

Artificial intelligence: opportunities and implications for the health workforce

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Healthcare involves cyclic data processing to derive meaningful, actionable decisions. Rapid increases in clinical data have added to the occupational stress of healthcare workers, affecting their ability to provide quality and effective services. Health systems have to radically rethink strategies to ensure that staff are satisfied and actively supported in their jobs. Artificial intelligence (AI) has the potential to augment provider performance. This article reviews the available literature to identify AI opportunities that can potentially transform the role of healthcare providers. To leverage AI's full potential, policymakers, industry, healthcare providers and patients have to address a new set of challenges. Optimizing the benefits of AI will require a balanced approach that enhances accountability and transparency while facilitating innovation.

Keywords: artificial intelligence, healthcare, health workers, productivity, professional liability, provider–patient relationship

Introduction

Globally, the needs-based shortage of healthcare workers was estimated to be about 18 million in 2013.¹ This shortage is being driven by a broad set of factors related to chronic underinvestment in health workforce education, recruitment and labour market constraints.² The shortage and distribution challenges have led to increases in the workload and stress-related burnout of remaining staff, creating unsatisfactory work environments. This is not only driving up the rates of attrition, but is also causing a growing reluctance among new graduates to pursue a healthcare career. Recent studies^{3,4} have shown that the ongoing staffing shortages will not only increase patient waiting times, but also dramatically impact the overall quality of healthcare.⁵

Healthcare is a cyclic process wherein healthcare providers collect, analyse and integrate data from multiple sources and corroborate these data with empirical research and clinical expertise to derive actionable decisions.⁶ In the current environment, healthcare providers are exposed to a variety of occupational stressors, such as high workload, time pressure, administrative chores, low social support at work, uncertainty concerning patient treatment and predisposition towards emotional responses. They often struggle to cope with these changes. Among others, burnout of healthcare providers, especially clinical staff, has become an occupational hazard, with its rate reaching between 25% and 75% in some clinical specialties.⁷

Health systems have to radically rethink strategies to safeguard quality and safety, maximize efficiencies and ensure that

staff are satisfied and actively supported in their jobs. Rapid, disruptive technological change has the potential to drive healthcare reforms to improve efficiency and augment provider satisfaction, thus improving patient experiences and outcomes.⁸ This prospect has focused global attention on the integration of technologies such as artificial intelligence (AI) to address current and emerging health system challenges, including the workforce.^{9,10}

Current healthcare challenges: the role of technology

Today's healthcare environment is rapidly evolving. While some of these changes are evolutionary and incremental, others have been revolutionary and transformative. These changes have not only impacted clinical processes and practices of healthcare providers, but have also affected the experiences for patients and their families.

A case in point is the exponential growth in biomedical and clinical evidence. The doubling time of medical knowledge in 1950 was estimated at 50 y, in 1980 it was 7 y and in 2010 it was 3.5 y. In 2020 it is projected to be only 73 d.¹¹ The sheer volume of information, coupled with time constraints and cognitive limitations, has outstripped the capacity of healthcare providers to apply this new knowledge. Studies on the adoption of proven innovations in healthcare confirm that there is unjustifiable slowness and incomplete implementation of evidence-based practices, even in the best academic health centres.¹²

Clinical encounters are becoming increasingly complex, as patients present with multimorbidity. In the UK, for example, recent estimates suggest that one in six patients have more than one chronic condition, and these patients account for approximately one-third of all general practice consultations.¹³ Although multimorbidity is common and costly, clinical practice guidelines and models of care delivery are still largely built on vertical monomorbidity approaches.¹⁴

The internet has revolutionized the way information is shared and accessed. Patients and their families now have more knowledge of, competence with and engagement in their health decision-making.¹⁵ They are also demanding more sophisticated, convenient, transparent, affordable and personalized care.

Against the background of steady advances in clinical knowledge and changing patterns of health needs, the traditional model of decision-making by solo providers relying on their memory and personal experience is inadequate to effectively address twenty-first-century health challenges. In addition, the growth of consumerism and the proliferation of internet-accessible sources of health-related information will continue to modify the provider–patient relationship.

Technological advancements have provided a breakthrough in addressing some of these challenges. From devices to medicines, technological developments have increased diagnosis and treatment options and contributed to improvements in efficiency and quality of healthcare. By transforming healthcare delivery, the use of technology has led to remarkable increases in longevity and quality of life.¹⁶ Until recently, technology has not been routinely used to gather, integrate and interpret data to formulate clinical decisions.^{17,18} Technologies such as AI have the potential to analyse and identify patterns in complex data and support healthcare providers in the delivery of care.¹⁹

The rise of AI

Over the past decade, AI has moved from the realms of science fiction to a tangible technology that is increasingly becoming a part of everyday life. The healthcare space is no exception—AI is already being introduced into healthcare settings.

AI involves the use of technologies such as natural language processing, deep learning, context aware processing and intelligent robotics. Analytics coupled with AI can potentially play an important role in the data mining of health records, thereby becoming an effective technique to guide healthcare decision-making. In contrast to analytics, which is based on a predefined set of programs, AI has the capability to self-learn using historical data.

AI aims to mimic human cognitive functions.¹⁸ There are already multiple applications in healthcare, ranging from automated administrative tasks to clinical decision aids, automated imaging, intelligent drug design and AI-powered surgical robots. In advanced economies, the adoption of AI technology has gained interest and momentum, with the primary objectives being decreasing cost and improving healthcare outcomes. Although all countries are currently at an initial stage of adoption, in many emerging economies the growth has been slow due to the paucity of digitized healthcare data. Nevertheless, AI adoption is estimated to increase in the future. According to

a recent report,²⁰ AI in the healthcare market is expected to grow from US\$2.1 billion in 2018 to US\$36.1 billion by 2025, at a compound annual growth rate of 50.2% during the forecast period.

The use of AI in healthcare is not new, but there have been rapid advances in the field in recent years. This has been enabled in part by notable progress in big data analytics and facilitated by growth in the availability of healthcare data. With appropriate analytical techniques, such as machine learning tools, AI can potentially revolutionize many aspects of healthcare.

AI to the rescue

AI is likely to transform the role of healthcare providers, and may even dramatically change the provider–patient relationship. As automation gains momentum, there is enthusiasm about the prospects on the one hand, but there are also concerns that technology-fuelled increases in productivity will make certain healthcare jobs redundant.²¹ Although there is still much uncertainty about how adoption of AI will proceed, there are indications that AI has the potential to augment provider performance to deliver efficient, effective and quality care.

Productivity

AI is being deployed in various applications, including assisting in administrative tasks, mining health records, designing treatment plans and providing consultations. The use of AI can make certain time-consuming repetitive processes faster and more efficient. This allows healthcare providers to spend more time on tasks that focus on the clinical context of their patients and attending to their needs.

In addition, the use of AI enables healthcare providers to manage care for a larger number of patients. In nursing, for instance, it has been reported that the use of AI-enabled tools increases productivity by 30–50%.²² The combination of AI and human intelligence, or ‘augmented intelligence’, has been touted as a powerful approach to deliver on the fundamental mission of healthcare.²³

Workload

High workload is a recognized occupational stressor that has implications for the quality of care and patient outcomes.^{24,25} Prior reviews²⁶ have demonstrated that administrative tasks contribute substantially to staff workload and time pressure. For instance, it has previously been reported that, in ambulatory settings, physicians spend 49% of their time on electronic health records and desk work versus 33% on direct clinical face time with patients and staff.²⁷

By auto-populating structured data fields from open-ended clinician notes, querying relevant data from prior clinical records and transcribing recorded patient encounters, AI has the potential to substantially reduce the administrative burden. A recent report estimates that voice-to-text transcription will result in work time savings of 17% for doctors and 51% for registered nurses.²⁸

Technology giants such as Amazon are working on introducing a new machine learning service that will extract meaningful

information from unstructured electronic health record (EHR) data and free-text clinical notes. Amazon Comprehend Medical makes it easier to analyse unstructured EHR data to extract key clinical terms related to a patient's diagnoses, medications, symptoms, treatments and other interactions with the healthcare system.²⁹

Performance

AI tools have the potential to improve diagnostic decisions and treatment outcomes and reduce medical errors. AI has expanded substantially in the fields of medical imaging and diagnostics. Deep learning techniques are aiding in the prevention of errors in diagnostics and improving test outcomes. For instance, AI has been reported to improve the assessment of medical imaging to detect cases such as malignancy and diabetic retinopathy.^{30,31}

Many healthcare providers are integrating AI into their daily functions to gather insights from the growing amount of clinical data, thereby minimizing patient risk. AI is also being used to automatically review clinical documents and either extract information for quality reporting or populate diagnosis coding.³² In some cases, AI tools have been combined with existing technologies to prevent healthcare providers from committing medical errors. For examples, start-ups like MedAware (Raana, Israel) are integrating AI capabilities with EHR systems to prevent prescription errors.²³

In addition, leveraging on the capabilities of machine learning applications, technology companies like Google (DeepMind), IBM (Watson) and others are currently conceptualizing the prospects of AI-powered surgical robots. It is expected that the use of robots with AI capabilities will increase precision, reduce damage and enhance the clinical pace of recovery.

Teamwork

The current care environment requires healthcare providers to collaborate and work in teams. This necessitates strong communication for shared decision-making, coordinated actions and evaluation of progress. AI has the potential to integrate data from a large number of sources, both structured and unstructured, to provide more cohesive, faster, more consistent access to patient information across different settings and disciplines.

In some cases, chatbots have been used to coordinate and schedule medical appointments, provide reminders and notify providers regarding a patient's condition based on symptoms. Start-ups like Babylon Health (London, UK) and Your.MD (London, UK) are AI-powered healthcare assistant applications that support providers, patients and caregivers, providing the above functionalities.

Satisfaction

Effective evidence-informed decisions require the gathering, integration and interpretation of vast amounts of data. Given the enormity and complexity of the data, healthcare providers are able to draw on a subset of the information. For instance, only about one-fifth of the available trial results are used when diagnosing and treating cancer patients.¹⁸ AI technologies have the

potential to process data, discover new knowledge and create novel methods to improve the quality of healthcare. AI is also being used to monitor patient outcomes. For instance, the National Institutes of Health has created the AiCure app to monitor the use of medication by a patient.³³ Thorough use of current research evidence and regular follow-up of patient outcomes can promote increased job satisfaction.

AI can enable patients with chronic conditions to become better informed about their health and stay connected with health caregivers. For example, home health monitoring technology powered by AI could help the frail and elderly stay connected with professional caregivers to ensure they receive timely care when needed. Individuals with diabetes or hypertension could benefit from similar technology that allows them to track their condition via clinically validated sensors and devices. This allows providers to extend patient care efforts outside of office hours and drive self-management.

Newer challenges

AI has vast potential to deliver better quality and more efficient healthcare, thereby enhancing productivity, provider satisfaction and user experience and dramatically improving outcomes. To leverage on AI's full potential, policymakers, industry, healthcare providers and patients have to address a new set of challenges.

Professional liability

Traditionally, clinical decision-making is within the purview of qualified, licensed healthcare providers. As AI becomes increasingly used to assist with clinical activities, the professional obligations of healthcare providers towards individual patients might be affected by the use of AI decision support systems. Considering the potential for AI to make erroneous decisions, the legal liability of AI-supported decisions often remains ambiguous. This is further complicated by the fact that the development of appropriate legal principles and guidance is often slower than technology's advancing capabilities. A related concern is that AI could make healthcare providers complacent and less likely to check results and challenge errors.³⁴

Labour market implications

As with many new technologies, the introduction of AI is likely to mean the skills and expertise required of healthcare providers will change. In some areas, AI could enable automation of tasks that have previously been carried out by humans. Moreover, as AI continues to evolve in healthcare, there will likely be a growth in the demand for new skill sets, such as informatics. Education and training programmes will have to be adjusted to match the labour market needs.

There are also some concerns that the introduction of AI systems might be used to justify the employment of less-skilled staff. This could be problematic if the technology fails and staff are not able to recognize errors or carry out necessary tasks without computing assistance.³⁴

Provider competencies

Future medical practice will be characterized by the use of a growing array of data from multiple sources and AI applications. Newer competencies will be required to better use the findings of cognitive computing systems, and the integration of technology and patients and their families in the care journey. To be effective, healthcare providers must be able to effectively leverage data platforms, analyse outcomes, improve performance and communicate the meaning of the probabilities generated by massive amounts of data to patients and their families.

Health profession education will have to move beyond the foundational biomedical and clinical sciences. Curricular reforms will have to incorporate competencies such as the use of intelligence tools involving large datasets, machine learning and robotics, while guaranteeing the mastery of people-centred care.³⁵

Ethical considerations

AI's current strength is in its ability to learn from complex datasets and recognize patterns. Application of AI technology is limited by the quality of available healthcare data. AI might not work as well where data are scarce or more difficult to collect or render digitally. Concerns have been raised that datasets used to train AI systems have inherent biases and are often not representative of the wider population.³⁴

Functioning largely as 'black boxes', the behaviour of AI systems is difficult to interpret and explain. The difficulties in validating the outputs of AI systems have raised concerns about accountability, transparency and human control.³⁶ At a practical level, both patients and healthcare providers will need to be able to trust AI systems if they are to be implemented successfully in healthcare.

Regulatory compliance

As the use of AI in the clinical space increases and evolves, legal and regulatory risk will increase, particularly since traditional regulatory principles are not yet attuned to AI. The evidence standard for certain AI tasks is currently ill-defined. For example, validating the accuracy of AI-enabled imaging applications against current quality standards for traditional imaging is likely sufficient for clinical use. For AI applications that predict, diagnose and provide treatment information, the evidence standards have to be significantly higher. A key challenge for future governance of AI technologies will be to ensure that AI is developed and used in a way that is compatible with the public interest while stimulating and driving innovation in the sector. This implies a regulatory framework that is supportive of technological innovations but safeguards leakage of sensitive information to unauthorized third parties and protects the patient's right to privacy.³⁷

Provider–patient relationship

A well-functioning provider–patient relationship is still the essence of healthcare. The success of providing care depends on collaboration, empathy and shared decision-making. Empathy skills of healthcare providers have been shown to positively influence patient outcomes.³⁸ AI can assist in improving efficiency

and quality, but is limited by its inability to possess some human characteristics, such as compassion, empathy and the human touch. Future developments in AI technology may redefine the relationship between providers, patients and their caregivers. For now, the role of healthcare providers is unchanged, but AI can be a very useful cognitive assistant.

Conclusions

AI is becoming a part of our daily lives, and the healthcare ecosystem is no exception. As AI continues to advance, its functionalities will potentially transform the healthcare space. Integration of AI will assist with care provision, with the advantage of increasing efficiency and improving the quality of certain services, leading to a higher volume of care delivery. While AI has tremendous potential to address important health challenges, it might be limited by the availability and quality of health data and its inherent inability to display some human characteristics.

Using pattern recognition, AI can assist healthcare providers with more informed clinical decision-making and enable patients to take an active role in their own health. It can automate repetitive tasks, allowing healthcare providers to focus on higher-level cognitive tasks and patient care. AI has enormous potential to enhance productivity, improve quality and efficiency and contribute towards higher provider and patient satisfaction.

As impressive as AI is as a cognitive assistant, its growing use in healthcare has posed a set of new challenges. These include concerns about ethical and medico-legal impacts; labour market implications, including effects on the roles and competencies of healthcare providers, and concerns arising from inherent data biases and data protection.

AI has a huge potential to alleviate some of the challenges that healthcare providers face. Optimizing the benefits of AI will require a balanced approach that enhances accountability and transparency while facilitating innovation, fostering responsible access to data to further develop computing abilities and building trust between providers, patients, researchers and innovators. Looking into the future—taking cues from the history of automation—AI is unlikely to displace humans, but will definitely redefine their roles and establish itself as an indispensable cognitive assistant.³⁹

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