

Spotlight

MEDTECH: DATA ETHICS AND CRISIS

Anne Marie Morris MP / Saira Ghafur / Darren Jones MP / David Delpy



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The tech response to a pandemic



As the coronavirus pandemic rages worldwide, the response of one country is being held up as an example to follow. South Korea, which initially suffered the worst Covid-19 outbreak outside of China, has reportedly been managing to contain its spread. Quick action, forward planning and wide-spread testing have led to a low casualty rate, estimated at just below 1 per cent of infected people.

Tech and data science have been a key, if controversial, part of South Korea's response. People with a mobile phone receive alerts about locations of infection so that they can avoid those areas. A government GPS-enabled app monitors citizens under quarantine. There are thorny ethical questions around the use of personal health data combined with surveillance technology. Those questions aside, however, tech's role in responses to this pandemic has brought into focus the importance of data. Not only is it vital in rapidly responding to a major public health crisis, but also in delivering healthcare today.

Asked how the Chinese reorganised their medical response to deal with the outbreak, Dr Bruce Aylward of the World Health Organisation said, "First, they moved 50 per cent of all medical care online so people didn't come in." As much of the world heads into lockdown, virtual solutions will enable people to continue receiving medical treatment, including for non-virus related issues, while keeping infections at a minimum. Speaking this month, Health Secretary Matt Hancock said the UK was taking a "digital-first approach" to tackling the virus.

Now more than ever digital solutions have the potential to save healthcare systems from becoming overwhelmed by demand. The NHS faces a number of issues, however. Not all households have internet access, and older patients, those most vulnerable to the virus, use the internet at far lower rates than the rest of the population. Further, the inability of a fragmented NHS to store and manage data effectively, and to deal with reasonable privacy concerns around data-sharing, hampers digital potential.

When this crisis is over, the healthcare system could be revolutionised by the increased use of digital services and data science that lockdown and social distancing is forcing us into. But if it is to be sustainable, the government must make sure that such a system leaves no one behind – and that it can effectively, and responsibly, make use of data.

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NewStatesman

Standard House
12-13 Essex Street
London, WC2R 3AA
Subscription inquiries:
digital.subscriptions@
newstatesman.co.uk

Account Managers

Harry Browning
Jugal Lalsodagar
Cyrus Ramezani

Commercial Director

Dominic Rae

Special Projects Editor

Alona Ferber

Special Projects Writers

Jonny Ball
Rohan Banerjee
Samir Jeraj

Design and Production

Erol Süleyman

Cover illustration

Sam Falconer



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News



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App diagnoses mental health via face and voice

Rohan Banerjee

A team of scientists at the University of Nottingham has developed a mobile app to help diagnose mental health conditions by analysing facial expressions and listening to people's voices when completing various tasks. These include reading a book out loud or answering a personality questionnaire. Harnessing artificial intelligence and smart cameras, the app, TrueBlue, spots changes in physical behaviour caused by conditions such as anxiety.

TrueBlue's creators have used it to form the basis of a spin-out company, BlueSkeye AI, which is being supported by Nottingham's Technology Ventures scheme. They hope that the AI-enabled technology could eventually have wider applications such as in the security sector, and also to check on the well-being of people at work.

According to the OECD, mental health costs the UK in excess of £94bn a year, including treatment and support.

Governments use tracking tech against coronavirus

Laurie Clark

A number of governments are using mobile geolocation data to limit the spread of coronavirus. In China, Taiwan, South Korea and, most recently, Israel, this data has been used to identify who infected individuals have been in contact with, and whether they have breached quarantine. Other countries such as Austria, Italy and Germany have used anonymised, aggregate mobile data in line with EU privacy laws to determine

US enlists tech giants in Covid-19 fight

Oscar Williams

The Trump administration has entered into discussions with 60 US technology companies, including Facebook and Google, to assess ways of sharing mobile location data in order to contain the spread of Covid-19. The proposed work focuses on aggregating location data to determine which US neighbourhoods are at risk of a future outbreak due to a regular influx of citizens from affected areas.

Google has said that the plans do not focus on individual data, which could be used to carry out contact-tracing, and that it may still decide not to participate in the project. Through

Google Maps, the company has existing measures in place to provide information about the number of people in particular locations.

The coronavirus outbreak offers an industry that has weathered substantial criticism in recent years a chance to improve its public standing, but tech companies will be hesitant to enter government deals that appear to undermine individual users' privacy.

One of Google's sister companies, which has developed a site to facilitate testing, has already been criticised for forcing users to sign up to a Google account in return for access.

whether people are staying at home and avoiding non-essential contact. The US and UK have also reportedly discussed harnessing mobile data.

Privacy advocates warn that such measures could compromise privacy, however. “We need further explanation and much more transparency,” said Silkie Carlo, director of Big Brother Watch. “The public needs to trust phone networks at this time, especially to seek health advice and social support. . . The government should be radically transparent about any tracking if it is to maintain public trust.”



New tech allows prosthetics to read nerve signals

Rohan Banerjee

Scientists at the University of Michigan have developed new technology that amplifies nerve signals to the extent that they can be read and understood by prosthetic hands. The so-called nerve interface uses muscle grafts, electrodes and machine-learning algorithms to augment nerve signals coming from an amputee or disabled person’s residual limb, so that the bionic hand or arm can process them quicker and more clearly.

The developers of the technology, led by Dr Robert Oneal, a collegiate professor of plastic surgery at the university’s medical school, claim

that an interface-enabled prosthetic can last for almost a year without any adjustments. In a statement, Oneal described the interface as the “biggest advance in motor control for people with amputations in many years”.

In a test at one of Michigan’s labs, Oneal confirmed that participants were able to pick up wooden blocks with a “pincer grasp” and move their prosthetic thumb in a continuous motion using only their thoughts. Study participant Joe Hamilton, who lost his arm in a fireworks accident in 2013, said: “You can pretty much do anything you can do with a real hand. . . It brings you back to a sense of normalcy.”

Government calls on private sector in ventilator drive

Jonny Ball

As the coronavirus pandemic spreads, the UK government has urged manufacturers to switch production to ventilators. Evoking memories of wartime production, the Health Secretary, Matt Hancock, called for a “national effort” to increase the supply of the machines for intensive care units. The Department for Health and Social Care is said to have delivered blueprints to over 60 large manufacturers and engineering companies, including Rolls-Royce and Jaguar Land Rover.

Ventilators are essential for Covid-19 sufferers with extreme symptoms as they maintain patients’ respiratory systems, getting oxygen into lungs and removing carbon dioxide. Some ventilators are complex machines and their manufacture is a highly specialised process. Experts have expressed concerns over whether automobile companies will be able to switch effectively their production. A request of this kind from government to the private sector is unprecedented in the postwar era.



Artificial pancreas app launched for diabetics

Jonny Ball

The world’s first artificial pancreas app, which works alongside an insulin pump and glucose monitor, is available to download for the first time. The software, designed to treat sufferers of diabetes, is the result of 13 years of research by Cambridge University Hospitals NHS Foundation Trust and Professor Roman Hovorka.

Type 1 diabetes occurs when the pancreas is unable to produce the requisite amount of insulin (the hormone that breaks down glucose), causing imbalances in blood sugar levels. Diabetics have to take regular insulin injections and administer regular blood tests to regulate their blood sugar. This app will allow automatic monitoring of the condition and will upload health data remotely to an online platform, facilitating personalised treatment.

In the UK, 4.7 million people suffer from diabetes, but only 8 per cent of those have type 1, the more serious, irreversible version of the condition. The World Health Organisation has estimated that the global prevalence of adult diabetes has risen from 4.7 per cent in 1980 to 8.5 percent today. ●

Why regulation must keep pace with science



Anne Marie Morris, chair of the APPG on access to medicines and medical devices, on tech in the NHS



Earlier this year, the Health Secretary Matt Hancock, said: “Better technology is vital... and embracing it is the only way to make the NHS sustainable over the long term.” These words have never been truer, but we have some way to go to realise the potential that Medtech holds. As we tackle the coronavirus pandemic and exit the European Union, the UK has the opportunity to embrace technology and shape our own approach to regulation, access and uptake.

In order to do so we face challenges on three fronts. We must ensure that our regulation is fit for purpose, that adequate funding for the best technology is in place, and that products that deliver the greatest benefits are used in the NHS.

For too long the UK has lagged behind in our readiness to make the most of life-changing technology. For example, the British scientist Godfrey Hounsfield invented CT scanners in 1972, a mainstay of current medical care. But the UK has among the lowest number of CT scanners per capita in Europe. Equally, the development of continuous glucose monitoring systems for diabetes has the

potential to improve patient experience and safety, but this is only available on the NHS for a fraction of the patient population. Against this backdrop it is imperative that we ensure the safety of all patients who may be treated with a medical technology. The recent coverage of the risks posed by vaginal mesh brings home the importance of regulation that keeps pace with the science.

Any technology-related adverse event is one too many. That is why policymakers must ensure patient safety remains top of the agenda when forming Medtech policy. The UK is making good progress in this area, with the Medicines and Medical Devices Bill introduced to parliament earlier this year. However, there are areas where the proposed legislation could go further to support patient safety and evaluate the way CE certifications, the stamp of regulatory approval for Medtech, are awarded through the Medicines and Healthcare Products Regulatory Agency. The UK has the opportunity to align with global standards.

I would like to see provision for a



central registry of all implanted devices stipulated in the bill, which would build on, and go beyond, the current European registry. Such a resource would support the better tracking of devices and patients as they move through the system. It would also provide accountability for industry and the health service.

Patient safety issues have far-reaching consequences beyond the immediate risks to patients' lives. The annual cost of "preventable adverse events" in the

Innovation is only as effective as its rate of uptake

GETTY IMAGES/STEFAN ROUSSEAU

NHS is likely to be more than £1bn, according to a report prepared for the Department of Health and Social Care. With better tracking and registering of technologies, this sum could be reduced and patient safety and experience improved. However, it is essential that these provisions translate into practice when the bill passes into law.

Furthermore, as the UK exits the EU, there is increasing pressure on the few notified bodies that award CE marks. As well as ensuring the regulation is in place, government should be concerned with establishing sufficient capacity in the system to evaluate technologies that come through the pipeline.

It can take time for a medical technology to be assessed and made available on the NHS following its approval by regulators. This can limit the number of patients who can benefit from the latest innovations. It is vital, however, to rigorously assess a new technology in terms of its clinical benefit, as the National Institute for Health and Care Excellence (NICE) does for some products.

These assessments must find the balance between data requirements, speed of access, and the handling of uncertainty. Conducting clinical trials for Medtech brings a number of challenges not seen elsewhere in the life sciences sector. For example, varying levels of clinical experience within trials can mean an intervention is represented as being less effective than it is in reality in a trial setting. Equally, choosing the correct time to assess a technology is also difficult; devices often undergo frequent changes in design after their initial launch.

Such challenges require a unique solution. It is more important now than ever that policymakers consider the role that access together with evaluation can play. Programmes such as Commissioning Through Evaluation (CtE) enable a product to be trialled in the NHS while allowing data collection and patient access. These are seldom used, however. Equally, the current consultation on the Medtech Funding

Mandate offers the perfect opportunity for the government to introduce meaningful funding for high-benefit technologies that may not save costs, but will likely be cost effective and good for patients. The government should consider the expansion of CtE and other interim access pathways for promising Medtech.

The NHS is world-leading on many counts, but encouraging uptake of new technologies is an area for improvement. Once an innovation has cleared regulatory and evaluation hurdles we often fail to use it. If we are to realise the improved outcomes the Health Secretary envisions then something needs to change.

The Innovation Scorecard reports on the uptake of medicines and medical technologies in the NHS in England that NICE has positively appraised. While on occasion the Innovation Scorecard has been used to measure uptake of Medtech, this has been too infrequent and not inclusive of all NICE-recommended medical devices. Harnessing the potential of the Innovation Scorecard would be one route to improving uptake.

Alternatively, adapting HealthTech Connect, a platform which aims to support products as they move from inception to adoption, could provide a solution. Policymakers should look at adapting HealthTech Connect to record and pool data on uptake of Medtech as it is introduced to the NHS.

Finally, the importance of leadership cannot be overstated. The Health Secretary's call to have "a digital and tech leader on every board" is commendable. Local leadership is important, and will be key to ensuring that the national momentum is fed into local systems. But national oversight is also required.

We must introduce the regulations, collect the data, speed up access and increase adoption. If we progress in these areas ultimately patients will be better off, and our valuable Medtech will be supported to grow sustainably in a post-Brexit Britain that is battling a pandemic. ●

Unlocking the potential of personal data

Genomics and digital technologies offer unprecedented opportunities – and insurers should use them wisely, says **Dr Subashini M**, associate medical director of Aviva UK

Personalised medicine offers the promise of substantial opportunities to improve the population's health, both through revolutionising the nature of healthcare and its provision, and by empowering individuals to take ownership for their health and wellbeing.

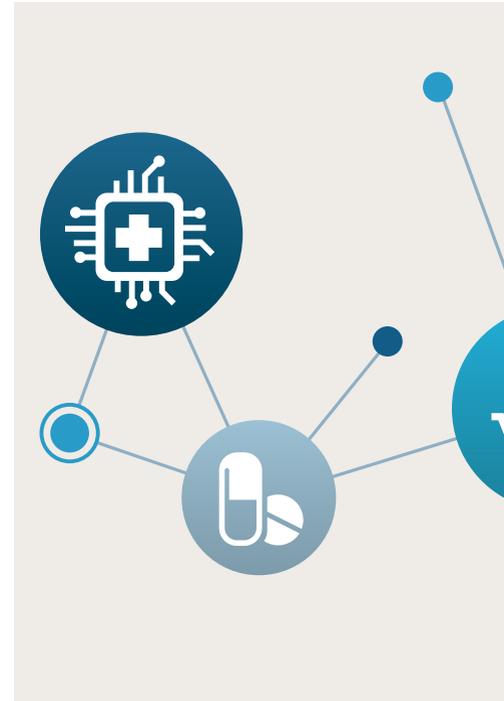
It also presents opportunities to improve the end-to-end patient experience, from supporting interventions to preventing the development of disease, to earlier detection that enables more effective and often less invasive treatment. Once a disease is detected, detailed characterisation of individuals and diseases enables specially tailored treatment and interventions.

But personalised medicine also presents challenges – particularly to assessing insurance risk. A more thorough understanding of the current and future health risks of an individual can be useful. However, the democratisation of health beyond healthcare systems has profound

implications for those parts of the insurance industry that provide cover.

Last month saw the publication of *Foundations of Fairness*. The report sets out the public's sentiment in relation to the sharing of NHS data with third parties. The research, which was led by Understanding Patient Data, in association with the Ada Lovelace Institute, highlighted that although the public see the benefits of sharing data with research groups, charities and industry, there are concerns around accountability and the potential exploitation of the NHS. The overall message was that the public will only support third parties using NHS-held health data when it helps drive benefits for the patient. This includes helping to improve detection of diseases like cancer and the development of new medicines.

Human beings are complex. While one individual may respond favourably to an intervention, outcomes will vary. Moreover, medical advances often come at a cost. Speed of adoption



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and access to treatment options can vary geographically and in different sectors. Outside of health systems, individuals will vary widely in their desire and ability to embrace these new opportunities for health monitoring and behaviour change.

Data is used in more ways than optimising care delivery. From an insurance perspective, it can be used to help inform product design and to predict, assess and mitigate risk. A recently announced partnership between Aviva and the University of Cambridge could help shed light on some of these issues. Aviva's Data Ethics Forum commissioned the University's PHG Foundation to analyse how these developments are likely to impact on the health insurance industry, through the lens of data ethics.

The *Personalised Medicine and Insurance* report provides a high-level exploration of the impact of personalised medicine on the insurance market. Through analysis of legal and regulatory requirements, professional

guidance and relevant policy, it explores two complementary aspects of the obligations owed by insurers: those owed to society, and those owed to their customers – the insured.

The findings showed that, while personalised medical advances offer opportunities, they also pose challenges for the insurance industry. For example, using technologies and integrating diverse data sources might create new opportunities for data analysis to support the early detection of disease and disease management. However, these could potentially require insurers to analyse data for early signs of disease and report these findings to their customers, such as predictions of future ill health or the detection of early signs of disease, in a more granular and personalised manner than we currently do.

Moreover, digital technologies used for surveillance and early detection could increase the potential for anti-selection and the numbers of people who become uninsurable. The consequences of a greater proportion of the population becoming uninsurable is that personalisation is likely to shift the obligations of insurers to society.

Before considering the use of this type of medical data in risk assessment, insurers need to be able to confidently answer questions such as whether it is clear how the information would help assess the insurance risk and more importantly, how it will benefit the customer. As an insurer, will we be morally or legally obligated to share that information? If so, do we

Sharing health data must benefit the patient

have the right people to have those conversations with our customers, and will the customer be equipped to deal with what they are about to hear? Are the right support services in place?

On a broader scale, insurers need to understand whether the insight gleaned from the use of data analytics drives the right behaviours. The use of artificial intelligence has already shown us that if used incorrectly, there is a danger that data can lead to prejudice.

When it comes to health data, public and private sectors are not mutually exclusive. However, as the *Foundations of Fairness* report shows, there is still some way to go to build patient confidence to share their data beyond the NHS.

As new external data streams become available, all relevant stakeholders need to work together to build consumer confidence and agree best practice approaches. The potential consequences need to be fully understood and decisions focused on how ethical it is to use the information.

Above all, consumers must understand how their data is being used and have the confidence that the recipient is acting with integrity. Only then will mutual trust build and the systemic bias of some socioeconomic groups opting out of data-sharing begin to be addressed.

As an industry, it is paramount that any data strategy enables us to stay true to our insurance fundamentals. It needs to support inclusivity and aid positive health outcomes for the individual, not make insurance less accessible.

It is about realising the benefits of technology but treading carefully to ensure that we do not exacerbate inequality. And, moving from purely mitigating risks to becoming more purpose based, using data insights to help inform and protect as many people as possible. Decisions should be predicated by codes of data ethics that support the changing role of insurers, using obligations of that role as a guide and driving positive customer, commercial and societal outcomes.

The coronavirus outbreak may provide a chance for tech firms to improve their public image, but some are eyeing a bigger prize. By **Oscar Williams**

What big tech wants from the NHS

At 7pm on Wednesday 11 March, Dominic Cummings welcomed more than two dozen tech executives into Downing Street. It was the eve of the government's decision to move from the "contain" to the "delay" phase of its coronavirus strategy, and Cummings – Boris Johnson's chief adviser – opened the meeting with a warning. Britain, he told his guests, was entering an unprecedented era.

Over the next 90 minutes, executives from Google, Facebook, Uber, Microsoft, Amazon and Peter Thiel's controversial analysis company Palantir, among other firms, volunteered a range of resources, from engineering and transportation to advertising and data modelling. Government officials, a source who attended the meeting told *Spotlight*, said they wanted to move fast, but that they also wanted to act ethically.

For an industry that had been frozen out of Downing Street during Theresa May's premiership, the meeting was emblematic of a new government drive to thaw relations with select UK and Silicon Valley firms. But it's not the first olive branch the Johnson administration has extended. And, while the coronavirus outbreak may provide an opportunity for tech firms to improve their public image, some are eyeing a bigger prize.

In December last year, leaked documents revealed the scale of the government's ambitions for the NHS's work with the tech industry. To date, research partnerships with tech firms have largely been limited to individual hospital trusts. Moorfields Eye Hospital, for example, has worked closely with Deepmind, a London artificial intelligence (AI) lab wholly owned by Google's parent company,

Chief advisor to the Prime Minister, Dominic Cummings (centre), outside a media briefing at Downing Street



to accelerate the interpretation of eye scans. The leaked documents, published by *The Register* news site, indicate that the government wants to go further, however.

Two months earlier, senior NHS officials had met with business leaders to discuss the centralisation and potential sale of the NHS's huge trove of anonymised patient data. According to the leaked documents, the meeting was attended by Amazon's UK director Doug Gurr and Microsoft UK chief executive Cindy Rose, as well as AstraZeneca's data science chief. (Rose, *Spotlight* understands, also represented the company at the Downing Street briefing.)

"Our hypothesis," a meeting agenda reads, "is that it is now widely accepted among researchers, industry, the NHS and policymakers that NHS health data holds some



unique characteristics, such as a large (55 million to 65 million) genetically diverse population, a single payer healthcare system, and access to clinical data.”

It is, in short, the largest patient dataset of its kind anywhere in the world. For researchers and the NHS, the opportunity to see into patients’ pasts and analyse health trends across a nation over time is unparalleled. It could, they hope, lead to seismic medical advances.

For the tech companies that will supply the data tools, algorithms and storage services upon which researchers depend – and, in some cases, carry out analysis themselves – it represents a major commercial opportunity. Alongside financial data, our medical records remain, for the moment, one of the few things tech companies struggle to monetise. For the British

government, it is a vast source of untapped revenue. Professional services firm EY has estimated that access to NHS patient data could generate £10bn every year for the Treasury.

Working with the NHS is a priority at the very highest levels of the tech industry. Speaking at a conference in London in November 2018, Microsoft’s chief executive Satya Nadella claimed that the deployment of AI within the health service could improve the Treasury’s finances.

“If you talk about any improvement of the economy here, there’s no way you’re going to think about it without taming the ever-increasing costs of healthcare,” he told delegates. “New tools could change how care is given, how the patient is informed and, most importantly, the trajectory of healthcare costs going up.”

Labour MP Darren Jones, a member

of parliament’s science and technology committee and self-described tech evangelist, echoes this sentiment. “We have to modernise our public services,” he told *Spotlight*. “But it has to be done in the right way.”

Although Jones believes that the private sector has a role to play, he fears that government officials “don’t properly understand what interest private companies have in being able to get access to this data”. He points to the NHS’s deal with Amazon to provide health advice through the Alexa voice assistant. The health service and Amazon both denied that the online retail giant would use queries to build health profiles, but the contract – published following a Freedom of Information request – was signed based on Amazon’s rather than the NHS’s templates. As TechCrunch reported in October, there were no terms to limit what Amazon could do with the health queries users made.

“Patients absolutely have to be part of the conversation about what we do and don’t do with [their] data,” Jones says. “As far I can see there is very little, if not no, attempt whatsoever to provide transparency and accountability around what the government is trying to do around patients’ health data.”

For those who feel encouraged by the opportunities AI could present for healthcare, the Johnson administration’s lack of transparency on the issue – evidenced by last year’s meeting with Amazon and Microsoft – is cause for concern, not least because there’s a risk of recent history repeating itself. Ministers took the decision in 2016 to cancel care.data, NHS England’s original attempt to centralise patient records, as public sentiment, driven by privacy concerns, turned against the initiative.

No matter how much goodwill the tech industry accrues by helping tackle the coronavirus outbreak, if the government continues to hold meetings about patient records behind closed doors, the public’s trust in its plans for NHS data may yet turn again. ●

Data and AI: The future of healthcare

Experts from the University of Liverpool and its partners on the development of medical technology



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The view from pharma

Jim Weatherall, vice president of data science and AI, R&D, AstraZeneca

Today, the healthcare sector generates and has access to more data than ever before. Big data and artificial intelligence have the potential to revolutionise how we predict and prevent disease before patients get ill, improve treatment, and change how we make scientific discoveries and develop new medicines.

At AstraZeneca, our vision is a future of individualised healthcare solutions focused on improved patient outcomes, driven by science and data. But to realise the potential of data for the benefit of patients, we need to work together. Academia, the NHS, government and industry are essential partners in this effort.

NHS data is a unique differentiator for the UK – the government acknowledged it as a key component in the NHS Long Term Plan – that should be harnessed to improve the health of the nation. This can be used to power new investments in life sciences research, monitor and manage disease therapies in real time,

and drive efficient use of medical treatments and technologies. A clear governance framework will help to ensure that every time health data is to be collected, its use is clearly warranted, the patient's privacy is protected, and the security of the data is upheld.

One key challenge is that the healthcare sector is behind many others in using data to drive actionable insights. It takes hard work to collect the right data, get data in the right shape, embed the right governance, implement the right analytics tools, and, most importantly, get that data into the hands of the right people to yield transformational benefits. Effective partnerships to enable the collection and sharing of findable, accessible, interoperable and reusable – or FAIR – health data will provide the foundation of sustainable healthcare systems.

I am passionate about ensuring the data we have is organised appropriately, analysed efficiently, and optimised fully to drive decisions. Working together, I believe we can unlock the potential of data to improve lives.



The view from the NHS

Helen Duckworth, deputy director of planning, performance and delivery, NHS Liverpool Clinical Commissioning Group

In recent years, analytical teams in the NHS have galvanised around the prospect of improved population health through data-driven insights using patient-level linked datasets. While the ambition is admirable, the execution was clunky. There were specific challenges around information governance, disparate administrative datasets, and a need for improved capacity and capability from within to maximise analytics in the process of decision-making, thereby improving patient care.

Within NHS Liverpool CCG, we have collaborated with our wider system partners to great success. We have established a patient-level linked health and care dataset to feed our system. It is organising itself to deliver integrated care around population segments. However, while just getting the data is a huge achievement in the healthcare environment, the challenges now begin

as we start to maximise its use and realise the benefits.

This is where partnerships with industry and academia come into play. Strong partnerships with academia allow the NHS to harness the power of ground-breaking analytical techniques, ensuring that the newest concepts of machine learning and artificial intelligence can be brought to bear in the process of intelligence production in a real-world environment.

Over recent years, the University of Liverpool has worked with NHS Liverpool CCG to create a “research in residence” model, which embeds big data experts within our frontline analytical environment. This transfers much needed skills into our in-house teams and equips them to deal with capacity and capability challenges. Industry partners bring the knowledge and experience of taking products to market and executing end-to-end processes as efficiently as possible.

At NHS Liverpool CCG, we are committed to working with both academia and industry to continue mobilising intelligence to the heart of patient care and decision-making.

The view from academia

Simon Maskell, professor of autonomous systems, University of Liverpool

As someone working at the crossroads of engineering, statistics, and computer science who transitioned from industry into academia within the last decade, I am naturally drawn to data-led approaches to inform difficult real-world decisions.

I firmly believe that we can, and should, extract the information we need to benefit society from the big and small data that the world generates. At the University of Liverpool, we are pioneering the research, development, and application of next-generation data science and AI technologies to use extracted information to solve pressing challenges across a range of sectors.

It is not enough to drive forward state-of-the-art innovation while turning a blind eye to the pressing issues faced

in the healthcare sector and beyond.

Research should be informed by challenges that existing solutions cannot address.

This perspective demands that academia is closely coupled to real challenges and that we form partnerships with organisations that live and breathe the issues that we can help to solve. For academia, the public sector, and private sector organisations to work in synergy, we need to ensure that they have access to the technology and the skilled people they need to turn those advances into problems solved.

Universities routinely generate large numbers of highly skilled graduates and important research papers. However, at the University of Liverpool, our work with the NHS and AstraZeneca exemplifies other ways that partnerships can deliver value.

In collaboration with NHS Liverpool CCG, we have successfully seconded postdoctoral researchers into their organisation to understand where the application of data science would be most effective. We have also helped Liverpool CCG to understand that the marketing hype describing the boundaries between big data, data science, artificial intelligence (AI), and machine learning is not relevant to the reality of applying appropriate solutions to the most important problems.

Through partnership, we are embedding our research outputs in widely used pre-existing and free software packages. This approach provided AstraZeneca with an opportunity to harness the University of Liverpool’s advances to drive data-based decisions and accelerate new innovation. By working together, academia, industry, and healthcare providers can create a mutually beneficial trifecta, where data science and AI drive advances in health, wealth and prosperity for all.

To learn more about digital research at the University of Liverpool, please visit: www.liverpool.ac.uk/digital

Professor **David Delpy**, Fellow of the Royal Academy of Engineering, on the practicalities of supplying the equipment the NHS needs to deal with the Covid-19 pandemic

Manufacturing ventilators for a system in crisis



New ventilators are seen at the Columbus Covid₂ Hospital in Rome, Italy.



The government has asked UK manufacturers to turn their hands to the production and assembly of ventilators, the number of which in circulation in the NHS is reported to be as low as 5,000. What are the challenges of the manufacturing industry switching assembly lines?

This should not be a problem for most of industry, so long as they have full specifications for the items to be produced and there is no need for materials that may not be standard stock. Ventilators will generally be hand-assembled from components, many of which can be made on more automated manufacturing lines. Note, however, that many modern ventilators contain specialist sensors and controllers – for example gas flow valves, gas mixers, pressure, and gas concentration sensors – which may be bought in from specialist suppliers outside the UK. Supply of these

may be the limiting factor in ramping up production. Specialist medical engineering knowledge or staff with specific skills are not required to make the components themselves, though knowledge of the relevant regulations will be needed in specifying these and in final manufacture and assembly. The skills needed for many complex industrial engineering products are transferable to medical technology.

In theory, could any manufacturer do it?

This depends on the type of ventilator being made. Producing modern high-tech ventilators requires a mix of skills as they contain electronic, mechanical, software and plastic or rubber-moulded components and sensors. The larger companies that have already responded to the government's call to manufacture ventilators, such as Rolls Royce, JCB, Unipart and Dyson, have all the necessary skills either internally or through their



supply chains, so long as any specialist components, sensors or materials are available. If the decision was to make some of the older-style mechanical ventilators, the components for these can be manufactured by most engineering companies with standard machine tools and moulding or injection equipment. Note that all ventilators involve the use of some “single use” or “disposable” items. These include plastic connecting tubing, intubation tubing, mouthpieces and so on, which are replaced for each patient. These are all supplied sterilised. There will be a need to significantly increase production of these components, as well as the numbers of ventilators in the system.

What is the risk of manufacturers cutting corners, and will ventilators be subject to testing or regulation?

The risks should be minimal as existing ventilator manufacturers and other major

Assembly and testing must be streamlined

engineering companies have a well-specified manufacturing specification and quality assurance system. One potential problem that could – but hopefully won’t – arise is if there are specific components or elements, such as gas sensors, from overseas suppliers who may not be able to supply them, either because of supply-chain disruption or demand from other countries with the same ventilator problem. These items have usually been specifically manufactured, tested and regulated. It may be possible to find alternatives, but obtaining approval usually takes at least a year, so some emergency exemption would be required if they were to be substituted.

Realistically, how quickly can the UK manufacture the number of ventilators it needs?

Assuming there are no supply constraints for the basic materials and components, which is certainly the case for mechanical ventilators, a switch over to manufacture should be very quick – my guess is around a week. For mechanical ventilators, many components could be produced by several suppliers, so the main constraint is likely to be assembly and testing.

How much cleaning and maintenance do ventilators need once they are in the system, and how much of a strain could that be on the NHS?

This is key. The ventilators will need a large supply of “single use or disposable” components. Additionally, between each patient use, ventilators have to be stripped, cleaned, reassembled and sterilised. This is most frequently done in hospitals by skilled technicians in clinical engineering or medical physics departments. The increased workload may not be sustainable with current staff numbers. This is another reason for perhaps considering simpler mechanical ventilators, and is a strong argument for limiting the new ventilator supply to one or two designs. The last thing we need is six different designs for which people have to be trained, and which use different components. Interchangeable parts should be the rule. ●

An NHS for the 21st century

Netta Nyrhinen, content and community manager at DrDoctor, on how technology can deliver better health outcomes, improve patient satisfaction and save money

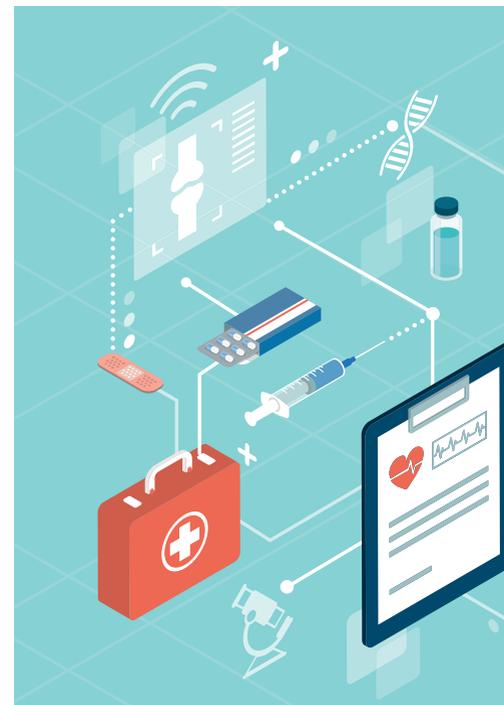
Ever read the papers and wonder why stories about the NHS always involve budgets going up or down, but rarely discuss efficiency? Increasing efficiency in the NHS sounds like it will cost members of the public more money, but in reality, it can be delivered through increased patient engagement. This is enabled by technology and means better quality of care with better outcomes that ultimately results in a positive impact on hospital finances.

Digital transformation is the lifeline to ensuring the NHS remains sustainable and able to cope with the growing demands of our ageing population. However, often the focus of technology is too small in scale and starts from the wrong place in the digital value chain. Patient engagement refers to all the parts of healthcare that someone can do for themselves, outside of the clinical setting, when enabled by technology. These include managing appointments, tracking symptoms, correspondence (letters or test results), two-way communication (chat, video consultations), care plans and repeat

prescriptions. These transactions are all important parts of the digital value chain, and when patients are encouraged to engage with their health provider online, they feel much more in control of their own health journey.

Experts say that 50 per cent of the people born today will live to 100. It is clear that healthcare is fundamentally facing an enormous supply and demand problem. We simply can't keep depleting precious NHS resources the way we have been. The way to fix the problem is by shifting the onus of care to the patient (in a positive way).

Today, the world revolves around data and technology. We use our smartphones to navigate through life, work and relationships. We are instantly connected across the globe and have access to limitless information with the simple click of a finger. Healthcare needs to follow this same channel shift, allowing people to look after themselves and to gain an awareness of their own healthcare and health data. We should no longer be told what to do by the health system, we should expect to be partners



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when it comes to our own health. This means being able to pick the format and frequency of interactions you have along your healthcare journey. Eric Topol put this brilliantly when he said that the patient is the “single most unused person in healthcare”.

To enable true patient engagement, technology needs to allow people to take control of their health by engaging with them properly from the moment they enter the healthcare system to the moment they leave, hopefully with a good outcome. The ultimate goal is to break the place and time relationship between patients and healthcare. What that means is that we stop relying on huge buildings to provide care and start employing data to support its provision.

When you are fully engaged as a patient, you can sit at home with your smartphone while being supported by a huge amount of data. Doctors could also work from home, and be the best at what they do because we only need them when we really need them. They no longer need to sit in a hospital treating countless routine cases.

This also means we can receive care whenever we need it, because the technology is always there for us. Now, when you are ill, you get seen in a hospital or GP surgery once or twice, or maybe four times a year for about 20 minutes if you are lucky. That is two hours of face-to-face time a year. Two hours of care try to enable positive outcomes.

Sometimes hospitals understand the value in transformation but end up entering the digital value chain from the wrong place or making financial commitments to the wrong tech. If you do not engage the patient as a real partner and empower them through transactional activities, transformation at scale will not be achieved. For example, records access is simply not enough; just like having a patient app or being able to get a video consultation with a doctor is not enough. These are all individual bricks that make up a structure, but on their own they do not make a house.

A house is made up of all these pieces together, building from the bottom up in a way that is easy to access at

any time. The key to getting digital transformation right is to introduce the online environment to patients from the moment their health journey begins. If it becomes the norm to manage hospital appointments online, and to access health data on your phone, it becomes the norm to allow technology to support care.

If you can use your mobile phone to enter a secure portal where you can pick a date for your knee operation, find out how to prepare for it, and sign a consent form, it will be completely natural for you to turn to your phone to fill in an outcome measure questionnaire, to consult your doctor via video, or to keep track of symptoms. By experiencing care in this way, you will feel in control and able to get better with closer monitoring, both important ingredients for a great patient experience.

What is also improved, however, is the cost that is associated with a traditional care pathway, or the cost that is incurred by seeing every patient in clinic every time. By putting emerging technologies to use, patients will not have to travel to the hospital for each of those face-to-face transactions. They will not have to wait for a letter for their random surgery date, then wait on the phone every time they try to reschedule it, or take time off work to travel to the hospital to sign papers before or after the operation. The clinics are busy, doctors stretched, car parks full, and patients probably feel rather disengaged and not very reassured.

Technology and expertise need to come together to form an ecosystem of support that is enabled by open standards and interoperability. This can transform the NHS for the better. Digital transformation offers the tools for real patient engagement and enables healthcare to evolve into an efficient, sustainable system. By following the digital value chain, and building the house from the foundation up, the NHS can achieve superior patient experiences and outcomes as well as financial savings.

For more information, please visit:
www.drdoctor.co.uk

How one tech company is using digital environments to help treat mental health problems. By [Rohan Banerjee](#)

The game of life

For some people, the prospect of standing in a queue, visiting the supermarket, or even ordering a coffee can be terrifying. Up to 12 per cent of the country's population will experience social anxiety disorder at some point in their lives, according to the latest Adult Psychiatric Morbidity Survey, which monitors the prevalence of mental illness in England. Social anxiety is the third-most-common psychiatric condition after depression and alcoholism. Roughly 6 per cent of the population will suffer from generalised anxiety, 5 per cent will suffer from panic attacks, and 2 per cent will report symptoms of obsessive-compulsive disorder. Many more live with these conditions without diagnosis.

Day-to-day interactions can exacerbate symptoms. What might be viewed as routine for the majority of the population can trigger a "real struggle"

Anxiety can be life-limiting and affect productivity

for those with anxiety, says Dr Ramesh Perera-Delcourt, a clinical psychologist at Oxford VR, a spinout from the University of Oxford. The company uses virtual reality technology to "enhance" therapy treatments for anxiety. "What other people might take for granted is a battle for them," he says. "This affects not only their mental health but their overall quality of life... they experience fear in public situations, especially when they're alone. It can be really debilitating and affect their capacity to carry out a job or even socialise."

Founded in 2017, Oxford VR creates immersive therapy sessions with technology similar to that used in films and video games. "The idea is not to replace or substitute traditional therapies," Perera-Delcourt says, "but rather to complement them." He goes on to explain that: "It's not the same as other forms of traditional exposure



A scene from one of Oxford VR's immersive therapy sessions



therapies where, say, you might show someone with arachnophobia a picture of a spider for a length of time until they became more at ease with the image. The VR scenarios allow us to coach patients, over time, in a controlled setting.”

Oxford VR’s social engagement series launched earlier this month. It puts patients with various forms of social anxiety into different virtual settings, including a shop, a bus ride and a street scene. Putting on a VR headset, patients use two handheld controls to interact with the environment. The VR programme can be delivered through a VR-ready desktop computer or laptop, or smart television. Once in the VR setting, a virtual coach guides patients who have to complete tasks, much like in a video game. This might involve, for example, locating and buying certain items on a shopping list. Each session lasts about 30 minutes. The number and intensity of

Gamification often helps to motivate patients

the sessions depend on the severity of a patient’s anxiety.

Benn Garnish, lead animator at Oxford VR and head of the company’s studio, previously worked on visual effects in film, including *Harry Potter and the Deathly Hallows: Part 2* and *Wonder Woman*. “As patients become more confident [with their progress or in the setting],” Garnish says, “we might introduce more complicated situations. They might need to speak to other characters within the programme, or we might introduce more characters around them, to create a bigger crowd.”

The graphics used in Oxford VR’s virtual environments are, Garnish admits, “not comparable” to gaming platforms such as “PS4, Xbox One or similar”. Instead, he would accept that Oxford VR’s settings are “more like [that of] a generation [of video game artwork] or two ago”. But that is deliberate, he says. “The idea wasn’t to make the technology hyper-realistic. You want it to be realistic enough for the settings and tasks to be believable and like the real world. But, actually, if you had a hyper-realistic setting with really, really life-like settings, then you run the risk of the patient being overwhelmed or disoriented.”

June Dent, Oxford VR’s clinical partnerships director, says that: “Patients report that the scenarios feel very realistic and evoke the sorts of emotions and thoughts that are unpleasant and usually avoided. On the one hand, they don’t feel safe. But on the other hand they know they are in VR and are safe.”

One patient, who prefers to remain anonymous, suffers from such severe social anxiety that he is often housebound for days at a time. He says that Oxford VR’s social engagement series is helping him slowly, but surely. The likeness to a video game helps to make some difficult situations “really good fun”, he says. “It’s very real. You can use the VR to practise being in those places to overcome the negative intrusive thoughts to build your confidence, so when you go back into the

real world you feel a lot better because you say to yourself, ‘I was able to do that in VR so it’s OK.’”

Dent has no concerns over the clinical validity of VR, which she stresses is rooted in more than 20 years of research by the Department of Psychiatry at the University of Oxford. All of Oxford VR’s programmes, she says, have been developed with patients with “lived experiences of serious mental health conditions”, involving numerous consultations with clinical psychologists. “Oxford VR gives high priority to making sure that the programmes do work, and has conducted trials to test them out. Our Fear of Heights programme was evaluated in a randomised control test (RCT) published in *The Lancet* in 2018 and found impressive clinical results. And the social engagement programmes launched this month were designed for use in a big RCT across five National Health Service centres.”

Currently, the company’s social engagement programmes are available on the NHS via Improving Access to Psychological Therapies, as well as through other mental healthcare providers, such as some community projects in individual trusts. Oxford VR’s aspiration, says Dent, is that its programmes will become widely available to help people with “life-interrupting” mental illness.

Nicky Lidbetter, the chief executive officer of the charity Anxiety UK, welcomes the growing role of technology in mental health treatments, and highlights the “transdiagnostic” potential of VR to treat anxiety disorders. Lidbetter hopes that “this type of support will soon become widely available to the many thousands of individuals affected by anxiety”.

Dent is hopeful that VR can help to streamline pathways to treatment and relieve some of the pressure on the NHS. “Exposure therapy and cognitive behavioural therapy (CBT) are two of the most effective treatments for phobias, but there are a number of drawbacks, both general and specific.” She



Digital therapy could reduce pressure on the NHS

highlights that there are far more people with disabling mental health problems than there are therapists to treat them. “Waiting times can be long, treatment itself can be delivered inconsistently, and outcomes can be variable. Furthermore, people can feel a great deal of stigma about asking for help, and talking therapies do not suit everyone.”

By automating aspects of mental health care – Oxford VR’s social engagement series can be delivered without a therapist present, as the virtual coach can guide patients through programmes – Dent believes that more people may be able to receive help at any one time.

The potential of VR in the mental health space is “really exciting”, says Garnish, who hopes Oxford VR can build on its existing social engagement series. “We will be looking to create even more scenarios, including an office setting, to help people overcome their problems.” ●



Tech in the time of coronavirus

Jonny Ball

Over the coming months, the unprecedented outbreak of Covid-19 in more than 150 countries will stimulate unknown and unpredictable phenomena. Technology has played a key role in the fight against the virus. Around the world, governments and the private sector are mobilising vast resources in international efforts to combat its spread. With echoes of wartime-era command economics, Health Secretary Matt Hancock has already urged UK manufacturers to switch production to medical ventilators.

China has won some plaudits from

the World Health Organisation for its response alongside criticism for lack of transparency. It constructed two hospitals with 2,600 beds in under two weeks to treat those infected and sequenced the virus's genome, sharing it internationally with scientists and experts. This enabled virologists in Germany to develop a test within three days. Beijing's National Genomics Data Centre has kept shared databases with assessments of the variations and strains of Covid-19 sequences, allowing researchers to investigate the new disease and share their findings. Efforts to develop a vaccine continue.

South Korea, which currently has a relatively low Covid-19 mortality rate (below 1 per cent) compared to many other countries, is using mobile phone technology to slow viral transmission. Controversially, the government has initiated smartphone alerts that detail the movements of those who have tested positive, giving advance notice to people who may have been in the vicinity of a Covid-19 patient.

On 12 March, the UK's Information Commissioner's Office released a statement assuring that it was a "pragmatic regulator", which recognised that public bodies "may require additional collection and sharing of personal data" due to coronavirus. Just one day earlier data analytics and big data companies had, along with NHSX, the health service's digital transformation unit, been present at Downing Street as part of Boris Johnson's "digital Dunkirk". But there are still concerns, in the UK, that privacy culture and strong regulations, coupled with the ramshackle state of patient data, could stymie efforts to fight Covid-19 with the latest technology. ●

Dr Saira Ghafur, Gianluca Fontana and Lord James O'Shaughnessy, of the Institute of Global Health Innovation at Imperial College London, on ensuring data stewards are responsible to the public

A new social contract for health data



Data must be shared quickly and effectively

The world is facing unprecedented challenges as coronavirus takes hold globally. The virus is expected to continue to spread for months to come. There is an urgent need for public bodies and healthcare professionals to share information rapidly and communicate directly with the public and patients. Researchers from locations across the world have been able to share data to help epidemiological modelling, vaccine development and evidence-based clinical care.

In the past two decades, there have been a number of global pandemics, including Sars and the avian flu (H5N1). Successful control and containment of any pandemic needs rapid data collection, analysis, modelling and timely reporting. This allows governments to make crucial decisions, implement containment measures and ultimately save lives.



The general public tend to trust the NHS



Polling shows that the public is widely supportive of sharing data, particularly to improve clinical care. To ensure that data sharing is as seamless as possible, privacy laws such as the General Data Protection Regulation, which came into force in 2018, contain exemptions to allow for it to be shared for the benefits of public health. Since the outbreak of this pandemic, this has been supported by the Health Secretary and the Information Commissioner's Office.

However, data sharing in such extreme situations and with the involvement of commercial companies remains an area in which privacy concerns are growing. Advances in technology have resulted in digitised health systems with capabilities to generate more high-quality data.

The NHS is one of the most trusted institutions in the UK; the Open Data Institute has reported that 64 per cent of consumers trust the NHS with their



Patient safety, not profit, is the priority

personal data. Any lack of transparency concerning data sharing fuels suspicion and erodes public trust. Some have called for a new “social contract” for data in healthcare that sets out the obligations of any data stewards within a given health system and their responsibilities to the public. This needs to be achieved with public consent. Going too far risks creating significant backlash and loss of trust later.

Several factors need to be considered in this social contract. Citizens must be involved in decisions regarding the use of health data; this should be done on an ongoing basis and should include all segments of the UK population. Any use of NHS data through partnerships between the health service and third parties must improve health and care for all. This needs to be prioritised over any financial return. Arrangements entered into by NHS organisations must agree fair terms for their organisation and for the NHS as a whole. Further, any arrangements agreed by NHS organisations must fully adhere to all applicable legal, regulatory, privacy and security obligations.

To support this, there must be a significant investment from government to improve data quality and infrastructure alongside a clear business case for the investment. This should include reassurances that, if the money is invested, the NHS can deliver. There should also be a role for businesses, particularly tech companies, that have critical capabilities in data science. However, their role needs to be defined within a framework that the public is comfortable with. There needs to be a way for taxpayers to share in the value generated by their investment.

Data sharing, with the right checks and balances, has the potential to save lives. This current pandemic has demonstrated the benefits of data sharing to permit a data-driven global response. Governments and data stewards now have the responsibility of demonstrating their trustworthiness with people's information, and ensuring that this is extended in more routine circumstances. ●



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