Chapter 11
Healthcare

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Abstract The use of Artificial intelligence (AI) has grown dramatically across various industries around the world, especially in the healthcare sector where AI supports patients, nurses, and doctors to complete tasks with greater precision, speed and safety. Although countries such as the USA and China are the most advanced in their use of AI, interest in AI use has grown in Australia, especially in healthcare facilities such as nursing homes and hospitals. Despite predictions of AI related job losses across the Australian economy, we argue that within the Australian healthcare sector the picture is much more complex, and that AI may create more jobs overall and enable clinicians and health care organisations to more efficiently and effectively support the needs of patients and communities in the future. That said, the growth of AI is not without its challenges and negative effects on clinicians, healthcare organisations and patients, especially where it is not managed ethically or strategically by healthcare organisations. This chapter focusses on the significance of AI in the Australia healthcare system and its impact on the work organisation and employment of the healthcare workforce.

Keywords Artificial intelligence · Australia · Healthcare · Doctors · Nurses

Introduction

Artificial intelligence (AI) continues to break ground in the healthcare sector addressing clinical challenges by assisting clinicians, such as doctors and nurses caring for patients in healthcare organisations (Mindfields 2018). The number of organisations within the healthcare sector utilising AI has increased dramatically

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over the last decade due to awareness, availability and the reduced costs of the technology (Davenport and Kalakota 2019; Mindfields 2018). AI is defined as 'technology designed to perform activities that normally require human intelligence' (Luxton 2014: 2). Globally, an increasing population is witnessing a decline in the number of healthcare workers, "and the gap is seen to be widening over time" (Mindfields 2018: 7). According to the World Health Organisation (WHO), in 2035 the world will be short of approximately 13 million healthcare workers. In developed countries such as Australia, the US, Canada, Germany, and the UK a large proportion of their Gross Domestic Product (GDP) is spent in healthcare. As a result, the adoption of new technologies such as AI has become increasingly important to their health systems to increase labour productivity and the quality of patient care, and alleviate clinician and budget shortages (Mindfields 2018).

In recent years there has been increasing interest in the field of AI and its applications to healthcare (Reddy 2018). AI is used to enhance the effectiveness of the delivery of healthcare and to address intractable healthcare challenges (Gambhir et al. 2016; Ramesh et al. 2004). The hundreds of AI-based healthcare applications covering assisted surgery, preliminary diagnosis, and administrative workflows that have been presented in recent years are testimonials to its importance. The AI science field is 'concerned with the computational understanding of what is commonly called intelligent behaviour and with the creation of intelligent agents that exhibit such behaviour' (Shapiro 1992: 89). AI involves machines assuming human-like capabilities via computer programming and displaying aspects of human intelligence, such as learning, adapting and self-correction, as well as thinking and acting like humans and displaying rationality. Using computer programming, AI tries to emulate intelligent behaviour (Kok et al. 2009; Ramesh et al. 2004; Reddy 2018; Warwick 2013).

Within healthcare, AI uses advanced algorithms to decipher relevant information from a large volume of healthcare data to assist nurses in clinical practice. AI may also reduce human error in clinical practice and identify diseases such as cancers more accurately in their initial stages (Dilsizian and Siegel 2014; Lee et al. 2013; Patel et al. 2009). For example, according to the American Cancer Society (Wilson 2017), a high percentage of mammograms yield false results, leading to errors. The use of AI enables mammograms to be reviewed and translated 30 times faster and with greater accuracy than before (Wilson 2017). Another example is the attention paid to the field of radiology. The ability to interpret imaging results using AI technology can help clinicians identify a minute change that they may unintentionally miss (Abhinav and Subrahmanyam 2019), thus decreasing the human error rate. AI allows medical digital devices to see and recognise objects, identify and respond to identifiable messages, make decisions, and even learn to change its behaviour and thinking by analysing data points in a distributed memory known as the cloud (Abhinav and Subrahmanyam 2019), all contributing to the increased accuracy of medical diagnoses.

Although AI has many benefits, it also has its challenges. The impact of AI on the workforce (for example, job design, deskilling), and the potential for job loss is a major concern (Frey and Osborne 2013; Smith and Anderson 2014). Frey and Osborne (2013) predict that half of the jobs in the USA will be automated within the

next decade. Moreover, Lee (2018) noted that a quarter of Asian countries, such as Singapore, will be at high risk from automation. It is predicted that in Australia, AI and automation will replace 20% of occupations in the public sector, such as those in health and education, by 2030. In the Australian healthcare sector, around 100,000 jobs are likely to be displaced; however, approximately 190,000 new jobs will be created for nurses and medical specialists due to the changes in technology (for example, the emergence of new jobs in areas such as nanotechnology, engineering and design – Taylor et al. 2019). At this stage, in the healthcare industry there are contradictory signs as to how the growth in AI will play out in terms of employment. What is certain is that the jobs of clinicians, and the organisation and management of health care facilities will be transformed by AI in the future.

Industry Overview

This chapter focusses on the healthcare industry in Australia, which is the largest employing industry. The sector employed 1.7 million healthcare workers in 2019 and is expected to increase to 1.9 million by 2024 (Australian Bureau of Statistics 2018). AI is one of the ongoing trends driving change in the Australian healthcare sector that has impacted jobs, and as a result, healthcare workers have needed to improve the skills required to work with this technology (ABS 2018). The COVID-19 pandemic has impacted healthcare workers physically and psychologically. Healthcare workers such as nurses, and doctors are vulnerable as they work face to face with affected patients (Ku et al. 2020). Due to the current pandemic, healthcare professionals need to work under pressure in very difficult circumstances which may lead to mental health issues, burnout and even turnover. Therefore, using AI is critical in this sector to assist healthcare workers in their routine jobs.

There are many factors driving the development of AI in healthcare. In the US, demand has increased due to its rising and ageing population and financial pressures on the healthcare sector (Trump 2019). The use of AI in medicine has increased by 40% and its expenditure is estimated to reach $6.6 billion by 2021 around the world. However, in Australia there is minimal investment in AI in comparison with 'super-power countries' such as China and the USA (Williams 2019). This chapter discusses the significance of AI in the healthcare sector. Further, it will outline how AI assists healthcare professionals such as doctors, nurses, people who work in Australian health care. Finally, the influence of AI on employment and deskilling will also be discussed.

Key Technologies

Machine learning and deep learning are two types of AI that allow healthcare organisations to analyse a huge volume of different data (Davenport and Kalakota 2019). Machine learning fits models to data and allows technology to "learn" by training

these models with the data (Davenport and Kalakota 2019: 94). In the healthcare sector, the primary application of machine learning is in precision medicine, predicting the best treatment for patients based on their situation and treatment context. Davenport & Kalakota (2019, 94) argue that 'the most complex forms of machine learning involve deep learning, or neural network models with many levels of features or variables that predict outcomes. The most significant application of deep learning in healthcare is 'recognition of potentially cancerous lesions in radiology images' (Davenport and Kalakota 2019: 94).

AI can increase the quality of patient care through deep learning in an automatic system for the recognition of diabetic retinopathy (Gulshan et al. 2016). Gulshan et al. (2016) investigated the significance of deep learning algorithms for the detection of diabetic retinopathy in the US. For the purpose of this study, fifty four US licensed ophthalmologists and ophthalmology senior residents were trained in its use. They found that the identification of diabetic retinopathy or diabetic macular oedema in retinal fundus images with high sensitivity and high specificity of deep neural networks can be trained, using large data sets and without the need to specify lesion-based features. This finding leads to the provision of high-quality outcomes in medical imaging tasks. Contreras and Vehi (2018) reviewed recent papers on AI from 2010 to 2018 and found that AI plays a significant role in clinical daily practice and the self-management of diabetes.

Jha and Topol (2016) discussed the theoretical importance of AI in the radiology and pathology area. They argued that the use of deep learning AI helps in the detection of diseases such as lung and breast cancer, and that the role of AI in pathology is important in some tasks such as Papanicolaou tests, cell counts, typing, and the screening of blood, have been automated by this technology. Similarly, Chang et al. (2019: 4) found that using AI assists in 'diagnostic pathology involves segmentation, detection, and classification, as well as quantification and grading'. Pearce et al. (2019) noted in their study that the POLAR Diversion Plan resulted in an automated decision-support tool (DST) driven by AI which was developed in an emergency department of a large Australian health service. The implication is that 'it can be delivered automatically to the GP when the patient is sitting with them, which enables immediate intervention that may reduce risk' (p. 538).

While AI has some benefits, it is not without its challenges. For instance, it has been shown that diagnostic applications should not be embedded in integrated environments such as electronic medical records as they have limited clinical acceptance. The application of AI may be challenging as healthcare professionals face ethical dilemmas in their practice, and AI is unable to provide ethical judgments, thinking, and reasoning (Luxton 2014). The challenges of AI are not just experienced by providers, but by patients themselves. Information is available for patients via the internet, creating the potential for healthcare to be democratised (Schulz and Nakamoto 2013). Moreover, in the context of the COVID-19 pandemic we have seen the emergence of tele-health consultations with healthcare practitioners. At the same time, there is evidence that a growing number of patients are not keeping their appointments, or are not making appointments with their doctors, or are having difficulty in accessing and using the technology, which in some circumstances may compromise their health and wellbeing (Hope 2020).

One of the most significant benefits of AI is helping people to manage their own health (Arnold and Wilson 2017). The use of AI in different healthcare applications allows people to manage their own health by healthier living, keeping themselves well and thus reducing the strain on healthcare services. For instance, 'the *Smart belt – welt* has a built-in mechanism that alerts a person when they overeat. It relies on a magnetic sensor to track waist size and tension to determine when the users may have over eaten and alerts the wearer' (Arnold and Wilson 2017: 3).

Such applications assist people to engage in healthier behaviour and manage their lifestyle. In fact, such technology may prompt patients to think about their wellbeing and health and improve their lifestyle choices. Moreover, AI has the potential to increase the understanding of healthcare professionals regarding the needs of people they care for. This understanding supports healthcare workers to guide and support patients, and to provide enhanced and often in-time feedback regarding their health outcomes (for example, using smart technology such as in-time health information from smart watches and similar technology) (Arnold and Wilson 2017).

In their study, Arnold and Wilson (2017) surveyed more than 11,000 people across twelve countries (Europe, the Middle East and Africa) to investigate people's willingness to use AI and robots in healthcare, as well as the advantages and disadvantages of using this technology in the healthcare system. The study reported that, up to 73% of all respondents (from 11,000 in total) were willing to have minor surgeries such as eye laser or cataract surgery undertaken by robots instead of human doctors. Moreover, the researchers found that 37% of participants were happy for their health records to be checked by robots, and 32% had no problem with blood test results being provided by robots. Moreover, respondents in Nigeria, Turkey and South Africa were the most willing to have minor surgery performed by robots (73%, 66% and 62% respectively), with the UK the least willing (36%). Based on their findings in Belgium, the UK, Germany and Sweden, respondents were generally not willing to be patients in surgeries undertaken by robots. However, one-third of the participants agreed that such surgeries were important. The participants were generally unwilling to be patients of robots undertaking procedures in major surgeries such as the removal of a tumour, or heart surgery.

Medical Applications

In the healthcare sector, AI is used for electronic medical records, clinical algorithms and image data analysis in pathology and radiology (Köse et al. 2018). For instance, AI assists healthcare professionals in the management and analysis of large amounts of data, reduces repetitive work procedures, and decreases human error. It can even go beyond those processes helping healthcare professionals to interpret radiological images such as mammography, ECG analysis, and the interpretation of arterial blood gas (Köse et al. 2018). In surgery, the use of AI can support decision-making and the application of surgical techniques during surgical

procedures. However, complex surgical procedures, instantaneous complications, and the personal solutions offered by the surgeons to patients may hinder or even prevent the full use of AI in surgery at the current time (Mirnezami and Ahmed 2018).

The most powerful application of AI is through its human-like performance. Specifically, 'artificial intelligence systems can perform certain tasks very well that normally require human intelligence' (Ho et al. 2019: 9). For example, with this technology, the error rate in the detection of cancer-positive lymph nodes reduced from 3.4 to 0.5% in samples used (Wang et al. 2016). The deep learning system errors were not connected with human pathologist errors. Therefore, while a pathologist may be better than a deep learning system alone in terms of quality, incorporating a deep learning system and a human pathologist reduced the error rate in pathology testing. The smart tissue autonomous robot is the first example of robots that can help surgeons perform intestinal anastomoses, a surgical procedure that 'involves connecting the tubular loops of the intestine' (Shademan et al. 2016:1), as they are more accurate and faster than surgeons, but it is still under the surgeon's control (Shademan et al. 2016). Robot assistance can also control all vital signs during operations, provide verbal warnings when needed, information analysis and pathological testing, and can determine surgical margins in solid organ tumours (Camarillo et al. 2004).

Minimally invasive surgical (MIS) techniques have been developed to support surgeons to perform their surgery without any need to place their hands on the patient's body during an operation (Camarillo et al. 2004). This technique has revolutionised the concept of surgical procedures (Camarillo et al. 2004). In MIS, small incisions are made on the patient's body to insert observation tools and instruments. Long manipulators are used to conduct operations under physical control (Camarillo et al. 2004). It is, therefore, clear that the surgical damage in these methods is reduced and the recovery of the patient is faster. These methods have many advantages, but there are difficulties in some areas, such as conventional endoscopic instrumentation (Camarillo et al. 2004). The advantage of robotics is to reduce many of these barriers, while at the same time improving tremor filtration and motion scaling (Camarillo et al. 2004), which concerns the movement of the surgeon's large hands to smaller movements and has a major role in increasing accuracy in robotic surgical systems (Prasad et al. 2004). Surgeons may now teleoperate a robot in skilful, comfortable and intuitive ways Satava (1999). Ballantyne and Moll (2003) have reported that laparoscopic surgery 'transitional' technology has led to substantial improvements in robotic surgery use and clinical results.

Nursing & Allied Healthcare Applications

Human-like robot nurses (or nurse-bots) can be used to support healthcare professionals in Australia due to the shortage of healthcare workers and an increasingly ageing population, which is expected to increase to around 8.1 million in 2050 (ABS 2018).

Robot nurses help patients to perform their daily tasks such as dressing, bathing and assisting them to engage in social activities such as simple conversations. Using nurse-bots allows hospitals to provide nursing resources to other significant areas such as critical care or emergency rooms. They are also beneficial for the aged care sector and supporting elderly patients. For instance, in Australia a social robot named Matilda supports elderly people in nursing homes, providing entertainment and group activities. Matilda was designed to have various attributes, such as emotions, a voice, gestures, music, and movement, including dance (Khosla et al. 2012a).

According to the McKinsey Global Institute report, by 2030, 400 to 800 million employees across all sectors will be replaced by robots around the world (Lost 2017). It is predicted that 2.7 million Australians who now have jobs could be completely replaced by automation by 2034 (Taylor et al. 2019). Robotic nurses around the world are the revolution in the healthcare sector making tasks and procedures more efficient and safer. In recent years, the advancement of technology in nursing has occurred; however, none is comparable with the effect of AI in the healthcare sector. AI is used in nursing in different areas such as developing treatment plans, medication management and the simplification of repetitive jobs (Bini 2018). Therefore, some nurses are concerned that the increasing implementation of AI may render them jobless (Pepito and Locsin 2019). In Australia, it is predicted that using AI in the healthcare sector will also lead to job loss for people such as radiologists who carry out automatable activities (Taylor et al. 2019).

While using AI has some benefits for nurses, it also has downsides. Robot nurses can only perform those tasks they were designed to do and they lack the emotional intelligence of human beings, rendering it impossible for such nurse-bots to communicate with patients on an emotional level (at least with current technology). Patient privacy might also be jeopardised if there are insufficient standards of protection, as robots often collect patients' personal data from different departments, such as blood test and x-ray results and other examination outcomes (Liang et al. 2019b).

In hospitals, nurse robots work as supplementary healthcare workers. For example, the Da Vinci Surgical Robot is a robot used in more than 3600 hospitals around the world (Kelly n.d.). In Australia, a lifting robot is an example of a nursing robot used in elderly care. They assist elderly people by lifting and moving bed-bound patients and carrying medication and meal trays (Khosla et al. 2012b; Sparrow and Sparrow 2006). Pepper is the name of a social robot with emotion recognition and is used in trials in Australian hospitals to study how robots could support the quality of care of patients (Forbrig 2019). Robear is another example of a nurse robot that has been used in Japan (Szondy 2015). In addition, another robot named Tug is now being utilised in numerous hospitals for prescription dispensing. According to the International Data Corporation (2017), around the world $91.5 billion was spent on robotics which will be increased to $188 billion in 2020 (Croce et al. 2017), suggesting that the use of robotics in the healthcare sector is set to increase. In Australia, the 2018–19 Australian Federal budget announced an AU$29.9 million investment over 4 years to support the development of AI (Williams 2019).

Technology advancements may make it easier for nurses to care for patients and perform their jobs safely (Pepito and Locsin 2019; Pepito and Locsin 2018). As examples, robotic-assisted surgery may one day replace nurses in operating rooms (Criss and Gadepalli 2018) and nurse-bots are replacing human nurses in some hospital departments (Eriksson and Salzmann-Erikson 2017). They also have increasing responsibilities such as supporting elderly patients, children with autism and people with disabilities. AI robots are also helping nurses in medication administration, which coupled with the major advancement of technology and AI, enables machines to coordinate patient care (Saraee et al. 2017), and make critical decisions in healthcare. As a result, nurses are facing challenges in the advancement of such technologies, especially in relation to their nursing practice. Resistance to change can often be found within the nursing fraternity amid these new technologies threatening and undermining their employment (Pepito and Locsin 2019). However, according to Healthcare Workforce, by 2025, all healthcare workers including nurses, doctors and midwives are expected to remain in the workforce even in situations of supply exceeding demand (Healthcare Workforce 2012).

Robot nurses learn to undertake nursing roles such as the measurement of vital signs, ambulation support, infectious disease protocols, medication administration and they augment the role of nurses in the delivery of care. Previous research indicates that, between 8% and 16% of nurses spend most of their time on non-nursing activities and duties that should be assigned to others. The challenge of AI assisted robot nurses is their lack of knowledgeable and complicated decision-making capabilities that are integral to the nursing role. For example, robots designed to remind patients to take medication are required to know the reason for patients refusing medications and need to have the ability to respond accordingly. Human nurses have knowledge, expertise, values and the ability to communicate and perform clinical roles effectively. In response to this, AI companies have developed machine learning applications to simplify daily tasks and computerise organisational processes to support nurses during patient treatment. To find the correct balance between AI support and personalised patient care, it is imperative that healthcare organisations balance their business needs by providing high quality care to patients and supporting clinicians to carry out their tasks efficiently.

Employment Impact

As discussed earlier in this chapter, the advancement of technology and the use of AI have major implications for the workforce (Wisskirchen et al. 2017). In Australia, with growing AI applications, different skills are required of employees even in healthcare. Advanced technology skills, high cognitive skills – such as applying specialist knowledge, social skills and emotional intelligence will be required by the healthcare workforce. In Australia, it is predicted that by 2030 there will be a

shortage of 600,000 university graduates in the health sector (Taylor et al. 2019). However, it has also been suggested that the adoption of AI leads to increased employment opportunities and demand for new-age skills (Thrall et al. 2018). AI impacts 25% of jobs across the country, but this differs depending on occupation. For example, it is predicted that in the healthcare sector, more doctors and nurses will be needed, but there will be lower demand for radiologists (Taylor et al. 2019).

The use of AI in healthcare may lead to the assumption that greater use of artificial technologies and robotics, as explained earlier, might lead to a reduction of jobs in this sector (Montemanni et al. 2019). For example, based on a survey in Norway (Nordlander et al. 2016) participants perceived that the healthcare system would be changed by 2035 and that consequently, individuals would not see this sector as a viable employment option (Montemanni et al. 2019). Healthcare is however a critical sector that will absorb more and more resources soon; hence, AI and new technologies should be adopted to increase efficiency. This situation could shift the workforce to more specialised employment roles capable of dealing with the advancement of technology (Montemanni et al. 2019). Furthermore, the over-usage of technology could have negative effects on clinical practices, such as communication and the socio-emotional aspects of patient care. In addition, the communication skills of physicians may deteriorate due to reliance on technology, hindering them from sharing information with their patients (without human interactions) (Verghese 2008). Physicians might spend most of their time reading information from assessments of technology, and therefore less time interacting with their patients, which leads to decreased communication skills (Gallagher and Payne 2015). In the clinical field, previous studies have found that electronic medical systems could be a barrier to communicating with patients because doctors need to type the electronic medical records of patients when interacting with them (Cummings 2013).

Another concern may be the deterioration of bedside or physical examination skills. With the advancement and prevalence of technology, physicians are performing fewer physical examinations (Verghese and Horwitz 2009). For example, it is reported that the number of physicians using an electronic health record system has increased by 16.9% to 33.8% since 2008. It predicted that this number would increase in the next few years as hospitals and physicians' rooms have the willingness to provide high-quality services to patients (Graham-Jones et al. 2012). In clinical practice, the use of medical technology may blunt doctors' examination skills. Moreover, the Electronic Health Record (EHR) could also reduce clinical knowledge and narrative note-taking skills and abilities. In a study of 78 primary care physicians in New York, it was found that most clinicians, when they wanted to write patient visit reports, tended to cut and paste some parts from other patients (Lu 2016). Hoff also found that physicians progressively lost their ability to understand and abstract information, believing that patient information should be rich and unique in the standardised electronic health record format, thus undercutting their ability to make informed decisions around diagnosis and treatment (Hoff 2011).

Challenges & Opportunities

There are implications for management practice around how employees relate to AI, management-employee communication and how best to deploy AI to increase the efficiency, labour productivity and overall quality of patient care. Management must establish clear lines of communication that integrate AI in day-to-day work activities which must be underpinned by strict adherence to human resource management (HRM) policies and ethical guidelines. We argue that organisations need to consider the recruitment and selection of staff who may be open to AI, and also ensure that all employees receive training and development to better support them to work alongside AI interventions both ethically and operationally. More research needs to be carried out in organisations that compare what is happening for workers across the healthcare sector when they are required to engage with AI. We encourage further research that compares how AI is implemented and evaluated across different healthcare professional groups and different health care organisations. It is also important to conduct research into its impact on the quality of patient care, safety and clinician mental health and wellbeing, as well as work-related attitudes such as organisational commitment, resilience and intention to leave.

Conclusion

In conclusion, the use of AI in healthcare settings has important implications for medical practice, the quality of patient care, employment, the types of jobs in the sector, and the wellbeing of clinicians. The support AI offers doctors and nurses may significantly lighten the burden of caring for patients in a fast-paced and underfunded sector. The use of such technology in offering accurate diagnosis, drug dispensary and minor surgery, not only supports healthcare workers but can also offer positive effects on the quality of patient care, such as reduced waiting times and decreased mortality rates. The support AI offers healthcare staff may increase their perceived wellbeing, by freeing up their time from administrative tasks and allowing them to spend more time with patients supporting their socio-emotional needs.

The concern surrounding deskilling and unemployment may be warranted in some circumstances, as some clinical tasks, such as minor surgeries, can be undertaken through AI. However, AI creates opportunities for new job roles, upskilling through the utilisation of data generated by AI, and more individualised patient centred care by reducing administration and tedious manual labour. AI should be celebrated and embraced in healthcare, although carefully managed ethically and systematically, to ensure that it is used to improve the quality of clinician jobs, enhance the quality of patient care, and build healthier communities.

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