National Centre for Universities and Business

THE HUMAN FACTOR

DRIVING DIGITAL SOLUTIONS FOR 21ST CENTURY HEALTH AND CARE

The Final Report of the National Centre for Universities and Business Task Force on Digital Health and Care

The National Centre for Universities and Business

Promoting business-university collaboration for a prosperous and inclusive economy and society

The National Centre for Universities and Business (NCUB) is an independent and not-for-profit membership organisation that promotes, develops and supports university-business collaboration across the UK.

Dedicated to Professor Patrick G Johnston, Former Vice-Chancellor, Queen's University Belfast and original co-Chair of the Task Force, who died in June 2017.

Foreword

The challenges and promises of digital health and care are a global preoccupation.

To recommend more effective implementation and commercial success in the UK, the National Centre for Universities and Business assembled a Task Force of more than 50 experts from business, universities, research councils, consultancies, public and commercial health and social care providers, policy makers and patient groups. This team explored ways in which universities, industry, public and private health and care providers, government, patients and users can successfully partner to deliver the changes necessary for 21st century healthcare. In this, our final report, we focus on the human factors in bringing about transformational change through digital technology. We are grateful for all who shared their hard-won insights and vision, and commend the conclusions and recommendations.

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Thank you to all those who have contributed to The Digital Health and Care Task Force, including those contributors to our previous report 'More Than a Game', chaired by Jo Pisani, PwC (see p37).

Testimony

"While someday the computerization of medicine will surely be that long-awaited 'disruptive innovation,' today it's often just plain disruptive: of the doctor-patient relationship, of clinicians' professional interactions and work flow, and of the way we measure and try to improve things."

Robert Wachter, The Digital Doctor: Hope, Hype, and Harm at the Dawn of Medicine's Computer Age

"The use of multiple IT systems for different aspects of clinical care creates significant day-to-day challenges.... For example, each hospital usually has at least one IT system for looking at patient imaging, another for requesting imaging scans, one system for pathology results, often a different one for histopathology results, another system for medical notes while in hospital, one for outpatient clinic letters and a further system for an electronic drug chart."

Junior Doctor, NHS. Interview for Task Force

"Overall in the next 10 years digital will enable truly personalised medicines and personalised treatment based on individual need rather than population characteristics."

Executive, Global Top 10 Pharmaceutical Company. Interview for Task Force

"The ballooning costs of health and care act as a hungry tapeworm on the American economy. Our group does not come to this problem with answers. But we also do not accept it as inevitable. Rather, we share the belief that putting our collective resources behind the country's best talent can, in time, check the rise in health costs while concurrently enhancing patient satisfaction and outcomes."

Warren Buffet, Chairman and CEO, Berkshire Hathaway announcing a digital health venture with Amazon and JP Morgan

"Ageing populations will create new demands for technologies, products and services, including new care technologies... We have an obligation to help our older citizens lead independent, fulfilled lives, continuing to contribute to society."

Industrial Strategy: The Grand Challenges, UK Government

"Patients want to access their test results, book appointments and view their records in the same quick, convenient digital way we access our bank accounts and do our shopping. Without these facilities, patients have less control and clinicians' valuable time is used with non-clinical questions, reducing the time they have to spend on care."

Patient Account, The Guardian

"All eHealth services entail some degree of responsibility shift from health professionals to patients. Giving patients more responsibility for their own care does not necessarily mean "empowering" them if they are not provided with adequate support. Health services must be implemented in a way that is respectful of patients' choices, capacity and willingness to participate in shared decision making."

European Patients Forum

Introduction – Why the Human Factor?

The UK must seize the prize of becoming one of the top digital health and social care systems and economies on the planet. To do so requires intense, unparalleled, and scaled-up collaboration between all the actors in the system, including universities, research funders, public health bodies, technology brokers and government. Global technology firms with deep pockets and billions of customers are seeking to enter and disrupt the market. To compete, players in the UK must be world-class at the art and science of partnering.

The National Centre for Universities and Business (NCUB) assembled experts and practitioners to reflect on the core challenges and recommend potential solutions. Led by Sir Leszek Borysiewicz, Beverley Bryant and John Jeans, the Task Force commissioned original research and cast the net wide for evidence to reach the conclusions and recommendations in this, its final report.

It became clear early in our deliberations that health and care innovators, including those in universities, were constantly producing fresh, indeed revolutionary, thinking in software, connected technologies, user-interfaces, process, and information systems. And yet, adoption and dissemination across the globe has been fitful at best and digital innovation has not delivered the transformational, system-wide change necessary to drive the UK to the top of the league, as envisaged by the UK Government's life-science and Artificial Intelligence (AI) sector deals.

There are fundamental problems to non-adoption, scaling failures, and wasted investment in digital health and care. As Oxford University's Professor Trish Greenhalgh points out:

"Planners and policymakers have often been overly focused on technologies and distracted by simplistic models and metaphors of technology adoption by individuals (e.g. 'tipping point'). They have paid scant attention to the dynamic socio-technical system into which new technologies and care practices must become embedded."[1]

At the heart of a successful digital health and care economy will be people not digits. Success and failure will come from the constant interplay of patients, consumers, users, practitioners, policy-makers, educators, researchers, financiers, developers, carers, business leaders, entrepreneurs, politicians, digital Uncle Tom Cobley and all. To lose sight of The Human Factor – both the challenges and opportunities – is to lose sight of both the greatest barriers and the biggest prize.

Government innovation policies seem often to imply a relatively simple hand-over from innovators to technology-savvy commissioners and purchasers, who in turn pass the wizardry onto willing patients, users, and consumers. Innovation seldom works that way, even in the most perfectly aligned consumer markets. Digital breakthroughs are marked by failure, feedback, iterations and abandonment, before another drive forward. Successful innovators stay successful by constant upgrades, being agile, and the creative destruction of their own products and services. There is a fundamental challenge in the cultural and economic models of technology and software providers, who are naturally drawn to rapid development, deployment, and iteration, and health and care systems which are necessarily slow, deliberative, and heavily regulated.

1 Greenhalgh T et al. (2017) Beyond Adaption: A New Framework for Theorizing and Evaluating Nonadoption, Abandonment, and Challenges to the Scale-Up, Spread and Sustainability of Health and Care Technologies. J Med Internet Res; 19 (1): e 367.

> **UNDERSTANDING AND MANAGING THE HUMAN FACTOR IS AS VITAL TO THE UK'S ECONOMIC HEALTH AS IT IS TO PATIENT, USER AND CONSUMER CARE**

Having reflected on this, our inquiries turned primarily to the Human Factor in digital health and care, and ways to instil more partnering and brokering to support training, education, and research. We focused on primary and ancillary workers, the role of patients, users and health consumers in driving change, and the ways in which higher education might deliver innovative graduates with the right skills for the 21st century, alongside impactful research and effective knowledge exchange.

We are clear that we are reflecting on health and care supported by digital solutions, rather than 21st century digital health and care. This may sound paradoxical, but in many other industries, the word 'digital' has disappeared. Ocado is not an online business, it is a convenient home shopping supermarket. Apple music provides tunes, not digital music. Netflix gives access to on-demand movies and TV. The 0s and 1s have disappeared to the consumer, just like electricity and radio waves. In much of our daily lives, 'Digital' is just another unquestioned technology, available at the touch of a switch or a voice command, and arguably, digitally-enabled health and care will have come of age, when it is just seen as health and care. But there is a long, and probably tortuous journey before we arrive at that destination, and in this report, we focus on creating better conditions for digital technologies to be developed, adopted, deployed and used by people at scale. If this can be achieved, it will generate a more receptive environment for transformational innovation and commercial success.

The downside risks are deeply concerning. The UK's traditional economic champions (and big employers) in pharmaceuticals and life science, such as AstraZeneca, GSK, and Smith & Nephew, are being challenged by emerging global digital software providers, particularly from the US and China. These firms are concerned about being on the outside of a digital health and care revolution that might commoditise their products and services. Furthermore, digital integrators, software providers, and clinical treatment algorithms may have more leverage and success than traditional pharmaceutical and medical technology companies. Understanding and managing the Human Factor is as vital to the UK's economic health as it is to patient, user and consumer care.

Definition of Digital Health and Care

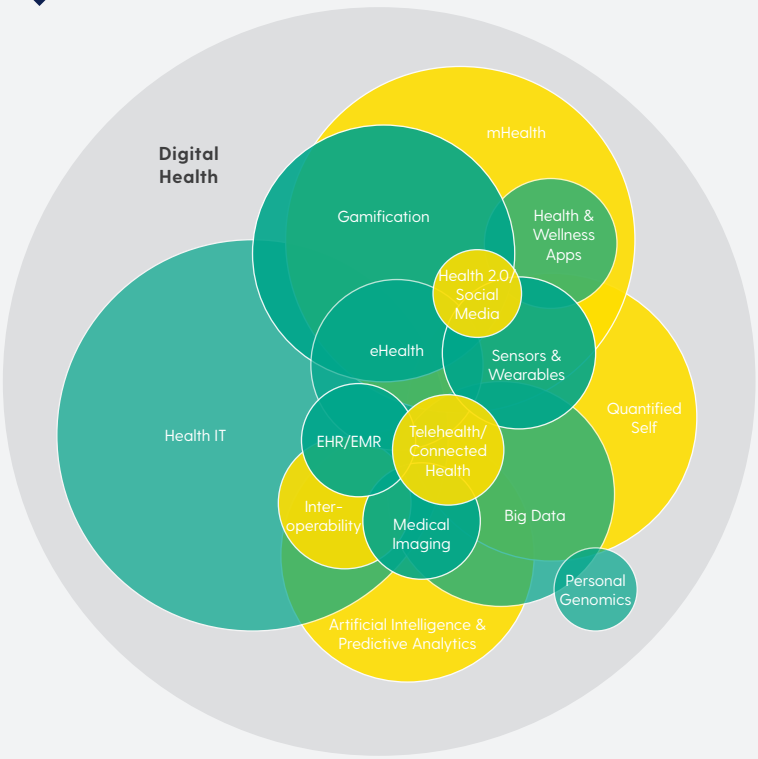
Over the past decade or so there have been multiple, competing and evolving classification systems for digital health and care. Some refer back to the network delivery technologies of the 2000s, and others forward to the complex meshing of the physical, biological and digital promised in the next health and care revolution. Older descriptions tend to focus on the delivery of existing services over digital platforms. For example, the World Health Organisation defines eHealth as: *the use of information and communication technologies (ICT) for health.*[2] However, others, such as Paul Sonnier, who convenes the largest digital health group on LinkedIn, claims that *digital health is the convergence of the digital and genomic revolutions with health, health and care, living and society.*[3] Others hone down on the transformational benefits of AI and big data to mine medical records (Google DeepMind Health), design treatment plans (Watson for Oncology), cognitive data review tool (IBM Watson Imaging Clinical Review), faster, safer drug discovery (AstraZeneca, GSK), building data lakes (Siemens Healthineers Digital Eco-System), and Machine Learning for Radiology (Microsoft Research and Cambridge University).

2 World Health Organisation (2018) eHealth at WHO. Retrieved from: http://www.who.int/ehealth/en/ (Accessed: January 2018).

3 Sonnier, P (2017) The Fourth Wave: Digital Health. A New Era of Human Progress. Independently Published: UK.

> AT THE HEART OF A SUCCESSFUL DIGITAL HEALTH AND CARE ECONOMY WILL BE PEOPLE NOT DIGITS

Figure 1: *The digital health landscape. Adapted from Innovatemedtech.*



Source: Innovatemedtech (2018) The Digital Health Landscape. Retrieved from: https://innovatemedtec.com/digital-health

We took an inclusive view that all these technologies and delivery systems are relevant to the core issue of strengthening the partnership between business, universities and government, and that all had implementation and scaling challenges at the human level (See figure 1). Overcoming these barriers to change through research, training, design, and education offers significant economic prizes for the health and care of the nation as well as the UK economy.

The UK lags significantly across a wide basket of digital measures. A 2013 survey of the deployment of eHealth services across Europe placed the UK 6th in the digital economy and society index, 19th in the provision of digital public services, and 20th in the provision of hospital eHealth.[4] (See figure 2)

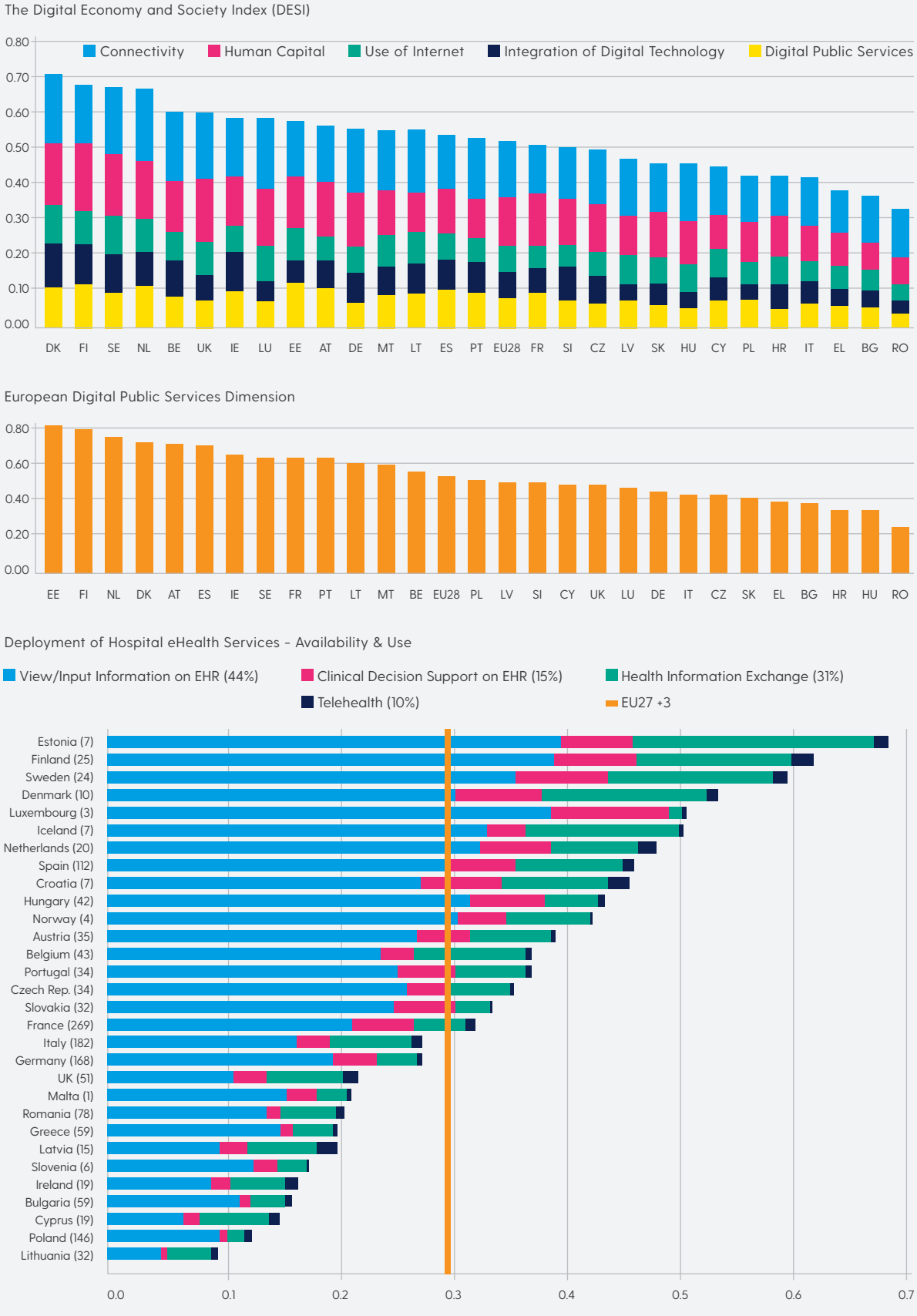
Comparisons are always problematic: different histories, economies, population sizes and demographics produce complex interrelated problems. But clearly some health and care systems are powering ahead and we should be trying to learn from them. For example: *'each person in Estonia that has visited a doctor has an online e-Health record that can be tracked. In order to keep health information completely secure and at the same time accessible to authorised individuals, the electronic ID-card system uses KSI Blockchain technology to ensure data integrity and mitigate internal threats to the data.'*[5] As a result, 95% of health data is digitised, 99% of prescriptions are digital, and there is 100% electronic billing in healthcare. Estonia's population is roughly that of Birmingham, but should the UK as a whole aspire to anything less? So, how might we get there?

First, we outline our conclusions and recommendations, before examining the evidence base. At heart we focus on changes in behaviour, cultures and systems.

4 Maghiros, I., & Sabes-Figuera, R. (2013). Composite Indicators on eHealth Deployment and on Availability and Use of eHealth Functionalities. European Hospital Survey: Benchmarking Deployment of e-Health Services (2012–2013). Retrieved from https://ec.europa.eu/digital-single-market/en/news/european-hospital-survey-benchmarking-deployment-ehealth-services-2012-2013.

5 e-Health Records – e-Estonia. Retrieved from: https://e-estonia.com/solutions/healthcare/e-health-record/ . (Accessed: March 2018).

Figure 2 - *Chute, C (2017). Digital Health & Care Benchmarking. Digital Health & Care Institute, University of Strathclyde*



Conclusions and Recommendations

01 Conclusion

Innovation in digital health and care technologies and processes continues to strengthen across the UK, and tech-savvy consumers are engaging with all kinds of apps and devices. **However, many primary and ancillary health and care professionals, as well as patients, consumers, and users lack the digital education and skills to drive system-wide change.** We commend the work on digital skills literacy undertaken by the NHS across the UK, the Local Government Association, and the Association of Directors of Adult Social Services. And, of course, the private sector. But there remain deep-seated challenges to widespread, sustained and enthusiastic adoption by those who most need to embrace it.

Recommendation

Establish a national Campaign for Digital Health and Care Skills. The Task Force legacy team will work with all relevant bodies, organisations, policy-makers and influencers on a national campaign to increase awareness of the need for digital skills for professionals, consumers, care users and patients. Amongst other things, it will campaign for:

- More integration of digital curricula into medical, health and care education in universities and colleges.
- Better and more communication with patients, users, and the general-public about the benefits of accessing and sharing their data.
- Data literacy: understanding what can and should be done with data and ways of managing data privacy.
- Public health education, particularly for older patients and their carers.
- Recognition within the Royal Colleges, medical, care, pharmaceutical and allied health bodies and councils of the benefit that digital solutions can offer to the delivery of patient and user care and the ongoing relationship between patient, user and care giver.
- Care practices that enable patients to gain maximum benefit from digital solutions.
- Promoting health and social care as an attractive and socially-responsible career choice for informatic and data scientists.

02 Conclusion

Implementation of successful change in digital health and care is complex, interrelated and most often fails if design and user-experience are not at the heart of the project, and where the human factor is overlooked in favour of technology push. Individual factors do not make or break technology implementation. The more complex an innovation or the setting in which it was introduced, the less likely it is to be successfully adopted, scaled up, spread, and sustained. We are concerned that even the digital projects flowing from the life sciences and AI strategies may still be too technology led, with top down implementation strategies. And that investment into more pilots and early stage projects may not, yet again, scale or achieve transformational change.

There is a massive difference between substitution and disruption. For example, online consultation services are substitutive because they still require medical staff to deliver the service. AI Health Assistants are disruptive because they encourage the patient to make appropriate decisions not to use face-to-face services. Innovation systems must recognise and cater for these different pathways. The NHS is, understandably, focused on augmenting and substituting, rather than the radical disruption being developed in the private sector.

Recommendation

User-centred design must be at the heart of digital health and care. And delivery projects must be assessed against proven, well-designed implementation frameworks, such as the NASSS approach outlined in this report. (See figure 10, p29).

03 Conclusion

There is an enormous gap between the digital skills of the health and care workforce and the present and future needs of the system. Universities and colleges must play a vital role in training and upskilling.

Nearly half of the NHS workforce is over the age of 45, with only 6% under 25[6]. The average age of an adult social care worker is 43, and a fifth are over 55.[7] Although the first web browser launched when these workers were in their 20s and 30s, and there was rapid take up in online consumer services, most are, at best, self-taught in digital. Moreover, the people needing most care are in the 60+ age bracket and probably require more support with the technology in their daily lives. This picture will obviously change as digital natives become both the workforce and the user; but until then we are in a transition period that puts extra strain on the system to adapt. The pace of change in the delivery of digital health and care must speed up to meet this challenge.

Even the next generation of graduate employees in the health and care sector are not systematically being prepared either at university or through CPD for the digital health and care environment of 2030. And informatics and data graduates are not being attracted into the NHS, the health and social care system, or life sciences businesses in the necessary volume or with sufficient quality. Furthermore, service improvement and organisational development teams often themselves lack the kinds of digital thinking required to deliver the new digital improvements.

Recommendation

The skills challenge needs scaled-up solutions and rapid take-up. These might include a digital literacy test for all health and care professionals, major curriculum review in medical schools, social care courses, and allied professional education to embed digital and data literacy and skills, and potentially mandated continuous professional development in digital.

6 NHSEmployers.org. Retrieved from: http://www.nhsemployers.org/-/media/Employers/Publications/Age-in-the-NHS.pdf. (Accessed: February 2018).

7 Davison, S; Polzin, G (2016) The state of the adult social care sector and workforce in England. Leeds. Skills for Care. Retrieved from: https://www.nmds-sc-online.org.uk/Get.aspx?id=980099 (Accessed: March 2018).

MEDICAL
Hospital
Pharmacist
Nurse
Dentist
First Aid
Surgeon
MEDICAL
Health Care
Doctor
Hospital
Pharmacist
Nurse
Dentist
First Aid
Surgeon
Emergency

04 Conclusion

Data protection has taken precedence over data sharing in health and care. We will show evidence that most patients in the health and care system are willing to share their data. The issue is how, to whom, and for what purpose. Furthermore, with the emergence of data safe havens and organisations such as Health Data Research UK[8], which support cutting-edge health informatics, academic researchers can drive deeper understanding of ways to benchmark clinical practice and feedback into frontline services. And this too, will enable businesses to drive out new models to build on this success.

Recommendation

Create an environment where sharing data is as vital as protecting it:

Building on a number of local information-sharing initiatives, the Health and Care National Information Board should work to establish a set of "exemplars" with leading health and care organisations to develop best-practice and guidelines. Based on the insights from citizen juries, it is clear that the key to successful implementation is establishing trust with professionals and citizens on how information is to be shared, and ensure upfront and ongoing transparency.

These exemplars will provide practical implementation and examples of the benefits of sharing data. They should focus on the development of key insight into how to establish effective public and professional engagement, the information governance framework for safe and secure use of data both to support individual care but also how to improve outcomes of population through the use of de-personalised data. They should focus on developing ways to establish effective public and professional engagement, and the information governance framework for safe and secure use of data, both to support individual care, and to improve health and care outcomes of the population through the use of anonymised data. In addition, they must not create more information silos. These exemplars should co-develop and implement interoperability and data standards to ensure that care information can be safely and securely accessed as citizens move across organisations and boundaries. These initiatives provide opportunities for local collabarations between academic, health, care and partner organisations to best serve their populations with the clear and transparent use of data, including how it is to be shared, and for what purpose.

Linked to this, the Department of Health and Social Care, or one of its arm's length bodies, should also begin a proactive and high-profile campaign to educate the public of the benefits of data sharing and build trust by ensuring that the public are aware of its importance for the safe delivery of care.

8 Health Data Research UK. Retrieved from: https://hdruk.ac.uk/. (Accessed: March 2018).

05 Conclusion

There is still a real gap in the research funding system for health and care technologies, particularly ones that try to grapple with the complexity of health and care systems. They come too high on the technology readiness level scale for the Economic and Physical Science Research Council; they are too complex and systems-wide for Innovate UK; too focused on health and care rather than medicine for the Medical Research Council, and on technology rather than delivery for the National Institute for Health Research. We are concerned that it is difficult to develop research proposals for researching deployment and usage that will be acceptable to any funder (or their review systems).

Recommendation

UK Research and Innovation (UKRI) and National Institute for Health Research to work together on multi-disciplinary research programmes on digital health and care.

Funders to initiate a joint call, with a view to creating a route for interdisciplinary "responsive mode" applications that focus on the complexity challenge and the Human Factor. UKRI have an established cross-sector programme on mental health, and Innovate UK is already funding digital health programmes. But the barriers to uptake are often the patient or user and badly-designed and implemented technology. Research that guides policy and practice to help overcome these social-psychological and design-based barriers is vital to the UK becoming a digital leader in health and care.

06 Conclusion

University knowledge exchange and technology transfer offices are often at the forefront of the sale of licensing or intellectual property and tangible university assets, learning and skills. We are concerned about the level and extent of specialist digital health and care knowledge amongst these professionals, and across the research base.

Recommendation

We strongly recommend that UKRI and universities establish well-funded mechanisms for continued and integrated innovation in digital health and social care, and translation into business. The UK must continually pioneer new solutions and technologies, as well as organisational and process breakthroughs, to be successful in the next digital health and care revolution. Furthermore, programmes developing research skills (e.g. PhD level) in AI and other advanced analytic and computational capabilities should have substantial focus on applied R&D training in an NHS and social care context through exchanges, co-supervision etc.

07 Conclusion

Health and social care are marked by a lack of risk-taking – and risk-takers – in procurement. Furthermore, tight budgeting constraints, limited organisational capacity, and regular short-term pressures on the NHS and the social care system are barriers to driving digital innovation from academia and business into daily practice.

Recommendation

NHS business-oriented programmes, such as the NHS Innovation Accelerator (NIA), the Clinical Entrepreneur Programme, and Scottish Health Innovation to engage more systematically with business schools and universities. This could be embedded in the Small Business Charter, and systematised with academics and knowledge exchange specialists at local universities to enable more and better partnerships and brokerage with local entrepreneurs. The Small Business Charter offers tangible advice from business schools to mainly local firms and can provide better, more practical mentoring for local and regional digital health entrepreneurs. Both innovators and commissioners need to become more aware of the barriers to roll-out in their organisations. This must be in the form of practical knowledge transfer and better corporate memory. More commissioners should be seconded to start ups and more start-ups need to work within the environment they are selling into. They require a general understanding that global digital technology does not overlay well on fragmented local decision-making structures.

08 Conclusion

Non-health and care digital products and services – such as videogames – show considerable, but largely unrealised potential in the UK's health and social care system.

Recommendations

Government departments responsible for health and social care, should work with universities, NHS and Innovate UK to collaborate with interactive media and games trade associations, such as TIGA and Ukie, to establish a standing network of therapeutic specialists and commercial developers.[9]

This network will provide advice on the rapid implementation of technology within clinical and care practice, whilst ensuring patient safety at all times. The development of guidelines in collaboration with the National Institute for Health and Care Excellence will aid implementation, whilst ensuring regulation of the industry. This will leverage the knowledge and skills of businesses accustomed to operating at scale with consumers and offer a better understanding of how to build networks of doctors, medical students, care professionals, and innovative businesses for other new services.

9 See our first report for analysis and recommendations. Jeans, J; Bryant, B; Borysiewicz, L; Docherty, D; Patel, N (2017) ***More than a Game:*** *Digital Healthcare and Healthy Living 2030 Task Force. National Centre for Universities and Business. London. Available from: http://www.ncub.co.uk/reports/more-than-a-game-digital-gaming-therapies-and-mental-health-in-young-people.*

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09 Conclusion

Entrepreneurs (including university spin-outs and start-ups), and businesses continue to struggle to build digital heath businesses in the UK, and the overall barriers for adoption discriminate against players with limited resources to 'take on the system'. A further problem is that young digital entrepreneurs are often technologists who may lack insight into the embedded and idiosyncratic policy and skills challenges in the health and care system. And experienced companies, who do have such understanding, are too often wedded to expensive solutions which were the product of the last digital wave, rather than the next.

We note the UK Government's response to the Life Science Sector's Industrial Strategy points to good solutions for streamlining innovation, particularly for SMEs.[10] It has:

- Established an Accelerated Access Collaborative for health technologies. This will develop a streamlined pathway to bring breakthrough products to markets and patients.
- Made available £86m of government funding to support innovators and local NHS.
- Through Innovate UK, launched an £8m Digital Health Catalyst to improve patient outcomes, transform health and care delivery, and enable more efficient delivery of health and care.
- Sought to improve the NHS's commercial capacity and capability.

We continue to be concerned, however, that without clarity of focus on scale and the Human Factor, these initiatives may suffer the fate of previous ones.

Recommendation

Guided by good systems and user-design, the NHS and care system should review approaches to risk and create more room for agility. This requires small amounts of funding that can be given to companies quickly, but also a recognised success route that leads to more support and assistance in marketing to the rest of the NHS. The Small Business Research Initiative grant system could dovetail with the Innovation Technology Tariff Programme, which has already been established to help innovators.[11] Innovators should be shown that all the programmes and initiatives are joined up and lead to the same ultimate outcome – human-oriented scaled-solutions backed by significant funding.

The system should be simplified for entrepreneurs. For example, there is the NHS Apps Library form, the CE mark for health and safety, the Medical and Health Council Regulatory Agency's level 1 medical process etc. There should be one process that covers technical, medical, data and user ability checks.

Establish a pilot and rapid rollout of the key principles contained in the Task Force report, with an innovative NHS Integrated Care System (ICS), an existing digital hub, a relevant disease area capable of showing early success.

These conclusions and recommendations will, we believe, put the Human Factor at the heart of digital health and care. They were built on and drawn from our evidence base of original research and a wide-range of secondary sources. And it is to these that we now turn.

10 HM Government (2017). Industrial Strategy: Life Sciences Sector Deal. OGL. London. Available from: https://www.gov.uk/government/publications/life-sciences-sector-deal.

11 NHS England (2016) NHS England announces first medtech devices and apps to join fast-track payment scheme for innovation. Retrieved from: https://www.england.nhs.uk/2016/11/innov-tech-tariff/ (Accessed: February 2018).

An Olympian Opportunity for the UK in Digital Health and Care

> "There is an Olympic-sized opportunity in digital technology but limitation in resources to enable the uptake of these."
>
> **VP and Head of Genomics, UK Pharma Company**

> "A lack of digital literacy development is a factor in the poor adoption of digital health technologies resulting in missed opportunities to support clients, patients and carers to self-care."
>
> **Health Education England Digital Literacy Literature Review, 2017[12]**

> "Across the value chain from early drug discovery to clinical research, digital health technologies are being applied to target identification, drug discovery, compound selection, patient identification for trials, data collection in research, product differentiation and launch and pricing and reimbursement."
>
> **Executive, Global Top Ten Pharma Company, Interviewed for the Task Force**

> "The challenge is to innovate, so older people's aspirations are met and that better, more effective care can support an independent lifestyle as they age. In working together, the government and industry can address the challenges of ageing while capturing a growing global market."
>
> **The Industrial Strategy Challenge Fund, UK Government**

The industrial context for this Olympian Opportunity is challenging, and Brexit will complicate matters, but there are major prizes to be won. For example, the Hall-Pesenti review of Artificial Intelligence took health as a core case study, pointing to its transformational potential, and arguing that AI would provide faster and more accurate diagnosis as well as earlier disease intervention.[13] Hall and Pesenti call for rapid advances in digital skills and data science, which would have significant spill-over benefits to health and care.

These initiatives are to be welcomed, but must fully address and embrace the Human Factor. For digital health and care to scale at the necessary speed we require informed and empowered patients and users, a highly-skilled and knowledgeable workforce, and liberated entrepreneurs and businesses.

There is a vital and potentially transformational intersection between the health economy and general prosperity. Health economics, which mostly drives the debate around the future of the NHS, is fundamentally about the rules, efficiency and ethics of resource allocation – clinicians, drugs, beds, therapists – within the public health system. Analysts have long argued that digital solutions can

12 Health Education England, Royal College of Nursing (2017) Literature review: Examining the extent to which digital literacy is seen as a challenge for trainers, learners and employees in the workplace. Health Education England. London. Available from: https://hee.nhs.uk/our-work/digital-literacy.

13 Hall, W; Pesenti J (2017) Growing the Artificial Intelligence Industry in the UK. Department for Digital, Culture, Media and Sport, and Department for Business, Energy, and Industrial Strategy. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/652097/Growing_the_artificial_intelligence_industry_in_the_UK.pdf (Accessed: February 2018).

solve some of the scarcity challenges. For example, forecasts suggest that the deployment of remote sensors and Internet-of-Health (and care) Things (IoHT) will save anything up to $300bn for health and care providers, as well as improving care, easing pressure on the system, and empowering patients.[14]

Digital wealth economics in health and care is different from that in other industries. Growing businesses (and profits) is subject to closer regulation, testing, scrutiny, price control and legislation. Put crudely, the closer the firm is to claiming a medical benefit for their product and service, the more expensive and restrictive will be the regulatory framework. Paradoxically, because therapeutic pharmaceutical must comply with regulatory licencing requirements, and be part of a prescription pricing process, its adoption in widespread clinical practice might be easier than digital technologies that require a significant change in working practices, even though the regulatory and pricing barriers are relatively low. However, incremental digital change with established and trusted technologies, continues to develop across the health and care and consumer health sectors.

Figure 3: *AI-based health applications will reach over six and half billion dollars in revenue by 2021*

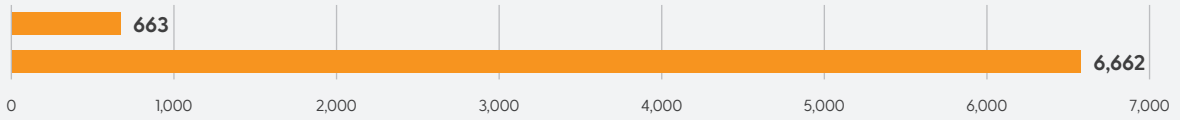


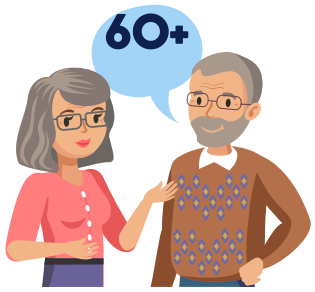
Figure 3: Source PwC (2017) What doctor? Why AI and robotics will define New Health.[15] Adapted from Frost & Sullivan (2016). Transforming healthcare through artificial intelligence systems. AI Health and Life Sciences.[16]

$6.7BN

AI-BASED HEALTH APPLICATIONS REVENUE BY 2021

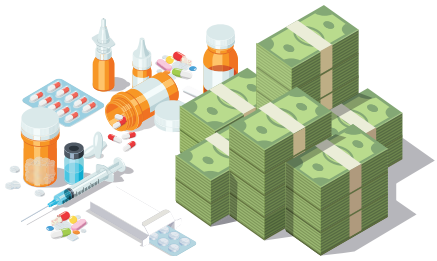
20%

ANNUAL VALUE GROWTH OF TRADITIONAL DIGITAL HEALTH DELIVERY



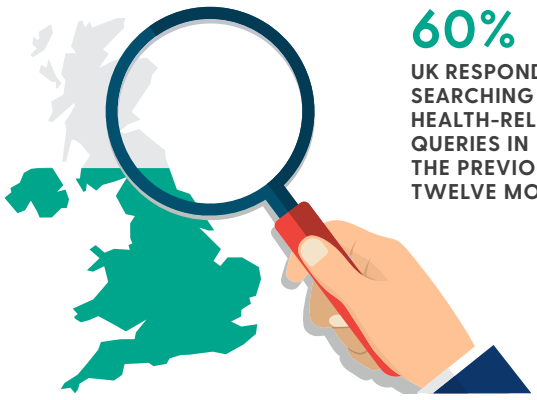
2BN

PEOPLE OVER THE AGE OF 60 BY 2050



£11.7BN

POTENTIAL REVENUE TO THE PHARMACEUTICALS INDUSTRY FROM NEW, DIGITALLY-DRIVEN BUSINESS MODELS



60%

UK RESPONDENTS SEARCHING FOR HEALTH-RELATED QUERIES IN THE PREVIOUS TWELVE MONTHS

14 Sandle, T (2017). How the Internet of Things will shape healthcare. Digital Journal [online]. Available from: http://www.digitaljournal.com/life/health/how-the-internet-of-things-will-shape-healthcare/article/498183 (Accessed: February 2018).

15 PWC (2017) What doctor? Why AI and robotics will define New Health. [online]. Retrieved from: https://www.pwc.com/gx/en/industries/healthcare/publications/ai-robotics-new-health/ai-robotics-new-health.pdf (p.19).

16 Frost & Sullivan (2016). Transforming healthcare through artificial intelligence systems. AI Health and Life Sciences. Available from: http://ai-healthandlifesciences.com/hypfiles/uploads/2016/08/AI-Healthcare-Research-Insights-KisacoResearch.pdf.

The global market for all kinds of digital health and care is significant and growing, in some cases exponentially.

The overall value of traditional digital health delivery is expected to grow at more than 20% a year, driven mainly by mHealth and smart-phones. The Maier review of industrial digitalisation attributes £11.7bn of potential revenue to the pharmaceuticals industry from new, digitally-driven business models.[17] Globally, there are likely to be two billion people over the age of 60 by 2050. UK businesses must take advantage of digital markets created by this rise in older consumers, patients and users.

These predictions are, of course, predicated on consumer demand and high levels of satisfaction. Health and care consumers (not necessarily patients) use and value information services. An EU flash report in 2014 noted that 60% of UK respondents had searched for health-related queries in the previous twelve months, and been content with the results. (See figure 3)

This satisfaction spills over into market dynamics. For example, online retailing increased its share of overall UK consumer health sales in 2017, challenging the supermarkets' status as the largest distribution channel outside health and beauty specialist retailers. Reasons include: convenience, discretion, and the general shift to online shopping. Health consumers are voting with their credit cards.[18] (See figure 4)

Furthermore, despite signs of slowdown, wearable technologies - which are potential medical platforms - continue to grow. (See table 1)

Table 1: *Forecast for Wearable Devices Worldwide 2016-2018 and 2021 (Millions of Units)*

Device	2016	2017	2018	2021
Smartwatch	34.80	41.50	48.20	80.96
Head-mounted display	16.09	22.01	28.28	67.17
Body-worn camera	0.17	1.05	1.59	5.62
Bluetooth headset	128.50	150.00	168.00	206.00
Wristband	34.97	44.10	48.84	63.86
Sports watch	21.23	21.43	5621.65	22.31
Other fitness monitor	55.46	55.70	56.23	58.73
Total	**265.88**	**310.37**	**347.53**	**504.65**

Table 1: Source Gartner (2017)[19]

As of 2017, there were 325,000 mobile health apps – a robust 25% growth on the previous year. According to estimates, the value of IoHT will top US$163 billion by 2020, with a Compound Annual Growth Rate (CAGR) of 38.1 percent between 2015 and 2020 (See figure 5). Within the next five years the health and care sector is projected to be #1 in the top 10 industries for IoT development.

However, despite this consumer growth, there are major sets of issues with adoption, rejection and scale by patients and users. One significant challenge is that online consumer markets tend to be driven first by a young, relatively affluent, tech-literate, and mobile demographic. And from early niche they reach mass uptake and deployment. Publicly-funded digital health and care, by contrast, is broadly aimed at a mirror image of this group, and that is at the heart of the Human Factor.

17 Made Smarter Review (2017). Retrieved from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/655570/20171027_MadeSmarter_FINAL_DIGITAL.pdf (p38) (Accessed: March 2018).
18 Country Report (2017) Consumer Health in the United Kingdom. Retrieved from: http://www.euromonitor.com/consumer-health-in-the-united-kingdom/report (Accessed: March 2018).
19 Gartner (2017) Gartner Says Worldwide Wearable Device Sales to Grow 17 Percent in 2017. Retrieved from: https://www.gartner.com/newsroom/id/3790965 (Accessed: March 2018).

Figure 4: *UK Users of Online Health Information*

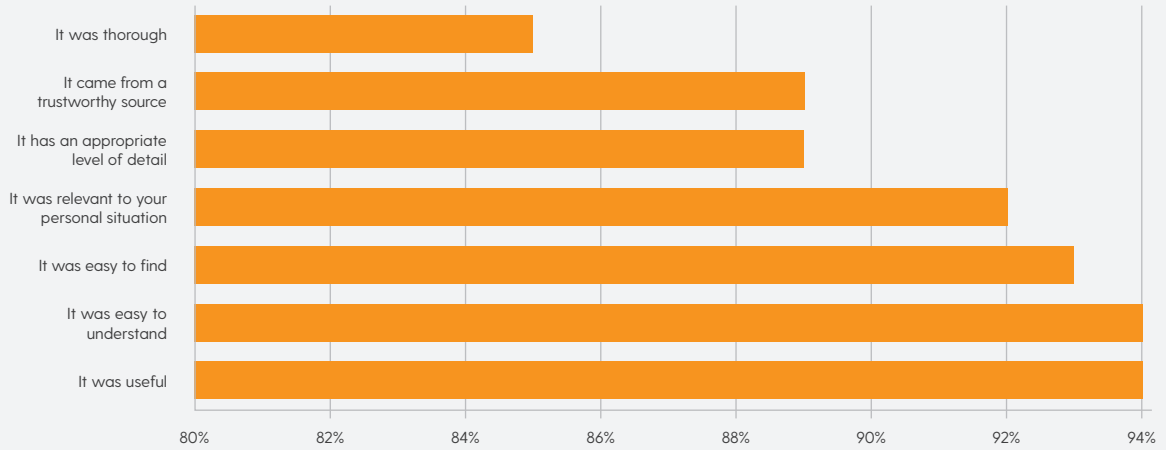
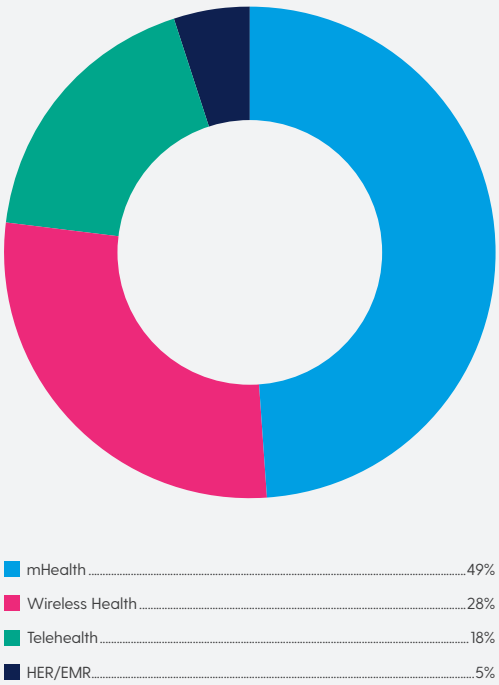


Figure 5: Source TNS Political & Social (2014)[20] UK Users of Online Health Information. Q.20 Let's talk about the quality of information you found on the internet... (multiple answers possible). Base: Respondents that used the internet to search for health-related information within the last 12 months (N: 15598).

Figure 5: *Projected Compound Annual Growth Rates for the global digital healthcare market between 2015-2020, by major market segments. Adapted from Statista, 2017.[21]*



20 TNS Political & Social (2014) European Citizens' Digital Health Literacy. European Commission. Retrieved from: http://ec.europa.eu/commfrontoffice/publicopinion/flash/fl_404_en.pdf (Accessed: March 2018)

21 Statista (2017). Projected CAGR for the global digital health market in the period 2015 – 2020, by major segment. Statista. Retrieved from: https://www.statista.com/statistics/387875/forecast-cagr-of-worldwide-digital-health-market-by-segment/ (Accessed: January 2018).

Design, Data and Delivery – the role of the Human Factor

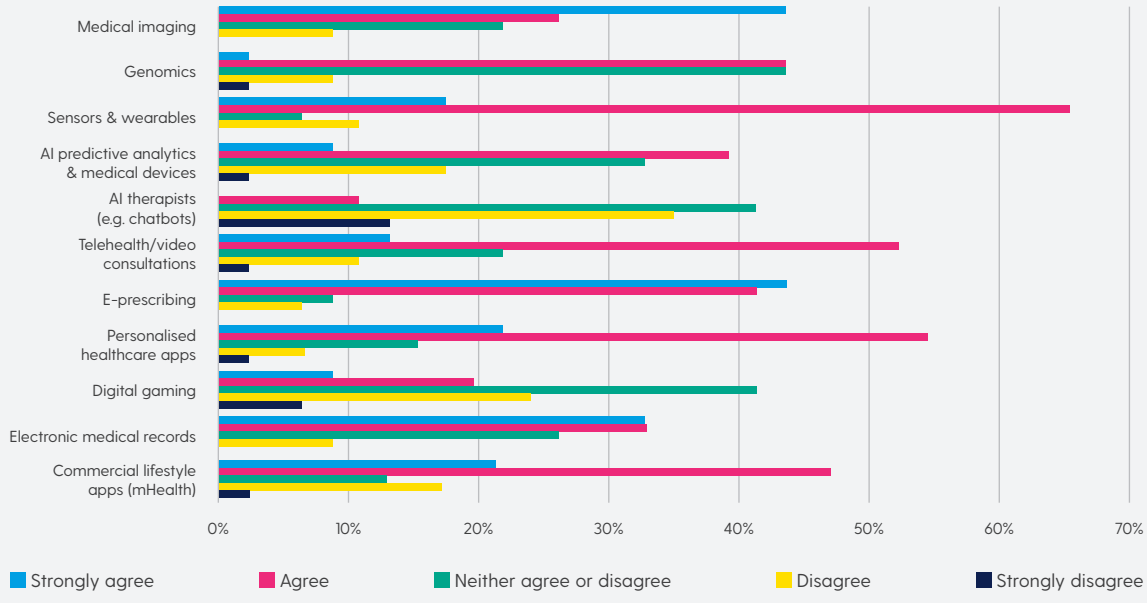
> "All aspects of care from appointments, consultations, treatment plans and management can be improved with the use of digital technology."
>
> **Senior Clinical Consultant, NHS – Interview for Task Force**

We explored the barriers to the promised digital health future with senior academic clinicians, and business and technology experts.

Provider Perception of Consumer Demand and Supply

First, we asked about the appetite for various types of services.

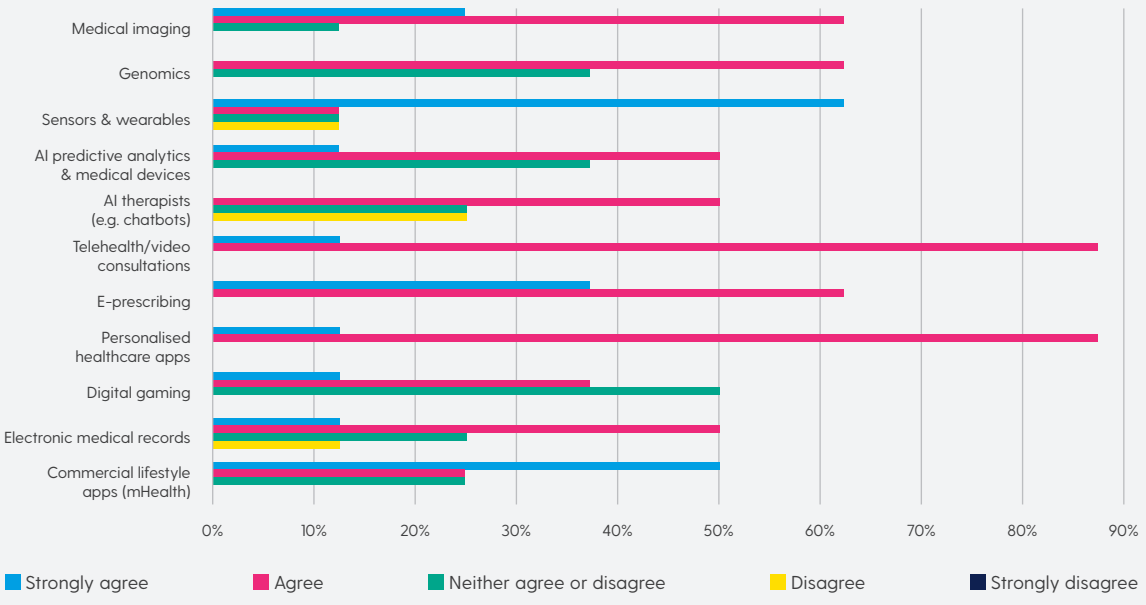
Figure 6: *In your view, what is the level of appetite amongst patients for the following digital healthcare products/services (n=65).*



Source Academic Clinicians. NCUB Survey 2018

Clinicians in the survey emphasised health applications and more classic e-health technologies like medical imaging and e-prescribing, and the commercial sector underscored the value of personalised health and care apps, telehealth and gaming. However, there is broad agreement amongst the providers about what patients and customers want, and how it should be delivered (See figures 6 and 7).

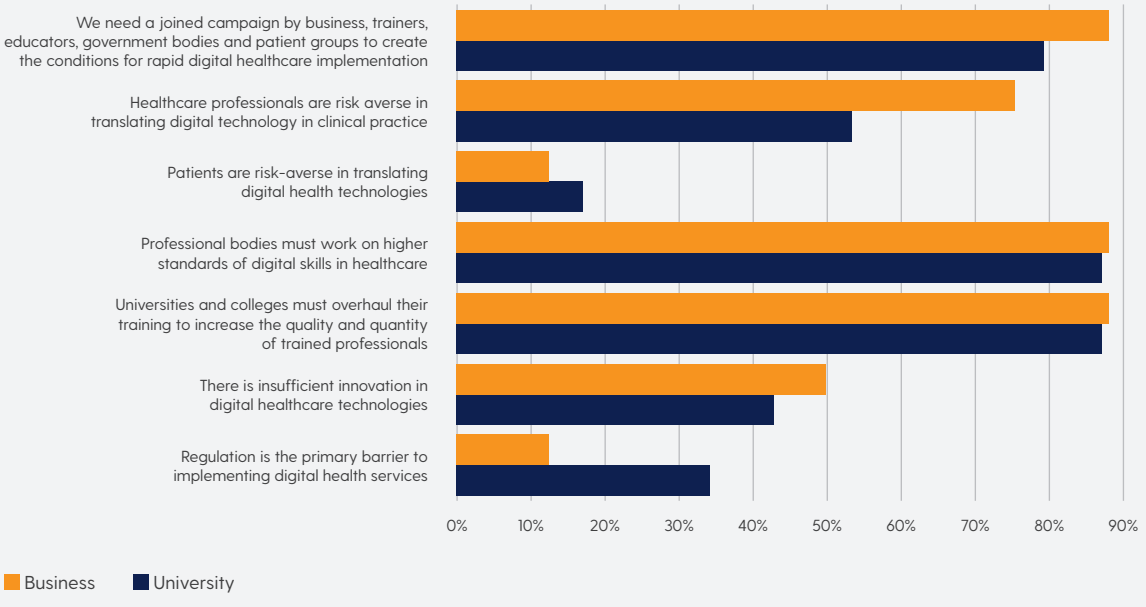
Figure 7: *In your view, what is the level of appetite amongst patients for the following digital healthcare products/services (n=15)*



Source Business and Technology Leaders. NCUB Survey 2018

The research also explored barriers to demand and supply. Again, there was unanimity on communication challenges, the risk-averse nature of health and care professionals, and the need to overhaul training, education and standards. These results fed directly into our recommendations for an integrated digital skills campaign, and changes to the ways in which frontline and ancillary professionals are (continuously) educated, and the need to attract more information specialists into health and care.

Figure 8: *How much do you agree or disagree with the following statements? (n=78)*



Source Academic Clinicians and Business Leaders. NCUB Survey 2018

> The use of multiple IT systems for different aspects of clinical care creates significant day-to-day challenges.... For example, each hospital usually has at least one IT system for looking at patient imaging, another for requesting imaging scans, one system for pathology results, often a different one for histopathology results, another system for medical notes while in hospital, one for outpatient clinic letters and a further system for an electronic drug chart.
>
> **Junior Doctor, NHS, Interviewed for the Task Force.**

As health and care becomes more patient- and user-focused, providers and businesses clearly understand their digital responsibilities. However, there are continued technology challenges. The 2015 digital maturity assessment of 239 NHS trusts revealed that:

ONLY 16%
provided adequate resources for technology implementation and change management.

7%
of health and care professionals had access to a consolidated view of their patients' local health and care records.

18%
of trusts provided digital access to all relevant diagnostic test results and images for patients under their care, including those undertaken by other local providers.

28%
had digital systems to alert health and care professionals of patients whose clinical observations or early warning scores are deteriorating and need review.

10%
had digital prescribing routinely performed across all specialties, departments and sites.

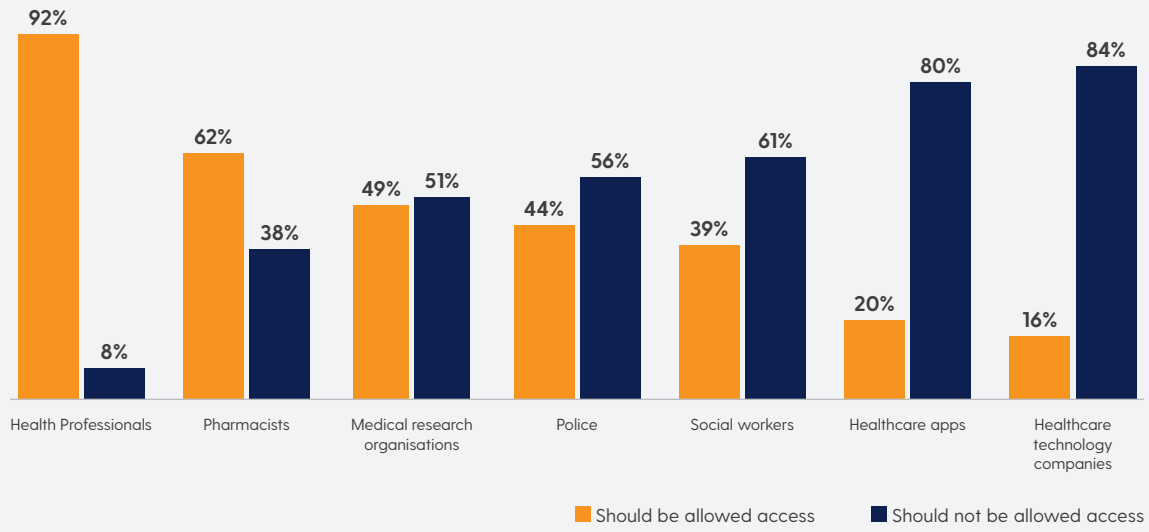
Driving the skills agenda requires IT platforms to support 21st century digital health and care. However, even assuming widespread technical diffusion and scaling over time, patients, users, providers and businesses must reach agreement on the use and guardianship of data if the UK is to successfully implement the right kind of innovative and entrepreneurial environment to deliver the industrial strategy and support the NHS and care system.

Privacy and Sharing Data – Who Guards the Guardians?

An overwhelming majority of the public (92%) are happy for their health records to be shared across the health system, and yet eight out of ten have never accessed them, and most claim not to know how. And while increasing numbers are embracing digital apps and smart devices to monitor their health and wellbeing, most UK adults are still wary of data privacy issues, particularly when it comes to sharing with the tech companies behind the products. (See figure 9)

This leads to a vital regulatory issue about data and data sharing that must be resolved if government, universities, innovators, and businesses are to work together more effectively and systematically on behalf of the patients, users, and consumers.

Figure 9: *Patient willingness to share health data*



PWC (2017) Health Records[22]

> **AN OVERWHELMING MAJORITY OF THE PUBLIC (92%) ARE HAPPY FOR THEIR HEALTH RECORDS TO BE SHARED ACROSS THE HEALTH SYSTEM**

Health and care technology companies obviously have some way to go before they persuade patients about their added value, but there is an overwhelming willingness to allow health professionals access (and to a lesser extent, medical research organisations).[23] This supports our conclusion that data sharing in a secure manner is fundamental.

22 PWC (2017) Health Records. Retrieved from: https://www.pwc.co.uk/industries/healthcare/patients-voice/health-records.html (Accessed: March 2018).

23 Local data for local use is acceptable to patients and health providers. See: New JP et al. BMJ 2 Jane 2018; 360 https://www.bmj.com/content/360/bmj.j5554.full Putting patients in control of data from electronic health records. See also: Caine K, Hanania R (2013) Patients want granular privacy control over health information in electronic medical records. J Am Med Inform Assoc. Jan 1; 20(1):7-15.

Control of health and care data is in the hands of data controllers. Caldicott Guardians (CGs) are senior members of staff responsible in each NHS organisation and local authority for ensuring data privacy and protection. In Clinical Commissioning Groups (CCGs), who plan and commission health and care for their local areas, patients can be confident that their data and information is being handled according to the law. The CCGs also have a responsibility to support data sharing for clinical care; but concerns about breaches of data protection, confidentiality, and ensuring patient consent, too often precludes the use of data for research.

Care fragmentation is a troubling side-effect of this caution. Organisations are often unsure as to when sharing data is appropriate and, possibly, critically important. Coroner's reports have emphasised the dangers of not sharing information on, for example, allergies, medication, mental ill health and a patient's vulnerability to risk to self or others. Two tragic examples include a patient who died after being given penicillin due to failures in sharing allergy details amongst medical professionals[24]; and where lack of information sharing was named as a contributory factor in a teenager's suicide.[25]

> **THE DRIVE FOR THE SUCCESSFUL INTEGRATION OF HEALTH AND CARE MEANS THAT INTEGRATED DATA SHARING MUST PROCEED AT PACE, OR IT WILL SERIOUSLY HAMPER PROGRESS**

24 STV News (2017) Patient died after being given penicillin despite allergy. Retrieved from: https://stv.tv/news/west-central/1380808-patient-died-after-being-given-penicillin-despite-allergy/ (Accessed: February 2018).

25 Inquest (2016) Coroner's report on death of 14-year-old girl raises serious concerns over Priory-run mental health unit. Retrieved from: https://www.inquest.org.uk/coroner-report-concerns-priory-run-mental-health-unit (Accessed: February 2018).

ORGANISATIONS ARE OFTEN UNSURE AS TO WHEN SHARING DATA IS APPROPRIATE AND, POSSIBLY, CRITICALLY IMPORTANT

Patients and users move across and between many different organisations. A simple example is treatment for a knee replacement. The patient will be treated by the GP, the physiotherapist, the occupational therapist, and the acute hospital where the operation will take place. If they are suffering from mental illness, ongoing support will also be provided by the mental health and community trust and social care providers. A monolithic system to manage this data flow was designed for paper records held within filing cabinets. It is unsustainable for 21st century digital care. This problem is compounded by the lack of interpretation, and sometimes clear NHS Trust and local government policies, which means that in extreme cases, data controllers will stick to the letter of the Data Protection Act, even though the legislation allows for information that may save a patient's life to be shared. The drive for the successful integration of health and care means that integrated data sharing must proceed at pace, or it will seriously hamper progress.

Over the past few years, there have been 61 initiatives in local information-sharing for health and social care. However, while these have led to success, the lack of common standards means we are in danger of developing new silos unable to support care when an individual moves between different localities, or when they are a member of a cohort of patients whose needs are best served at a wider geographical level (e.g. regional burns units or the Centre for Rare Diseases).

Consequently, NHS England are looking to establish a set of Local Health and Record Exemplars (LHCREs) to "raise the bar" in how the NHS and its partners share information safely and securely to help deliver better care for our populations. Each exemplar must adhere to a secure, robust, and transparent information governance framework (including the national opt-out framework), demonstrate meaningful and ongoing engagement with the public (based on the principles of 'no surprise'), and be willing to work with the other exemplar sites and national bodies to co-create a set of standards that will become mandatory for all Local Health and Care Records.

The primary focus of local Health and Care Record Exemplars will be on improving and coordinating individual care. Local communities will be able to utilise this information to support local health and care planning and management as well as to better understand the health and care needs of their local population.

In addition, the UK Government has recognised these challenges and, in England, will:

- Establish Digital Innovation Hubs for research, subject to strict guidelines.
- Set out clear and consistent guidelines for interoperability.
- Streamline ethical approval for researchers via NHS Digital.
- Create a sandbox for secure remote data access for anonymised data.

We welcome and support these initiatives. However, the success of translating digitally-orientated interventions is dependent on the UK having an adequately-skilled workforce to deliver, and on patients and carers willing to use. And, no matter the legislative environment, or the theoretical willingness of patients and users to share, it remains true that in the real world, with deployed services, take-up is slow, patchy, and seldom sustained.

Digital Vision meets Analogue Reality

A comprehensive review of uptake and scaling of digital health and care solutions demonstrates that many small-scale, proof-of-concept telehealth services are rarely mainstreamed or sustained, and that non-adoption and abandonment of such technologies by their intended users is common.[26] It offered telling examples:

- In Norway, despite the geographical remoteness of many patients, a history of early adoption of telehealth, a strong policy push, and adoption in principle by 75% of all hospitals, fewer than 1% of outpatient consultations in participating specialties were undertaken via telehealth in 2013.
- In an extremely busy prenatal diabetes clinic, video consultations aligned poorly with a context involving multidisciplinary teams (patients were typically seeing multiple clinicians across departments) for a relatively short-term but high-risk condition. This was compounded by the absence of integrated records (paper medical notes were held by the patient so not physically at hand for the clinician).
- In a heart failure clinic, the physical examination (e.g. heart rhythm, leg oedema) that the nurses considered essential was not easy in the remote environment (although sometimes possible with patient and caregiver assistance).

The study concluded that individual factors did not make or break technology implementation; it was the dynamic interaction between them. The more complex an innovation or the setting in which it was introduced, the less likely it was to be successfully adopted, scaled up, spread, and sustained. It offered a framework to guide the Human Factor, and isolated seven underpinning factors for potential success or failure: condition or illness, technology, value proposition, actual or intended adopters, organisation, wider system, and the process of adaptation over time. (See figure 10)

> “Planners and policymakers have often been overly focused on technologies and distracted by simplistic models and metaphors of technology adoption by individuals (e.g. ‘tipping point’). They have paid scant attention to the dynamic socio-technical system into which new technologies and care practices must become embedded. This system has seven interacting domains, which we consider below. Each can be simple (few components, predictable – as in making a sandwich), complicated (multiple components but still largely predictable – as in building a rocket) or complex (dynamic, composed of multiple interacting elements, and unpredictable – as in raising a child).”[27]
>
> **Trish Greenhalgh, Professor of Primary Health Care Sciences, University of Oxford**

Such frameworks[28] may seem daunting to teams trying to implement major (or local) digital health and care programmes, but without a clear understanding of context, patient, carer, clinician, funder, business executive and policy-maker the results are clear: many – if not most – programmes will fail. In 2018, reports of major problems with the $4.3bn electronic patient records system for the US military, suggest that even within a closed system and with multi-billion-dollar technology, without the Human Factor the technology can fail at scale.[29] User-led and provider-informed design is more important in digital health than any other industry.

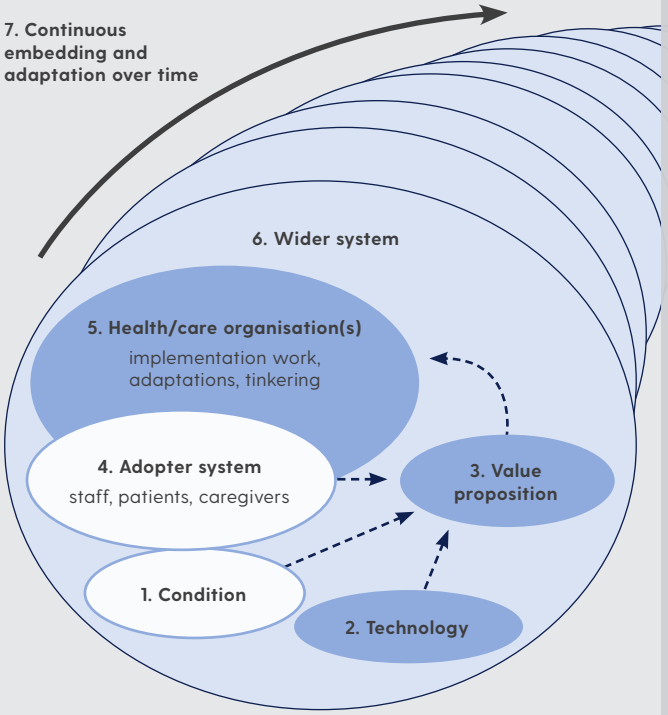
26 Greenhalgh T et al. Beyond Adoption: A New Framework for Theorizing and Evaluating Nonadoption, Abandonment, and Challenges to the Scale-Up, Spread, and Sustainability of Health and Care Technologies. J Med Internet Res 2017;19(11):e367.

27 Greenhalgh, T (2018) Personal Communication. 9th January.

28 See also Kayser, L. et al. (2018) A Multidimensional Tool Based on the eHealth Literacy Framework: Development and Initial Validity Testing of the eHealth Literacy Questionnaire (eHLQ). JMIR publications. Vol 20 (2).

29 Allen, A (2018) We took a broken system and just broke it completely. Politico. Retrieved from: https://www.politico.com/story/2018/03/08/veterans-military-health-system-trump-386232. (Accessed: February 2018).

Figure 10: *The NASSS framework (Greenhalgh et al J Med Internet Research 2017; 19 [11]: e367)*



1. CONDITION
- Nature of condition or illness
- Comorbidities
- Socio-cultural factors

2. TECHNOLOGY
- Material properties
- Knowledge to use it
- Knowledge generated by it
- Supply model
- Who owns the IP?

3. VALUE PROPOSITION
- Supply-side value (to developer)
- Demand-side value (to patient)

4. ADOPTERS
- Staff (role, identity)
- Patient (passive v active input)
- Carers (available, type of input)

5. ORGANISATION(S)
- Capacity to innovate in general
- Readiness for this technology
- Nature of adoption and/or funding decision
- Extent of change needed to organisational routines
- Work needed to plan, implement and monitor change

6. WIDER SYSTEM
- Political/policy context
- Regulatory/legal issues
- Professional bodies
- Socio-cultural context
- Inter-organisational networking

7. EMBEDDING AND ADAPTATION OVER TIME
- Scope for adaptation over time
- Organisational resilience

Increasingly, in business, design thinking is being recognised as a vital management tool. By putting users at the heart of every decision, developing a much more iterative approach to innovation, and adopting a visual approach to the articulation of ideas, more effective, user-led solutions are being created.

Apple is the most high profile example of an organisation with design thinking at the very heart of the culture of the organisation. It is not focused on being at the digital or technological leading edge, rather its highest single priority is the best, the most consistent user experience. Such design-led thinking is increasingly being adopted in public services and in the health and care system. With the user, patient, clinicians and allied health and care professionals and the administrator at the heart of the decision-making process we believe that better, more sustainable solutions to the real problems can be achieved.

Design, in its deepest sense, must be incorporated into the successful deployment of multi-disciplinary teams and frameworks. Digital solutions in health and care need just as much, if not more, design input as consumer products to ensure that they work for all. This was demonstrated in another, vital lesson of the Greenhalgh study: many clinicians and health professionals are uncomfortable with digital technology as a means of delivering health and care. A minority were reluctant to refer patients or engage with trial protocols, citing “previous bad experiences with telehealth,” concern that a remote monitoring service would threaten their jobs, or a perception that patients “deserved better”. This brings us to the heart of the provider element of the Human Factor: the training, education, and continuous development of health and care staff. Our focus, here, is on the role of universities and colleges.

Research, Technology, and Education – the role of universities and colleges

> Establish a coalition of funders to create the Health Advanced Research Programme to undertake large research infrastructure projects and high risk 'moonshot programmes', that will help create entirely new industries in health and care.
>
> **UK Life Sciences Industrial Strategy 2018**

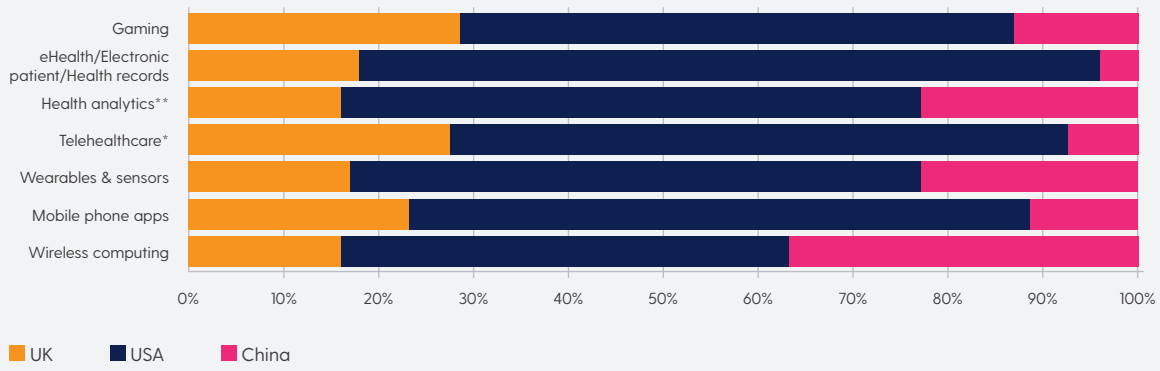
> Currently there is very little evidence to support how best to incorporate digital tools into practice. Stanford faculty have the expertise to help with the design and implementation of new digital health tools.
>
> **Associate Professor of Medicine, Stanford University**

Research excellence and translation

There are six highly-regarded, multi-disciplinary Digital Health Institutes across UK universities – UCL, Strathclyde, Warwick, Oxford, Nottingham, and Cambridge. Others, such as Manchester University, are deeply integrated into the regional health and social care system.[30] Cumbria, Edinburgh and Imperial College focus on digital health training and leadership.[31] Finally, other higher education institutions are developing strong links with digital entrepreneurs, such as the University of Leeds £10m plan to develop Yorkshire medical technology and bring innovative products to market[32] and the University of Liverpool technology hub utilising £3.5m to explore the role of 5G in healthcare[33]. Additional examples include, Bradford's Digital Health Enterprise Zone; Scotland's Digital Health and Care Institute, hosted at the University of Strathclyde, and mhabitat – an NHS hosted team which brokers collaboration between the NHS, academia and health tech companies.[34]

The US leads the way in digital health research (with China following hard), but a citation review conducted for the Task Force showed the UK with a broad range of research interests. (See figure 11)

Figure 11: *Number of publication citations in digital health and care (2016-Jan 2018)*



***Health analytics includes machine learning, artificial intelligence, genomics, sequencing, information and precision health and care.*

**Tele-Health and care includes Telecare and Telehealth*

Source: Scopus database.

30 Manchester Ecosystem. Available from: http://www.manchesterecosystem.org.uk/

31 University of Cumbria. Digital Health and Social Care Education and Training. Available from: https://www.cumbria.ac.uk/research/centres/cachet/digital-health-and-social-care-education-and-training/; Imperial College London. PgDip Digital Health Leadership. Available from: https://www.imperial.ac.uk/study/pg/medicine/digital-health-leadership/

32 Leeds University (2018) New £10m plan to develop Yorkshire medical technology. Retrieved from: https://www.leeds.ac.uk/news/article/4209/new_10m_plan_to_develop_yorkshire_medical_technology (Accessed: April 2018)

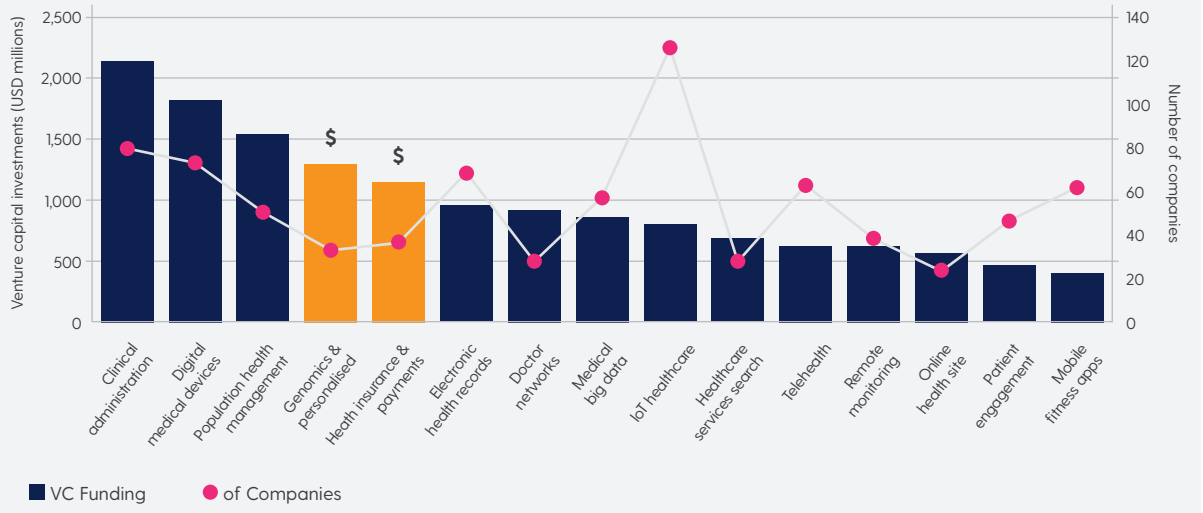
33 Digital Health (2018) Liverpool technology hub awarded £3.5m to explore 5G in healthcare. Retrieved from: https://www.digitalhealth.net/2018/03/liverpool-technology-hub-explore-5g-healthcare/ (Accessed: April 2018).

34 University of Bradford. Digital Health Enterprise. [online]. Available from: https://www.bradford.ac.uk/alumni/get-involved/digital-health-enterprise-zone/; Scottish Development International. Digital health and care. [online]. Available from: https://www.sdi.co.uk/invest/sectors/technology/digital-health-and-care; mhabitat. People Centred Digital Innovation. [online] available from: https://wearemhabitat.com

As always, excellence in research does not always translate into excellence in translation, implementation and commercialisation. Resources that break down barriers to business-university collaboration are already in place, including the establishment of UKRI, continuing work of the National Institute for Health Research, the Industrial Strategy Challenge Fund, brokerage platforms like Konfer, Interface, and Expertise Wales, and Innovation Centres for ageing, healthy living, and digital health technologies. But the UK-system must also successfully leverage and work with private capital and public funding to create and sustain many more digital health and care companies in the UK, as well as reduce cost and improve patient, user, and consumer outcomes.

Venture Capital underpins investment across a range of digital health technologies (See Figure 12).

Figure 12: *Graphical representation of total venture funding on health technology to the number of companies within each category. Health Technology Market Report and Data. Appcessories, 2016*[35]



The UK still risks being left behind in the race for commercial success in digital health and care. US digital health start-up companies have received 75% of global private investment since 2013, followed by India (4%), China (3%) and the United Kingdom (3%)[36].

Although companies such as Babylon, Antidote.me, LumiraDx, and BenevolentAI have attracted significant funding[37], and personalised medicine, genomics and health insurance innovations have gained most traction, innovation systems in other countries are driving hard at integration, translation and market leadership. For example, in 2017, Stanford University launched the Stanford Center for Digital Health to support their faculty and help Silicon Valley digital health and care entrepreneurs make sense of the landscape. The Center recognises the challenge at the heart of this report – how to shape the Human Factor in practice.

In 2015, $378 million was invested in Boston-based digital health start-ups, and Massachusetts, with its strong university core, is making a bid to be the pre-eminent digital health and care eco-system in the world. To do so, they are joining up 350 companies, 79 hospitals, academic medical centres, and innovative players. They offer high quality infrastructure, sandboxes, and world-leading researchers to the entrepreneurial base. (See figure 13). This is supported by a high-profile Digital Health Council, a public-private partnership that advises the administration on the future of the Commonwealth's digital health and care industry.

35 Appcessories (2016) Venture Investing Health Technologies. Retrieved from: http://www.appcessories.co.uk/state-health-technology/ (Accessed on: February 2018)

36 Research Briefs (2017) Healthy Planet: Mapping Digital Health Startups Across The Globe. CBINSIGHTS. [online]. Available from: https://www.cbinsights.com/research/digital-health-startups-world-map/

37 Carey, S (2018) 22 UK healthtech startups to watch. Techworld. Available from: https://www.techworld.com/picture-gallery/startups/uk-healthtech-startups-watch-3653416

Figure 13: *The Massachusetts digital healthcare ecosystem*

Source: http://massdigitalhealth.org/why-massachusetts

THE BUSINESS SKILLS REQUIRED TO NAVIGATE THE DIGITAL HEALTH ENVIRONMENT ARE, IN MANY WAYS, FAMILIAR TO ALL INDUSTRIAL SECTORS STRUGGLING TO COME TO TERMS WITH THE 4TH INDUSTRIAL REVOLUTION

To compete, the UK must ensure that its universities are as embedded into the digital health knowledge exchange process as those in California and Massachusetts. Furthermore, as the UK cannot outspend the US, our systems for procurement and deployment into the NHS, and the high quality of research in UK universities, must be connected more effectively in the ecosystem. We noted earlier that patients and consumers are willing to share their data for research – although there is a sensible debate about opt-in versus opt-out, and patient control over what might be shared – but there remain significant standardisation challenges across primary and secondary care systems that must be overcome to drive research excellence.

Digital skills and education

> Modern health and social care environments need lifelong, self-directed learners. They also need capable digital users and knowledge workers. We need to know which learning and teaching approaches fit with future practice and support better learning outcomes.
>
> **Royal College of Nursing and Health Education England Digital Health Literacy Report 2017**[38]

> We need formal 'board certification' for clinicians in informatics, and if the Royal Colleges were a good model, a Royal College of Informatics.
>
> There is no formal teaching (in digital health). Most health professionals are self-taught.
>
> Regulatory bodies are slow to recognise the importance of including digital in the curricula. The evidence-base for the role of digital technology and how it should be taught is also scant.
>
> Medical school curricula are constantly discussing this but with limited resources and high regulation it is difficult to keep ahead of the curve.
>
> **Senior Academic Clinicians – Interviews for the Task Force**

38 Health Education England (2017) Improving Digital Literacy. Royal College of Nursing: 006 129.

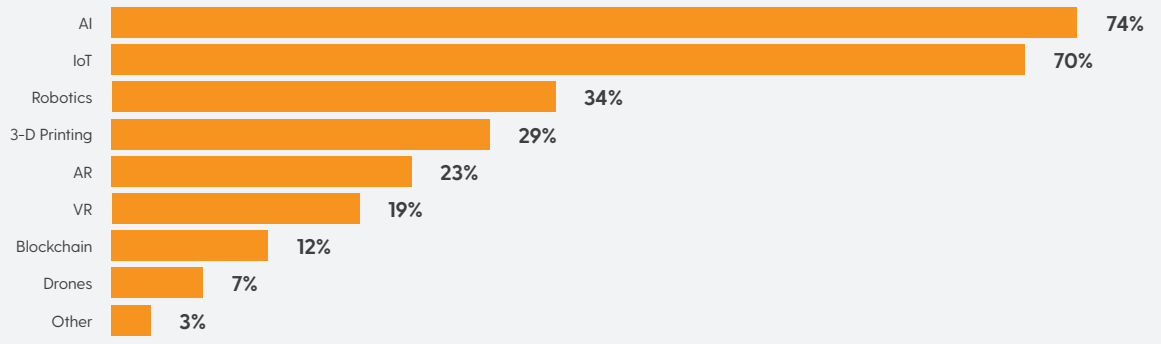
The lack of digital skills and training in the health and care and life-sciences workforce is at the heart of the Human Factor, and is the most important barrier to large-scale adoption, implementation, scaling and profitability. In March 2017, across Hospital and Community Health and Care Services (HCHS), the NHS employed (full-time equivalent): 106,430 doctors; 285,893 nurses and health visitors; 21,597 midwives; 132,673 scientific, therapeutic and technical staff; 19,772 ambulance staff; 21,139 managers; and 9,974 senior managers.[39] Life Sciences supported 482,000 UK jobs in 2015. These comprise 140,000 direct employees of Life Sciences firms, 196,000 jobs in the supply chain and 146,000 supported through induced effects.[40] The number of adult social care jobs in England as at 2016 was estimated at 1.58 million.[41]

How many are digitally trained? Surely, all should be offered structured pathways to digital literacy alongside creating the specialist skills required to ensure high-quality technical development and deployment of health and care systems. And as importantly, innovation within the system will flow from a digitally literate workforce.

The business skills required to navigate the digital health and care environment are, in many ways, familiar to all industrial sectors struggling to come to terms with the 4th Industrial Revolution. But, because of its unique nature a range of other competencies are required, such as software, engineering and data specialists who currently work for Google or Facebook. This data and analytical skills gap is at the top of every CEO's to do list. A 2017 PwC investment survey of Health and Care, Pharmaceutical and Life-Science (PLS) companies showed a similar pattern to other industries. (See figure 14)

> **PHARMACEUTICAL COMPANIES NEED THE KINDS OF SOFTWARE, ENGINEERING AND DATA SPECIALISTS WHO CURRENTLY WORK FOR GOOGLE OR FACEBOOK**

Figure 14: *The replace this title with: What healthcare and PLS execs plan to invest in within three years*



Source: PwC (2017) Global Digital IQ Survey. Healthcare, Pharmaceutical & Life Sciences.

This is a digital health world far in advance of remote monitoring and telecare of the past. A UK system that it is yet to be fit-for-purpose for the first or second waves of digital is seriously ill-prepared for the next tsunami. Life science and pharmaceutical companies are, of necessity, embedding digital skills throughout their business. Furthermore, new entrants and start-ups will bring digital skills learned in consumer products to the healthcare market. Amazon has linked up with JPM/Berkshire Hathaway, but have also signalled their intent to enter the pharmacy market. Furthermore, Apple have announced use of their HealthKit for patient records in the US,[42] and Google/Alphabet have investments in life-sciences through Google ventures/Google X/Calico, in addition to Deep Mind.

39 NHS confederation (2017) NHS statistics, facts and figure. Retrieved from: http://www.nhsconfed.org/resources/key-statistics-on-the-nhs (Accessed February 2018).

40 Pisani J, Ambler M, Snook R (2017) What impact does Pharmaceutical and Life Sciences have on the UK economy? PWC: Health Matters. Retrieved from: http://pwc.blogs.com/health_matters/2017/03/by-jo-pisani-mark-ambler-and-richard-snook-life-sciences-is-a-critical-industry-for-the-uk-which-brings-life-saving-and-lif.html (Accessed February 2018).

41 Skills for Care (2017) The size and structure of the adult social care sector and workforce report in England, 2017. Leeds. Available from: www.skillsforcare.org.uk/sizeandstructure

42 Ramsey, L (2018) Apple is going after a project Google abandoned - easy access to your complete medical records. Business Insiders UK. Retrieved from: http://uk.businessinsider.com/apple-complete-medical-health-records-iphones-2018-1?r=US&IR=T (Accessed: March 2018).

This activity brings with it a culture of fast-moving innovation and transformation that still must market and sell to slower-moving health and care providers. This might provide an opportunity for nimble entrepreneurs to find ways to mediate between traditional pharmaceutical, life sciences and health technology companies, and health and care commissioners and data providers.

Universities and colleges must step rapidly into delivering this new wave of skills and competencies if the UK is to continue to be a market leader in health, care, and life sciences. Health and social care workers are marked by their willingness (indeed professional imperative) to engage in lifelong learning. (See figure 15).

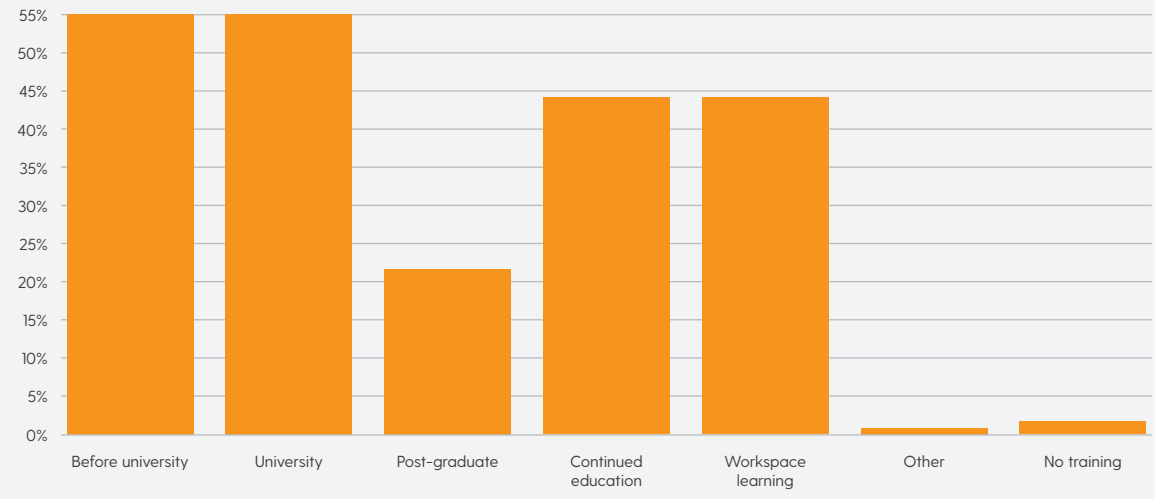
Most professionals in the public-health and care system are frustrated by their lack of training in digital health, not just in the UK but across the EU. In a 2016 European Parliament survey of digital skills for health professionals, 79% said that eHealth/mHealth will have a significant impact on their careers.[43] It will offer more time with patients and less with 'paper-work', increase efficiency, simplify daily work, help find information faster, and improve communication with other caregivers. However, 61% had never received any training, and 80% agreed that what was available was poor.

The European Commission is looking to mandate tailored training programmes that would be continuous and embedded in workplace training and CPD. It will update clinical guidelines to include e and m-Health, and make health and care professionals co-developers by placing them at the centre of the development process. Alongside this, it has launched a cross-border eHealth Hub to provide long-term support to the ecosystem and address key challenges facing European digital health SMEs to fine-tune business models, secure investments, engage the demand-side, accelerate commercialisation, and gain legal and regulatory guidance to develop solutions in compliance with a multi-layer complex framework.

As the UK leaves the EU, its health and social care workforce, and businesses, must be ever smarter and more agile, and be backed by a flexible and supportive culture and management.

A further pressing issue is the recruitment and retention of specialists in, for example, data analytics. A 2016, KPMG study of Chief Information Officers reported that health and care companies face the greatest skills shortages in big data/analytics, project management, change management, and security and resilience. This is equally true of the NHS and must urgently be addressed.[44]

Figure 15: *When and where should digital training happen?*



Source: Digital-skills-for-health-professionals. 2016

43 European Health Parliament: Committee on Digital Skills for Health Professionals (2016) Digital Skills for Health Professionals. [online]. Available from: http://4883dc5101.url-de-test.ws/wp-content/uploads/2017/09/Digital-skills-for-health-professionals.pdf

44 The Creative CIO (2016) CIO Survey 2016 Healthcare Sector Findings. KPMG. [online]. Available from: https://assets.kpmg.com/content/dam/kpmg/xx/pdf/2016/10/cio-survey-2016-healthcare.pdf

> **USE OF PATIENT DATA CREATES THE POTENTIAL FOR MAJOR BREAKTHROUGHS IN RESEARCH, CLINICAL PRACTICE AND ENTREPRENEURIAL SUCCESS. BUT DATA ITSELF IS NOT ENOUGH**

As we have argued earlier, the use of patient data creates the potential for major breakthroughs in research, clinical practice and entrepreneurial success. But data itself is not enough. It must be actionable, provide clinical guidance, and aid decision-making. And even here, the Human Factor is crucial. The doctors, nurses, care-workers and allied professionals will never be as data-literate as the IT professionals, and therefore translational skills are vital. Furthermore, when patient data is so rich, multifaceted and pervasive, can release really be restricted to Caldicott Guardians or data controllers? All staff must be educated in the use and restriction of data.

There are admirable CPD higher degrees in developing doctors to translate and integrate digital health and care. Additionally, Cass Business school has an Executive Masters in Medical Leadership (EMML)[45] Strathclyde runs a course in digital health systems,[46] and UCL-Farr puts on short courses in, for example, Electronic Health Records.[47] But these are small programmes when the challenge is one of scale. The NHS is recognising this with the launch of the NHS Digital Academy, but even here numbers are limited to 300 a year and focused on Chief Information Officers and Chief Clinical Information Officers.

The problems are complex, deep and system-wide, as recognised by the Royal College of Nursing's Every nurse an *e-nurse* campaign.[48] The sheer scale of the digital skills and competencies challenge demands a joined-up, integrated UK-wide response from business, educators, the government, NHS, entrepreneurs and academic researchers. This must explore radical solutions to the challenges facing the UK, including, but not exclusively:

- A potential digital literacy test for all NHS and care professionals.
- Major curriculum review in medical schools and allied health and social care courses, to embed data literacy and digital skills.
- Mandated continuous professional development in digital.
- Training for data controllers on sharing rather than restricting data.

The undergraduate intake of 2030 are entering secondary school in the next few years. The health and care professionals and business executives of 2030 are in our universities and colleges today. Now is the time for our generation to make the difference to the world in which they practice and thrive.

45 CASS Business School. Executive Masters in Medical Leadership. Available from: https://www.cass.city.ac.uk/study/executive-education/our-programmes/executive-msc-in-medical-leadership

46 University of Strathclyde Glasgow. MSc Digital Health Systems. Available from: https://www.strath.ac.uk/courses/postgraduatetaught/digitalhealthsystems/ Also see: British Journal of Healthcare Computing (2018) A Hotbed of Health IT Innovation: Keele University. Retrieved from: http://www.bjhc.co.uk/hotbed-health-it-innovation-keele-university (Accessed: February 2018).

47 UCL Farr Institute London Short Courses (2018) Harnessing Electronic Health Records for Research. Available from: http://www.ucl.ac.uk/farr-short-courses

48 Royal College of Nurses (2017) Every Nurse an e-nurse. [online] Available from: https://www.rcn.org.uk/clinical-topics/ehealth/current-work

Conclusion

> The environment has never been as ripe as it is today.
>
> **Head of Digital, Global Top 10 Pharmaceutical Company – Interview for the Task Force**

> Implementing new technologies as part of changes to health and social care services is inherently challenging. While policy makers are calling for technology to be implemented rapidly and at scale, the reality is that when dealing with the multiple complexities of health and care, it is extremely difficult to go beyond small-scale demonstration projects.
>
> **Greenhalgh et al**

The health and care system as we know it today will need to reorganise itself, with digital as an enabler and catalyst.

This will allow work to be done in different locations, at the patients, consumers or users convenience, and with different sets of skills. We have stressed integration, open data, and the necessity of radical and incremental change. There will always be a sensible balance between pragmatism and vision, but if the UK is to seize the golden prizes in digital health and social care, we must embrace it wholeheartedly. We must go all-in to win.

"CHAMPIONS AREN'T MADE IN THE GYMS. CHAMPIONS ARE MADE FROM SOMETHING THEY HAVE DEEP INSIDE THEM -- A DESIRE, A DREAM, A VISION."

MUHAMMAD ALI

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**Some titles have since changed*

Glossary of Abbreviations

AI	Artificial Intelligence
AR	Augmented Reality
BN	Billion
CAGR	Compound Annual Growth Rate
CCG	Clinical Commissioning Groups
CGs	Caldicott Guardians
CE	Conformité Européenne
CEO	Chief Executive Officer
CPD	Continuous Professional Development
EMML	Executive Masters in Medical Leadership
EU	European Union
GSK	GlaxoSmithKline
GP	General Practitioner
IBD	Inflammatory Bowel Disease
IBM	International Business Machines
ICS	Integrated Care System
ICT	Information and Communication Technologies
ID	Identity Documents
IOHT	Internet of Health and Care Things
IOT	Internet of Things
IT	Information Technology
JPM	John Pierpont Morgan
KPMG	Klynveld Peat Marwick Goerdeler
KSI	Keyless Signature Infrastructure
LHCRE	Local Health Care and Record Exemplars
MHRA	Medicines and Healthcare products Regulatory Agency
M	Million
NASSS	Non-adoption Abandonment, Scale-up, Spread and Sustainability
NCUB	National Centre for Universities and Business
NHS	National Health Service
NIA	NHS National Innovation Accelarator
OGL	Open Government Licence
PhD	Doctor of Philosophy
PLS	Pharmaceutical Life Sciences
PWC	PricewaterhouseCoopers
R&D	Research and Development
SBRI	Small Business Research Initiative
SMEs	Small and Medium-Sized Enterprises
UCL	University College London
UK	United Kingdom
UKRI	United Kingdom Research and Innovation
US	United States
VP	Vice-President
VR	Virtual Reality

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