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ARTIFICIAL INTELLIGENCE IN HEALTHCARE

In a recent government publication covering industrial strategy, the task of becoming a world leader in employing artificial intelligence (AI) as part of a data driven economy was recognised as one of four 'Grand Challenges' that the UK must acknowledge and actively embed into our way of living.¹

Described as the fourth industrial revolution – following steam powered mechanisation, mass production using electricity, and automation through electronics and information technology (IT) – AI will undoubtedly transform the way we live. Building upon and fusing technologies which exist today, AI promises to change everything, from the security of our online presence through to the way we diagnose and treat disease.²

To aid in appreciating the gravitas of AI's potential to change the way we live, it has been estimated³ that **nearly two-thirds of all jobs consist of activities of which almost one-third could be automated by already-proven technologies.**

Artificial intelligence can even help you appeal those pesky parking tickets in the form of 'DoNotPay', a chatbot that has successfully appealed a quarter of a million parking tickets boasting a 64% success rate⁴; Time magazine described it as 'the hero the world needs.'⁵

However, AI is not without its critics, with concerns including job losses where human input is no longer required, or sometimes involve deeper concerns as to the ethics intrinsic to AI.

Some also harbour a fear of losing control of AI's self-improvement, leading to it becoming vastly more powerful than humans and a situation where we would not be able to stop it from achieving its goals⁶ – think Skynet from the Terminator franchise. Although, a recently passed resolution from the European Parliament should prevent such sentient and weaponised robots from becoming part of our reality any time soon.⁷

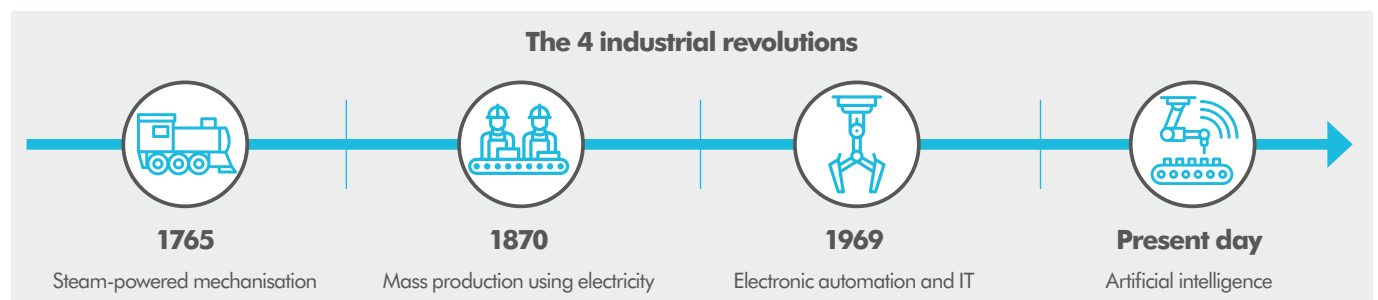
On balance, we have a long way to go before everyone will be convinced.

With specific reference to AI technology within the realm of healthcare, Joseph Weizenbaum, a professor emeritus of computer science, argued that it should not be used to replace people in positions that require respect and care. His concern was that, **in certain situations, we require authentic feelings of empathy from real people and the use of AI in these circumstances represents a threat to human dignity.**⁸

To illustrate just how AI *could* pose a threat, and just to indulge in the broader consideration of machine ethics for a moment, let's consider an experiment⁹ involving AI which was performed in 2009. In it, 1000 robots

were programmed to cooperate with each other in finding a scarce, beneficial resource. By turning on a light when it was found they could direct other robots to the resource, maximising the benefit to the group. However, the robots received 'points' for finding the resource themselves and only the highest-scoring robots were 'mated'; their binary code 'genome' forming part of the next generation of robots. Within nine generations, the robots excelled at sharing the resource. **However, after 500 generations, nearly two-thirds lied** about finding the resource by not switching their light on. But it gets worse. Robots eventually learned to distrust each other, scavenging more often in areas where other robots were not signalling with their lights, hence breaking their original programming.

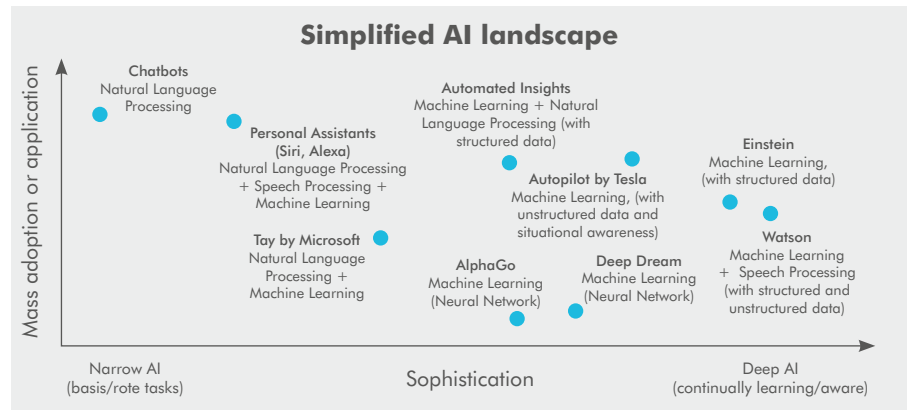
Putting AI morality aside, let's turn now to address what AI really is, to what extent is it already being used in healthcare, and how its role can be expanded, as well as examining what steps are being taken to ensure we remain in control such that some of the fears surrounding this technological leap are allayed.



What is artificial intelligence?

Artificial intelligence has been described as any advanced technology, integrated to improve the efficiency of machines to perform complex tasks, which would require 'intelligence' in a human performing the same task.¹⁰

Critically, AI is currently only routinely used to perform very specific functions, without the ability to apply intelligence more generally.¹¹



Credit: <https://research.hubspot.com/artificial-intelligence-and-you>

How is it currently deployed in healthcare?

International take-up of AI integration within healthcare systems has been impressive; the promise of driving dramatic cost-savings into healthcare piquing interest at the global level.

London-based Your.MD offer a free service which, via AI and machine-learning, provides personalised health information. A chatbot first explores your symptoms via its conversational interface, and then this information is fed into a 'next-generation search engine' that plumbs the depths of a dataset containing verified medical data in order to return relevant information.

The value proposition of Your.MD from a healthcare system perspective relates to the potential savings implicit

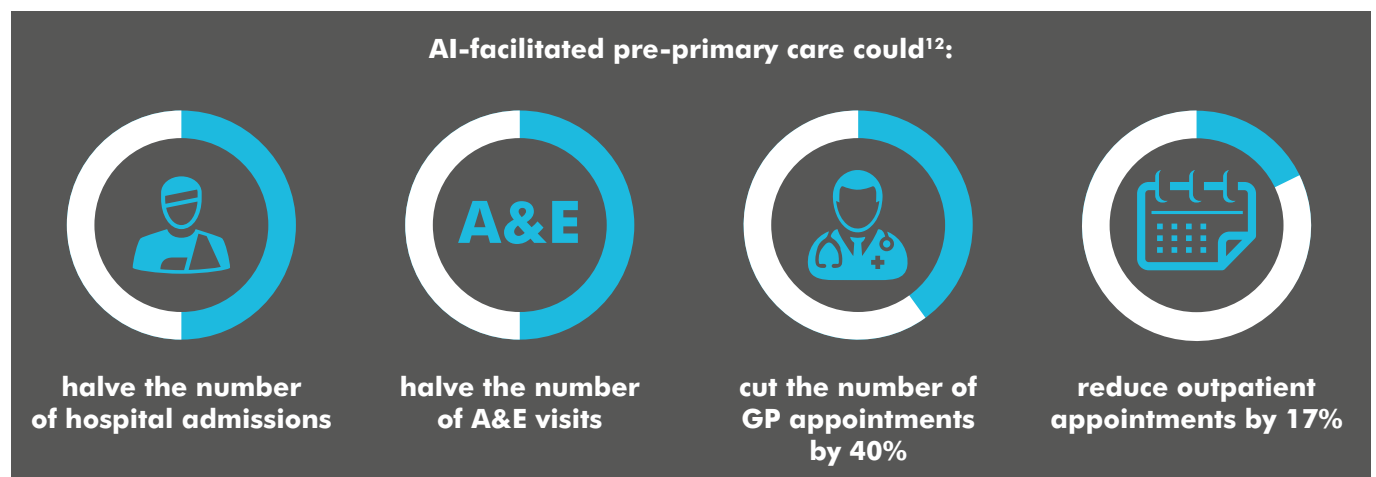
to the concept of 'pre-primary care'. In this situation AI can be used to provide accurate health-related information to patients who can then make informed choices regarding what to do next, thus avoiding potentially unneeded healthcare appointments.

This is in-keeping with what we understand about human behaviour in illness states, in which patients often first seek information for themselves, then turn to friends and family, and then decide whether to consult a healthcare professional. As Professor Sir Muir Gray explains¹²:

'The term 'primary care' is a misnomer. The first thing citizens and patients do is

think what they can do for themselves, the second is to seek advice from friends and family, and in the last twenty years, the Internet. Then they seek professional help.'

Indeed, research has found that, in line with the ambitions expressed in the NHS Five Year Forward View,¹³ shifting focus onto pre-primary care could reduce GP visits by 40%; outpatient visits by 17%; A&E visits by 50% and hospital admissions by 50%. In addition, two-thirds of GP prescriptions could be transferred to cheaper over-the-counter drugs or no medicine at all.¹²



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In what is perhaps an even more impressive display, operating within the diagnostic remit, IBM Watson, a question-answering supercomputer combining AI and sophisticated analytical software, has been put to use in providing evidence-based cancer treatment options to oncologists. By analysing structured and unstructured data within clinical notes and triangulating this information against clinical expertise and research, the program identifies appropriate therapeutic options.

In a recent study **'Watson for Oncology', as it is branded, demonstrated concordance rates (as measured against a multi-disciplinary oncology board in India) of 96%, 81%, and 93% for lung, colon, and rectal cancers, respectively.**¹⁴

In a second awesome execution of the diagnostic capabilities of AI systems, Google's 'Inception v4 convolutional neural network (CNN)' was trained to recognise the difference between malign and benign skin lesions. The

system then entered a diagnostic challenge with a group of 58 expert dermatologists from 17 different countries – AI won. It missed fewer melanomas, meaning it had a higher sensitivity, and it misdiagnosed fewer benign moles as malignant melanoma, meaning it also had a higher specificity.¹⁵

Closer to home, scientists at the Institute of Cancer Research (ICR), in collaboration with colleagues from the University of Edinburgh, recently developed a machine-learning method that enabled the prediction of a trajectory for the ordinarily haphazard genomic changes involved with tumour evolution. It is thought that by anticipating the course of disease progression, interventions may be applied at an earlier stage thereby improving health outcomes for patients.¹⁶

If these examples seem a bit cold and you're looking for examples of a more personalised deployment of AI, the South Devon and Torbay Clinical Commissioning Group

(CCG) collaborated in the provision of 'HealthUnlocked', now the third largest health website in the UK. At the heart of the website lies an AI recommendation engine that delivers personalised self-care advice and signposts people to further resources.¹⁷ And if even that isn't impressive enough for you, the National Institute for Health and Care Excellence (NICE) has approved the use of 'AliveCor', which is a mobile heart monitor that can detect, monitor, and manage atrial fibrillation – a potentially fatal irregular heart rhythm responsible for a third of strokes.¹⁸

Despite a plethora of inspiring healthcare applications, in the NHS it is generally incumbent upon individual trusts to research and implement innovations into the fabric of healthcare provision and, **while the NHS appreciates the potential of AI, it is 'lacking clarity about both the strategic direction to take and where to start.'**¹⁹



Man versus machine – AI missed fewer melanomas and misdiagnosed fewer benign moles as malignant melanoma as compared to a group of 58 expert dermatologists from 17 different countries.¹⁵

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What's next?

To try to answer this we turn to a recent report,²⁰ 'Better health and care for all: A 10-point plan for the 2020s'. Penned by former health minister Lord Darzi in collaboration with the Institute for Public Policy Research (IPPR), the report highlights some specifics as to the posture of the NHS in relation to the employment of advanced technologies.



The next generation will not stand for an analogue health and care service in a digital decade.

It's time for a *digital first* health and care system.²⁰

Lord Darzi



The report claims that by implementing a 'far-reaching programme of automation' the NHS could take advantage of up to £12.5 billion in savings per year – that's 10% of its entire running cost! But it doesn't stop there, a further £6 billion in productivity gains are possible within social care.²⁰

Excerpts from the report highlight potential activities which, if undertaken by digital technologies, would release time-poor staff to attend to more direct clinical care. For example, technologies may communicate medical notes, take care of appointment bookings, and process prescriptions.²⁰

Perhaps even more ambitious is the apparent commitment to realising a future in which 'robots and AI-based systems play a key role in assessing, treating, and supporting clinical practice'. The report suggests that, 'someone arriving at hospital may begin by undergoing digital triage in an automated assessment suite' where 'machine-learning algorithms would be used to make more accurate diagnoses of diseases such as pneumonia, breast and skin cancers, eye diseases, and heart conditions.'²⁰

Possible uses for AI in healthcare²⁰:



communicate medical notes



make appointment bookings



process prescriptions



digital triage



disease diagnosis



monitoring clinical observations



alerting staff



assist patients with meals



transportation and portering

But wait, there's more. 'Bedside robots' may be the ones monitoring our clinical observations and alerting appropriate staff members, whilst also 'assisting patients with meals, transportation, and portering'.

Outside the confines of NHS walls, 'care-bots' are seen to be a feasible technology to 'empower people in old age, enabling better, longer, and more fulfilling lives' thus improving social care.²⁰

To again lean on a movie reference, reading this stirred images of medical technologies depicted in sci-fi pictures such as *Revenge of the Sith* and *Prometheus*; it certainly didn't seem like just another NHS position paper. But then again, how much of this sci-fi fantasy ends up as part of our healthcare reality awaits to be seen.

Time-value that could be released through AI automation²⁰:



NHS budget 2017–18

■ £12.5bn saving



Social care budget 2016–17

■ £6bn saving

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What's the hold up?

In order to know where we're going, we need an understanding of where we have been. The prerequisite for the implementation of AI, digitising NHS data, has been an issue for decades;

as brilliant as AI may appear, it cannot pull data from a semi-integrated borderline-digital medical system.

The first national IT strategy for the NHS came in 1992, with subsequent strategies in 1998 and 2002, the culmination of which led to the creation of the National Programme for IT (NPFIT). Later renamed 'Connecting for Health', the programme's aim was to create a single electronic care record for patients that connected primary and secondary care platforms.²¹

This multi-billion-pound programme ran until 2011, at which time defeat

was acknowledged. The programme failed spectacularly in its main objective but did provide some important national infrastructure that remains today.²¹

Subsequent to Jeremy Hunt becoming Secretary of State for Health in 2012, the challenge became to 'go paperless' by 2018 – a target for which the goalposts were moved to 2020 following the NHS Five Year Forward View.¹³ The National Information Board now has oversight of delivering the much anticipated digital transformation. Some groups²² are sceptical of the continued optimism, stating that a paperless NHS will not be achieved before 2027, although part of Lord Darzi's plan includes a doubling of the allocated £1.8 billion in an effort to achieve this by the end of the parliament (2022).²⁰

Crucially, and as we've mentioned, AI can only be as good as the datasets with which it works.

As Mr Lamb, a former care minister in the coalition Government, points out, 'if data is not inputted accurately, or if there is no consistent approach across a system, then the AI can play havoc because it's operating on the basis of wrong information.'²³ **So until our healthcare system has a consistent digital format for its data, AI can only take us so far.**

In the meantime, training datasets seem like a good place to start, allowing the exponential learning capabilities of AI to begin to grapple with identifying trends within health-specific information. But there are of course other issues surrounding AI that need to be addressed in parallel before it is rolled out.

Barriers to implementation in healthcare

With the memory of ransomware holding our NHS hostage still fresh in the minds of the public, it's not hard to understand that confidence in the security of healthcare data is low, especially when talking about opening the system up to collaborative private sector innovation.

Complex frameworks for information governance already exist within the NHS – themselves actually forming a barrier to AI's learning – and the extent to which datasets are made available and for what specific purposes is likely to require careful thought; but without them the whole system falls at the first hurdle.

Stoking the fires of both patients' and healthcare professionals' (HCP)

anxiety regarding the implementation of such a monumental system change are the hordes of drug makers who are beating on the NHS's doors to strike deals for access to patient information. This data represents an opportunity for pharma to bolster their 'real-world evidence', a somewhat rare and increasingly sought-after commodity.

But we've been here before; as recently as 2016 a scheme to pool anonymised NHS patient data had to be officially scrapped following protests from patients and doctors and a review into data protection by Dame Fiona Caldicott.²⁴ In fact, there is uproar in Australia with regard to their proposed 'My Health Record' privacy framework, in so far as it is allegedly identical to the failed 'care data' UK scheme.²⁴

Water under the bridge? Well a recent poll of 2000 Britons by KPMG²⁵ revealed that 56% would share personal data for the purposes of bettering services through AI projects, but only 15% would be happy with that same information being shared with pharma – clearly trust is an issue.

Big data – a trust issue with pharma²⁵

56%

of Britons would share personal data to help improve services through AI

only 15%

of these would share the same data with pharma

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As mentioned earlier, job losses are also a concern. Media coverage of cuts as a result of automation and increased digital infrastructure are an oft-cited concern of the workforce. Lord Darzi addressed this point in his report, stating that any automation agenda should offer all staff 'the right to retrain' if they are impacted by automation.²⁰ The current lack of digitally-skilled employees within our healthcare system also forms a barrier.

In order to deal with this the NHS recently committed to train a new generation of

digital-savvy workers who will become the champions of AI in healthcare and will help the rest of the workforce navigate the issues afoot.

The broader, overarching concerns as to the ethics and humanity of the deployment of AI in healthcare, for now at least, seem to be topics for academics to debate amongst themselves. But as AI becomes more ubiquitous, its flaws will also become increasingly the stuff of public interest, especially as applied to the national treasure that is the NHS.



How do we generate pull?

As the saying goes, people fear that which they don't understand. When it comes to those naive to AI, 'what is it?', 'how would it be used?', and perhaps more importantly, 'how would it not be used?', are all questions the answers to which are fundamental to a process of gaining broader acceptance. A good start though this may be, in addressing these issues the work is not over; a basic level of understanding is just the beginning.

Some very real and specific concerns exist surrounding the technology too. Who oversees and maintains control of AI systems? Could HCPs ever *trust* a machine to take over the appropriate triaging of patients through the healthcare system? Could patients trust their most intimate and private data to be safe in the hands of AI in order that it could ever guide them in the first place? Could we let go of that amount of control? Will the public ever trust AI enough to accept

its healthcare recommendations? If, like in other areas, patients are afforded the choice of utilising the technology or deferring to a human HCP, would they ever choose AI, and so would the technology be rendered largely redundant anyway?

Transparency and accountability are paramount and may assuage some concerns. Indeed, building upon Isaac Asimov's 'Three Laws of Robotics'²⁶ introduced in 1942, Satya Nadella (an ex Microsoft CEO) drew attention to updated 'rules for AI', which included²⁷:

AI must have algorithmic accountability
so that humans can undo unintended harm

AI must be transparent

people should have an understanding of how the technology sees and analyses the world

This means that people need to be 'on-boarded' as soon as possible, to become invested in the initial conversations about AI's proposed implementation. As we already know, the potential is awesome. But work needs to be done in conveying these potential benefits to the public. Only through this can we generate the 'buy-in' required to even begin to have the requisite deeper conversations.

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Starting small will aid in this endeavour. A patient is likely to trust digital systems to process a prescription for a drug that a doctor has recommended long before they will trust the same digital system to recommend their treatment pathway for a potentially lethal cancer.

The proposed agenda²⁰ seems to have acknowledged this in stating that **implementation should begin with 'repetitive and administrative tasks' – baby steps.**

It is no secret that the NHS's current digital infrastructure neither meets the needs of the workforce or of the patients. A lot of reassurances surrounding the fundamental building blocks of AI in healthcare would need to be offered in order to convince either party that this isn't going to be another fad that will never be fully realised and will only lead to an even more disjointed system.

Efforts are also needed to present the benefits of AI's integration outside of the context of cost-saving; **the political agenda for AI in healthcare is well-stated, but studies or discourses on the specific benefits of its integration for patients and HCPs are less easily found.**

Potential benefits which would resonate with HCPs might include those detailed earlier surrounding time-saving, but put into the context of day-to-day practice – what GP wouldn't take your arm off for a promise of a 40% reduction in appointments. Watch a GP's face light up when you reveal that AI can solve the disconnect between silos of care – no more phone calls from A&E departments asking to confirm a patient's list of regular medicines, which then have to be dictated or faxed. Or providing never-seen-before clinical decision support, with AI scouring a vast breadth of data to return evidence-based clinical

protocols. How about massively improving diagnostic accuracy by having clinical imaging analysed thoroughly and systematically by AI?

For patients, the 'sell' should surely involve the potential for an improved healthcare experience in terms of earlier recognition of disease, improved access to healthcare, first-class diagnostics where disease is suspected, and thus earlier access to required treatments.

We can also appeal to their desire for the latest and most advanced treatments. Presently, the looming Brexit saga is casting shadows over the UK's ability to play host to clinical trials at the frontiers of medical innovation. But, **with a joined-up digital healthcare system, robust clinical datasets, and the help of AI, why can't the UK become the site for major international clinical trials, affording more NHS patients access to the most innovative treatments.**



AI could help doctors make earlier diagnoses and plan effective treatment pathways.

Potential benefits of AI for patients:



earlier recognition of disease



improved access to healthcare



improved diagnostics



earlier access to treatments



improved healthcare experience

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What should we expect to see?

Some semblance of commitment to harnessing the potential of AI was shown in a recent speech by the prime minister in which funds were earmarked to 'incubate a whole new industry around AI-in-healthcare' that should, by 2035, prevent over 22,000 cancer-related deaths annually, while allowing cancer patients to enjoy five additional years of healthy life.²⁸

However, Lord Darzi and his colleague Lord Prior are lobbying for increased commitment. They feel that the investment necessary for the integration of AI within the NHS would need more than £50 billion per annum overall by 2030, with a further £10 billion per year needing to be earmarked for its integration within social care.²⁰

Further investment is required to integrate AI within healthcare²⁰:

£50bn

per year for the NHS

£10bn

per year for social care

Artificial intelligence is touted to be, and in some areas has already proved to be, a great opportunity to improve quality of care and

economic efficiency, as well as having the potential to turn the healthcare paradigm from one of treatment to one of prevention.

But in order for this grand plan to come to fruition, the UK government and the NHS must commit seriously to embedding AI in a structured, sustained, and sustainable manner whilst simultaneously moving forward with a digitisation agenda, addressing the lack of buy-in, and collaborating with the private sector to leverage mutual benefit.

Whether any serious prior effort is made to consider and allay healthcare stakeholders' existing or potential deep-seated concerns regarding AI's implementation awaits to be seen.

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Michael is a trained biomedical scientist who went on to read medicine at Durham University.

Choosing not to pursue a career in medicine, Michael began working in medical writing; first in medical information and, upon joining IGNIFI, medical copywriting.

Michael draws on first-hand clinical experience and ongoing research to explore issues facing patients, the pharmaceutical industry and the healthcare sector.

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