DIGITAL HEALTH & CARE INSTITUTE

Review of Emerging Trends in Digital Health and Care

A report by the Digital Health and Care Institute

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a collaboration between

INNOVATION SCHOOL THE GLASGOW SCHOOL OF ART

University of Strathclyde Glasgow

Contents

1. Introduction

This report has been written by the Digital Health and Care Institute (DHI), as commissioned by the national Technology Enabled Care (TEC) Programme.

DHI is a collaboration between the University of Strathclyde and the Glasgow School of Art as part of the Scottish Funding Council's Innovation Centre Programme. It is partly funded by Scottish Government to support digital innovation between academia, public services and Scottish businesses with a focus on harnessing innovation to seek and solve key challenges for the health and care sector – 'transforming great ideas into real solutions.'

A review of emerging trends in Digital Health and Care was requested by TEC to help inform the future direction of the programme and support wider digital interests in Scotland. As the digital environment is fast-paced and constantly fluctuating, the trends which are identified capture the position of the Digital Health and Care sector at Autumn 2018, with a probable 'shelf-life' of around 3 - 5 years.

This report provides an overview of the emerging trends in Digital Health and Care but does not claim to be exhaustive. The report is based on rigorous research but has not been subjected to an academic peer-review process.

2. Current Digital Health and Care activity

The emerging Digital Health and Care sector does not have a single and agreed upon definition, which reflects the dynamic and constantly developing nature of the technological revolution that we currently operate within [1]. The sector has been characterised as arising from the intersection of Health and Care services, information technology, mobile technology and as encompassing digital products that can monitor, analyse, educate and improve health and wellbeing [2].

At its most basic level, Digital Health and Care is about electronically connecting points of care for easier and more secure sharing of relevant health and wellbeing information [3]. This is also seen in definitions that emphasise the changing nature of the relationship between citizens and care providers, which see citizens engaged as part of their own care teams, managing their health and wellbeing using digital technologies, devices and applications [4]. It should be noted that much of the existing literature and comments focus specifically on 'digital health' rather than 'digital health and care'. Where relevant and appropriate, DHI has used its own expertise and experience in this area to extend references beyond Digital Health to include the Care sector.

Frost and Sullivan provided the following definition of Digital Health in 2017: "Digital health refers to a vast market of information technology applications, platforms and services leveraged by healthcare providers, payers, med tech and life sciences companies, patients, and consumers. (It) is highly dynamic and fast moving and sits at the intersection of multiple major vertical markets, including healthcare, the information communication technologies space, automotive, and many others" [5].

The Digital Health (and Care) sector was divided into the following four subsectors by Deloitte in 2015 (as displayed in Figure 1) [2]. Much of this remains current.

1. Telehealthcare
2. mHealth (or Mobile Health)
3. Analytics
4. Digitised Systems

Telehealthcare

Telecare and telehealth provide support and assistance for a patient/service user/client at a distance using Information and Communications Technologies (ICT); remotely exchanging information and data between a citizen and a care provider. According to Deloitte, the key distinction between telehealth and telecare is that telehealth systems enable the user to exchange clinical data with their clinician, while telecare systems monitor users to provide assistance at a distance (for example falls detection) [2]. The boundaries between these sub-sectors are becoming increasingly blurred, as new functionality and capabilities emerge. Telehealthcare is increasingly developing more integrated care solutions and overlapping with mHealth as it moves out of bespoke hardware-based approaches into software-based solutions [2].

Frost and Sullivan reported in 2017 that Telehealth markets were continuing to gain momentum with the

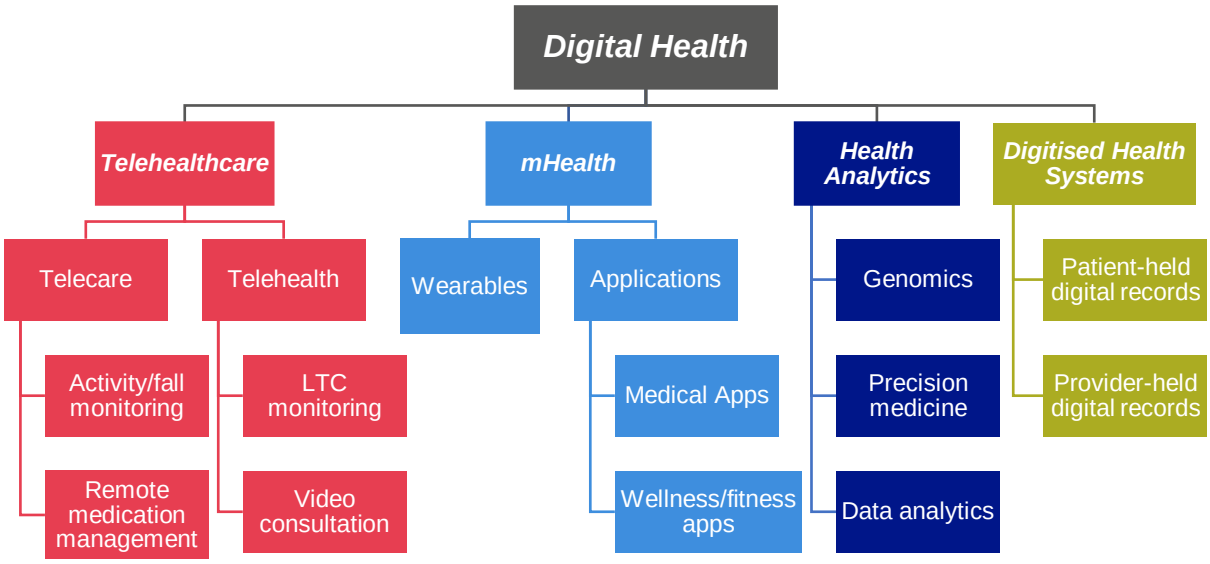


Figure 1: Sub-categories of Digital Health in the UK. Adapted from Deloitte UK (2015) [2].

market focus being on widening adoption and efforts being made to quantify the value of the services. In particular, they want to focus on "the need to de-emphasise the term telehealth and concentrate instead on the value associated with replacing haphazard in-person care with a patient-engaged continuum of care" [5].

mHealth

mHealth refers to the use of smart mobile devices and wearable technologies that collect health and wellbeing data; deliver health and care information to citizens, care providers and researchers; perform real-time health and wellbeing monitoring and can facilitate the provision of direct care. [2]

Wearables are hardware products, e.g. wrist-worn devices that monitor activity levels, heart rate and sleep patterns. Applications are software-based health solutions ranging from consumer-driven wellness and fitness apps to professional-driven medical apps.

Analytics

Health (and Care) Analytics encompass software solutions and analytical proficiencies required to integrate and utilise Big Data. It covers the collection, use and application of data analytics that relates to individual and population health, using both clinical and research and development datasets. Healthcare analytics is widely regarded as a key enabler of value-based care because it allows for data-driven decision making.

Digitised Health Systems

Digitised Health Systems refer to the management, secure storage and exchange of digital health and care information between citizens and care providers, for example, by using electronic personal health records.

Digitised Health (and Care) Systems are generally divided into citizen-held and citizen-controlled personal records, and system-held records. The former tends to entail more advanced digital versions of traditional paper records, with greater personalisation and functionality .

3. Digital Health and Care Market

The Digital Health and Care sector is part of the wider Digital Technology sector, which is one of the fastest growing economic sectors in the world. The global Digital Transformation market was valued at $150 billion in 2015 and is predicted to increase in value to $431.7 billion by 2021, growing at 19.2% Global Cumulative Annual Growth Rate (CAGR) between 2016- 21[5]. The global Digital Health market is predicted to grow at an even higher rate at a 25.9% CAGR to 2024, exceeding a value of **$370 billion by 2024** [6]. A driving factor for the growth of the global digital health market is the growth of start-up companies fed by early-stage investments from accelerators, incubators and Venture Capital Firms. In 2016, early stage investors injected approximately $5.4bn globally into digital health start-ups [5,6, 7]. The UK market size for Digital Health in 2015 was £2 billion and was expected to reach £2.9 billion in 2018 (see Figure 2).

In the UK, the Digital Technology economy was creating jobs twice as fast as the wider economy in 2017 [8, 9]. The same trend is evident in Scotland, where the Digital Technology sector is the fastest growing economic sector over all, predicted to expand twice as fast as the rest of the Scottish economy until 2024 [10, 11]. The Scottish ICT sector is projected to require 12,800 new employees per year until 2020 to satisfy the need for a sufficiently skilled workforce [11]. The expansion of the Digital Technology sector is creating significant employment opportunities for skilled workers, young people and other new entrants to the field [11]. These trends are also reflected within the Digital Health and Care sector.

Figure 3 displays the global Digital Health market by major segment in 2015 and 2016, with a projection from 2017 until 2020 [12]. Statista valued the global Digital Health market at $79

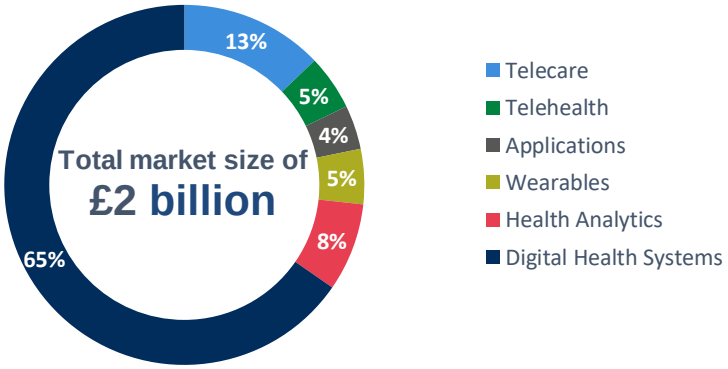


Figure 2: UK Digital Health Markets. mHealth has been divided into Wearables and Applications. Adapted from Deloitte 2015, p. 8 [2].

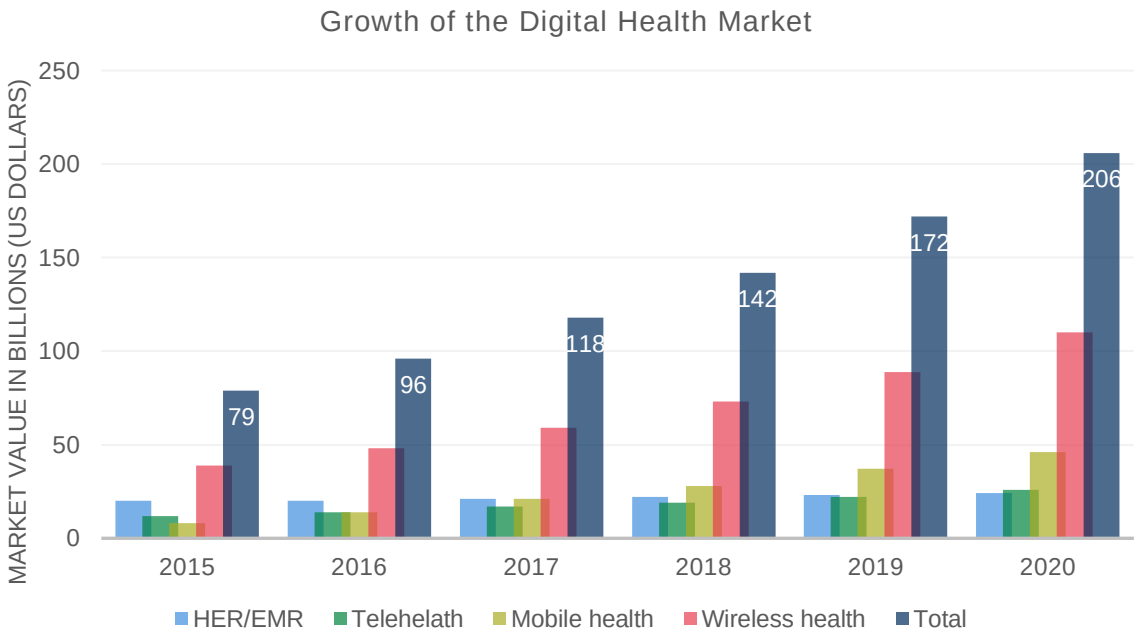


Figure 3: The growth of the Digital Health Market. Adapted from Statista [12].

billion in 2015, expecting that it will exceed $200 billion by 2020. This growth will be driven primarily by the mobile and wireless health markets [12]. According to Deloitte, on the other hand, the global market for Digital Health in 2014 was worth £23 billion and was expected to almost double at £43 billion by 2018 [13]. The global CAGR for Digital Health is at 18%. The differences in the figures are most likely down to divergent definitions of the Digital Health sector used by the evaluators. With this in mind, it is useful to view the individual sub-sectors in more detail to get a clearer picture of the Digital Health market, rather than the composite view used by market evaluators such as Statista.

3.1 mHealth

The fastest growing and the most promising market sub-sector of Digital Health market both globally and locally is Mobile Health (mHealth). Deloitte Centre for Health Solutions predicts Europe to become the largest mHealth market worth $7.1 billion with predicted annual growth of 61.6%, but Statista has pointed to the Asia-Pacific region as the main growth area for this market [12, 13]. This emerging market is expanding due to high consumer demand, and common prevalence of smart phone ownership. For example, in 2017 the smart phone penetration in the UK rose to 85% of the adult population; in 2018 it was reported that there were over 318k health apps available for smart phones, and that 59% of women looked for health-related information online, compared with 50% of men [13]. The wearables market expanded at 24% CAGR in the UK, and at 21% globally. However, a recent update from Silicon Valley states that “2017 was the first year in which smartphone unit shipments didn’t grow at all. As more of the world become smartphone owners, growth has been harder and harder to come by. The same goes for internet user growth, which rose 7% in 2017, down from 12% the year before. With more than half the world online, there are fewer people left to connect” [14].

Therefore, the steep growth in mHealth may begin to slow down from 2018 onwards

The thin line between wearables, health apps and medical devices is blurring, and technology vendors are now focussing on integrating the clinical, fitness and wellness dimensions to take advantage of the quantified-self trend in the mHealth domain [5]. However, **monetisation in the market is being restricted due to the absence of a clear reimbursement model and possibly the lack of clinical approval.** This is a problem, not only in the UK's NHS and Social Care sector, but also more widely throughout the EU [12, 13]. However, as the pathway for regulation and approval of mobile apps becomes clearer, mHealth adoption in clinical settings and mHealth prescriptions may become more prevalent [5]. Figure 4 shows the different organisations that are involved in Health and Wellness across the globe and that will continue to have an influence in this domain towards 2025 [15

3.2 Telehealthcare

Telehealthcare is the second largest subsector of the market, contributing 13% of the UK Digital Health market with around 1.8 million UK service users in 2018, and approx. 180,000 service users in Scotland [16]. This sector is mature and well-established, thanks to the UK being an early adopter of telecare with strong central Government backing and a robust cost/benefit assessment in Scotland. This has created a steady infrastructure of existing hardware supporting the adoption and use of Telecare services. The UK Telecare market was predicted to grow by only by 4-5% CAGR by 2018 [2, 13, 17]. In comparison to Telecare, Telehealth – the remote exchange of clinical data between a patient and the health service – is not as well-established a market in the UK and is currently more

Figure 4: Organisations involved in Health and Wellness globally in 2017 [15].

dynamic and faster growing than Telecare (approx. 18,000 current users in Scotland). The worldwide Telehealth industry is forecast to grow from approximately £700 million in 2014 to £1.2 billion in 2018, showing a CAGR of 13-14%. Telehealth and Telecare are already merging with the mHealth Apps market, which is currently segmented by the apps' target audience (consumer vs. professional) [2, 17]. It is important to note that within the next 5 years, telecommunication systems across Scotland will move from an analogue to a digital infrastructure, as analogue infrastructure is being gradually replaced by the Telecommunications sector [18]. This presents a **significant opportunity for new preventative and integrated service models and solutions,** which is recognised by Scotland's Digital Health and Care Strategy [18].

3.3 Health Analytics

Health Analytics is an emergent and fast expanding market sub-sector. The growth prediction is at 24% CAGR in the UK, and 22% globally by 2018. The UK is being hindered from becoming a world-leader in this sector due to **shortages in relevant skills and capabilities** (e.g. staff with data analytic and data science skills), **limited access to consistent and significant data, and data governance challenges** [12, 13]**.**

3.4 Digital Health Systems

The largest of the four sub-sectors in the UK is Digital Health Systems, with a 66% share of the market. This includes electronic health records (EHR) and e-prescriptions, with a total existing market size of £1.3 billion. The UK is a global leader in the sector thanks to the early adoption of primary care electronic health records, but adoption has been slower in acute hospital settings. The market is now saturated, with the market share only predicted to grow at 6% CAGR in the UK and at 7% per annum globally by 2018. **The market could be accelerated through incentivising the use of EHR platforms, by investing in interoperability between systems, and in cyber security to move data securely between organisations. Attention is also needed on safe storage of confidential data, data linkage and reliable analytical practices** for supporting clinical, other professional and self-management of decision making. [12, 17]

A push to improve data interoperability is still a major trend within the Digital Health Systems domain, because it is a key enabler to connect the 'ecosystem' of health IT, and also social care. Scotland's Digital Health and Care Strategy released in 2018 promotes the need for a joined-up approach when it comes to the sharing of data between different levels of the NHS and social care. It states that "the (strategic) board will drive forward this agenda by: Making key national decisions, including on areas such as the standards required to deliver interoperability and information sharing across health and care" [page 9, 18].

4. Emerging Trends in Digital Health and Care

Digitisation has progressed over the last ten years through advances in digital technologies and genomics. While the internet, mobile networks, IT and social networking form the basis upon which digital health and care can be built, the developments in next generation communication networks, mobile and wireless devices, hardware sensors and software sensing technologies, microprocessors and integrated circuits have taken the field forward [51]. The use of Big Data and the Internet of Things (IoT) will also play a significant role in digital health and care in the future, assisting, for example, clinical and self-management, decision support, predictive analytics and innovations in population health. Outwith health and care, these technological advances are rapidly transforming the world of work and leisure, with the majority of organisations going through a digitisation process in terms of their service delivery models. [19- 23]

In their recent report, "2018 Global Health Care Outlook", Deloitte summarises what the future of 'smart health and care' is likely to look like [24]. The main observations include:

- Appropriate treatments are delivered at the appropriate time, in the appropriate place, for the appropriate patient (otherwise known as Precision Medicine or personalised medicine).
- Clinicians will use technology to more accurately diagnose and treat illness and deliver care.
- All care delivery stakeholders across the ecosystem will effectively and efficiently communicate and use information.
- Patient data is in one, easily accessible place.
- The correct individuals will do the correct work (e.g., nurses handle patient care, not administrative tasks).
- Patients are informed and actively involved in their treatment (& care) plan.
- New, cost-effective delivery models will bring healthcare to places and people that don't have it.
- Efficiency will improve; waste will decline.

Although Deloitte apply the above specifically to the Health environment, much of this is equally relevant to a Scottish integrated Health and Care environment.

A recent blog by Digital Health London predicts that digital technology will become increasingly omnipresent whereby the end goal for digital health and care will be an "environment that seemingly has nothing, just your life" [25]. To reach this future ubiquitous norm, there are various emerging trends that could act as major enablers. Artificial intelligence (AI), virtual and augmented reality, and Internet of Things (IoT) are trending topics within the Digital Health and Care domain.

IT decision-makers are starting to make strategic procurement decisions around artificial intelligence and blockchain, with AI leaping from 8% to 18% as a priority area in the UK and blockchain growing from 3% to 6% in the UK between 2017 and 2018 [26]. Many industries are adopting new

technologies, new business models and new work flows, and the number of companies in the digital health and medical wearable space continues to grow. The following trends in disruptive technologies are also worth noting;

- The technologies perceived with the most disruptive potential in the next 5 years are AI and remote monitoring.
- Wearables, IoT (Internet of things), virtual reality, 3D printing and blockchain are next in the ranking,
- With 5G identified as the least disruptive new technology [6]

A further breakdown of these trends can be seen in Figure 5 below.

As well as several technical trends that are emerging, there are also other 'softer' trends which support the acceptance, adoption and scale of these technologies. These trends include change management techniques, citizen empowerment and improved regulatory approaches for digital health and care technologies. These trends are considered in more detail below.

4.1 Technical Trends

4.1.1 Artificial Intelligence

Artificial intelligence (AI) is an area of computer science that emphasises the creation of intelligent machines that work and react like humans [24]. AI makes it possible for machines to learn from experience, adjust to new inputs and perform human-like tasks. Core elements of AI are knowledge engineering (artificial intelligence must have access to objects, categories, properties and relations between all of them to implement knowledge engineering) and machine learning (learning without any kind of supervision requires an ability to identify patterns in streams of inputs, whereas learning with adequate supervision involves classification and numerical regressions) [27]. Some

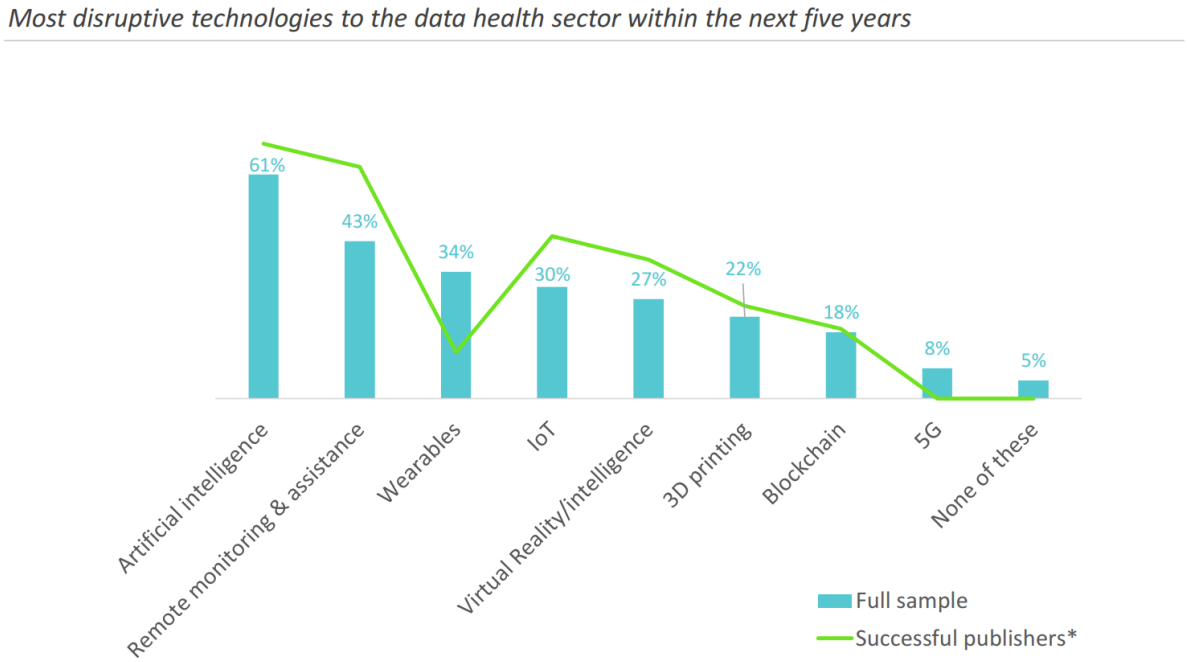


Figure 5: The most disruptive technologies to the data health sector in the next 5 years. Adapted from Research2Guidance 2017 [7]

sources cite AI as the biggest commercial opportunity in today's fast changing economy because AI will exploit the digital data from people and things to automate and assist in what we do today, as well as find ways of doing things in ways that we have not imagined before [27-29].

AI Market

New data predicts that the market for AI-driven healthcare technologies will exceed $6bn in just 3 years which is a significant leap from the $600m valuation that was proposed 4 years ago [29]. Statista have projected a dramatic increase in the size of the AI market by 2025, see figure 6 for more details. The surge is being driven largely by growing demand and acceptance among consumers for electronic, data-driven and virtual-based care, and the desire for more convenient, accessible, and affordable care. According to PwC (2014), the potential contribution to the global economy from AI will by 2030 be $15.7tr, making AI the biggest commercial opportunity in today's fast changing economy [29]. North America and China are expected to witness the greatest GDP gains from AI increasing productivity, but the trajectory of the impact for the two countries differs. China will likely uptake AI technology more slowly but could see a large impact on GDP by 2030. North America is expected to realise many AI benefits faster [29].

Potential Benefits of AI in Health and Care

Artificial intelligence has been mentioned in almost every article about upcoming digital health and care trends. The idea is that AI will support better decision making at the point of care and will allow for predictive analytics to be used in practice. Interestingly, according to PwC's report "Sizing the prize of AI" (2014), Health scored the highest potential AI consumption impact score (3.7) followed by Automotive sector (37) and

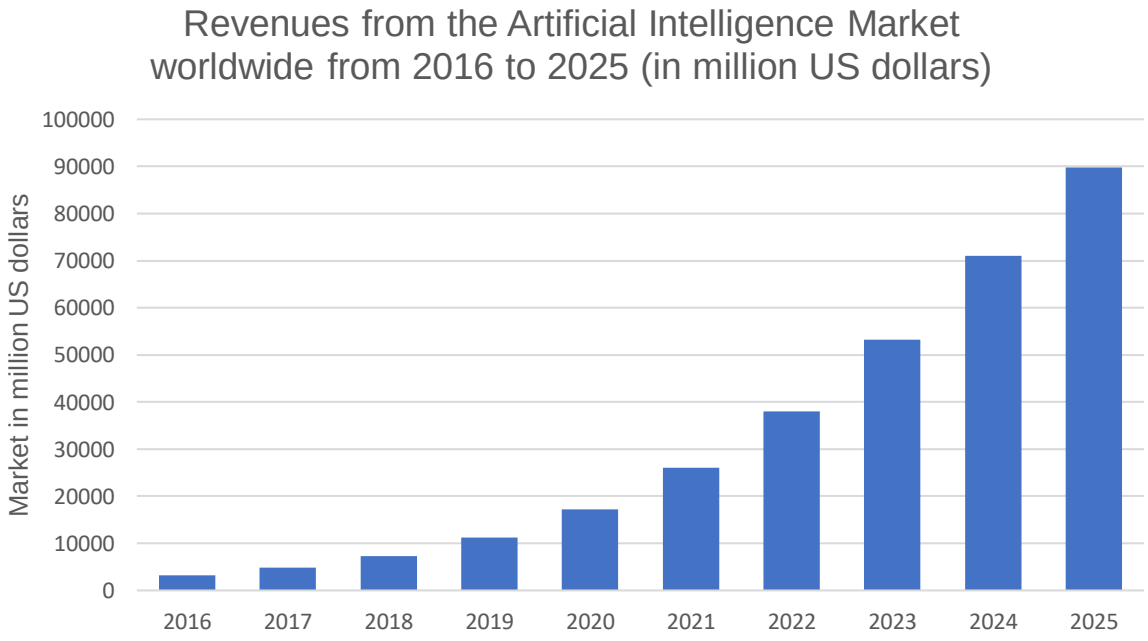


Figure 6: Revenues from the artificial intelligence (AI) market worldwide from 2016 to 2025 (in million US dollars) [30].

Financial Services (3.3) [29]. However, unlike most other sectors, Healthcare is anticipated to see adoption in the longer term (+ 7 years) in comparison to the Financial Services sector, which is anticipated to see impact within the shorter term (0-3 years) [29].

The report identifies three major areas within the Healthcare sector that should be impacted by AI [29]:

1. Supporting diagnosis in areas such as detecting small variations from the baseline in patients' health data or comparison with similar patients.
2. Early identification of potential pandemics and tracking incidence of the disease to help prevent and contain its spread.
3. Imaging diagnostics (radiology, pathology).

Benefits to citizens are expected to include faster and more accurate diagnoses and more personalised treatments in the shorter term, with intelligent implants being a potential in the longer term. AI is initially likely to be adopted as an aid rather than a replacement for human clinicians. It will be used to augment clinical diagnoses but, in the process, also provide valuable insights for the AI to continuously learn and improve its performance, as anticipated within the recently announced Innovate UK funded iCAIRD project in Scotland for diagnostics in Pathology and Radiology [31]. Interaction between clinicians and AI-powered diagnostics are anticipated to enhance the accuracy of the systems, and over time, provide enough confidence for humans to delegate the task entirely to the AI system to operate autonomously. "Over the long-term, AI has the potential to increase a clinician's understanding of a patient's unique care requirements to such an extent that personalised patient care could one day be possible" [32].

4.1.2 Blockchain

Blockchain can be described as a tool which allows new information to be added onto the end of a chain of existing information and is sometimes referred to as an append-only ledger. The ledger can have new information written onto it, but the previous information, which is stored in blocks, cannot be edited, adjusted or changed. This is accomplished by using cryptography (the art of solving codes) to link the contents of the newly added block with each block before it, such that any change to the contents of a previous block in the chain would invalidate the data in all blocks after it. This means that blockchain has offered a new 'type of internet' by allowing digital information to be distributed but not copied. Blockchain was originally devised for the digital currency Bitcoin but the tech community is now finding other potential uses for the technology [33]. Figure 7 provides a visual representation for Blockchain technology.

Information held on a blockchain exists as a shared — and continually reconciled — database. This is a way of using the network that has obvious benefits. The blockchain database is not stored in any single location, meaning the records it keeps are truly public and easily verifiable. No centralised version of this information

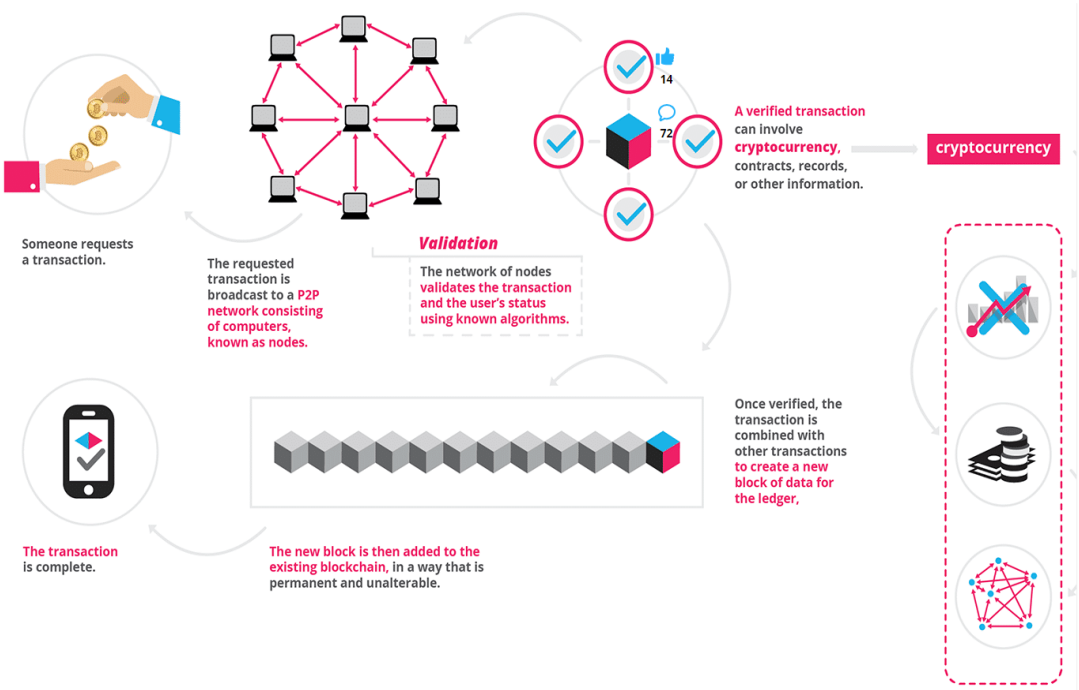


Figure 7: What is Blockchain Technology? Adapted from blockgeeks.com [33]

exists for a hacker to corrupt. Hosted by millions of computers simultaneously, its data is accessible to anyone on the internet [33]. By design, Blockchain is a **decentralised technology** which is an emerging trend in itself and will be discussed further in Section 4.2.5 of this report.

Blockchain Market - Bitcoin

Bitcoin has been called "digital gold," and for good reason. Bitcoin transactions in 2016 averaged over $200,000 US per day. With the added security brought by blockchain, new internet businesses are on track to unbundle the traditional institutions of finance. Goldman Sachs believes that blockchain technology holds great potential, especially to optimise clearing and settlements, and could represent global savings of up to $6bn per year [34]. Recently, the existing crypto currency market, including Bitcoin, have been falling significantly as central banks are beginning to produce their own crypto currencies. As these are backed by "real" securities these may become more popular with investors and speculators alike.

Potential Benefits of Blockchain in Healthcare

Blockchain has been recognised as a factor that could greatly reduce the time, costs and risks associated with how Health and Care organisations operate. It has been described as a technology, which solves "many of the problems that data governance professionals have been trying to solve for years [35]". According to Deloitte (2016), blockchain technology has the potential to transform health and care, placing the citizen at the centre of the Health and Care ecosystem and increasing the security, privacy, and interoperability of data [36]. This technology could provide a new model for health information exchanges by making electronic medical records more efficient, disintermediated, and secure. While it is not a panacea, this new, rapidly evolving field provides fertile ground for experimentation,

investment, and proof-of-concept testing. Blockchain technology creates unique opportunities to reduce complexity, enable trust-less collaboration, and create secure and immutable information [36]. Forbes(2017) advises that the Health and Care industry is drowning in data—clinical trials, citizen health and care records, medical research and more. Technology such as blockchain could support systems to interoperate and bring data together [37]. Forbes advise the most likely applications within healthcare for blockchain are [37]:

- Medical data management;
- Drug development and supply chain integrity;
- Medical research, and
- Data security.

IBM have also commented on the future applicability of blockchain within the Healthcare domain. In their report released in 2016, IBM discuss how valuable it would be to have the full history of an individual's health [35]. They say that "data captured on blockchains can be shared in real time across a scalable group of individuals or institutions. Every event or transaction is time-stamped and becomes part of a long chain, or permanent record, that can't be tampered with after the fact. On permissionless blockchains, all parties can view all records. On permissioned blockchains, privacy can be maintained by agreement about which parties can view which transactions – and where desired, by masking the identity of the party. In this way, blockchains shift the lens from disparate bits of information held by a single owner to the lifetime history of an asset. This holds true whether that asset is a patient's health record or a bottle of pills as it moves through the supply chain" [page 2, 38]. As part of the IBM report, 200 healthcare executives were interviewed. Those surveyed identified four main pillars of medical care which can be improved through blockchain. These were [38]:

1) medical/health records,
2) data device integration,
3) adverse event safety and
4) clinical trial records.

4.1.3 Cloud-based Platforms

Computer Weekly recently released an e-guide outlining their view of the UK IT priorities for 2018 [26]. The report involved a large-scale survey to explore IT spending priorities for the year ahead. The headline finding from

Case Study: Blockchain Implementation in Estonia

Estonia is considered by many to be the most advanced "blockchain nation" in terms of government and citizen services where all medical health records are already stored online. Estonia has been testing the technology since 2008 and in 2016 announced their intention to secure health records on a blockchain that would provide real-time visibility to individuals and institutions. Experts have cautioned that the privacy, security and regulatory hurdles are so high that, even in Estonia where citizens already carry a unique ID, enabling medical records on blockchains could take considerable time. Blockchain was developed by the Estonians and is also being used by NATO, U.S. Department of Defence, as well as European Union information systems to ensure cyber security [38].

the report is that IT organisations in the UK are accelerating the move to cloud-based platforms. “When asked about IT manager’s priorities in datacentre, storage and software plans for 2018, cloud came out top every time” [26]. The cloud refers to software and services that run on the Internet, instead of locally on a computer. Most cloud services can be accessed through a Web browser like Firefox or Google Chrome, and some companies offer dedicated mobile apps. Some examples of cloud services include Google Drive, Apple iCloud, Netflix, Yahoo Mail, Dropbox and Microsoft OneDrive. The advantage of the cloud is that information can be accessed on any device with an Internet connection. By virtue of the information being available on the internet, several people can be editing documents or using the same resource at the same time. However, the downside to this is that if there is a poor internet connection, the information is inaccessible until the connection is restored [39].

Cloud-based Platforms Market

According to Statista (2013), the cloud computing infrastructure and platform market worldwide was forecasted to reach $43bn by 2018 [40]. However, Gartner released projections in **2017** where they speculated that worldwide public cloud services revenue will grow 18.5% in 2017, reaching $260.2 billion, up from $219.6 billion in 2018, with more information shown in Figure 8 [41].

Potential benefits of cloud computing in Healthcare

Several sources are discussing the potential impact of cloud computing in the Healthcare domain. The consensus is that cloud computing is “playing a vital role in making the healthcare industry more patient-centric and data-driven” [42]. In January 2018, NHS Digital released national guidance setting out clear expectations for Health and Care organisations who want to use cloud services or data offshoring to store patient information, formally endorsing its use within this sector [43]. The UK Government released a ‘cloud first’ policy back in 2013 for the public IT sector and the use of cloud services has been endorsed by the National Information Board (NIB) which released a report in 2014 about personalised health and care 2020 [44,45]. The guidance released in 2018 stipulates that “provided that the upmost care is taken when collecting, transferring, storing

	2016	2017	2018	2019	2020
Cloud Business Process Services	39.6	42.2	45.8	49.5	53.6
Cloud Application Infrastructure Services	9.0	11.4	14.2	17.3	20.8
Cloud Application Services	48.2	58.6	71.2	84.8	99.7
Cloud Management and Security Services	7.1	8.7	10.3	12.0	13.9
Cloud System Infrastructure Services (IaaS)	25.4	34.7	45.8	58.4	72.4
Cloud Advertising	90.3	104.5	118.5	133.6	151.
Total Market	**219.6**	**260.2**	**305.8**	**355.6**	**411.4**

Figure 8. Worldwide Public Cloud Services Revenue Forecast in Billions of US Dollars). Adapted from Gartner [41].

and processing patient data, NHS and social care organisations are permitted to host data within the UK, EEA (countries deemed by the European Commission to have adequate protections for the rights of data subjects), or in the US where covered by Privacy Shield" [43]. The guidance goes on to briefly introduce the benefits of moving to cloud infrastructure. The main benefits for the NHS and social care organisations are [43]:

- Lower IT costs
- The ability to develop, test and deploy services quickly without large capital expense.
- Cloud computing will support the drive to interoperability of data and systems as more services become internet-based.

However, the NHS has also high-lighted some important considerations associated with moving to cloud-based services. These are [43]:

- Moving critical services to the cloud will increase the importance of Internet access to your organisation. If your Internet access is disrupted or is unreliable, you may lose access to your data and services.
- Budgeting for technology may need to change as cloud services usually operate on a pay-as-you-go (revenue) model rather than capital expenditure.
- The right capability will require to be recruited or trained to deliver and manage cloud services if the organisation has no prior experience of running this type of service.
- Not all systems are designed to run in the cloud, and so some may not be compatible.
- Use of the cloud increases the portability of data, meaning data can be distributed across multiple devices both within and without the boundary of your organisation. The right cultural understanding and behaviours need to be in place to manage this portability and appropriately mitigate any risks.

4.1.4 Electronic Health Records (EHR)

An Electronic Health Record also known as a Personal Health Record ('PHR') is a universally accessible, layperson comprehensible, life-long tool for managing relevant health information, promoting health maintenance and assisting with chronic disease management via an interactive, common data set of electronic health information and e-health tools. Whereas EHRs are an older concept in which information is digitised and utilised by the health system, the PHR is owned, managed, and shared by the individual or his or her legal proxy(s) [46].

There are two main types of PHRs available. PHRs may be "tethered" or "untethered". A tethered PHR is where the record is connected to the clinician's Electronic Medical Record, whereby PHR data is derived from subsets of information within the EMR. Tethered PHRs are referred to as patient portals because they allow patients to access parts of their EMR. Alternatively, untethered PHRs are not tied to a specific EMR and may be internet-based services in which the patient can enter and maintain their health information [47].

EHR Market

The global electronic health record market was valued at approximately $20.5 billion in 2016 and is expected to reach $33.3 billion by 2023 [48]. This represents a compound annual growth rate of 5% from 2017 to 2023. The increase in adoption of EHRs, increased use of cloud-based EHR software, rapid surge in global ageing population, and a subsequent rise in the number of chronic diseases have been driving this market growth. The cloud-based software segment of EHRs accounted for more than two-fifths share in the global market, although ambulatory EHRs are expected to be the fastest growing technology towards 2023 with a CAGR of 5.6%. However, high cost of EHRs and increase in consumer concerns regarding patient data, safety & security are expected to impede the market growth. Figure 9 depicts the major segments of the market between 2016 and 2023 with 'reporting' demonstrating a clear lead [49].

EHRs in Scotland

NHS Scotland has released a position statement regarding electronic health records [50]. These are not yet generally available to citizens in Scotland through the NHS (although the Key Information Summary is already accessible by patients, and the NHS West of Scotland Boards have been developing a Health & Care Portal with citizen access). Here, they state that the commitment to providing citizens with a personalised view of their health and care information will be realised in Scotland by pulling together summarised specific information on demand from a range of computer systems in the NHS Boards (and eventually social care systems)

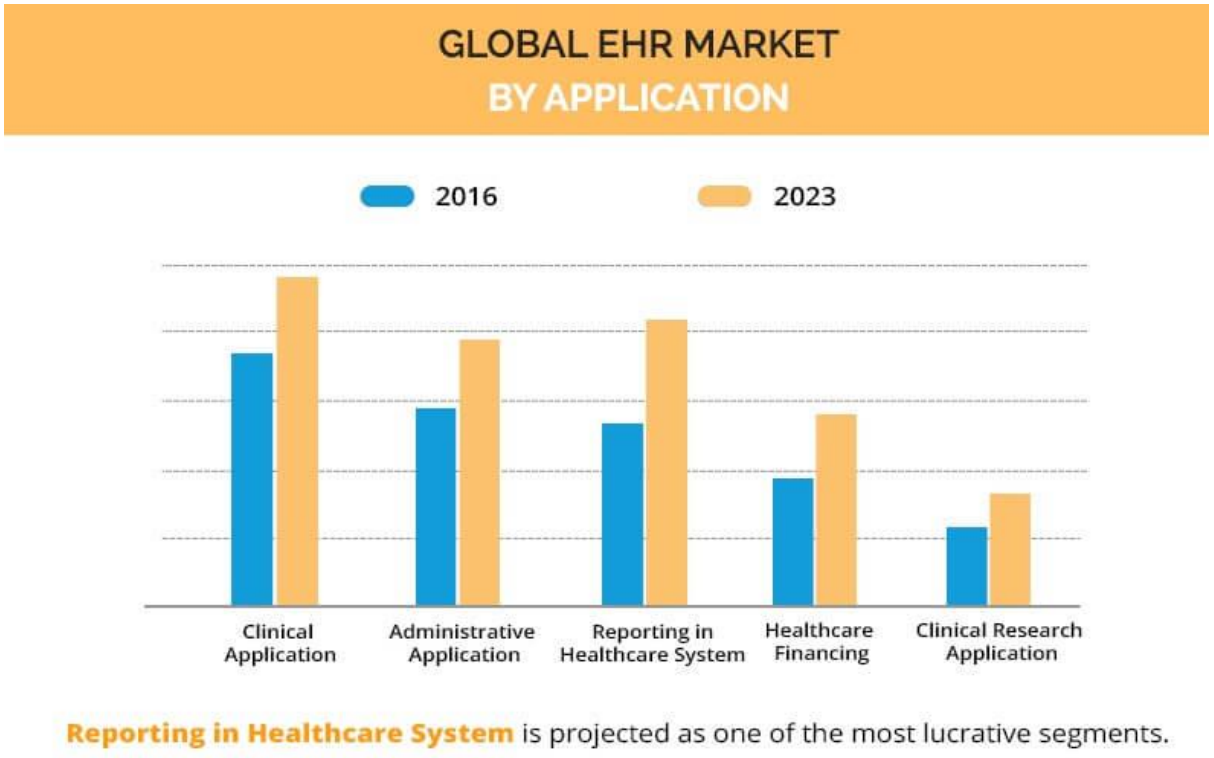


Figure 9. Global EHR Market by segment application between 2016 and 2023. Adapted from Allied Market Research [49].

and making this visible and accessible to each individual.

Impact of EHRs on healthcare

According to Health IT.gov (2017), EHRs will provide a greater and more seamless flow of information within a digital care infrastructure whereby care delivery is transformed. They add that EHRs will provide [51]:

- Improved citizen care. People have no need to fill out the same information time and time again as well as electronic referrals and convenient e-prescriptions. Health and potentially care providers have quicker access to citizen records for more coordinated and efficient care, legible documentation to facilitate accurate coding as well as enhanced decision support [52].
- Increased citizen participation in their care. Care providers and patients who share access to electronic health information can collaborate in informed decision making. Citizen participation is especially important in managing and treating chronic conditions [53].
- Improved care coordination. EHR systems can decrease the fragmentation of care by improving care coordination. EHRs have the potential to integrate and organise an individual's health and wellbeing information and facilitate its instant distribution among all authorized providers involved in a patient's care [54].
- Improved diagnostics and citizen outcomes. With EHRs, providers can have reliable access to an individual's complete health and wellbeing information. This comprehensive picture can help providers identify and address problems sooner [55].
- Improved organisational efficiencies and cost savings. Many care providers have found that EHRs help improve service management by increasing efficiencies and cost savings. EHRs benefits medical practices in a variety of ways, including reduced medical errors through better access to patient data as well as reduced transcription costs [56].

4.1.5 Big Data

Big data describes enormously large data sets that can be analysed to reveal patterns and trends, especially with regards to human behaviour and interactions. The Health and Care industry produce vast amounts of clinical, financial, administrative and genomic data, and requires the use of big data techniques to help manage it. In the sphere of digital health and care, big data refers to the use of these massive data sets to positively impact citizen care outcomes.

Statista (2019) have forecasted global revenues for the global big data industry from 2011 to 2027 (see figure 10). In 2018, they projected that the global big data market would grow to $42 billion in size [57].

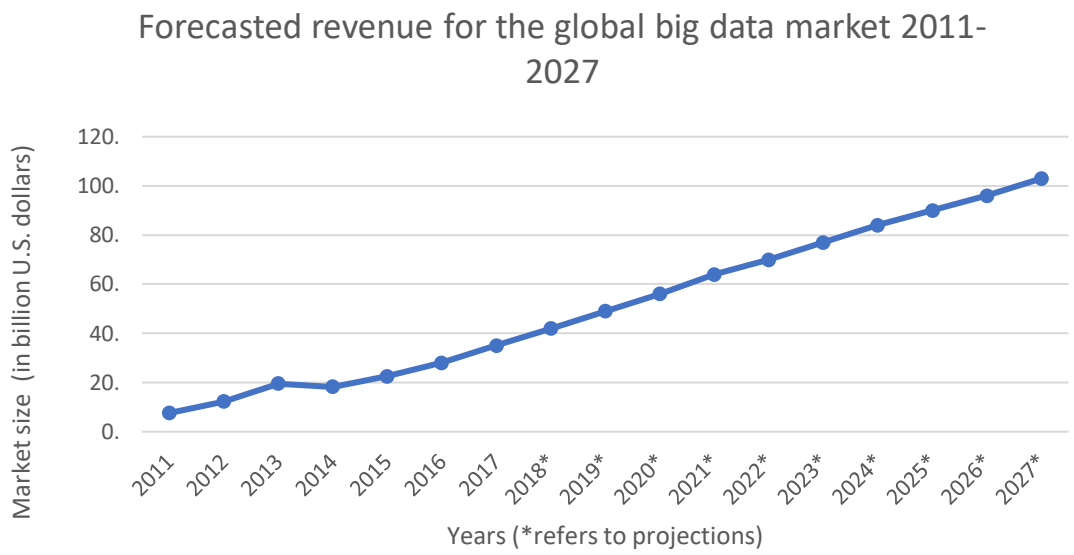


Figure 10. Graph depicting the estimated growth in the global big data market size. Adapted from Statista [57]

According to a market report by BIS research (**"**Global Big Data in Healthcare Market- Analysis and Forecast, 2017-2025**"),** the Big Data market in Healthcare was estimated to be $14.25 billion in 2017, and it is estimated to grow over $68.75 billion by the end of 2025 [58]. This growth is most likely due to the increased use of analytical tools, artificial intelligence and machine learning to develop and deliver personalised and precision medicine. For big data, analytics services have been predicted to dominate the market, with financial analytics being the most popular of analytic services.

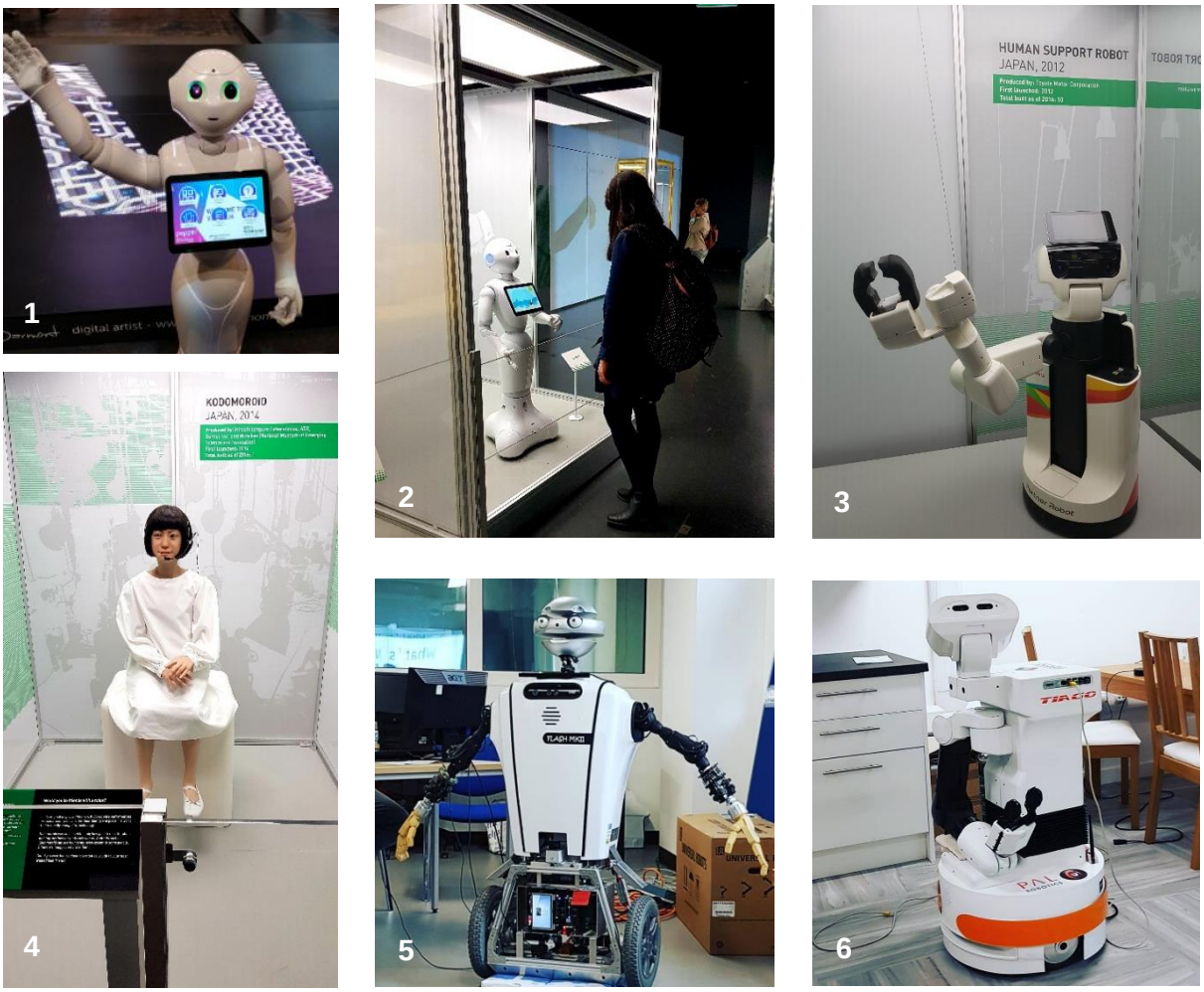
4.1.6 Robotics

The social and medical impact of the increasing aging population and the increase in long term conditions, such as diabetes and dementia, are major drivers for the uptake of robotics in health and care. This is clearly evident in Japan, where the elderly population (65+) has been predicted to be 30% of the population by 2025 [3]. This has pressured Japan to rapidly adapt to an integrated care system that can be delivered remotely at home or in a homely setting. This in turn means that the market estimations for healthcare robots in Japan are showing growth to 14,950 million yen (£150.2 M) in 2020 [59]. The developments pushing this growth focus on the utilisation of robotics as monitoring systems, mobility aids, toilet aids, bathing aids and numerous other areas of health and care.Whilst the majority of robotic advancements are still being researched, there are a few working examples of robotics in health and care. Panasonic's Resyone is a transfer assist bed, in which half of the bed can be detached and transformed into an electric wheelchair. This allows for a seamless transition from bed to chair helping to reduce the mental and physical stress for the user and their care providers [60]. Another example can be seen in Cyberdyne's Hybrid Assistive Limb (HAL) device. HAL is a wearable robot that combines user, machine and information to assist a physically challenged user to move and utilise greater mobility than their

condition usually allows [18]. Finally, one of the most well-known examples of healthcare robotics is Softbank's 'Pepper' robot, which recognises faces and a set number of emotions and is currently being used in approximately 500 Japanese care homes for users to interact with to play games, perform exercise routines and have basic conversations [19, 21].

The emergence of robotics in surgery is now widespread, and in some countries promises capacity and choices for those that need care outwith the hospital setting, more commonly in social care, tackling challenges like social isolation. In a recent Royal College of Nursing article, a case study from Care South was used to demonstrate how using robots in nursing homes assist patient care [61]. Other areas predicted to gain momentum over the next 5 years is the use of robotics to undertake "Repetitive tasks such a blood sampling and heart rate monitoring and Robotic assistance for those needing care" [62].

Whilst these examples appear basic in principle, continued research and development will see the field of healthcare robotics advance in leaps and bounds. Currently the real



Collection of images taken by DHI staff depicting modern advanced robotics, Image 1&2 are the images of the 'Pepper' robot, 4 is a non-care related robot shows how far robotics has come, with 3 &6 being care related robots, and 5 is an assistive robot for autistic children to learn to recognise expressions.

emerging trends in healthcare robotics pertain to the social and cultural shifts towards the development and integration of robotics into health and social care. Whilst the examples above show real world progress, the sector is currently in its infancy. However, if research and development continue at its current pace, in the near future, healthcare providers and their patients can expect to interact with robotics day-today seamlessly.

4.2 Softer Trends

4.2.1 Change Management

New technological advancements and technology-enabled services hold promise for the transformation of the Health and Social Care sector. At the same time, there remains a widely held belief that Health and Social Care struggle to manage large-scale change involving technology. Past attempts at NHS digitisation have, both locally and nationally, fallen short of ambitions by failing to understand that successfully implementing digital technology is as much about managing change as it is about installing technology [63]. This is recognised by the TEC Programme, which commissioned a report from Just Economics that recognised the role played by the national programme in helping manage the change process and asserts that the TEC interventions have now been sufficiently demonstrated to be realised at scale [64].

In their report about managing large-scale change in the NHS, The King's Fund (2018) defines digital change as "both a technical and an adaptive change, featuring unpredictable and complex interactions between the people and technology involved [63]. Spreading digital change beyond local areas requires continuous investment in capturing and disseminating lessons from implementation, going beyond copying technical solutions" [63]. Figure 11 shows the key themes involved in successful digital change in the NHS.

The themes are [63]:

1. ***Leadership and management***: This involve relationship management and leaders who

Figure 11. Key themes in successful digital change management. Adapted from The King's Fund [63].

recognises that there are various working practices. Good leaders are focussed on outcomes rather than immediate cost savings.

2. ***User engagement:*** Engaging end users in the change process is critical to success. This involves difficulties regarding a cultural gap between technologists, clinical users and citizens that is sometimes hard to overcome. It is advisable to build a group of stakeholders who are interested in exploring new technologies and who meet regularly to identify problems and the solutions that could solve them. Identify a wider group of users who can be involved in the design process as early as possible and are a source of potential champions for change.
3. ***Information governance***: This is a cultural issue (which people often try to fix with technical issues) but fundamentally the trust between organisations is damaged through poor information governance policies.
4. ***Partnership***: Unrealistic timelines, an unwillingness to share data and undefined roles and responsibilities makes successful partnerships difficult to create and maintain within digital change projects. The King's Fund advice is to choose external partners that can provide both change management and technical support.
5. ***Resourcing and skills***: Digital change projects need to have the right people with the right skills and as the project evolves and adapts, managers need to be able to identify what skills sets are missing. An ethos of continuous improvement is needed to keep staff on board with the changes required. It should also be noted that tasks are given to people who are interested and able to undertake them rather than letting role or organisational affiliation stand in the way of matching the right people with the right task.

Realistic planning for the peaks and troughs that occur in a digital change process is imperative to success. Moreover, allowing digital initiatives to 'bloom from the ground up' tends to be the most effective because local projects have higher success rates than national implementation projects [63].

In Figure 12 Deloitte (2018) have summarised the top challenges facing Health (and Care) stakeholders over the following 3-4 years. Each of them requires 'buy-in' from the highest level to make any change possible [23]. It also highlights that the whole ecosystem of health and care will need to be open to the changes to ensure that the best care can be provided using new emerging technologies that offer personalised services [23].

4.2.2 Citizen Empowerment

Empowerment has been defined as the enhancement of "the possibility for people to control their own lives" [60, 65]. Empowerment engages individuals, groups, organizations, communities and governments while it requires the ability to gain control over many aspects of individuals' lives. For citizens it implies individual responsibility in health and care, whereas for communities it implies the broader health professional, group, organizational, institutional and societal role in enabling citizens to assume responsibility for their own

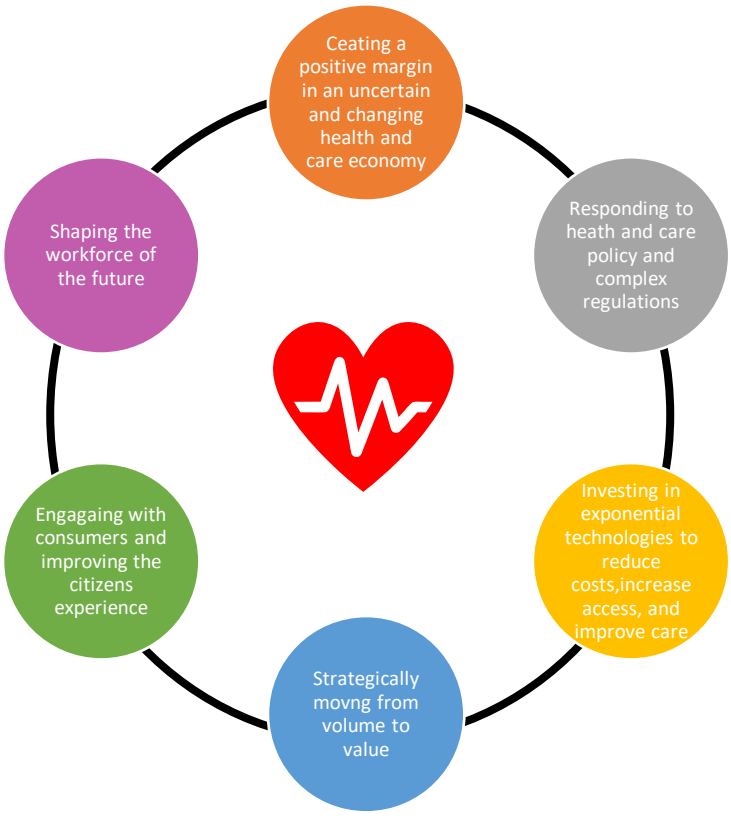


Figure 12. Top challenges facing health and care stakeholders. Adapted from Deloitte Global Healthcare Outlook 2018 [23].

health and wellbeing - as individuals and as communities [66].

Empowerment requires that citizens possess the skills, understanding, and political voice to help shape innovations in the ways that best suit their needs [67]. With understanding being a key element of citizen empowerment. Health and Care services produce, collect, analyse, store, and transfer sensitive personal data that, if compromised, could cause harm an individual's employability or standing in society. As online devices are increasingly used to generate and store sensitive data, citizens need to understand their rights regarding data ownership and data protection. Knowledge does not automatically translate into attitude and practices, but a more profound understanding will help citizens to protect their data and contribute to the public discourse on this. The state is responsible for ensuring that privacy choices are clearly stated, and robust security frameworks are in place when data is stored in, shared or moved to the cloud. By providing clear privacy guidelines, the state will create conditions for better-informed citizens. Therefore, trust in data sharing is going to be an important aspect of empowerment. This aspect is clearly recognised by the Health and Social Care Alliance in Scotland (2015), who have led extensive citizen engagement to promote this and published supporting reports such as "Digital Technology for Health & Wellbeing – Giving you choice and control" [67].

A white paper by the Scottish SME and Community Interest Company, MyDex (2016) talks about the

generation of new person-centred services saying that, “with the individual at the centre, they are able to store, acquire, manage and share personal data about their lives, citizens, families and communities and will have control and choice in their relationships with service providers. Together, the public services and citizens could work to improve the way we all participate in the delivery of our needs. Two-way communication and trust can be created with mutual respect and joint working” [58]. Despite this emerging trend for citizen empowerment gaining traction across the UK, the NHS still demonstrates systemic mistrust of a citizen’s ability to reliably record and share data for clinical decision-making processes, even though most health-related policies promote the fact that patients with long term conditions are the expert in their own care and wellbeing.

4.2.3 Regulation of Digital Health and Care technologies

One major limitation for the Digital Health and Care market are strict and often complex regulations. These are often named as one of the biggest reasons for the slow adoption of digital health solutions. Digital as well as non-digital health solutions that could pose a risk to patient safety must be cleared by an approved regulatory body, such as the Food sand Drug Administration (FDA) in the USA, or the Medicines and Healthcare products Regulatory Agency (MHRA) in the UK. However, the regulations on digital health are likely to change in the future. In July 2017, the most prominent regulatory body – the FDA – announced a new approach to approving digital health solutions (called Digital Health Innovation Plan). Instead of approving individual digital products, entire companies could be approved, and digital products released by the pre-selected companies would not have to go through a regulatory process for each of their product releases. This development is still very fresh, but the FDA seems to initiate a paradigm change in regulating digital health solutions. This could act as a blueprint for more countries to follow, although regulations differ between countries [6].

A recent journal by Duggal et al (2018) in the BMJ states that an agile and future-proof framework is needed that everyone can trust [69]. The authors suggest that regulators will need to develop more agile approaches, perhaps requiring Digital Health services to provide updates to regulators based on predetermined criteria. They also suggest that regulators participate in horizon-scanning activities so that they are aware of how digital health evolves and how their regulations must adapt in response [69].

The Clinical Digital Council was set up in 2017. Its membership includes senior clinical digital health leaders from across England – currently the MHRA, the National Institute for Health and Care Excellence (NICE), Care Quality Commission, Public Health England, NHS England, NHS Digital and the Department of Health. The goal of the Clinical Digital Council is to ensure issues affecting digital health policy are raised in the right environment, and it acts as an advisory body to the governance and delivery groups informing the Digital Delivery Board – the governing body

which decides NHS technology spending. It is a clinically led forum for informed discussions and sharing of standards and policies relating to digital health and clinical implementation [70]. This currently exists in NHS England, but a similar group is being formed in Scotland within a more integrated health and care environment.

NHS England have developed a quality assurance framework called the Digital Assessment Questionnaire (DAQ) to allow the NHS to decide whether to approve an app or service [71]. The initiative was created to assess and endorse apps for the NHS Digital Tools Library. The questions have been developed by NHS UK, who have worked "with key partners to develop thorough Digital Assessment questions" [71]. The developed questions "cover a series of clinical and technical standards, questions and best practice, " which have been grouped into nine categories for extensively assessing digital health and wellbeing services [72]. These include [73]:

1. Indicators of Effectiveness
2. Regulatory Approval
3. Clinical Safety
4. Privacy & Confidentiality
5. Security
6. Usability & Accessibility
7. Interoperability
8. Technical Stability
9. Change Management

A similar framework is anticipated in Scotland. The intention is that the final version will become a national standard which any app should comply with to be recognised as safe and appropriate for the context of Scotland's health and care. The framework takes account of information such as the purpose of the app, its target audience, whether or not the app would store personal data and whether or not it is defined as a medical device. Should this development not progress, consideration of adopting the NHS UK approach may be helpful.

4.2.4 Skills and Workforce development

Nesta (2017) has recently published an extensive report, which discusses future skills requirements and anticipates what employment will be like in 2030. Their report "identifies the bundles of skills, abilities, and knowledge that are most likely to be important in the future, as well as the skills investments that will have the greatest impact on occupational demand. We provide information that educators, businesses, and governments can use for strategic and policymaking purposes to better prepare us for the future" [74].

The key findings of the report are [74]:

- Around 10% of the workforce are in occupations that are likely to grow as an overall percentage of the workforce and around 20% are in occupations that will likely shrink.
- Education, healthcare, and wider public-sector occupations are likely to grow while some low-skilled jobs, in sectors like construction and agriculture, are less likely to suffer poor labour market outcomes than has been assumed in the past.
- The report highlights the skills that are likely to be in greater demand in the future, which include interpersonal skills, higher-order cognitive skills, and systems skills.

Nesta also identify how the skills make up of different occupations can be altered to improve the odds that they will be in higher demand in the future.

- The future workforce will need broad-based knowledge in addition to the more specialised skills that will be needed for specific occupations.

The report also identifies the current trends that are influencing the changes in employment and skills demands. They highlight the need for countries such as the US and UK to be less risk averse when it comes to technology adoption and automation in order to lessen structural productivity problems that are currently being faced in these countries.

Embedding skills and workforce development will be a major emerging trend as digital becomes ever more omnipresent in the working lives of Health and Care professionals.

The DHI (2018) has also carried out an extensive review of the future skills requirements that are likely to be required for the Digital Health sector in Scotland to remain competitive and attract and retain talent within the sector [1]. This review highlighted that there are various aspects of workforce development and education that need to be improved to support a flow of talented individuals into the sector. The report has summarised the top 10 skills that digital health and care employers look for in staff. The skill that comes out on top is Software Development [1]. As the digital technologies sector continues to expand, those with a background in software development and the ability to learn and adapt to new software practices will be ever more attractive to employers across the digital technology sectors. As Digital Health and Care matures as a sector, it will require more highly skilled individuals to work within it.

Clinical Informatics is also becoming a focus within the workforce trends, particularly in Scotland. The DHI and NHS Greater Glasgow and Clyde are working closely together to develop the career pathway of a Clinical Informatician and Innovator. They are developing a fellowship which pulls upon Medical Doctors' clinical, digital and operational/systems knowledge. Clinical informaticians will transform healthcare by analysing, designing, implementing and evaluating information and communication systems to enhance individual and population health outcomes, improve patient care and strengthen the clinician-patient relationships.

Following the Watcher review in 2016, the NHS Digital Leadership Academy was developed [75]. This is a year-long learning programme for health and care leaders, delivered by a partnership of Imperial College London, the University of Edinburgh and Harvard Medical School. This shows promise that things are developing in the clinical informatics space from a leadership perspective but more developments at grass-roots level will be required in the coming years to ensure a clear career pathway is in place [76].

4.2.5 Decentralised Systems

Decentralisation is the transfer of authority and responsibility for public services from the central government to subordinate or local government organisations. Where it works effectively, decentralisation helps alleviate the bottlenecks in decision making that are often caused by central government planning and control of important economic and social activities [77]. Decentralisation can help cut complex bureaucratic procedures and it can increase government officials' sensitivity to local conditions and needs. Moreover, decentralisation can help national government ministries reach larger numbers of local areas with services; allow greater political representation for diverse political, ethnic, religious, and cultural groups in decision-making; and relieve top managers in central ministries of "routine" tasks to concentrate on policy [77].

4.2.6 Innovative Procurement

One of the major challenges to digital transformation of public services and realising the potential of emerging technologies is procurement. Vendors are hungry to shake up the public sector, but the processes, institutions and mindsets of the public sector throw up hurdles often too high to vault. Until procurement processes work for small, agile players, the public sector will always be behind the cutting edge. Other issues include inflexible business models, weak competitive pressure to motivate improvement and inconsistent practices around data. Research conducted by iGov in 2017 evaluated the progress of digital transformation in UK central and local government [32]. They concluded that a major ‘digital gap’ still exists in the public sector. This gap needs to be overcome before their estimated £2 billion in savings can be made through the use of online service delivery [32].

Case Study: Estonia

E-governance was a strategic choice for the Estonian Government to improve the competitiveness of their state and increase the wellbeing of their people, while implementing hassle-free governance. All public-sector services can be accessed easily online (except getting married, divorced or buying a house) and have been for years. This strategic choice made almost 2 decades ago has allowed Estonia to become arguably the most advanced digital nation in the world. By 2008, patient health data was accessible and now 95% of all data generated by hospitals or doctors is digitized. In discussing the importance of decentralisation to achieving their success, Kaspar Korjus, managing director of e-residency in Estonia says that “starting from scratch allowed us to design solutions based on our core principles: decentralisation – there is no central database and every stakeholder, whether a government department, ministry or business, gets to choose its own system interconnectivity and integrity.” He adds that a key enabler to allowing for a decentralised system such as that found in Estonia to be realised and to flourish is trust. He says “our digital society couldn’t work without trust between the people, state authorities and private enterprises. Building trust has very little to do with technical solutions but has a great deal to do with mindsets and culture. And changing this mindset is much more difficult and time consuming than creating technical solutions. “The fact that in Estonia each citizen – resident or e-resident – knows exactly which administration has checked their personal data undoubtedly helps to build this trust because the administration needs to be accountable and transparent”. [35]

4.2.7 Health 4.0

In the 1700s, society saw the advent of the first Industrial Revolution, with the adoption of steam and water power and mechanisation. In the late 1800s, the second Industrial Revolution started with the arrival of assembly lines, mass production and electricity. In the 1980s, the third Industrial Revolution introduced computers and automation. At present, the fourth Revolution (Industry 4.0) has brought along with-it cyber technologies, the Internet of Things (IoT), cloud computing and cognitive computing [78]. The fourth Industrial Revolution encompasses a vision where human-machine interface technologies, such as collaborative robotics and augmented reality, become the norm and data is sourced from all steps in the manufacturing process to support better decisions, to drive efficiencies, flexibility, and maintain the highest standards of product quality.

Health 4.0 is a strategic concept for the health domain derived from the Industry 4.0 concept. The aim of Health 4.0 is to allow for progressive virtualisation in order to enable the personalisation of health and care for patients, professionals and formal and informal carers. The personalization of healthcare will be achieved through the mass use of Cyber-Physical Systems (CPS), (Edge) Cloud computing, the Internet of Everything including things, services and people, and evolving mobile communication networks (5G) [79]. With the help of cyber-physical systems, software building blocks and Big Data tools (algorithms) “objects” will be virtualised involving a spatial-temporal matrix. The virtualization will enable the analysis of snapshots of the physical world in next to real-time and allow for theragnostics where therapy and diagnostics are brought together. This again will allow for Personalized/Precision Medicine [79]. This approach is also relevant for Care, with DHI publishing a recent paper on Care 4.0 [79].

Case Study: The Future of Asthma Management.

In Scotland, the prevalence of Asthma is 18% and the societal burden of asthma is significant. It is in the interest of all stakeholders, including patients, doctors, carers, and pharmaceutical companies to reduce the societal burden while at the same time to increase effectiveness and efficiency of asthma therapy as well as the perceived quality of service. New technologies including the IoT, industrial internet, network slice technology (such as the Chinese mIoT), next generation network technologies such as 5G, Narrow Band IoT (NB-IOT), LoRa, Big Data, CPS, edge cloud computing, and new strategies for the safe and secure aggregation of services hold the key for new and massively improved treatment strategies for asthma, allowing for progressive individualization of asthma treatment anywhere, anyhow and at any time and the integration of pharmaceutical and non-pharmaceutical therapy. First conceptual strategies in the asthma domain have been developed by the pharmaceutical industry. Smart asthma inhaler concept studies are available from Teva, Boehringer, GSK, Astrazenica and others [80-84].

5. Conclusions

The global Health and Care industry is changing rapidly, with technology taking a key role to drive new business and service models where both technical and cultural trends are enabling the transformation. The latest generation of communication networks, digital technologies, such as cloud, mobile, AI, Augmented & Virtual Reality, IoT and blockchain and robotics, promise to deliver efficiencies but also to support entirely new ways of working and to alter radically the relationship between citizens and the state. To achieve this, leaders needs to shift their organisations to more agile ways of working. They must ensure their organisations have the right skills to do so and be prepared to move out of their comfort zones to better engage with citizens and consider digital as a powerful enabler of necessary change.

A recent report by Nesta (2018) discusses the role that Government in the UK must take to achieve positive digital transformation to engage better with citizens and to ensure that the UK remains competitive. In the moving digital world, user expectations are soaring and the potential of what public services could be delivering is increasing [32]. Nesta asserts that digital transformation is driving change from an environment where digitisation previously involved technology being bolted onto old processes towards a comprehensive revision of policies, processes and services to create simpler user experiences for citizens and frontline workers alike [32]. The key to transformation is the mindset, not structure, and that transformation is a lifecycle not a one-off event. The changes required need to be sustained over time: success comes from well-supported, steady change.

There are potential benefits to be gained from implementing these emerging technologies and supporting approaches in Scotland's Health and Care settings. As the citizen becomes more responsible for their own health and wellbeing, attitudes will shift, and paternalistic service models will be challenged. New service models will place citizens at the centre of their care, enabled by technologies that allow for digital health and care to be omnipresent within peoples' daily lives. There is still far to go before Scotland's Health and Care services can fully incorporate these emerging trends. Yet this report has highlighted some of the key areas to focus on and the benefits that could be obtained from doing so, while shedding some light on some of the barriers to the successful implementation of such approaches.

Scotland's Digital Health and Care Strategy outlines a specific domain on Service Transformation (Domain C), which would benefit from building on the successful approach already demonstrated by the national TEC Programme to go faster, further and provide a vehicle to consider some of the findings of this report [18].

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