



Future opportunities

Throughout our discussions there have been four key areas which are seen as major opportunities for patient data to improve efficiency and drive innovation. Although, again, not all are the same in the detail of execution in every location. This is often due to differing regulatory frameworks around privacy or the influence of a single payer system. However, they are all seen as major areas for potential change to occur over the next decade. Significant investment has already been made in some areas, both by government and the private sector. All are fields where there is tangible change to be delivered and, if undertaken in a coherent and effective manner, considerable benefits to be achieved.

These four areas are:

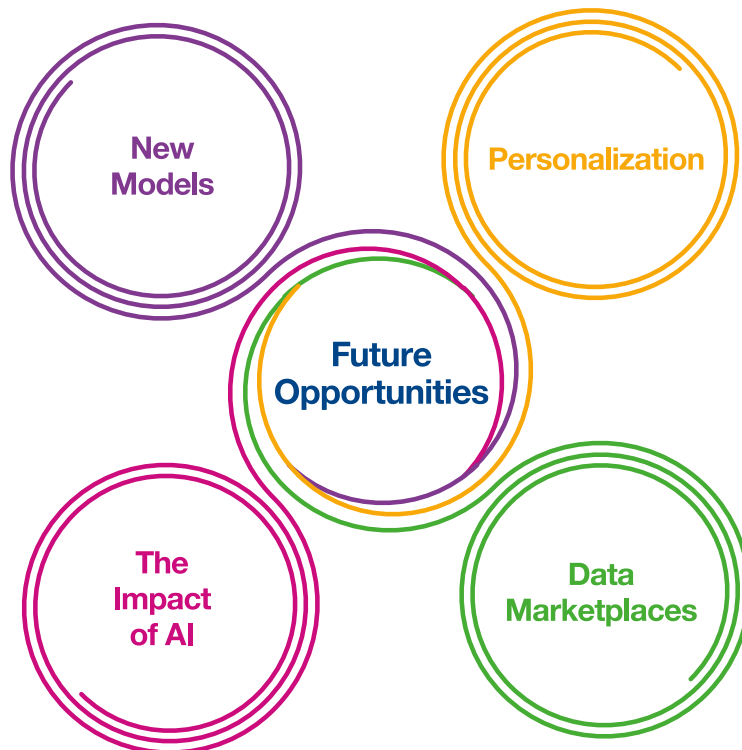
Personalisation – The prospect of more individualized ‘n=1’ healthcare is accelerating. Remote access, localised support and decision-making are all central to creating more personalized information which in turn will drive better healthcare. Predictive analytics and genetic profiling will further transform treatment: But will the benefits extend beyond the lucky few?

Data Marketplaces – Embedded in the future of access to patient data, is its wider exchange and what may be public commons vs. what is open for commercial purposes. Personal and clinical data will be represented in health data marketplaces that seek to both create financial value as well as enable better care. Given the value of health data in some key regions, marketplaces will undoubtedly expand but ensuring that the patient gains advantage will be pivotal.

The Impact of AI - There are great expectations around AI. Initial advances from machine learning and pattern recognition will be significant in enabling more efficient diagnosis and better prediction. As deep learning and self-learning then develop, the ability to deal with unstructured data delivers major improvements in diagnosis and treatment and AI is embedded into many clinical decisions. Moreover, with voice and facial recognition increasingly analysing users’ behaviour patterns, AI is also applied to identify stress and anxiety.

New Models – While we will see some change from within, expect big tech, led especially by Amazon, to further disrupt health care. This will shift reimbursement mechanisms and drive shared risk across payers and providers. Equally significant change is emerging from China and India where the creation of identity related platforms is driving innovation at scale. At the same time, some anticipate that the reinvention of healthcare business models will come from more unexpected places.

Each of these are explored in the following pages.





Personalisation

The prospect of more individualized ‘n=1’ healthcare is accelerating. Remote access, localised support and decision-making are all central to creating more personalized information that in turn will drive better healthcare. Predictive analytics and genetic profiling will further transform treatment: But will the benefits extend beyond the lucky few?

The consistent view in many locations we visited was that *“more detailed, personal information will help generate better health outcomes.”* Therefore, better and more access to data about the individual is key to future healthcare delivery. This belief is driving much of the appetite for the collection, sharing and use of patient data.

GREATER PATIENT CENTRICITY

Whether through the use of new technologies, changes in approach to patient interaction or by making information more tailored at the individual level, personalisation is a major driver of change

particularly as more providers seek to move away from cumbersome ‘hospital-centric’ care to ‘patient-centric’ support that is integrated in the wider health and social care systems: a more customer-centric approach is at the fore for many. The consensus is that if patients can be persuaded to make more use of advice based on some of the social determinants of their particular health needs, they will enjoy a better quality of life and, receive more focused health care services which can, in turn, be delivered in a cost-effective manner.⁹⁷

The personalisation of healthcare looks set to manifest itself in many ways across different areas of

the system. One example of how it may evolve is in the delivery of hospital care; rather than build bigger buildings, it seems more practical to offer treatments in a more intimate way with hospitals becoming 'smaller and more distributed' – certainly more local. Indeed, several national health systems are already preparing for an increase in walk in or 'ambulatory' out-patient care facilities, a corresponding reduction in general hospital and the establishment of more centres of excellence for complex surgery. In the UK, for example, integrating care locally is one of the key areas of focus for the NHS over the next five years.⁹⁸ Key actions on the agenda here include better integration of the varied strands of support including GPs, community nursing, mental health, social care and moving specialist care out of hospitals into the community. But joining up the primary and acute care systems relies on improved information sharing across parties and intelligent interrogation of data. In principle, in a single payer system such as the NHS this should be a credible ambition as it is more about the technological challenge than commercial interests of different parties as found in some other systems.

INTEGRATION

There are a good number of challenges to address before mass personalisation becomes a reality. The ambition is to extend access to information beyond just pills and sick-care to include behaviour and lifestyle data in the mix. So greater integration, meaning the bringing together of multiple sources of information - personal, proxy and contextual - in order to create a more holistic health profile, is vital. Delivering this will require as much policy change and collaboration between parties as it does technology development.⁹⁹ On top of this understanding data quality and differentiating between different kinds of data will also be important. As we begin to use a range of sources from accurate, complete and integrated data to, for example, circumstantial data, trying to select what is, and what is not, relevant will not be straightforward.

OWNERSHIP

End-to-end management of individuals' health only becomes possible when there is clear control, ownership or custodianship of personal health data, and that data is of high quality and consistency. Therefore, as highlighted earlier, understanding who owns what data, and who can decide who or which organisations can access it and if or how they will profit by it, is key. Failure to agree on this, some suggest could lead to a scenario where data mining and analysis will cease to be cost effective because confusion around ownership will make it hard and expensive to access. As we explore in more detail in the next section of this report, some believe that the monetization of health data is the only way to manage this process; *"in this world, only data that has monetary value will be of interest and hence supported."* But some argue that if the focus remains mainly on the financial value, then the overriding concern is that the benefits are likely to be limited to the few, targeted conditions where significant impact can be made, or to those for which the rich are willing to pay. If this problem is not sorted out many quite right, several wonder whether more individualized medicine will widen the healthcare gap rather than close it.

INDIVIDUALISED MEDICINE

It seems obvious to many that an increase in accurate information about our genes, our bodies, our behaviour and our environment can improve our understanding about personal well-being and that therefore the ability to develop and deliver more individualised medicine has great potential to shape the provision of health services in the future. A good number of those we spoke to see that within the next decade, truly bespoke, targeted healthcare at the (n=1) individual level will be available – certainly for those governments, organisations or individuals who can afford to pay. Even at a population level, many believe that precision medicine that allows decisions, treatments, practices, or products to be tailored to small groups, is a realistic ten-year ambition.



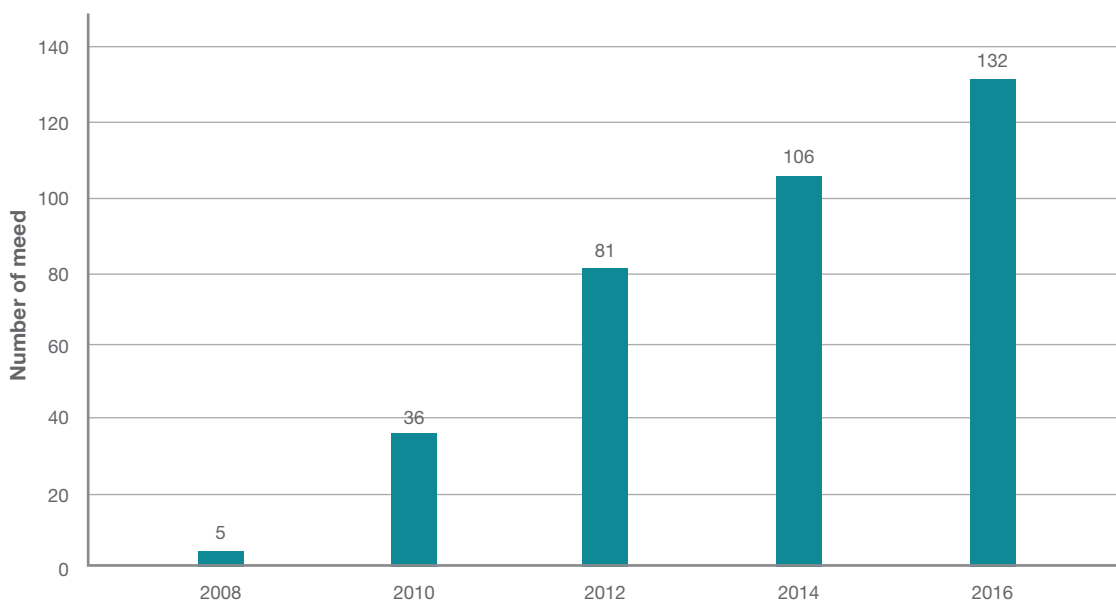
To an extent some conditions, including cancers, are already benefiting from individualised medicine. However, this is not so for the majority of cases - even though there is growing understanding of its potential. This does not necessarily mean there will be an increase in individualized treatments, rather the focus is on identifying the approaches that will be effective for specific patients based on genetic, environmental, and lifestyle factors and, as the evidence is gathered, can better inform care for an increasing number of patients. In Johannesburg the view was that *“over the next ten years, there will be constant iteration to both identify best practice and manage the market”* and that *“predictive analytics and genetic profiling together will create more connected prediction and drive hyper-personalization.”*

Looking ahead most expect that personalisation will remain concentrated on specific areas, such as oncology, and that proof of impact will drive wider adoption. *“Technology will improve, and prices will*

drop. Medical advances will mean that the market will grow and the ability to improve prediction and manage our health accordingly will increase.” In addition, more genetic profiling will eventually reveal *“a gradual, non-linear move from reactive medicine and treatment to the delivery of preventative medicine that means we will have cheaper, faster and more effective healthcare”.*

But there are reasons to be cautious. In San Francisco it was pointed out that *“15 years ago, we were talking about precision medicine which was not delivered – now it’s called individualised medicine - maybe we have just changed the name.”* In Johannesburg the outlook was that personalised medicine will simply be too expensive for the majority so, in poorer regions it will be a *“niche in healthcare”* and so *“for the next decade will only be for the wealthy and the rich economies.”* Despite its obvious growth (see chart below), most agree that the opportunity should be kept in perspective.

Number of Personalised Medicines (US - 2008 to 2016)



Source: Personalised Medicine Coalition (2017)

Many believe that personalisation will have a significant impact on the development of drugs. In Frankfurt, where a number of participants were from the pharma sector, it was suggested that individualized medicine feels *“like the end of the blockbuster era where one product would treat many thousands”* and that *“that the pharma industry needs to change, or it will not survive.”* However, as is slowly being shown with some chronic conditions such as diabetes, in order to realize significant change patients will need to recognize the benefits too;¹⁰⁰ *“we might need to use incentives to ensure a better understanding of the patient’s perspective. Without this we will not be able to have a precise diagnosis or individualized treatment.”*

INDIVIDUAL BEHAVIOUR

Many believed that the greatest opportunity that personalization presents is the way it can increase public understanding around health and lifestyle; *“over the next decade we will move from patients being uninformed and dependent to becoming more informed and therefore more empowered. Certainly, they will be less encumbered by legal, social and political restrictions.”*¹⁰¹ In addition, as understanding of health conditions and future needs grows, it will be possible to nudge people (and systems) to change behaviour in order to prevent symptoms developing unnecessarily. Ideally this can benefit everyone. In Dubai, one scenario saw that *“as more data is increasingly easy to access at low cost we can use appropriate analysis to help improve patient behaviour.”*

However, to achieve this, several major shifts need to take place:

1. **Education:** For the **patient** the focus should be on education, independent ‘activation’ and becoming more empowered – giving them the opportunity to use different digital tools (e.g. those provided by the likes of Atlantis Health).¹⁰²
2. **Integration:** For the **system**, the change is about integrating multiple platforms. These include tailoring information from smart phones,

wearables and biometrics etc.; delivering remote diagnostics to give accurate healthcare information; and using more AI and pattern recognition to provide personalised support, warnings and guidance of deviation from ‘normal’ health for you.

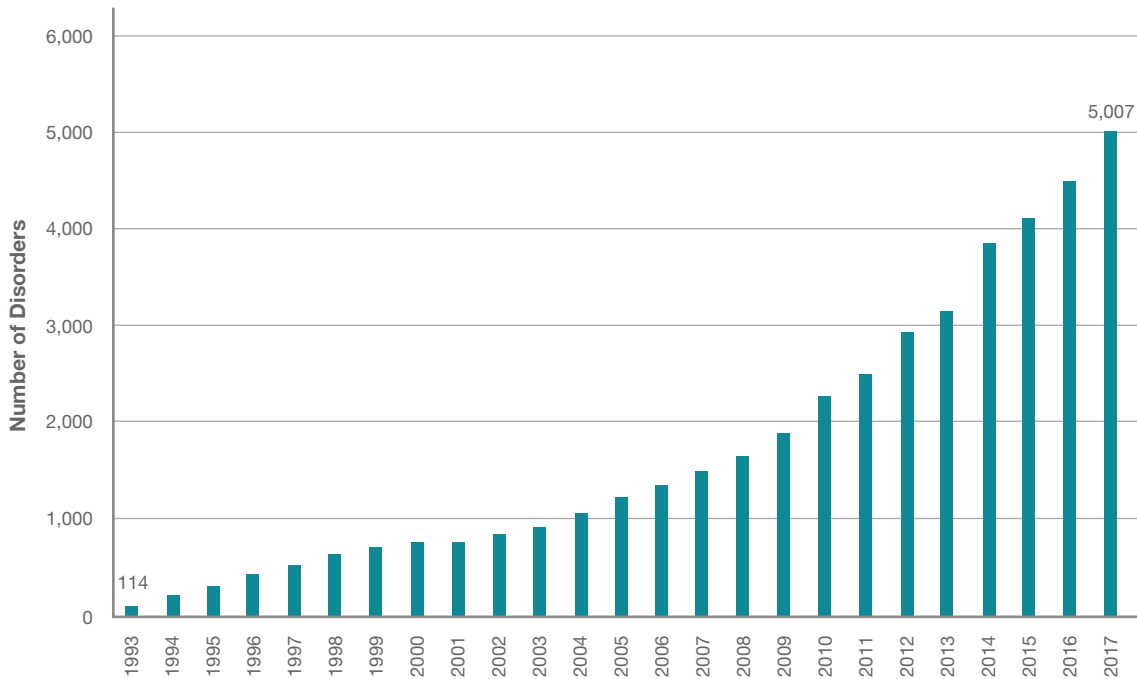
3. **Skills:** For **clinicians** there is a need to ensure that the use of data is not just pushed to already over stretched GPs. Properly managed, integrated data should support the provision of care and enable a more distributed supply of services.

GENOMICS

In addition to improvements in the healthcare service the widespread use of personalised data is expected to significantly reduce the cost of care. Take for example the potential from our DNA data. As the cost of genetic profiling is dropping quickly how well we use the associated information raises a number of questions. On a positive side with more investment in the sequencing of genomes, such as with the UK’s Biobank¹⁰³ programme, many foresee a better understanding of “genetically defined” diseases that will aid the development of drug discovery, diagnostics and testing (see chart right). This will enable medicines to be made specifically for patient groups. As understanding of the molecular base increases, we can breakdown diseases into sub-diseases and so better treat them and even identify as yet undiagnosed conditions. But how should that information be managed by individuals, employers, insurers, healthcare providers and governments?

The Human Genome project completed the first sequence in 2003. Since then cost of profiling has reduced considerably (down from \$1bn to around \$100),¹⁰⁴ and it is now affordable and accessible through companies such as 23andme and Ancestry.com. A host of organisations such as Chinese company **iCarbonX** and Alphabet’s **Verily** (see case studies) are capitalising on this and are combining biological, psychological and behavioural data, in order to provide individualized health analysis, predict users’ health and so make lifestyle recommendations.

Genetic Disorders with Diagnostic Tests Available



Source: Genetests (5/17)

As the cost of acquiring data declines, so the businesses around it evolve. Organisations such as **Nebula Genomics** (see case study) are changing the model so that the core genome sequence belongs to the individual but can be rented out. Genome pioneer Craig Venter's latest start-up, Human Longevity, is hugely ambitious and aims to offer genomic analysis, personalized vaccines and cell therapies, as well as supporting predictive and personalized care including cancer analysis, integrated health analysis, new-born screening and the identification of rare and undiagnosed diseases and, for a fee of \$25,000 per person, wants to customize treatments for each patient's DNA.¹⁰⁵ Given these types of ventures it is little surprise that bioinformatics scientists and genetic counsellors are two of the fast-growing new professions.

Again, however, a word of caution, some in the US workshops felt that individualized medicine, while a bold ambition, is not going to occur universally any time soon.¹⁰⁶ The challenges are simply too intractable. Although some of the key ingredients are starting to align, it will take more than ten years to establish the business models that drive it, the interoperability that enables it and the insights and evidence upon which to make true impact assessments.

MICROBIOMES

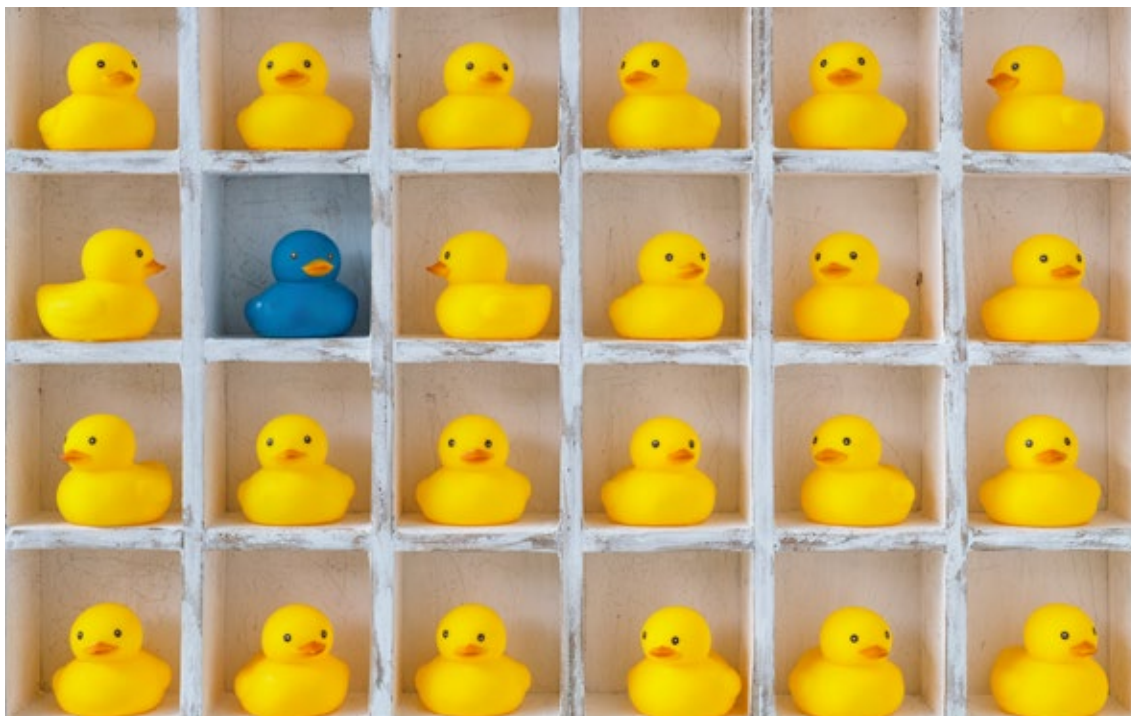
Despite this there is growing support for other new technologies as, equipped with understanding of individual genetic dispositions and new intervention technologies, we can start to proactively edit genes

and, for instance, undertake minimally invasive surgery thus reducing the need for major surgery in later years. Indeed, such is the enthusiasm for this, some, both in London and Mumbai, suggested that we should go beyond talking about just genetic profiling and look at the microbiomes – the genomes of our bacteria. This may well give us better, richer information about disease risk.

In Singapore it was suggested that the growth in high-resolution bio-tracking through ingestibles has led to increased innovation opportunities for smart toilets and faecal analysis. This was already highlighted as a major future opportunity area in our 2015 London 'Future of Health' event.¹⁰⁷ Companies such as iCarbonX in China and Japanese toilet manufacturer Toto are leaders in this area. Several platforms already analyse your urine, take your blood pressure, and send the statistics to your doctor.¹⁰⁸

PERSONAL DATA STORES

Another potentially pivotal development here is the role of new personal data stores. Companies such as **digi.me** (see case study) are seeking to give control of health data 'back to the individual' and are gaining traction. US regulation now requires healthcare providers to create citizen-facing APIs while in Europe GDPR is enshrining in law greater rights for individuals to access, interrogate and correct their own data. As more patients gain 'control' of more of their health and wellness information, then they can share it, as well as other relevant personal social data, with trusted organisations. These, in turn, use this more personal information to provide more personalised health services.



PATIENT COMMUNITIES

Core to all of this is the premise that greater shared knowledge and more peer-to-peer interaction can influence behaviour change. There is certainly evidence to support the benefits of connecting local patients (maybe digitally) who share similar symptoms. In general patients prefer to talk to others in their local community or within already known groups, so, as was highlighted in London, we should *“focus on sharing experiences within existing communities – not just in creating new ones – connecting neighbours and fellow employees who have the same conditions and so pooling people with similar characteristics with private social networks.”* However, it is not a given that deeper understanding and even community support will drive behaviour change in everyone. After all, despite years of informed advice many of us still smoke - including doctors!

As more wearables and other self-managed options for data creation evolve, more lifestyle data will be linked to AI systems that will, in turn, support personalized medicine. In Singapore, a conversation was very much AI focused: *“By 2030 we see that there will be a blend of AI and human support creating the hybrid integrated healthcare system with the patient at the centre.”* Chat-bot consultations, especially with pregnant women, are perhaps the most prominent example of this today but this is only just the start. Most significantly, as new tech is developed, we will have to ensure that humans become comfortable with its use so that it can be more easily deployed.

Benefits for the Patient

The tailoring of healthcare more to the individual, driven by more personal information is at the core of the future patient data ambition. If access, integration and analysis can be successfully aligned then few doubt the impact that more tailored and more focused health support can have. There may well be a few false starts, but if greater personalisation can be delivered for the many and not just the few, then the short and long-term impacts for individuals should be significant.



Data marketplaces

Core to considering how patient data will be accessed in the future, is its wider exchange. A key issue will be what is considered to be public commons vs. what is available for commercial use. To manage this, personal and clinical data will be represented in health data marketplaces that seek to create financial value and enable better care. Given the value of health data in some key sectors, the marketplaces will undoubtedly expand but ensuring how the patient can still benefit will be a challenge.

Along with more connected, interoperable and shared health data comes an opportunity for data marketplaces. The ability to aggregate, access and hence analyse vast amounts of patient data is a core ambition for many and achieving this through centralised systems that draw together multiple information sources is also a common wish. But there are huge costs involved and challenges around quality control. A suggested solution is to establish data marketplaces which can determine value and enable exchange. [The broad view is that](#)

as “data is a currency, it has a value and a price, so it requires a marketplace.”

EVERYTHING CONNECTED

The commonly cited view is that by 2020 the IoT will be made up of over 50bn connected devices and maybe up to 1 trillion sensors. Some see that much of this growth may well come from medical sensors that generate, track and share our health

information. Indeed, the volume of health data is predicted to triple by 2020. This means that it will soon be possible to access previously inaccessible details which may have the potential to change how healthcare can be delivered. But managing this wealth of information is complicated, not least because the data needs to be cleaned and organised before it can be made available for interrogation and exchange. Also, the ordering and sharing of this will cost. How this can be achieved effectively has been the subject of much debate.

MARKETPLACES

The idea of a data marketplace is not new. Banks use data marketplace for credit-referencing: Experian is probably one of the most recognised players here. Other examples include such applications as performance analytics on mobile-operator network coverage and real-time aircraft flight information. What is new is the potential creation of multi-party data marketplaces focused specifically on healthcare which operate in a similar fashion to those in other sectors. There is much appetite for this approach and much discussion. Indeed, it was chosen as an area for deeper focus in seven of our workshops; Boston, Brussels, Dubai, Frankfurt, Johannesburg, London and Singapore. In Boston, the concept was articulated as *“a way to capture the inherent value of patient data and more easily allocate it and share it among the players, rather than just letting it accrue to those collecting it today.”* Some felt they offer *“an important step in building relationships with patients (raising awareness of the value of their data could help) and in helping patients change their behaviour.”* All agreed that there are some pivotal decisions that must be addressed when establishing such marketplaces include governance models and whether, for instance, they are independent platforms or limited ownership hybrids. Answering these questions and working out how to manage patient data exchange is an area that many organisations are currently exploring.

McKinsey sees that data marketplaces are “platforms that connect providers and consumers

of data sets and data streams, ensuring high quality, consistency, and security. The data suppliers authorize the marketplace to license their information on their behalf, following defined terms and conditions. Consumers can play a dual role by providing data back to the marketplace.”¹⁰⁹ Here, key enablers include; the building of an ecosystem, opening up new monetization opportunities, enabling crowdsourcing, supporting interoperability, creating a central point of ‘discoverability’ and achieving consistent data quality. Data marketplaces differ from data warehouses in that they allow for cataloguing and curating.¹¹⁰ Although most traditionally begin within a single company or organisation, it is when they start to connect across a wider ecosystem that they prove to be an effective platform for information sharing and analysis – and hence create value.

HEALTH DATA MARKETPLACES

Some patient data is already being traded - but as yet largely only on a bilateral company-to-company basis. Indeed, many would argue that ‘private’ data marketplaces have been around in the healthcare sector for a while – particularly within or serving the pharmaceutical and insurances industries. IQVIA, for example, is one of the more well-known organisations that have been built on the ability to acquire, analyse and then sell health data - especially around clinical development trials.¹¹¹ Their success and that of others led several experts to comment that *“perhaps health data is a gold-mine?”* Certainly, it has *“very high potential value”* and if used responsibly could drive significant change, maybe even paying for basic healthcare.¹¹²

Going forward it was widely agreed that *“ecosystems for trading data are already emerging and personal and clinical data will be represented in these new healthcare data marketplaces.”* Many suggest that the process will become more open and transparent as more organisations seek to combine multiple patient data sets. Ensuring trust in the system is vital to its survival so there was concern that due consideration should to be given to the fundamental principles behind the establishment of a marketplace

and much debate about what these should be. Everyone also agreed that different business models still need to be explored to establish “how a data marketplace can pay for itself” and *“what is the sustainable model for data trading?”* A number of existing open data platforms were discussed - including the Genome project and the UK biobank. All agreed that this is work in progress, *“there will be business models that will be trustworthy, but we haven’t seen them yet.”*

While there is a cadre of established companies which are active in the development of healthcare data marketplaces including TCS, IBM and Alphabet (via Verily and DeepMind), it is also an area of high start-up activity with many seeking to integrate AI and block-chain.^{113,114,115,116} In addition a number of organisations are taking different approaches to data ownership, for example:

- **HealthVerity** provides a marketplace for data providers and data buyers.¹¹⁷ This has “linkable HIPAA-compliant, de-identified healthcare data on more than 300m individuals in the U.S. from more than 30 national healthcare data suppliers.” That means the marketplace includes data from medical claims, prescription claims, lab results, electronic medical records and other data sources.¹¹⁸ Its founders advocate the potential for researchers to undertake deeper exploration of data that could, for example, provide a better understanding of disease progression and a drug’s impact through the course of a disease.
- **CoverUs** sees that “your health care data should be your private property, and if anyone is making money from that data, it should be you” and is focused on rebalancing the ‘billions of dollars’ that private companies make by selling individuals medical data.¹¹⁹ The system provides users with a digital wallet that is accessible from their smartphone. This can then be populated by data from their electronic health record, wearable devices and other health trackers which can then be shared, and indeed monetized, by the individual, whether it’s with their healthcare provider, medical researchers

or other sources.¹²⁰ The offering rests upon a proprietary cryptocurrency which is earned by sharing data.

PERSONAL VS. ANONYMOUS DATA

Most agree that these and increasingly sophisticated data marketplaces will be a key feature of the future of healthcare and that many will be driven by more and better-quality patient data. As this evolves, so too will the need for a clear demarcation between personal data and anonymous data. At the moment, most of the data being exchanged is aggregated or anonymized, but there were questions around whether this will always be the case. Consent is the key issue here. Lessons may well be taken from, for instance, CODE - the European collaboration on oncology data¹²¹ which proposes there needs to be deeper consideration of what is meant by meaningful consent in the digital economy so that citizens understand how their personal data could be used; and where they can decide what happens to it.¹²² Not everyone agreed that this is an area of significant public concern pointing out that *“people say they are worried about data but they will sell it for less than a penny.”*

In South Africa several consider that *“there ought to be publicly managed global health data exchanges that ensure that high quality information is made available for all key parties.”* Given the sensitivity of the topic effective regulation is clearly important. In Singapore the argument was that broader public awareness is key to ensuring that the maximum benefits of data marketplaces are realised - *“If the data value extraction can be democratised then this will open the door to information sharing at an extraordinary scale.”* There was also much discussion about how this can be achieved; one view in Canada was that *“people like rewards – using air miles as an incentive for healthy living is working.”* Others took a more holistic approach pointing out that *“in the healthcare market, trust, consent and governance are the first challenges to address ahead of building the marketplace and the products that can operate within it.”*¹²³

In the Brussels event, legal expertise considered that *“there should be a clear demarcation of what is the commons space vs. the commercial space”* and that *“if health data is to be exchanged in a marketplace, regulatory frameworks should be developed that determine how we build / incentivise reward systems for investment, trading and stewardship.”*¹²⁴ Moreover *“there has to be clear governance and comprehensive guidance on both accountability and quality of data as well as views on who will use the data and what they will actually pay for.”*

In London, there were fundamental questions around what marketplaces are used for and whether they act as mechanisms for social good or are a way of monetizing human failure. These included:

- How can you define what is to be used and not used?
- How do you define a marketplace – is it a co-operative?
- Who will define what the commons space is vs. the commercial space?

And before we forget the practicalities when all these challenges are sorted out, many agree that *“someone still has to manage the process so that the all-important data to be ‘cleaned’ and that someone will have to be paid for their efforts.”*¹²⁵ In some discussions it was apparent that not all consider that data marketplaces will be a good thing. In South Africa, the position was



that *“healthcare data should not be monetised. It should be seen a public good and used to benefit all. Specifically, it should not be in the hands of a few private companies nor should it be a source of profit.”* Others see a parallel with the different opt-in vs opt-out approaches used around the world with organ donation – putting the choice of benefit in the hands of the patient.

However, in Frankfurt, the final assessment was that new marketplaces will emerge based on business models that offer greater incentives for success and penalties for failure. By 2025 we will have clearer views about which data we should use for what purpose. *“As patients become more supportive, driven by disruptors such as Apple, Facebook,*

Amazon they will be prepared to buy and sell their data, so it is important to understand what they will be willing to share.” That said, some consider that there will have to be a paradigm shift in behaviours and that data markets will only work if patients understand the process: *“We have to make data marketplaces simple.”* To achieve this there needs to be more research around health and prevention and greater health literacy; payment needs to be based on outcomes and pharmaceutical companies in particular will have to sell ‘better health’ not ‘managing sickness’. Furthermore, the transparency that will required from data market places will drive greater awareness around efficacy so it may well be that in future, alongside treating disease, doctors will be reimbursed for training people to remain healthy.

Benefits for the Patient

Patient data is already being traded, albeit at an aggregated and anonymised level, but this is not widely recognised. As awareness grows and there is greater focus on more personalised information, a common question is the extent to which individuals will be involved in managing their personal data and whether they will be able to benefit from it financially. There are issues around privacy and trust, but maybe well-designed models with a greater focus on the social and health / wellness benefits, as well as the financial side, could develop. Given the rising value of health data, marketplaces will undoubtedly expand but ensuring that the patient gains advantage will be pivotal.



The impact of AI

Initial advances from machine learning and pattern recognition will be significant in enabling more efficient diagnosis and better prediction. As deep learning and self-learning then develop, the ability to deal with unstructured data delivers major improvements in diagnosis and treatment and AI is embedded into many clinical decisions. Moreover, with voice and facial recognition increasingly analysing users' behaviour patterns, AI is also applied to identify stress and anxiety.

Today we can see growing activity across the AI arena – barely a day goes by without a new report or media feature on how AI will take over and replace our jobs or else deliver massive improvements in efficiency across multiple sectors. From energy management and traffic flows to education and healthcare, investment in new AI propositions is growing rapidly.

The potential impact of AI on healthcare is considered to be enormous – and most believe that much of this revolves around the improved analysis of patient data. An initial perspective that *“as more people use AI health advice, the more data is collected and therefore the more accurate diagnosis can be”* was widely supported. However, it was often pointed out that the impact of AI will be far greater than just this. *“We are just at the very early stages”* was the common view.

INITIAL GROWTH OF AI

AI is already making primary care more effective and efficient. This potential has been frequently reported by the likes of IBM Watson¹²⁶ and Google Deep Mind^{127,128,129}. Another player Babylon Health^{130,131,132} has recently struck a deal with Chinese internet giant Tencent to provide an automated symptom-checker and paid-for video consultations to WeChat's almost 1bn users. At the same time in India Tricog¹³³ is improving the time, cost and efficiency of cardiac diagnosis,¹³⁴ highlighting immunotherapy cancer links¹³⁵ and identifying rare diseases in children lacking key enzymes. Elsewhere artificial intelligence (AI) is being trained by a unit of Alphabet, to identify cancerous tissues and retinal damage. Other notable AI healthcare companies include CloudMedx, iCarbonX, Deep Genomics, Lunit and Zephyr Health,¹³⁶ and, in an adjacent space of meditation, the latest version of Headspace.¹³⁷ As patients' data is collected from smartphones and "wearables", they will teach AIs to do much more. Future AIs will, for instance, provide automated medical diagnosis from a description of your symptoms, spot behavioural traits that suggest you are at particular risk of a specific condition and even work out if you are suffering from depression.

In Oslo, the observation was that *"AI adoption will be led by primary care support with a particular focus on specialist conditions."* In Dubai, the perspective was that we are *"very much in the learning phase"* but that within 10 years the impact can be significant. In Brussels, although concern was expressed about how 'clean' the data needs to be for it to have impact in the short term, it was suggested that, while initial focus is on improving diagnosis, *"over time we will quickly move to using AI for treatment."*

PATTERN RECOGNITION

Until now many of the developments in the news have been niche applications. For instance, while **Deep Mind** (see case study) has been in the headlines with its pioneering work in machine learning, as yet most of its healthcare activity with the NHS in the UK has focused on leveraging

more mature pattern recognition via the Streams technology in a few specific areas. These include acute kidney injury with the Royal Free and age-related macular degeneration in partnership with Moorfields Eye Hospital. However, as it and other organisations gain access to more medical data, the potential from pattern recognition alone is seen to be massive. *"At the moment, the focus is on imaging and radiology because that is well structured information and good for pattern detection."* In these first steps the dependency on restricting usage to high quality, clean data sets has both pros and cons. On the positive side it is allowing swift and successful proof of capability, but, on the other hand, the range of patient data currently available for analysis is, in some eyes, relatively narrow.

*"AI is already having impact where we have structured data available – and so can improve efficiency."*¹³⁸ For example, DeepMind has crunched data from thousands of retinal scans to train an AI algorithm to detect signs of eye disease more quickly and efficiently than human specialists. However, if it is going to have wider effect, then either AI will have to become adept at dealing with unstructured data or new ways must be found to clean data before it can be fed into the system. Achieving this will rely on a combination of regulatory standards and new business models around reimbursement that make the effort worthwhile. Key will be the role in helping with the integration of multiple sources of information. *"If we get it right there could be a different 'geometry of connection' based on human relationships."*¹³⁹

Recognising that so far this is largely about machines doing what humans can do, but faster and with increasing accuracy, the overall consensus was that in the short-term machine learning and pattern recognition will support doctors – and certainly not replace them: *"Doctors diagnose accurately 74% of the time."*¹⁴⁰ An agreed view was that *"AI is already here – we are using algorithms already and learning from them. AI is improving research effectiveness, increasing the efficiency of clinical care and enhancing education."* AI and doctors are increasingly working together.

ARTIFICIAL GENERAL INTELLIGENCE

Although we are still in the early days, the possible future change that can be achieved with the use of AI with patient data is universally seen as being substantial. Within the wealth of potential AI opportunities being explored, in Boston it was suggested that it is important to recognize that:

- AI can be applied across a broad spectrum of healthcare provision including R&D, care delivery, patient engagement and behavioural modification, population health, admin and material resource planning.¹⁴¹
- Moreover, assumptions are being made on the *“key characteristics of future AI in healthcare will be that it is ambient, global, open-sourced, patient-focused and include humans in the loop.”*

Several experts in London and the US pointed out that while some are talking about the ambition for AI as Artificial General Intelligence (where a machine that could successfully perform any intellectual task that a human being can), others are looking way beyond that target. One side-remark in Boston was that *“my ideal view of this is Scarlet Johansen in the movie HER – is that the ultimate AI experience?”* ‘She’ is intuitive, sensitive and playful.

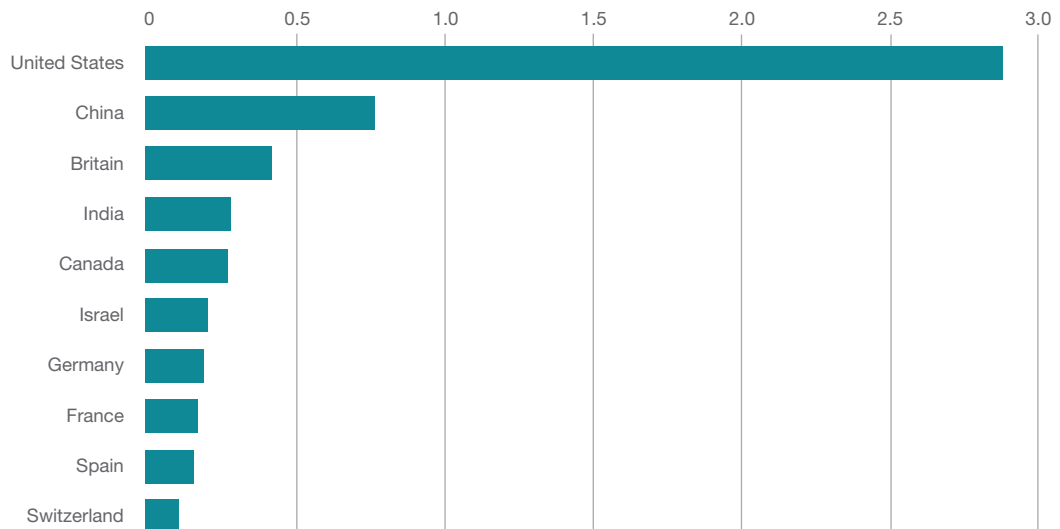
In a positive scenario from London, the perspective was that in the next decade *“AI increasingly automates routines that currently occupy up to 80% of the GP’s time. In doing so it enhances human interactions, drives development of regulation, thereby reducing revisits and rewiring decision making.”* Doctors can then focus on more of the ‘human’ activities so *“AI will lead to a change in the relationship between providers and patients.”* Others suggested that *“we will move from isolated pilots to established solutions for single diseases and then on to holistic approaches. Over time algorithms will build trust and lead to much greater efficiencies in diagnosis and the management of disease progression.”*¹⁴²

AI IN CHINA

It was often highlighted - and especially in Singapore, Dubai and India - that although much of the media attention is on US and UK based enterprises, we should be paying closer attention to what is underway in China. Recent analysis by the Economist (see chart on the next page) highlights this and argues that China may well beat America at AI.¹⁴³ Over the past decade, while the number of AI based patent applications in the US has risen by 25%, albeit coming from a lower base those from Chinese companies has doubled. Moreover, as of the end of 2016, with 7,000 organisations in operation, China had the world’s second largest portfolio of AI companies. With 730m Internet users, some see China as the *“Saudi Arabia of data”* providing massive amounts of rich information for new algorithms to experiment with. Within healthcare, as it seeks to build a full ‘digital life ecosystem’ **iCarbonX** (see case study) is just one of the Chinese companies getting significant investment support and is one of the fastest growing in the sector.

Number of Artificial-Intelligence Companies

Selected countries, 2016, '000



Source: Economist.com 2017

DEEP, SELF AND REINFORCED LEARNING

As we shift from pattern recognition and machine learning to deep-learning, self-learning and reinforced learning, the view in Singapore, was that, *“by 2030, AI will be embedded in much clinical decision support providing greater precision and personalization for patients and higher productivity for clinicians - all reinforced by more automated work flows.”* For the consumer, new apps will become more clinically focused which will facilitate medical decision making. For hospitals (and healthcare providers), med-tech will incorporate more AI into equipment for detection and prediction. It was also suggested that as we shift to reinforced learning - where AI agents learn by trial and error from their own actions and experiences and so take actions to maximise some notion of cumulative reward - then we can really be more efficient in the data we use. *“The next stage of AI will require less not more data. As we move to self-learning, machines*

will not have to sift through lots of information and the amount of data needed to be processed will decrease – machines will know exactly what to look for and focus on that key data.” Then, as AI develops ‘soft-skills’ *“we can spend less time collecting data and more time connecting the dots and conceptually thinking about the problems.”*

In the US one view was that AI will have particular impact both at a national population level (resource optimization, machine vision, model development etc.), but also at an individual level. *“Nationally the initial focus will include data brokerage and government domains but will then move onto example applications such as micro insurance where pricing, incentivisation and guarantees will all occur at an individual level.”* There will be a growing need for regulation that, as with all new technologies, will have to strike a balance between helping to accelerate innovation but at the

same time manage its ethical implementation and implication. Getting this right will open the door to many more personal applications that will aid the patient and the healthcare professional. In the first instance these are likely to be around *“the provision of routine applications however the continued growth in mass-personalization will most likely drive outcomes based on patient preferences rather than physician preferences.”*

AI AND MENTAL HEALTH

Looking forward, several also commented on the implications of greater integration of Alexa, Siri and similar voice activated platforms. As these services develop, we may unlock the ability to sense and analyse individual behaviour patterns and consequently deliver a wider range of AI-driven support. One specific example that gained traction across the discussions is the use of emerging technologies in diagnosing anxiety and supporting mental health. In many of our conversations the view was that *“mental health is a growing issue that has not been getting the right level of attention in patient data discussions.”* This may be changing as it was also observed that *“facial recognition software¹⁴⁴ already has the capacity to recognise stress and anxiety and, alongside other digital diagnostic tools - such as voice pattern analysis, it will be increasingly used to identify and monitor mental health problems.”* Many believed that this might herald a step change in the way mental health could be diagnosed and treated. **Facebook** (see case study), for example is seeking to make

a contribution to the mental health arena using AI analytics of Instagram feeds to diagnose depression. Although there are obvious benefits to this, in Dubai questions were raised around the negative implications if more detailed information about patients’ mental health became available, *“if the information is available to them, will employers refuse to recruit people who may be prone to depression?”*

In some circumstances AI and chat-bots give those who are uncomfortable talking to others the confidence to communicate more openly because they have a perceived anonymity. This has proved to be successful in Singapore, where *“mental health is not as openly discussed as it ought to be”*. Initial papers¹⁴⁵ detailing evidence of the potential of chat-bots for mental health care have started to explore this and the role of technology in ‘emotional chatting.’ Elsewhere chat-bots are being used to help with depression.¹⁴⁶ Also in Singapore chat-bots are an increasingly popular source of information and advice for pregnant women who, in a deeply conservative culture, often find it difficult to be open and honest with human doctors. Technology such as this is not only felt to be less judgmental, but it is convenient too; there is no need to make appointments and the conversation can take place from patient’s homes at their time of choosing rather than in a surgery which some may find too public. In Mumbai comments reinforced the view that AI can support diagnosis of mental health¹⁴⁷ and also socially unacceptable diseases such as tuberculosis where *“people often lie about whether there is TB in their household.”*



Although AI can release humans from mundane tasks and enable them to work on more exciting and value-added tasks it is not without risk and indeed most would argue it comes with its own set of responsibilities. Indeed, it was clear through our conversations, that human evil, incompetence and poor design remain a big threat for the foreseeable future. There are concerns that although AI technology alone may not reveal any inherent biases, it may unleash all manner of biases that reflect those of the humans who design the systems. Given this there is a growing sense that AI should be used not just for the right predictions, but also to make predictions for the right reasons. While AI is on a par with humans in aspects such as reading radiology images, the same neural network algorithms have potential for discriminatory profiling based on facial recognition and other decisions that have implications for society – potentially showing racial or ageist bias for example. *“What if algorithms present different treatment decisions about patients depending on their age, sex, race or even insurance status or ability to pay?”* Given this, some argue regulators should step up and ensure that tech companies and manufacturers be held liable for the misuse of their AI-enabled products in the

same way that pharmaceutical firms are responsible for the harmful side-effects of their drugs. This needs to be taken seriously as retro-fitting effective principles will be like shutting Pandora's box. However, a recent Financial Times article pointed out that there are estimated to be just 100 researchers in the western world grappling with the ethics of AI in healthcare. That seems far too few, given the scale of the challenge.¹⁴⁸

Of course, having the data and the AI capability doesn't guarantee improved quality or reduced costs in health care. Intervention models and care plans also need to be in place. Some argue that in an era of high-volume and high-velocity, real-time data, these limitations will slow the adoption. Given the ethical challenges perhaps this would not be entirely a bad thing. And yet, across multiple areas of healthcare, it is evident that the enthusiasm for AI to make a major contribution is growing apace. There are tangible results from its early use and as the technology and societal acceptance evolves, it seems that the future potential is indeed discernible.

Benefits for the Patient

Discussion of the impact of AI is pervasive and the potential for change is substantial. If patients are willing to both engage with new systems and also provide more of their personal data for analysis, the capability for earlier diagnosis and hence treatment is increasingly palpable. While trust is a pivotal issue, the possibility of faster, more effective healthcare support may also be on the horizon.



CASE STUDY:

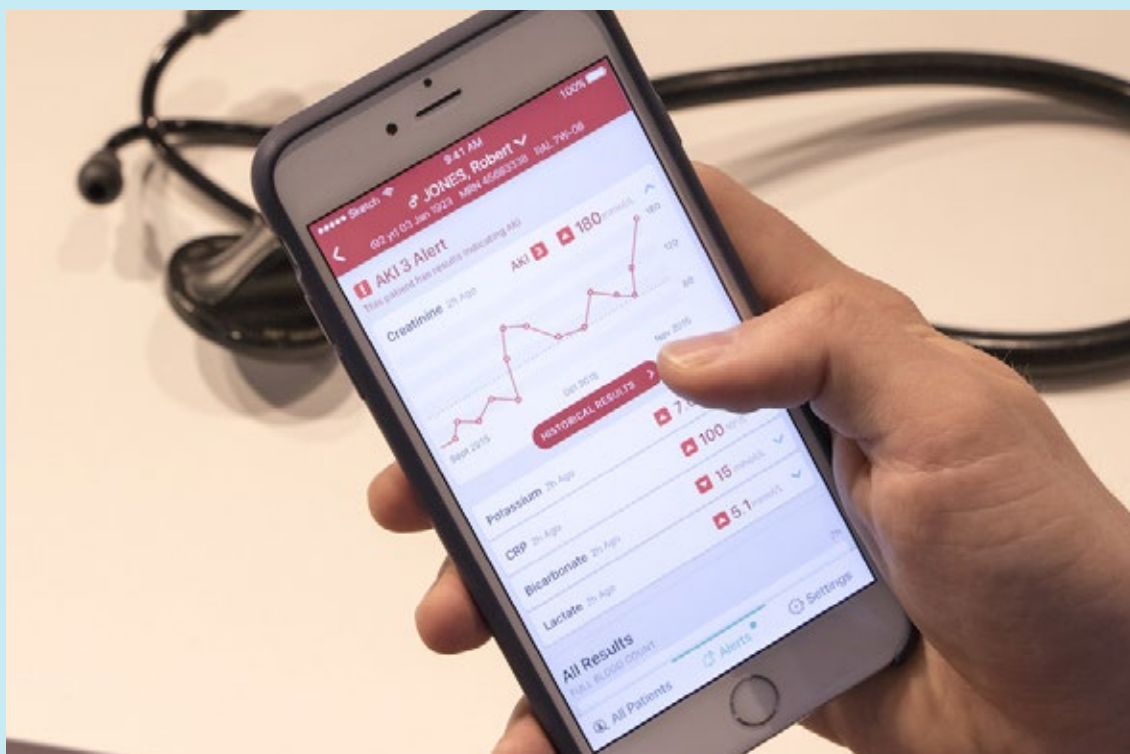


Founded in 2010 in London and acquired by Google for £400m four years later, Deep Mind has been one of the most visible of the world's AI companies – largely through its success in building machine learning algorithms that can beat the best in the world at Go. Its rather bold ambition is to “solve intelligence, (and) use it to make the world a better place.” DeepMind, together with Amazon, Google, Facebook, IBM, and Microsoft, is a founding member of Partnership on AI, an organisation devoted to the society-AI interface. While DeepMind is not exclusively a healthcare company, its products with the clearest path to commercialisation are focused here. As such, led by co-founder Mustafa Suleyman, the DeepMind Health business¹⁴⁹ is one of its most public activities as the company seeks to bring its leading expertise to bear on the health sector and its choice to initially do this with the UK's NHS which offers a single, standardised market. It is collaborating with the UK's National Health Service on delivering better care for conditions that affect millions of people worldwide.¹⁵⁰

DeepMind has partnerships with four large hospital groups to which it provides its best-known healthcare product - an app called Streams. This is designed to decrease the incidence of acute kidney injury before it occurs by alerting clinicians to the warning signs that indicate a patient is a candidate for such an injury. The app itself doesn't yet contain any deep learning AI at present but it is likely elements will make their

way into the products in future. With other NHS partnerships DeepMind has been testing whether its products can analyse medical scans more quickly than doctors.

If the pilots prove successful, DeepMind can provide the software as a means of cutting down doctors'



busy work, so they can get on with seeing and treating patients.¹⁵¹ Although facing a legal push-back from the way the data from 1.6m patients was shared by the Royal Free NHS Trust in 2015 during the co-development of Streams,¹⁵² it is now rolling out further collaborations including with the Taunton and Somerset NHS Foundation Trust, where it uses pattern recognition to “alert doctors and nurses to a potential deterioration in their patients’ vital signs that could indicate a serious problem.” The app is available at the bedside to alert doctors and nurses to any patients needing immediate assessment and help them rapidly determine whether the patient has other serious conditions such as acute kidney injury.¹⁵³ Results are impressive with nurses triaging patients in less than 30 seconds compared to the norm of up to four hours. “This is really based on the patient, so that what we’ve got in there is data about the patient and about what’s happening to the patient while they’re here with us as an in-patient that can help us identify when there are potential problems.” It is a fully integrated EPR with DeepMind acting as the data processor and

delivering that EPR via a mobile application. In other collaborations, DeepMind, Moorfields Hospital and two London universities are trying to see if AI software can learn to read OCT retina pictures, head and neck images and mammography scans as well as or better than doctors.¹⁵⁴

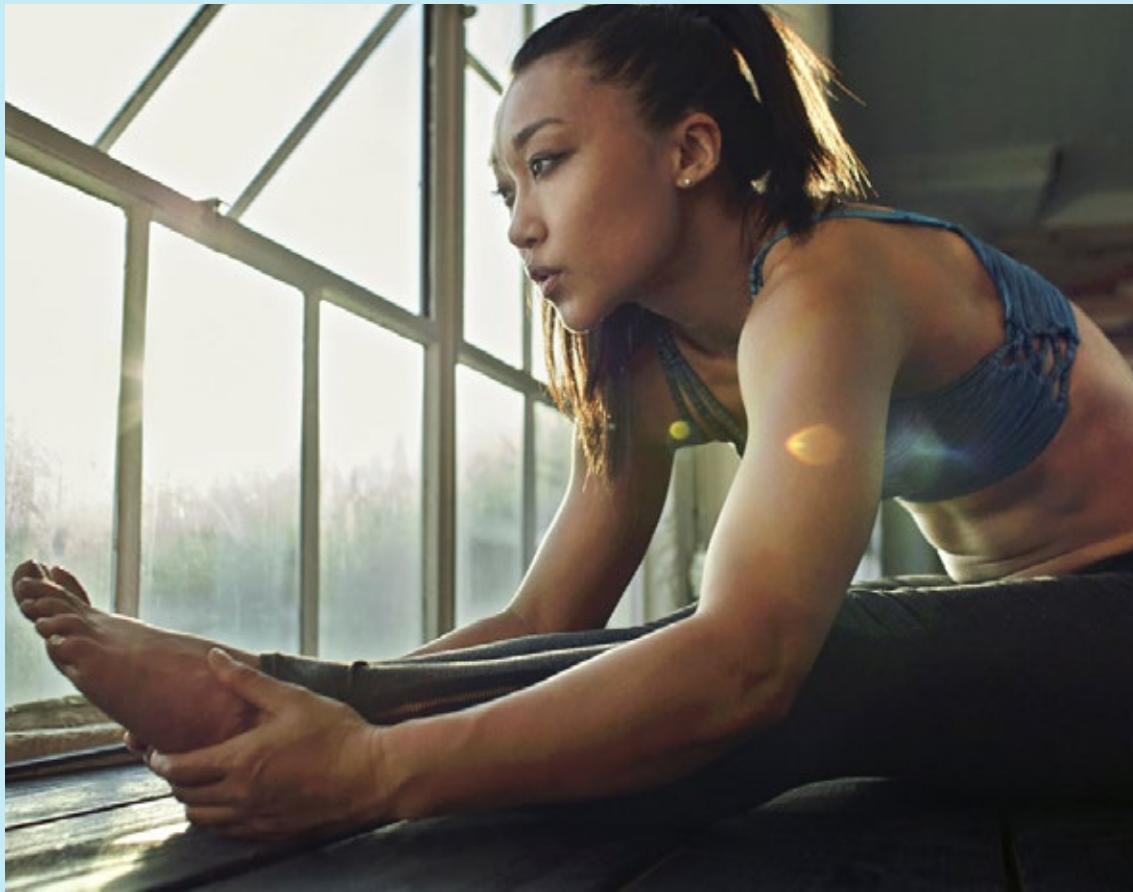
Initially, DeepMind is not making money from its NHS collaboration. “Only when we can prove that we have improved outcomes will we be paid accordingly within IT supplier market rates. We’re not driven by a desire to maximize profit, but rather to create a mutually sustainable business model.”¹⁵⁵ As such, DeepMind is ‘years away’ from major healthcare revenues. In 2016 it reported a loss of £94m. However, with its pioneering research in deep learning, all its health data, strong partnerships with the NHS and deep pockets of Alphabet, few doubt that DeepMind will be one of the companies changing the way people experience health care.

CASE STUDY:



Within the fast-growing Chinese AI community that is part of the country's ambition to be a global leader by 2030, there is one healthcare company that is already standing out on the global stage. While many other of the high-profile Chinese start-ups are focused on facial recognition and driverless cars, one of the leaders is very much seeking to change healthcare.

Only founded in 2015, iCarbonX (ICX) has quickly become one of the fastest growing AI companies in the sector. Having already received over \$600m in funding and now officially a 'unicorn' it tops many charts¹⁵⁶ and is making strong headway in its ambition to build a 'digital life ecosystem' combining biological, psychological and behavioural data, provide individualized health analysis, predict users' future health and so make recommendations on everything from diet to exercise. The company uses the analogy of providing a roadmap "that shows us where we are in terms of our health, with clear place markers for risks and opportunities. A guide based on the experience of those on the road ahead that gives signals about which paths lead to health, or to disease. A compass that points where to step first. All in a GPS that makes it easier to move toward our personal health goals, every day."¹⁵⁷



ICX wants to capture more intelligence about your body than has ever before been possible. Starting with your DNA profile and adding fit-bit style activity and key health information plus frequent blood tests, heart data and your medical history, the goal is “continuous monitoring of your health and suggestions of adjustments you might make in your diet and behaviour before you slip from being healthy into the early stages of an illness.”¹⁵⁸ Integrating data fed from a broadening range of sources including partners such as Patientslikeme, Sema4 and HealthTell is an AI system that undertakes the core analysis. Founded by Jun Wang, former professor at the University of Copenhagen and founder of the Beijing Genomics Institute, ICX recognises that this is ‘ridiculously complicated’. However, in blending Chinese AI expertise with global health data sources the ambition is to quickly move from working with

populations in the tens of millions required to get meaningful insights towards far greater population sets. Starting in China with plenty of people and less stringent privacy laws than some regions, patient data is already being gained from a growing range of feeds including faecal analysis and continuous heart monitoring. Aiming at a target \$200 for an AI-generated personal full profile, ICX sees that it can make a major contribution to preventative activities and bringing down the cost of health care globally.

CASE STUDY:

facebook®

Facebook is already widely used by clinical trial recruiters. This is a growing revenue stream for the company with some forecasting a health-sector spend of \$3.1 billion on digital advertising by 2020.¹⁵⁹ There are millions of health groups on Facebook where people with a variety of health conditions discuss their symptoms. But, so far, many marketers have not been using that data in their outreach. This is now changing as the company formalises patient groups so that, despite recent public revelations about personal information misuse, pharmaceutical companies become more confident in data integrity.¹⁶⁰ This is intended to drive a change in the platform's cut of a growing direct to consumer ad spend in a sector where the digital share is currently only 3%.

However, it is not just in targeting patients that Facebook is becoming more active in healthcare. Another big future bet is on making a positive impact on mental health. Although frequently criticised for detrimental effects, especially on heavy users,¹⁶¹ the company is using AI to monitor its customers' online behaviour for patterns which indicate depression, and to reach out in an effort to prevent suicide. For example, photos on Instagram can signal depression, depending on the colours they contain, the times at which they are posted and whether they show faces.¹⁶² 2017 Harvard research has showed that Instagram can help diagnose

depression better than your GP.¹⁶³ Machine learning tools successfully identified markers of depression from participant Instagram photos, using colour analysis, metadata components, and algorithmic face detection with "resulting models outperformed general practitioners' average unassisted diagnostic success rate for depression."¹⁶⁴ Facebook is now expected to incorporate the analysis within its platform to provide new avenues for early screening and detection of mental illness. As social networks come under increasing pressure on trust and truth, how effectively this is managed is being watched by many across healthcare.





New models

While we will see some change from within, expect big tech, led especially by Amazon, to further disrupt health care. This will shift reimbursement mechanisms and drive shared risk across payers and providers. Equally significant change is emerging from China and India where the creation of identity related platforms is driving innovation at scale. At the same time, some anticipate that the reinvention of healthcare business models will come from more unexpected places.

Personalisation, data marketplaces and the application of AI are among some of the digital disruptions already impacting the provision of healthcare. A growing array of large and nimble organisations are variously seeking changes to delivery models, identifying different ways of working, reinventing HCP training and reinvigorating local, out-of-hospital care. But, many recognise that, in a way, this is just scratching the surface and believe the sector needs more fundamental change. The expectation is that this will come from disruptive new

business models – either from big tech companies with access to a wealth of additional personal wellness and proxy data or from the governments looking to manage the huge population centres in the new economies of China and India.

THE NEED FOR CHANGE

Given the rising costs and population shifts, the calls for new, improved healthcare models are many and

varied. But delivering the required change is no easy task. There are multiple reasons for this. Encouraging it from within is a constant battle in many organisations and systems, particularly ones which have evolved gradually or grown steadily over many years. Often the best-laid plans get bogged down in the sheer complexity of multiple legacy information systems - despite the vast sums that may have been spent on IT. Add in the challenge of encouraging lasting behaviour change and it is understandable that a sustained transition within any large entity can take years to define, test, pilot and embed. On top of this, changing culture takes much longer to adapt than installing new technology. In one 2016 UK Digital Health discussion¹⁶⁵ it was stated that *“clinicians and health professionals are often naturally conservative and change averse – it is often viewed as a threat to roles and responsibilities.”* In South Africa it was suggested that one reason for this locally is the comparative age of GPs; many are over 50 and a good number are set in their ways – so hence they tend to push-back against digitisation. But they are also concerned that too much technology will remove them from being able to take proper care of their patients’ emotional needs, *“healthcare providers are hesitant to use new technology and many GPs see the PC screen as a barrier between them and their patients.”*

Whether they like it or not, established healthcare systems will however have to be ever more alert to change because, attracted by the rising levels of spend, more and more tech firms and new start-ups are lining up to get involved and maybe even take control. Whether they will, in the end, be successful is up for debate – they have tried and failed before.¹⁶⁶ Google started its Google Health health-records initiative in 2008, but shut it down by 2011, citing poor adoption. Microsoft’s HealthVault has made similar efforts with likewise low take-up.

Perhaps the timing was wrong? Many now see that now that the widespread global availability of smartphones, with their ability to give patients access to their data whenever they want and wherever they are, has opened the door to new

opportunities. Major disruptions may be coming our way. As already highlighted, new data sets that contain information about human health are hugely valuable. The more data the tech firms can handle, the more they will learn about human health, and the better the services they can offer will become.¹⁶⁷

CHANGE FROM WITHIN

But don’t give up on the existing players just yet. Numerous experts we talked to still believe that significant change is emerging from within the current healthcare systems - be that from governments and the systems directly or via companies in key sectors, such as pharmaceuticals and insurance. In Brussels, it was proposed that the ability of government(s) to drive collaboration across traditional silos and link health and wealth could be transformational for Western systems. Many have pointed to Singapore as leading in this area. The need, they argued, is for governments to rethink and *“support wellbeing as an investment rather than a cost.”* While Western models are on most radars, there was also an alternative view which pointed to India and China as being likely centres for future data-driven healthcare innovation.

INDIAN EFFICIENCY

In Mumbai we heard that *“innovation happens when there are gaps and there are lots of gaps in India - so lots of opportunity.”* Moreover, India is the only market in the world with huge price diversity – a place where you can pay \$1,000 or \$50,000 for the same complex procedure. Here the potential for change is tangible and we are already seeing action.¹⁶⁸ While previous successes of Aravind¹⁶⁹ and Narayana¹⁷⁰ in reinventing cataract and cardiac surgery for high-quality / low-cost treatment are well documented, the major future shift is very much expected to be a consequence of the way almost the entire population is now connected onto a single digital platform. In both Sydney and Singapore, as well as in Mumbai, the impact of Aadhaar¹⁷¹ linking healthcare data to identity¹⁷² was seen as highly significant. *“With over 1bn people using Aadhaar there is volume advantage in terms of available*

datasets” and, as financial inclusion becomes more integrated, the opportunities for change from, for example, microfinance and health insurance are considerable.¹⁷³

While there are several other nations making significant progress at integrating and sharing data (e.g. Iceland, Singapore and Sweden), they are operating with a maximum population of just a few million. What is happening in India, with over a billion people, will not only have huge local impact but also has the potential to set new standards globally. Although a number of concerns need to be addressed such as ensuring informed consent of those who are illiterate; managing the strict privacy regulation; and understanding the consequence of the threatened data inversion legislation (the forced repatriation of data to India), the sheer scale of what is underway in India in terms of the harmonised data sets of so many people on one platform is enormous. Many are now watching what is going on with great interest. With the high-level support of the Modi government and associated initiatives such as Digital India and Start-up India all gaining traction, confidence is clearly building. India is creating a new model for its own healthcare system that may well leap-frog many other nations. One suggestion in Mumbai was that, as it is already so intertwined into the global health care procedures from years of BPO activity, then, as India innovates, so its’ advances will quickly become integrated into other systems.

CHINESE MOMENTUM

But it is not just India that could deliver wider change. Also well-worth tracking are healthcare developments in China, where some suggest that major advances in technology that are now being applied to healthcare may well have global reach. Certainly, momentum is building fast and China is making great progress in many core areas – from the adoption of robotics within surgery to the application of AI to diagnosis. Although initial emphasis for many Chinese healthcare companies is on the huge domestic market, many see that the ‘Made in China for China’ focus will soon shift to be global. Just as has occurred in telecoms with Huawei, other

Chinese firms such as Tencent, Baidu and Alibaba are arguably now also ‘shaping the global future of tech.’¹⁷⁴ Whether or not coming from the ‘pure-play’ healthcare-focused firms like iCarbonX or new health apps on broader platforms such as WeChat and Alipay, the scale of the impact on healthcare that could emerge from China is significant, particularly given a fundamentally different outlook inherent to its current healthcare model. In our Toronto discussion, it was, for example, pointed out that China has a completely different attitude to the doctor/patient relationship as *“the patient determines the efficacy of his or her treatment and so whether or not to pay the doctor. Maybe this approach could be adopted in the West?”* New models in Chinese healthcare built around a different philosophy coupled with better and large data sets are emerging from multiple directions and are rapidly being applied to hundreds of millions of patients - delivering quick proof of new concepts at scale. Coupled with already huge and fast-rising domestic venture investments, several in our workshops feel that much of healthcare in the second half of 21st century could have a distinct Chinese flavour.

NEW PHARMA MODELS

In terms of specific sectors within healthcare, there was almost universal consensus that, alongside elements of insurance, the pharmaceutical industry is ripe for disruption as a result of the growth in patient data. In London, the view was that many are already exploring how to break funding silos, while in Singapore it was suggested that *“pharmaceutical firms should only be reimbursed if their drugs work – and can prove that the targeted benefits can be delivered.”* Assuming the growing demands for higher quality healthcare continue, that patients are increasingly data-aware and that all parties agree that change is needed, the UK discussions also suggested that the better use of patient data would increase the potential for multiple future shifts. These include:

- Using data focused on outcomes to change reimbursement models and drive shared risk,
- Policy and process changes with payers and providers increasingly in alignment,

- Leveraging data to bridge the silos between social care, medical devices, hospitals and chronic care,
- Integrating data to get the whole customer view as well as shared interests,
- Bringing society along as a partner for change with individuals willing to provide their data to support it,
- Developing 'consumer products that care' rather than care products for consumers, and
- Data cooperatives driving the buyers of data – that are willing to pay and understand the value of data.

In Frankfurt, many pointed out that the patient will probably become the co-producer of care in the future and that many changes in healthcare are likely to be patient-driven rather than solely powered by the corporates. A focus on, and support for, more personalised and preventative healthcare *“will also add pressure on the current “artificially high-level pricing of drugs.”* Indeed, it may herald the end of the blockbuster era for pharmaceuticals. *“Progress with cancer care and type 1 diabetes may well set new precedents for a world in which improved availability of data will drive new revenue streams.”*

BIG TECH MOVES

Alongside the multiple shifts from within healthcare systems, many of the big tech organisations are also making some major moves in healthcare. Learning from their past mistakes, many believe that as patients are now more used to sharing information on the cloud, this time around they will be more prepared to trust and share their sensitive health records.

Although many of the big tech companies are highly secretive about their 'special projects', it's an open secret that they are all busy hiring talent and buying or backing external health-care start-ups. With hundreds of PhDs recently moving from the

public research centres within key universities into Alphabet, Amazon and Apple as well as Facebook and Microsoft, the signals are clear that healthcare-focused activities within the varied skunk works are escalating. The question is how fast they will move and with what intention. Current acquisitions and announcements already suggest major movements.

Several shifts are visible – *“look for example at Health Records embedded in the next version of Apple’s Health App and the launch of (Alphabet’s) Cityblock Health”* was one suggestion. Apple is indeed embedding the next generation of sensors within all its products to capture and analyse more personal health data; **Flatiron Health** (see case study) is building its capacity to turn health data into insights transforming EHR data into analysable, actionable information; Microsoft started a health-care division in Cambridge, England in September 2017 which will devise medical algorithms of its own; and Alphabet spin-out **Verily** (see case study) wants to be the R&D partner for the world’s leading life sciences companies. It is looking to become “the OS for healthcare.” These are all in play. Other options being speculated upon include Google, Amazon or Apple moving into the EHR space by purchasing one of the major existing EHR vendors.

In many of our discussions, the future focus for healthcare innovation is still very much seen to be around the US big tech firms where *“the sheer scale, wealth and reach are a major driver of future change.”* This is particularly true of the ones with nearly global reach as part of their existing services. In Sydney, it was felt that *“by 2030, a growing number of non-traditional entrants will have enabled a more specialised consumer-centric care system.”* It won't be easy to generate a change in behaviour, but, assuming the aim is profit creation, most likely from data markets, then, alongside the need to generate higher levels of consumer acceptance, the Australian view was that there may also be a few political and regulatory hurdles to negotiate. Moreover, if we get it right, there will be a greater focus on preventative healthcare with the doctor increasingly *‘riding side-car.’*

AMAZON HEALTH

Across the vast majority of our events, time and time again the biggest source of disruption for the future of healthcare was seen to be coming from one organisation – **Amazon** (see case study) and its secretive lab 1492: *“Amazon has made the biggest strides so far”*.¹⁷⁵ It has already initiated significant change in how drugs are sold and is making shopping for healthcare easier for both customers and medical professionals.¹⁷⁶ It is bringing the efficiencies proven elsewhere into the healthcare supply chain. Several see that Amazon could, for instance, soon build or, more likely, acquire a health insurance platform.

In addition, for more patient data focused services, although some see that Alphabet and Apple’s current investments may have greater visible impact in the short term, the often-repeated opinion in our discussions was that *“Amazon will own all your data in the end.”*¹⁷⁷ In San Francisco, one assessment was that *“even though coming from outside the sector, Amazon could be the catalyst that creates a ‘single’ more unified (US) system.”* Many others agreed with this. *“I have invested in 18 new healthcare ventures – 17 of them use AWS.”* While that does not imply that Amazon has access to the data, the fact that it is already sitting on its servers then, should permission be granted then integration and interrogation can

easily follow on. Although recent announcements around the use of employee data¹⁷⁸ have been assessed as Amazon’s next move in healthcare, this was considered to be *“just the beginning.”*

Another suggestion was that *“EPIC had its time but failed to take advantage of the opportunity,”* so *“Amazon will take the lead and may run the whole marketplace.”* This *“may well be the monetization platform for health data in the US (and beyond). It has the capability, the reach and the intent.”* The view, again in San Francisco, was unequivocal – *“Just look at the signs. It is happening: It is the same as Einstein in Salesforce”*¹⁷⁹ – *one organisation will be able to integrate all the data and in healthcare that company will be Amazon.”* Some also asked whether *“we may all see the end of our social security number as how our identity is managed changes.”*

There seems to be a belief in the impact of Amazon, not just because of its wealth and reach, but also because of its proven approach to business model innovation. As mentioned in the accompanying case study, it has consistently demonstrated the capability to deliver highly efficient reinventions of existing systems and to do that with world-leading levels of customer service and satisfaction.

Benefits for the Patient

The common core ambitions for many of the new models that are evolving are two-fold: Maximising system efficiency and vastly improving customer satisfaction. Whether from outside or inside healthcare, from India, China, Europe or the US, these innovations should improve patients’ lives. Greater convenience, lower costs, faster service, better engagement, smoother processes and enhanced personal health are all central.



CASE STUDY:



Officially launched in 2015, Verily is a subsidiary of Alphabet focused on life sciences and healthcare. A spin-out of the Google X lab, the company's mission is "to make the world's health data useful so that people enjoy longer and healthier lives." Verily develops tools and devices to collect, organize and activate health data, and creates interventions to prevent and manage disease.¹⁸⁰

It is creating tools and platforms to enable more continuous health data collection for timely decision-making, running longitudinal studies to better understand ways to predict and prevent disease onset and undertaking significant joint efforts with partners to 'radically transform' the way healthcare is delivered.

Indeed, most projects are in partnership with established major healthcare companies where Verily can bring its advanced hardware, software and scientific data skills to bear – collaborating is fundamental to the approach as the company applies its expertise, learns and, in doing so, builds up access to a wealth of health data. It wants to be the R&D partner for the world's leading life sciences companies.¹⁸¹

Key areas of focus to date include developing sensors, such as miniaturized continuous glucose monitors for people with diabetes, analysis of physiological and environmental data linked to clinical studies, improving surgical robotics, developing machine-learning driven retinal imaging solutions; and developing tools to better analyse and report performance data across healthcare systems.¹⁸²



Presently, Verily makes around \$1bn of revenue from research grants and development fees from its collaborators.¹⁸³ Assumptions about future plans include the idea that it will sell access to its healthcare platform, disease data and software to the broader health sector.¹⁸⁴ Others see that Verily could become the OS for all healthcare devices.¹⁸⁵ In January 2018, Dr Jessica Mega, Verily's Chief Medical Officer, suggested that it is "Google Maps for health."¹⁸⁶ Clearly there are many options ahead, but as one of the Alphabet's major 'Other Bets' expectations of future impact are high.

CASE STUDY:



Few would doubt Amazon's ambitions in healthcare. Over recent years, it has made significant investments, recruited leading-edge talent, made some initial announcements and is seen as the biggest disruptive threat by many leaders across the health sector. The question is not whether Amazon Health will be big, but rather just how big?

Some already see the ability to apply many of its existing capabilities to the sector. For example:¹⁸⁷

- **Comprehensive customer records** - providing 'complete longitudinal information and intelligent analytics at every point of care' that integrates all patient data - health, clinical and personal.
- **Personalized content and user experience** - having intelligible information and recommendations based on a full view of a patient's health history, condition and provider interactions with feedback / advice.
- **Price transparency and choice** – giving the world's first 'comprehensive view of cost options for treatments or medications' supported with intelligent assistance in choosing between them.

- **Quality reviews** - a 'single source for trustworthy quality ratings of hospitals, physicians and other health care providers' that sets new standards and validates its accuracy.

Other organisations are focused on achieving one of these, but as some argue, Amazon already does them all to an exemplary standard and just needs to apply them to healthcare. In addition, it does this with one of the highest rated customer satisfaction globally – many times better than the norm for healthcare. As with many of its previous new platforms, many see the recently announced partnership between Amazon, Berkshire Hathaway and J.P. Morgan as the opportunity to experiment internally on 1.2m employees and get this all working very well before expanding to the wider population.



Beyond this, others have suggested¹⁸⁸ the potential in applying Amazon Prime and Amazon Flex quality and reliability of delivery to healthcare products, using the Whole Foods footprint as a base for health services like those provided by CVS MinuteClinic, integrating the passive data capture seen in Amazon Go stores to hospitals to improve efficiency, and using its considerable data analytics capabilities to integrate patient records. Others expect another go at disrupting the pharmacy sector, a potential \$50bn Amazon opportunity in the US alone.¹⁸⁹

However, looking further, additional opportunities include integrating Alexa insights on individual behaviours from within the home into personalised health data profiles, as well as applying analytics to much of the millions of terabytes of health-related data already on the Amazon cloud service, AWS, that some see as potentially accounting for 50%

of Amazon's future revenues. Add on more AI innovations and new technology emerging from the 3000 plus R&D experts in the company's lab 1492¹⁹⁰ and the potential is significant and growing.

Like other potential disruptors, Amazon clearly sees the 17% of US GDP spent on healthcare as a highly attractive opportunity to provide new platforms that can improve efficiency and reduce cost. Unlike many others, it has most of the ingredients to hand, plus deep pockets to fund necessary add-on acquisitions and buy talent, deepening relationships with the 64% of US households that have Amazon Prime and over 300m existing customers worldwide.¹⁹¹ Expect a steady stream of revelations of new means of making more of health data over the next few years - and the corresponding drop in incumbent companies shares with each announcement.¹⁹²