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The Oxford Academic Health Partners is part of a nationally and globally acclaimed ecosystem that brings together the best in academia, the NHS, research, teaching and education and the life sciences sector.

To celebrate this, and to highlight the work of partners, we are launching a series of case studies. The first of these is from Optellum, a company based in Oxford which has gathered the largest real-world dataset of CT scans and, using Artificial Intelligence and Machine Learning, developed a solution to enable clinicians to identify at-risk patients and to guide lung cancer management.

Further information can be found at [www.Optellum.com](http://www.Optellum.com)

Case study: How AI could revolutionise lung cancer diagnosis and treatment

# Overview summary:

A ground-breaking machine-learning imaging-based artificial intelligence neural network can recognise the signs of lung cancer, enabling early interception and giving doctors a huge opportunity to get patients treated before the disease has metastasised, crucially increasing survival rates.

The AI is part of software, Virtual Nodule Clinic, has achieved FDA clearance in the United States and is on track to receive CE marketing in 2021, which will allow it to be deployed in NHS Trusts. The Optellum technology has been developed and clinically-validated in partnership with several NHS hospitals – including Oxford University Hospitals NHS Foundation Trust (OUH).

The initial origins of the collaboration date back to a relationship between Mirada Medical which had an industry-led Innovate UK grant where Oxford University Hospitals was a clinical partner. Optellum later licenced the research proof-of-concept from Mirada and went on to develop a commercial product. Since then OUH has worked with Optellum on a number of grant funded projects including Data using Artificial Intelligence to Improve Patient Outcomes with Thoracic Diseases (DART) funded by the UK Research and Innovation’s Industrial Strategy Challenge fund, the LUCINDA project funded by EIT Health, the IDEAL project funded by NIHR, and the DOLCE project funded by NHSX.

# Challenge identified:

Lung cancer is the leading cause of cancer deaths in the UK, accounting for 21% of all cancer deaths in any one year[[1]](#footnote-2). When diagnosed at an early stage, almost 57% of people in the UK with lung cancer will survive their disease for five years or more, compared with only 3% when the disease is diagnosed at the latest stage2. Currently, around three-quarters of lung cancer cases are diagnosed at a late stage in the UK[[2]](#footnote-3), although the survival rate for small tumours treated at Stage IA is up to 90%[[3]](#footnote-4) .

A key opportunity to catching lung cancer sooner is in the hundreds of thousands of Computed Tomography (CT) scans NHS patients already have each year[[4]](#footnote-5) for other conditions, such as heart scans or chest trauma scans after accidents. These scans often detect nodules which could be cancerous. The challenge is that most of the suspicious nodules are harmless, but doctors cannot immediately diagnose those which are cancerous; patients undergo further tests such as multiple CT scans and invasive procedures. Many patients with benign nodules undergo unnecessary and dangerous procedures such as biopsies and surgical resections, before knowing their diagnosis.

Cancer Research UK recently revealed that, due to delays in care caused by COVID-19, the number of people urgently referred for suspected lung cancer fell by 34% between March 2020 and January 2021 and added the numbers were of concern as cancer is more treatable when spotted at an early stage. Waiting lists are a problem for the NHS even at the best of times and due to the pandemic, researchers have estimated between 1,235 and 1,372 additional deaths in lung cancer due to diagnostic delays [[5]](#footnote-6).

With funding provided through the Innovate UK and the [National Institute for Health Research](https://www.nihr.ac.uk/) (NIHR) partnerships[[6]](#footnote-7) as well as EIT Health, Optellum’s researchers have been using wealth of clinical information including CT images to train a machine-learning neural network to recognise the signs of the deadly disease.

# How are Oxford Academic Healthcare Partners involved?

The Optellum technology has been developed and clinically validated in partnership with several NHS hospitals – including Oxford University Hospitals NHS Foundation Trust (OUH), Nottingham University Hospitals NHS Trust, the Leeds Teaching Hospitals NHS Trust, and the Royal Brompton and Harefield hospitals. The Optellum team look the lead role in drafting and creating a number of successful grant proposals working alongside OUH physicians.

Optellum and OUH are partners in Data using Artificial Intelligence to Improve Patient Outcomes with Thoracic Diseases (DART); an [£11m Oxford-led artificial intelligence (AI) research programme](https://optellum.com/2020/07/optellum-partners-with-university-of-oxford-in-11-million-ai-programme-to-accelerate-lung-cancer-diagnosis/) to improve the diagnosis of lung cancer and other thoracic diseases. Professor Fergus Gleeson at the University of Oxford will lead on the programme of research focusing on accelerating pathways for the earlier diagnosis of lung cancer. The programme results will be integrated into Optellum’s AI-driven Clinical Decision Support platform that supports physicians in choosing the optimal diagnostic and treatment procedures for the right patient at the right time.

DART is hosted by the National Consortium of Intelligent Medical Imaging (NCIMI); also funded by the UK Research and Innovation’s Industrial Strategy Challenge fund as part of the government’s investment in ‘data to early diagnosis and precision medicine’. NCIMI is a partnership between NHS trusts, companies, universities, charities and patient groups. The consortium is led from Oxford University at the Big Data Institute, recognised as the world’s best institution for medical research and the best in Europe for both engineering and computer science. NCIMI supports projects at all stages along the development pipeline – including initial project scoping and pilot data collection, large data set acquisition, development for algorithm training and validation, reader studies and real-world evaluation.

In the IDEAL study, academic clinicians from Oxford (led by Professor Fergus Gleeson), Nottingham (led by Professor David Baldwin), Leeds (led by Dr Matthew Callister) and Reading (Dr Tara Barton) are collaborating with Oxford-based Optellum Ltd to use artificial intelligence (AI) to extract information about a lung nodule from a CT scan and predict malignancy by comparing it to data from thousands of nodules where the diagnosis is known. This AI model is currently undergoing validation and rigorous testing in a representative clinical environment. The aim is to implement the model into a clinical system that will support clinicians, deliver improvements to patient care, and save the NHS money.

The Early Lung Cancer Diagnosis Using Artificial Intelligence and Big Data (LUCINDA) project leverages the expertise of top radiologists to help develop and validate the Optellum Lung Cancer Prediction (LCP) AI as a clinical tool that has robust performance across various patient populations, clinical pathways and CT scanner types. The Optellum Lung Cancer Prediction AI generated a malignancy score for each nodule in the dataset demonstrating excellent performance on identification of benign nodules (sensitivity 99%) in an independent multi-center dataset from three European countries not included in the training data. The key result is that malignancy could be ruled out in about 20% of patients with 5−15mm benign nodules using the Optellum Lung Cancer Prediction, who might otherwise undergo stressful and potentially harmful diagnostic workups

# DOLCE is a landmark research project led by Professor David Baldwin, Honorary Professor of Medicine at the University of Nottingham, and Consultant Physician at Nottingham University Hospitals NHS Trust. It will show how many CT scans, expensive PET scans and biopsies are saved by the Optellum software and how much faster the diagnosis of cancer is confirmed. If the utility and safety are confirmed, the solution could be implemented nationally with fewer harms to patients, reduced anxiety for patients waiting for tests and substantial savings in precious radiology resources.

# The project is part of the NHS AI Lab’s £140million AI in Health and Care Award. The AI in Health and Care Award aims to accelerate the testing and evaluation of AI in the NHS so patients can benefit from faster and more personalised diagnosis and greater efficiency in screening services.

# Impact / outcomes

Physician use of Virtual Nodule Clinic is shown to improve diagnostic accuracy, clinical decision-making and consistency among physicians. The LCP AI has been extensively validated in multi-centre studies led by co-authors of clinical guidelines, and shown to consistently outperform conventional risk prediction models, currently recommended in clinical guidelines and considered state-of-the-art in classifying nodules as low, intermediate or high risk. It was published in the BMJ Thorax[[7]](#footnote-8) by lead author Professor David Baldwin, Chair of the Clinical Expert Group for Lung Cancer, NHS England and co-author of the current clinical guidelines for lung cancer in the UK.

In an independent validation study led by physicians from Vanderbilt and Oxford, the AI was shown to correctly reclassify indeterminate nodules into high- and low-risk categories in more than a third of cancers and benign nodules,[[8]](#endnote-2) illustrating the potential to speed up lung cancer diagnosis and reduce invasive biopsies and surgeries on patients without lung cancer, compared to the current standard of care.

# More about Optellum

Optellum was founded by a team of medical technology experts who first met at the University of Oxford’s world-renowned computer vision laboratory. The company raised initial funding and commenced operations in 2017. To date the company has secured over £9 million in seed and government funding, including early-stage investments from St John’s College (University of Oxford), and the family office of Sir Martin & Lady Wood (founders of Oxford Instruments Plc, the first University of Oxford spin-out).

# Supporting quotes

**Jan-Phillip Beck, Chief Executive Officer at EIT Health, commented:**

“EIT Health is delighted to see the result of this consortium of leading university hospitals in Oxford, Groningen and Heidelberg, and lung health software company Optellum. We’re proud to have supported Optellum’s journey through our accelerator programme and several grant awards including the LUCINDA project. This illustrates how EIT Health is working hard to facilitate the rollout of artificial intelligence solutions in healthcare across Europe, transforming the lives of doctors and cancer patients.”

**Professor David Baldwin, Chair of the Clinical Expert Group for Lung Cancer, NHS England and Professor of Medicine and Consultant Physician at Nottingham University Hospitals:**

“Very early stage lung cancer can be difficult to diagnose because it shows up on scans as small pulmonary nodules. These can be tricky to classify so we need better ways to confirm whether a nodule is lung cancer or harmless and quickly as possible. Every day that a diagnosis is delayed diminishes a patient’s chances of survival. That is why my NHS colleagues – leading radiologists and pulmonologists – and I have teamed up with Optellum to develop and validate this imaging AI-based software.

This will help identify and urgently prioritise referrals for patients with a genuine high-risk of cancer, speeding up time to the start of treatment, reducing unnecessary procedures on patients with benign lesions and saving NHS time and resources for those who ideally need them.”

**Dr Claire Bloomfield, CEO of NCIMI**

Congratulations to all the team at Optellum on the news of the FDA approval of the Virtual Nodule Clinic - this is a huge milestone and is the first FDA approved AI solution for enhancing lung cancer diagnosis. NCIMI look forward to working with the team to further develop Optellum’s solutions for lung heath, with impact for the NHS and global patient communities.

**Václav Potěšil, Ph.D., co-founder and CEO of Optellum**

“Our world-first AI technology has the potential to revolutionise the diagnosis of lung cancer – benefiting the lives of tens of thousands of people every year. The NHS doctors have helped to develop the AI and now the AI will assist the doctors and their patients.”

1. Cancer Research UK: <https://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/lung-cancer> [↑](#footnote-ref-2)
2. England 2014, Scotland 2014-2015, Northern Ireland (2010-2014): <https://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/lung-cancer#:~:text=Around%20three%2Dquarters%20of%20lung,per%20100%2C000%20people%20by%202035>. [↑](#footnote-ref-3)
3. AJCC Lung Cancer Staging manual (7th edition): <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3351680/> [↑](#footnote-ref-4)
4. September 2018-September 2019, Diagnostic Imaging Dataset: <https://www.england.nhs.uk/statistics/wp-content/uploads/sites/2/2020/01/Provisional-Monthly-Diagnostic-Imaging-Dataset-Statistics-2020-01-23.pdf> [↑](#footnote-ref-5)
5. The impact of the COVID-19 pandemic on cancer deaths due to delays in diagnosis in England, UK: a national population-based, modelling study: <https://www.thelancet.com/journals/lanonc/article/PIIS1470-2045(20)30388-0/fulltext> [↑](#footnote-ref-6)
6. <https://www.oncology.ox.ac.uk/news/new-national-programme-ai-research-lung-cancer-screening> [↑](#footnote-ref-7)
7. <https://thorax.bmj.com/content/70/Suppl_2/ii1> [↑](#footnote-ref-8)
8. Massion PP, Antic S, Ather S, et al. Assessing the Accuracy of a Deep Learning Method to Risk Stratify Indeterminate Pulmonary Nodules. Am J Respir Crit Care Med. 2020 Jul 15;202(2):241-249. https://www.atsjournals.org/doi/full/10.1164/rccm.201903-0505OC [↑](#endnote-ref-2)