Artificial Intelligence in NHS and Social Care

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Abstract

This commentary explores the potential of artificial intelligence (AI) in transforming the UK national health service (NHS) and social care to address challenges like health disparities and chronic diseases. It outlines various applications of AI in different healthcare domains, including pre-hospital health monitoring, elective care waiting lists, triaging, online treatment, diagnosis, imaging, electronic prescribing, and customising treatment. Leveraging AI can identify vulnerable populations and reduce health disparities.

However, it also emphasises the need for further research and careful consideration of ethical and privacy concerns to maximise the benefits of AI integration in healthcare.

Overall, AI offers innovative solutions to enhance healthcare delivery and improve public health outcomes.

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Introduction

The UK National Health Service (NHS) is undergoing reforms to meet changing health needs, such as the increasing importance of non-communicable diseases, the new global face of rapidly spreading infections, a diversification of population growth with varied health needs, a shrinking economy and a population unwilling to pay more while demanding the spiralling cost of new personalised treatment such as genetic modifications and monoclonal antibodies. In this perfect storm, where waiting lists have remained sky high and services are battling plummeting morale, evidence suggests that the current system is failing to deliver adequate public health outcomes, with lower life expectancy and rising mortality rates compared to other high-income countries (1). Challenges for the NHS in the future include addressing multimorbidity, chronic diseases, health inequalities, and health threats like COVID-19, BREXIT, climate change, and antimicrobial resistance (2).

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It is crucial to focus on health promotion, disease prevention, and a coordinated approach to tackle the various factors contributing to health disparities(3). While the immediate focus of the NHS is to mitigate the broader and enduring health effects of the COVID-19 pandemic, it must also enhance its ability to withstand and minimise the repercussions of other health threats. Digital health is perceived as having the capacity to revolutionise the healthcare system by facilitating the integration of care systems (ICSs), thereby enhancing the delivery of improved health outcomes for citizens and patients. Simultaneously, it enables innovative approaches to address the challenges posed by the high levels of healthcare demand, allowing for more effective management strategies.

A systematic review conducted by Maguire et al.(4) examined the utilisation of emerging technologies, including artificial intelligence (AI), smartphones, wearable devices, and the internet of things, within healthcare settings worldwide. The findings revealed varying levels of supporting evidence for their use. The review emphasized the necessity for further research on the impact of all emerging technologies on the healthcare system, encompassing aspects such as cost-effectiveness, reliability, security, acceptability, and privacy.

For NHS, the *'Five Year Forward View'* which targets to decrease the gap in health provision can be made more effective by using AI. The gap in health and well-being could be reduced by using AI to identify the most vulnerable individuals or community and the NHS could focus the treatment on such groups more effectively. As AI tools offer cutting-edge diagnostics and treatment tailored to individual needs, they could support the reduction of care and quality gaps. Automating tasks, triaging patients to the best services, and empowering them to take care of themselves would help the NHS address the efficiency and funding gap (5).

Pre Hospital	Health monitoring Elective care waiting lists Triaging powered by AI Online treatment Drug testing Increase communication between primary and secondary care
Hospital	Diagnosis and imaging Genetics Customising treatment Electronic prescribing
Post Hospital	Rehabilitation: Virtual reality Musculoskeletal modelling and training Transcraninal magnetic stimulation Falls prevention in elderly
Administrative	Job recruitment

Diagnosis

Elective care waiting lists

University Hospitals of Leicester NHS Trust utilized Dora, an AI clinical assistant developed by Ufonia, to engage with patients awaiting spinal and orthopaedic surgery. Dora is an AI system trained in artificial intelligence and machine learning to conduct phone calls, allowing patients to interact with it as if it were a real person. The primary objectives were to effectively manage and validate the growing number of patients on the waiting lists, as well as to ensure clear communication with patients. Dora proactively contacted these patients, assessing their condition, documenting any additional risk factors, understanding their treatment preferences and history, and providing regular updates on waiting times. The successful

outcome was that 12% of spinal and 10% of orthopaedic patients were removed from the waiting lists, either due to no longer desiring treatment or having received it elsewhere. By replacing routine healthcare calls, Dora relieved the burden on clinical and administrative staff, while consistently delivering a reliable and safe service for patients. Furthermore, Dora's capabilities can be extended to contact any patient who has been seen by a specialist or a GP and has been listed for a procedure, investigation, or treatment that is pending. The implementation of Dora at University Hospitals of Leicester NHS Trust has revolutionized patient communication, allowing clinicians to allocate more time to emergency care(6).

Health monitoring

The process of adopting proven innovations that create high-impact benefits for patients and enable a necessary change within the NHS is being made more faster and systematic with NHS Innovation and Accelerator(7). *'HealthUnlocked'*, one of the largest health websites in the UK has been supported by the accelerator. It provides personalised self-care advice and a gateway to various healthcare support and information available. This has been used by South Devon and Torbay Clinical Commissioning Group (CRG) to engage healthcare users with their own health and improve outcomes(5). National Institute for Health and Care Excellence (NICE) has approved '*AliveCor*', which is a mobile heart monitor which can detect, monitor and, manage atrial fibrillation with the help of AI. It is also part of the NHS Innovation and Accelerator(8).

Triaging powered by AI

London Clinical Commissioning Groups (CCGs) have joined hands with the health app company Babylon Health to introduce an AI chatbot which will support the NHS 111 to answer inquiries and help reduce the increasing health burden. This chatbot is seen as an instant triage system which may replace the 111 in the future. Using clinically based algorithms, the chatbot will triage patients based on reported symptoms without any human intervention. According to NHS England, the whole process takes only less than 2 minutes for each patient(9).

Online treatment

NHS has collaborated with a smartphone app '*Ieso*' to treat mental health conditions like depression, anxiety, and panic attacks. It provides online cognitive behaviour therapy to patients and evidence shows that the treatment time has been reduced to around 50%(5).

Diagnosis and imaging

Convolutional Neural Networks (CNNs), a type of AI is used to analyse visual images, while radiomics combines clinical data with Computer Tomography (CT) data. These AI techniques have been developed to predict the development of Colorectal Cancer Liver Metastasis (CRLM) in patients diagnosed with colorectal cancer. Additionally, AI is applied in histopathological examination to quickly and accurately identify CRLM tissue based on its unique growth patterns. This allows efficient analysis of histopathological images and helps in diagnosing CRLM and planning appropriate treatment(10).
Another example of AI in Health Care is CNNs being used to identify Diabetic retinopathy. It uses a huge pool of database to compare and identify the patterns. This has led to substantial improvements in detection of diabetic retinopathy, achieving a significantly higher sensitivity (89 – 90%) and specificity (98%)(11).

Electronic prescribing

Currently in NHS hospitals, prescribing is done on computers which is called as E prescribing popularly called as HEPMA, in the NHS UK. Hospital Electronic Prescribing and Medicines Administration (HEPMA) digitises prescribing and medication administration processes by replacing inpatient medication charts with a digital solution. This method of prescribing medicines has not only reduced errors in prescriptions, but also helps the clinicians to choose the best medication which is research based. Recently, a research has taken place in Swansea bay university health board which proved the efficiency of HEPMA. As per the

research, it showed improvement in prescribing medications by reducing the errors made of missed medicine doses from 7.43% to 0.96% and also, played a significant role in obtaining the maximum appropriateness of antibiotic choice. One of the wonderful features of HEPMA is that it enables the clinician to stay up to date with medical antibiotic protocols and also helps in prescribing them appropriately(12).

Customising treatment

In 2021, researchers from The Royal Marsden NHS Foundation Trust and the Institute of Cancer Research (ICR) employed artificial intelligence to discover a more effective treatment for an incurable childhood brain cancer known as diffuse intrinsic pontine glioma (DIPG). This cancer has been challenging to treat in children for a long time. It is characterized by mutations in a gene called ACVR1. The conventional drug used for DIPG treatment is vandetanib, but it faces difficulties in crossing the blood-brain barrier (BBB), leading to decreased effectiveness. Through AI-enhanced tools, the researchers identified that combining vandetanib with everolimus enhanced the concentration of vandetanib in the brain, resulting in improved therapeutic outcomes. This finding offers promising prospects for treating this challenging childhood brain cancer(13).

A cloud-based AI technology called OSAIRIS is making a significant impact on radiotherapy in the NHS, leading to time savings for doctors and reduced waiting times for patients. Developed by Dr Raj Jena and his team at Addenbrooke's Hospital, OSAIRIS enables specialists to plan radiotherapy treatments about 2.5 times faster than doing it manually. This improvement in efficiency is benefiting patients with prostate and, head and neck cancers initially, and there is a potential to extend its benefits to other cancer types across the NHS.

OSAIRIS uses machine learning techniques from Microsoft Research's Project *'InnerEye'*, combined with open-source software and data from consenting patients. It simplifies the process of outlining healthy organs on scans, which is essential for protecting healthy tissue from radiation during radiotherapy. This process typically takes doctors between 20 minutes and three hours per patient. OSAIRIS streamlines this step, and doctors verify the AI's segmentation for accuracy and safety.

The safety and reliability of OSAIRIS have been thoroughly tested, including "Turing tests" where doctors couldn't distinguish between the AI's work and that of human colleagues. Dr Raj Jena highlights that OSAIRIS simplifies the planning process, allowing doctors to focus more on making informed treatment decisions. As the first cloud-based AI deployed within the NHS, OSAIRIS is proving to be a valuable tool, and its implementation is expected to expand further across the NHS after extensive testing(14).

Musculoskeletal modelling and training

From clinical evaluation of motor control patterns to prosthesis design and preclinical testing, knowledge of the internal loads acting on the human body during daily life movements has a variety of applications. It can also serve as input for finite element models that predict bone adaptation. Unlike external forces, assessing the internal loads acting on the human body like joint contact forces and muscle forces are considered too invasive and not much data is available. Musculoskeletal models designed through 'OpenSim' in Imperial College London provides a way of estimating these internal loads(15). The lower limb musculoskeletal model has been used to understand the internal forces that act up on the pelvis as well as lower limbs during walking(16). A complex model depicting lower limb bilateral amputee will help to evaluate joint contact forces and muscle forces in the hip and lower limbs during stair-climbing, sitting and amputee gait. Physiologically accurate loading scenarios will be created for future finite element analyses of amputee biomechanics based on these results. The internal forces coming into play during various daily activities including weightlifting in the vertebrae were depicted using a lumbar spine model. As a result of these simulations, we will gain a deeper insight into the adaptability of human spines under different loading conditions(15). Combining these 'OpenSim' biomechanical models with AI algorithms will help develop novel methods for

improving the outcomes of rehabilitation in brain and sports injuries(17).

Falls prevention in the elderly

Injuries related to fall are the second most common case of unintentional injury related deaths after road traffic accidents(18). In persons aged 75 years and above, falls are the most common cause of injury related death(19). Moreover, psychological complications can limit older adults' daily activities, reduce their independence, and lead to them relying on formal and informal caregivers(20). Various forms of AI are being developed and tested to predict, prevent, and detect falls. These include machine learning (e.g., supervised, unsupervised, and reinforcement learning), natural language processing, fuzzy logic, and expert systems, among others(21). 33 studies were analysed in a systematic review for machine learning trends for fall detection and prevention. The majority relied on datasets from wearables and sensor devices and tested the models on younger participants in controlled laboratory settings(22). A study was conducted using reinforcement learning to reduce the process of muscle ageing and its consequence on human falls. The study utilized simulations to investigate the impact of age-related changes in muscle physiology on human falls. A 3D musculoskeletal model was employed, and the deep deterministic policy gradient (DDPG) method was implemented. Different muscle descriptors for aging were integrated, including maximum isometric force, contraction velocity, deactivation time constant, and passive muscle strain. The results demonstrated that the simulation model considering multiple ageing-related factors closely resembled experimental elderly fall data, outperforming simulations that only considered age-related reductions in force. The study highlights the potential of using reinforcement learning to explore the effects of ageing on kinematics and muscle control during falls, and it may pave the way for personalized rehabilitation programs for elderly individuals. These can help build strategies to prevent falls or at least reduce the consequence of falls(23).

Recruitment

Recruitment in the NHS is a complex process that involves selecting the most suitable candidates for a diverse range of roles with varying skill requirements. This process can be time-consuming, as it involves reviewing numerous applications, CVs, and supporting documents to identify the best candidates for each position(24). Employers use AI-based solutions in today's recruitment software to filter a large quantity of applications and shortlist candidates. It has become much easier for recruiters to approach and attract talents thanks to AI(25). Furthermore, artificial intelligence (AI) aids recruiters in effortlessly obtaining and analysing candidate data to determine suitability for job positions. Mundane and repetitive tasks are streamlined through AI, allowing recruiters to dedicate more attention to innovative and strategic aspects. AI systems are intelligently designed to mitigate bias during the selection process, effectively avoiding potential biases related to personal characteristics such as name, age, gender, race, and beliefs(26). Studies showed that lack of skills and fear of change were some of the main challenges with AI adoption in recruitment processes(27). Moreover, the challenge with using AI or machine learning models in recruitment is the potential replication and amplification of human bias present in the historical data used for training. If the model learns from biased data, it may perpetuate or even worsen the existing biases in the recruitment process. The model focuses on patterns in applications that led to shortlisting without comprehending specific data points or features that contribute to a candidate's suitability. Hence, thorough analysis and testing of the models are essential to identify and address any bias replicated by the AI system(24).

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