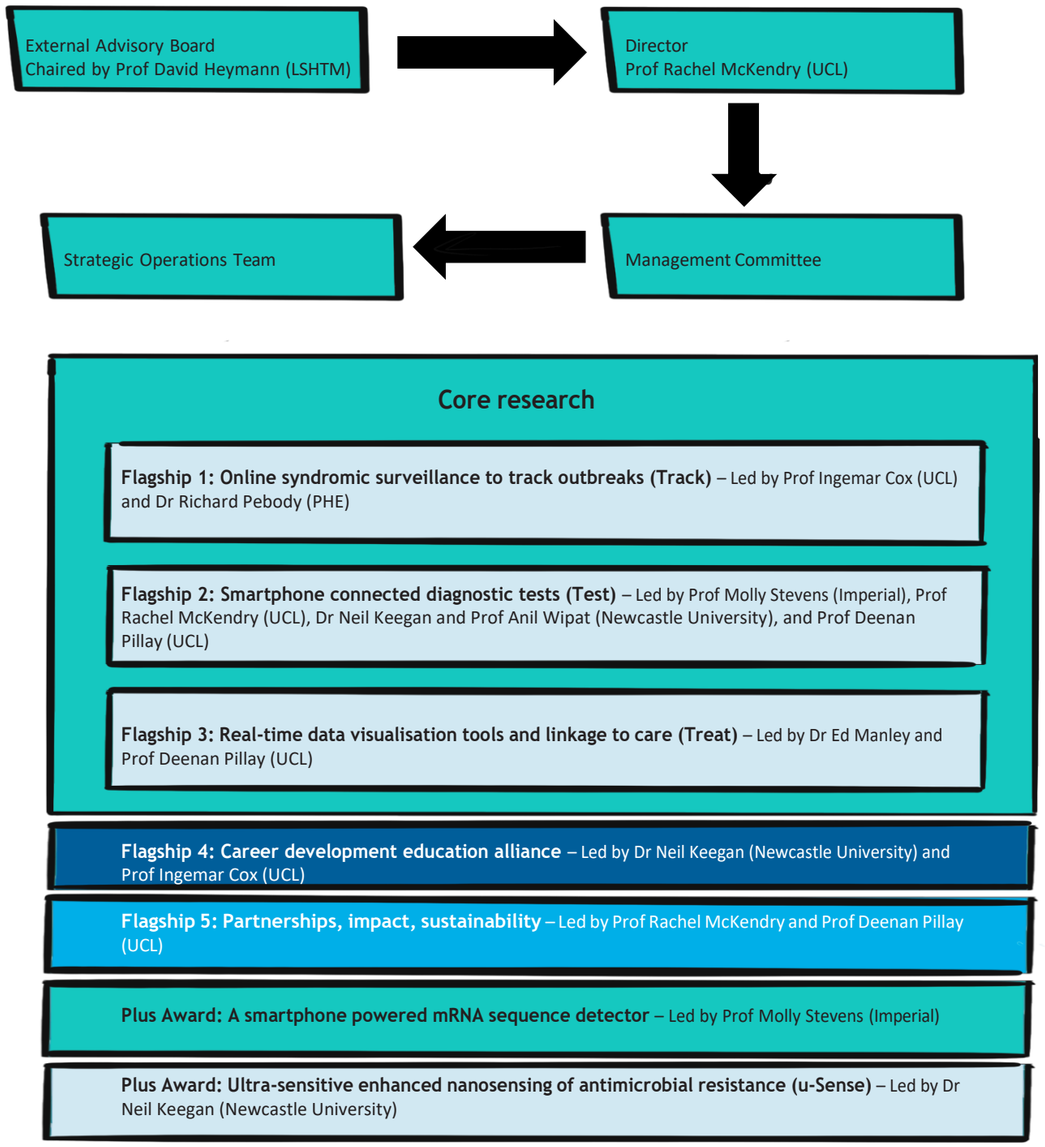
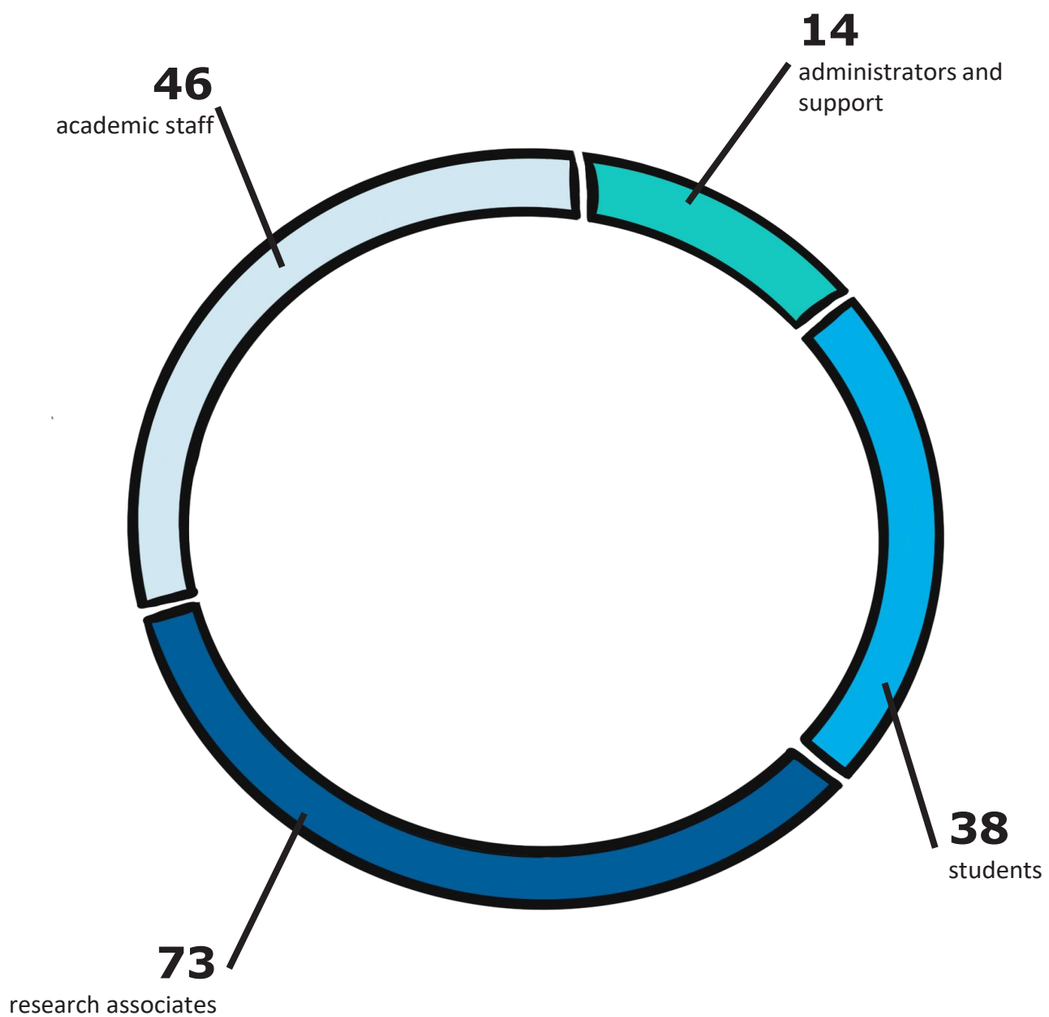
Organisational chart



The i-sense network

As an EPSRC funded IRC, i-sense is uniquely placed to offer an environment that allows our members to work collaboratively across different disciplines, institutions, and countries, as well as with clinical and industry partners.

Our work would not be possible without our diverse team of biochemists, chemists, physicists, engineers, computer scientists, microbiologists, statisticians, bioinformaticians, architects, philosophers, clinicians, and epidemiologists from University College London, the London School of Hygiene and Tropical Medicine, Imperial College London, Newcastle University, the University of Surrey and Public Health England.



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Prof of Computer Science, UCL, and i-sense Deputy Director and Flagship (Track) lead

Prof Deenan Pillay

Prof of Virology, UCL, and i-sense Deputy Director and Flagship (Treat) co-lead

Prof Molly Stevens

Prof of Biomedical Materials and Regenerative Medicine, Imperial College London, and i-sense Deputy Director, and Flagship (Test) and Plus Award lead

Dr Neil Keegan

Senior Lecturer, Institute of Cellular Medicine, Newcastle University, and i-sense Plus Award and Education Alliance lead

Prof Ed Manley

Prof of Urban Analytics, University of Leeds, and i-sense Flagship (Treat) co-lead

Prof Vince Emery

Emeritus Prof of Translational Virology, University of Surrey

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Prof John Brownstein

Associate Prof of Paediatrics, Harvard Medical School, and co-founder of HealthApp

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Director, N8 Research Partnership

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Regius Prof of Physics and Head of the School of Clinical Medicine, University of Cambridge

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Founder, Diagonal

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University of Surrey

Public Health England

University of Strathclyde Glasgow

GCU Glasgow Caledonian University

University for the Common Good

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