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Ten ways artificial intelligence is transforming healthcare

Introduction

There is increasing appetite to apply artificial intelligence (AI) to solve many of medicine's pressing problems including earlier cancer detection, drug discovery, prevention, genomics and relieving the workload of NHS staff.

Most AI health technology proposals are aimed at primarily tackling mounting cost pressures and inefficiencies across the healthcare industry.

The NHS Long Term Plan includes several pledges to help clinicians leverage AI in their day-to-day roles. It plans to use data-driven technologies and deliver on the Industrial Strategy life sciences mission to use data, AI and innovation to transform prevention, early diagnosis and treatment of chronic diseases by 2030.[1]

In June 2019, Simon Stevens, Chief Executive of NHS England, set a target for the NHS in England to be a world leader in AI within five years. He challenged tech innovators to come forward with proposals for how the NHS can harness innovative solutions that can free up staff time and cut the time patients wait for results.

At the same time he pledged to consider reimbursement reforms to the NHS tariff and other payment systems to incentivise quick and safe adoption across the NHS.

This has been recently followed by the announcement of £250 million for a National Artificial Intelligence Lab as part of NHSX, the new joint organisation for digital, data and technology, which will take forward digital transformation in the NHS.

The lab plans to boost the role of AI within the NHS with the aim of enhancing care of patients and research such as predicting demand for hospital beds and tools that identify signs of disease from diagnostic images.

It was set up in partnership with the Accelerated Access Collaborative and its focus will be to speed up the work within safe and ethical boundaries so it can get benefits to more people - patients and staff alike - more quickly.

The NHS Long Term Plan includes several pledges to help clinicians leverage AI in their day-to-day roles.

However, experts say that a number of challenges exist before this technology can be harnessed in the NHS. For example, even though the NHS potentially has the best health data in the world, local systems rarely communicate with each other, and the process of accessing and organising data for research is slow and costly.[2]

Questions also remain about how regulatory frameworks will evolve to deal with fast-changing technologies, such as algorithms that are dynamically updated. Redesigning clinical workflows and patient pathways around technological innovation will take time and people, yet the NHS has a shortfall of 100,000 staff.[2]

Also most projects are small so it is currently hard to ascertain how these could help greater numbers of patients if they were scaled up.

Despite these challenges, the Health Secretary Matt Hancock has said he wants the UK to be one of the leading countries using this technology and believes AI has "enormous power" to improve care, save lives and ensure doctors have more time to spend with patients.

What is artificial intelligence?

When mathematician Alan Turing, famous for breaking the Nazi encryption machine Enigma, wrote his landmark paper *"Computing Machinery and Intelligence"* in 1950 he established the fundamental goal and vision of artificial intelligence with the simple question: "Can machines think?"

The term artificial intelligence was first coined by John McCarthy in 1956 when he held the first academic conference on the subject.

Since then, the main advances in AI haven't been Jupiter space machines or robots, but the use of search algorithms, machine learning algorithms, and integrating statistical analysis into understanding the world at large. This has been used in more subtle ways such as examining purchase histories and to influence marketing decisions.[3]

AI has many definitions and its development is growing and changing every day. It encompasses a wide-ranging branch of computer science that could be described as computers and computer software that are capable of intelligent behaviour, such as analysis and learning.

The foundation of modern AI is machine learning that is powered by data. New technologies are emerging when an algorithm can learn from huge amounts of data to spot patterns.

Any software with decision-making capability is considered AI such as spam checks on email to flagging unusual activity on bank accounts to prevent fraud.

Artificial intelligence examples

- Smart assistants (like Siri and Alexa)
- Disease mapping and prediction tools
- Manufacturing and drone robots
- Optimised, personalised healthcare treatment recommendations
- Conversational bots for marketing and customer service
- Robo-advisors for stock trading
- Spam filters on email
- Social media monitoring tools for dangerous content or false news
- Song or TV show recommendations from Spotify and Netflix

Source: *Built In*

AI technology is divided into two different categories: weak and strong. This is based on supervised and unsupervised programming.

Weak AI systems are usually programmes designed to carry out one particular job such as video games and chess programmes or voice-activated assistance technology like Siri and Alexa.

Strong AI systems tend to be more complex and act more like a brain. They use clustering and association to process data. These kinds of systems can be found in applications like self-driving cars or in hospital operating rooms.

The ability of AI to identify complex patterns within raw data and to learn on its own to rewrite its own algorithms is the reason why there has been phenomenal growth of AI technology in healthcare.

By 2025, AI applications in healthcare are expected to represent a $34 billion market.[4]

Ten areas that will be transformed by AI

1. Primary care

A recent paper looked at the ways AI will impact primary care and its key stakeholders. It states that AI used properly can free up physicians' cognitive and emotional space for patients, and shift the focus away from transactional tasks to personalised care.[5]

The Royal College of General Practitioners has published an introductory report to provide an unbiased introduction to AI for clinicians and healthcare professionals.[6] Since publishing the AI report, the College has continued to champion the development of AI that supports the clinical team to provide the best possible care.

It said that the potential near-term benefit of AI to primary care is in its application to administrative tasks and freeing healthcare professional's time. This could be automating the display of information on medication (e.g. the BNF) or pathways, therefore supporting clinicians to deliver care by ensuring relevant information is available in the consultation.

The College said that it was important that this revolution in primary care offers:

- patients and their carers timely access continuity of care, comprehensiveness and co-ordination of care
- supports care delivery to be person centred
- supports GPs and healthcare professionals to meet the needs of each person
- engagement and co-development with stakeholders ensure integration of AI into long-standing systems with established practices and norms in the short term and establishing new workflows maximising the strengths of humans and computational systems in the longer term.

2. Medical imaging

One area that has already started to embrace AI is medical imaging. The aim is that the technology can be trained on thousands of scans and has the potential to let doctors focus on the most urgent cases and rule out those that do not need treatment.

According to Royal College of Radiologists, in mammography screening the NHS is performing around two million breast screens for women a year in the UK, with each test result reviewed by two clinicians. Testing of AI and machine learning technology has already demonstrated its potential to ease the burden on staff and free them up for other work.

In addition, diagnostic scoring of medical images suggests disease probabilities and automated workflows reduce error and improve the efficiency of medical image diagnoses.

3. Genomics

Genomics is the study of all of a person's genes (the genome), including interactions of those genes with each other and with the person's environment. The global genomics industry is expected to be worth $41.2 billion by 2025 and genomics data in the next 10 years is projected to equal and surpass other data-intensive disciplines including social media and online videos.[7]

The amount of information being generated by genetics projects lends itself well to AI programmes that can comb through the massive data pool and provide analysis storage and security.

The increasing number of research projects in genomics and diminishing sequencing costs are major factors driving the global genomics market. As is the rising preference for personalised medicine.

A patient's predispositions to certain life-limiting or life-threatening illnesses such as cystic fibrosis, Huntington's disease and sickle cell anaemia are determined by an individual's genetics. Better understandings of genetic makeup can help scientists comprehend, predict, and even change the function of genes. The introduction of AI and data algorithms will add a possibility of accuracy and wide-scale efficiency to both gene sequencing and gene editing.[8]

NHS England says it is working towards embedding the personalised medicine approach into mainstream healthcare. Through the 100,000 Genomes Project, the NHS is building partnerships with academia and industry to decode the human genome in people with rare diseases and cancer. This will help to predict the future development of disease, to make a diagnosis where one has not existed previously and to identify treatments where possible.[9]

The question now is how AI systems can enable clinicians, doctors and scientists to truly capitalise on the genomics data goldmine.

Case study: predicting sudden death in heart failure

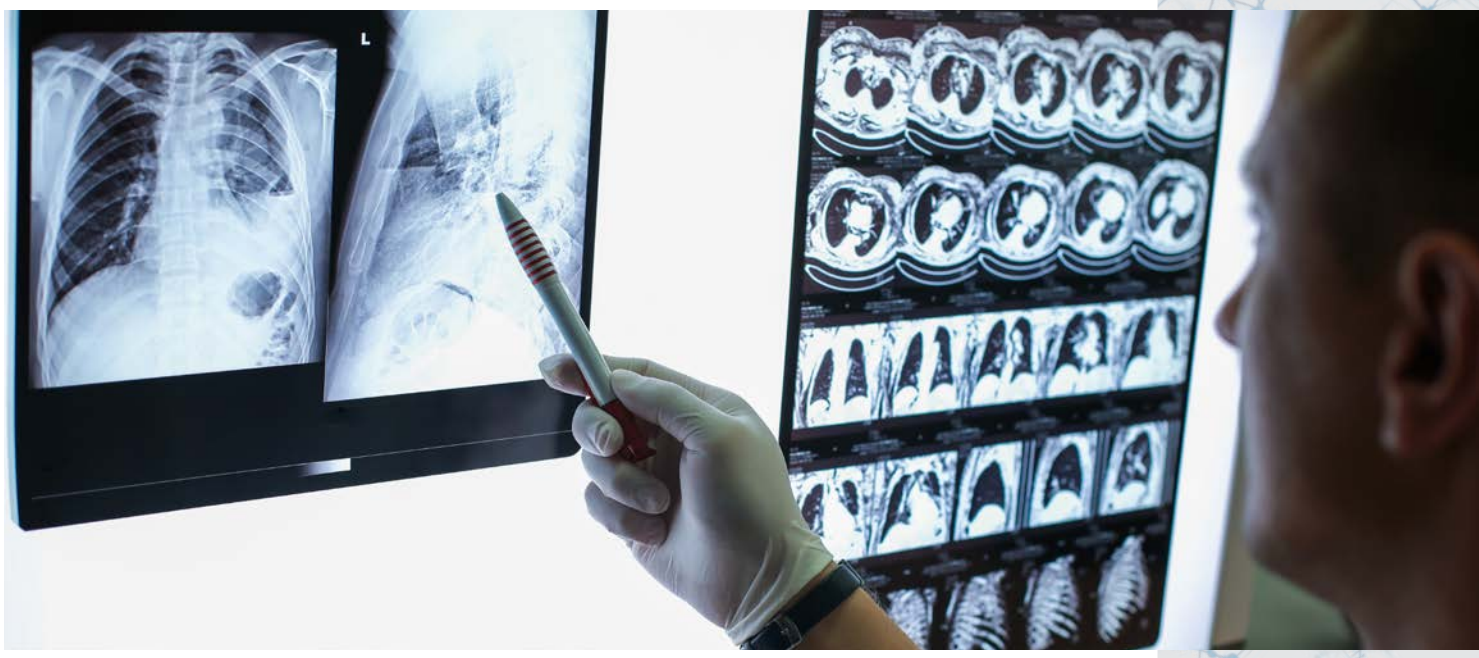
Artificial intelligence could predict sudden death in heart failure patients and help select them for expensive treatments.

In a study AI was used to discover how eight variables used to predict prognosis of heart failure patients were connected and create a formula correlating them to two-year outcomes.

A high proportion of deaths in heart failure patients, especially those with milder symptoms, occur suddenly due to ventricular arrhythmias. Implantable cardioverter defibrillators (ICD) or cardiac resynchronisation therapy with a pacemaker and defibrillator are recommended for some patients to correct potentially lethal arrhythmias and reduce the risk of sudden death. However, these treatments are expensive and do not work in all patients.

The study included 529 heart failure patients with known two-year outcomes for sudden arrhythmic events (including arrhythmic death, sudden cardiac death, and appropriate shock from an ICD) and death due to heart failure.

The eight factors were age, sex, heart failure severity (New York Heart Association functional class), heart pumping function (left ventricular ejection fraction), whether heart failure was caused by restricted blood supply (ischaemia), B-type natriuretic peptide level in the blood, kidney function (estimated glomerular filtration rate), and a nuclear imaging parameter.



4. Cancer diagnosis

AI technology can improve cancer diagnosis and prognosis by helping detect the disease at an early enough point for treatments to work.

Developments in multivariate statistical analysis to analyse the prognosis of the disease and use of AI has meant that cancer prediction performance has flourished in recent years.

Cancer Research UK has funded a four-year early detection project using AI to enhance breast cancer screening. Researchers from the Queen Mary University of London and University of Warwick will develop and test an AI system to aid risk-stratified breast cancer screening to determine if this enhanced approach will be better than the current standard in detecting, minimising false negatives, and determining long-term risk of an interval breast cancer.

The charity said that while questions remain how the AI algorithms will account for differences in the collection of the images, there is a clear clinical need to improve the efficiency and accuracy of early breast cancer detection in radiographic images.

5. Wearables and prevention

Wearable devices fall under the umbrella of Internet of Health Things and can generate vast quantities of personal data about patients. As the market grows for wearables, tech companies are coming up with AI enabled technology, which is now pushing the boundaries of the capabilities in wearables.

When combined with analytics, wearables have the potential to contribute to health, preventative care and aid management of ongoing conditions as well as allowing healthcare professionals to tap into continuous information.[6]

The use of wearable patient monitoring systems lends itself well to machine learning approaches, which can be used to analyse real-time clinical data.[6] Examples range from screening programmes, chronic care monitoring using ECGs, in-community rehabilitation, clinical decision support and risk assessment of falls and vascular events in hypertensive patients.

Although these technologies have generated a lot of 'hype,' their real-world effectiveness will depend on patients' uptake.

A study in Nature looked at patients' perceptions of the use of wearables and AI in healthcare. Out of a total of 1,183 patients, 20% considered that the benefits of technology greatly outweighed the dangers. Only 3% of participants felt that negative aspects (inadequate replacement of human intelligence, risks of hacking and misuse of private patient data) greatly outweighed potential benefits.

It also found that 35% of patients would refuse to integrate at least one existing or soon-to-be available intervention using a wearable and AI-tools in their care. This suggests that even among patients who were the most ready for the use of technology in their care, they would only see AI as a complement—and not as replacement—for human care for situations related to sensitive topics (cancer) or which involved lasting interventions (monitoring for chronic conditions).[10]

6. Drug discovery

The research and development of a new drug comes with a massive price tag. It is estimated that the discovery of each successful drug is nearly $2.6 billion and on average only nine out of 10 potential medications reach the market.[11]

Pharma are now using AI to improve the success rates and speed up the drug discovery process. One way they are doing this is by identifying potential treatments on the basis of the precise biological causes of disease.

AI platforms are turning the drug-discovery paradigm upside down by using patient-driven biology and data to derive more-predictive hypotheses, rather than the traditional trial-and-error approach.[11]

Researchers think the potential of AI to pinpoint previously unknown causes of disease will accelerate the trend towards treatments designed for patients with specific biological profiles.[11]

Case study: missed appointments

University College Hospital London has created an algorithm using records from 22,000 appointments allowing it to identify 90% of those patients who would turn out to be no-shows.

Patients missing their appointments cost the NHS £1bn last year and it is estimated that on average the tool could save £2-3 per appointment.

Although the tool incorrectly flags about half of patients attending appointments as being at risk of not showing, researchers say that even an imprecise indication of which patients will attend could save hospitals vast sums of money and help cut waiting times.

The tool took data from 22,000 MRI scan appointments, which included the time of day, number of previous scans and how far from the hospital the person lived. The data did not include gender, age or ethnicity, details which are kept in a patient's medical records, but are not as easy to extract from the hospital's appointments database.

This would allow the hospital to target reminder phone calls at those most likely to be unreliable. The hospital calculates it has to call 11 people to prevent one appointment being missed. Under a more targeted system, this could be reduced to five.

7. Robot assisted surgeries

While AI-assisted surgery is still in its infancy, the numbers of robot-aided microsurgical procedures are expected to grow in the next few years as health systems collect and integrate data into their processes.

Robotic surgeries allow surgeons to use smaller tools and make more precise incisions, which will help reduce surgical variation and lead to better long-term health outcomes.

AI-assisted robots can also use data from past operations to inform new surgical techniques. A recent study of 379 orthopaedic patients found that robots resulted in five times fewer complications compared to surgeons operating alone.[12]

8. Virtual nursing assistants

Virtual nursing assistants could reduce unnecessary hospital visits and lessen the burden on medical professionals by replicating the typical behaviour of a nurse. This includes around-the-clock access support, monitoring, and quick answers to questions about medications.

According to Syneos Health Communications, 64% of patients reported they would be comfortable with AI virtual nurse assistants.[13] The survey also found that 72% of patients wanted the virtual assistant to have a realistic voice with a professional tone and this was more important than a human face or name.

Nursing assistants can also help patients self-manage chronic conditions and alleviate concerns about treatment side effects when a doctor is not available.

Hampshire County Council are trialling the use of Amazon Echo/Alexa within its technology service for 50 people with social care eligibility. They have built a 'skill' (app) that uses Alexa to record tasks and reminders for the home care provider carer to act on when they arrive for their visit, which can be created by a remote carer or family member. It will also remind the carer to prompt the service user to do certain things like take pills, or to remind them about a visit.

Patients have reported decreased feelings of social isolation as measured through pre- and post-project surveys and evaluations. The level of assurance of family members also increased as they can be alerted through the device.[14]

Accenture estimates that virtual nursing assistants could reduce healthcare costs by $20 billion.[15]

9. Administrative workflow assistance

The same report from Accenture estimates that AI-powered administrative work assistance could lead to $18 billion in annual savings.[15]

The NHS relies on paper records and technology-wise the gap between where it is and where it wants to be is only getting bigger. Currently the technology landscape is varied and diverse, and interoperability is poor[14] with many healthcare professionals struggling to access basic information at the point of care.[2]

Already, automated scheduling and appointment reminders are commonplace, but a move to automating record maintenance and discharge formalities could happen with AI-powered tools and techniques. By streamlining administrative functions, healthcare providers could then prioritise and address urgent matters and more complicated tasks.

10. Ageing population

The population is ageing and a third of children are now expected to live to be 100-years-old. In response to this, the Government has set up the healthy ageing challenge and plans to invest up to £98 million to help people to live active, independent and happy lives as they age.[16]

It says that ageing populations will create new demands for technologies, products and services, including new care technologies and new housing models.[15] This will allow them to stay in their homes for longer and provide more effective care options when this is needed.

Most diseases of old age from osteoporosis and diabetes to dementia require quick diagnosis and continuous supervision by a healthcare professionals. AI-based tools can improve remote patient monitoring of these conditions.

Sussex Healthcare NHS is trialling Patients Know Best (PKB), which is an online platform that is empowering more than 4,000 patients to play an active role in managing their inflammatory bowel disease (IBD) as well as offering them greater access to clinical expertise and innovative treatments.[17]

Patients record their symptoms and communicate with their clinical team remotely, accelerating timely access to advice, clinical reviews for flare-ups, and escalation to disease-modifying therapy where appropriate. It also offers reassurance to those who are stable without the need for a face-to-face review.

This remote monitoring could be extended to patients discharged from hospital. As well as helping manage illnesses, older people would feel reassured and more confident about living alone.

Case study: breast cancer scans

An artificial intelligence model has been shown to be as effective as human radiologists in spotting breast cancer from x-ray images and also reducing the proportion of screening errors where cancer was either incorrectly identified or where it may have been missed.

The findings, published in Nature, show the AI was able to correctly identify cancers from the mammography images from almost 29,000 women with a similar degree of accuracy to expert radiologists, and holds the potential to assist clinical staff in practice.

In the latest study, researchers at Google Health trained an AI model on depersonalised patient data – using mammograms from women in the UK and US where any information that could be used to identify them was removed.

The AI model reviewed tens of thousands of images, which had been previously interpreted by expert radiologists. But while the human experts had access to the patient's history when interpreting scans, the AI had only the most recent mammogram to go on.

During the evaluation, the researchers found their AI model could predict breast cancer from scans with a similar level of accuracy overall to expert radiographers (or were shown to be 'non-inferior'). Compared to human interpretation, the AI showed an absolute reduction in the proportion of cases where cancer was incorrectly identified, as well as cases where cancer was missed.

Security issues

One potential downfall to using AI in healthcare is cyber-security and patient confidentiality concerns. The NHS recognises that there are significant ethical and safety fears associated with the use of AI in health and care and to address this the AI team at NHSX have produced guidance on how this can best be done including the Code of Conduct for data driven health and care technology.[18]

The principles are:

1. Understand users, their needs and the context
2. Define the outcome and how the technology will contribute to it
3. Use data that is in line with appropriate guidelines for the purpose for which it is being used
4. Be fair, transparent and accountable about what data is being used
5. Make use of open standards
6. Be transparent about the limitations of the data used and algorithms deployed
7. Show what type of algorithm is being developed or deployed, the ethical examination of how the data is used, how its performance will be validated and how it will be integrated into health and care provision
8. Generate evidence of effectiveness for the intended use and value for money
9. Make security integral to the design
10. Define the commercial strategy.

Summary

The Government plans to put the UK at the forefront of the AI and data revolution as it believes embedding AI across the UK will create thousands of good quality jobs and drive economic growth.[16]

In healthcare, the capabilities of AI are endless. It can help diagnose diseases or conditions and use patient data to drive personalised treatments and highlight preventative measures. In addition, robotics and voice assistants can support people and their carers in rehabilitation, dementia support or medication management.

To achieve this, ambitious investment is needed along with a robust national strategy for AI and data analytics that delivers for all patients and healthcare professionals equally and fairly across the whole of the healthcare system.

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