

# Harnessing artificial intelligence for South African healthcare: Clinical applications and ethical considerations

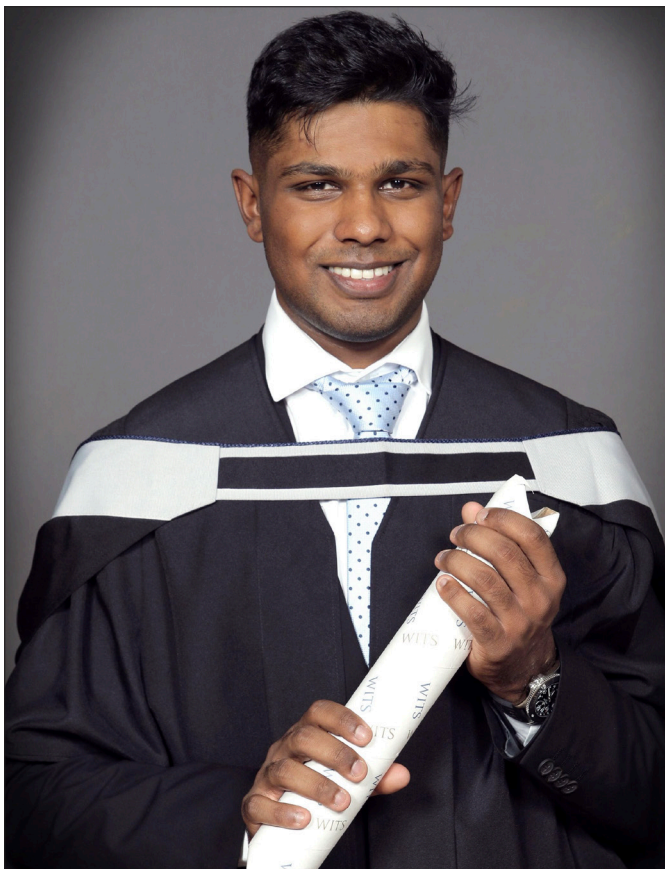
Y Pillay, BHSc, 3rd-year MB BCh student

Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa

**Corresponding author:** Y Pillay (pillay.yudarshan@gmail.com)

Artificial intelligence (AI) has become a household device over the past few years. More recently, use of AI and specifically large language models has skyrocketed thanks to OpenAI's ChatGPT and others. Many people use AI's incredible power for mundane everyday tasks, but it has far greater potential. The adoption of AI into fields such as medicine and healthcare carries extraordinary benefits in terms of helping streamline workflows and aiding in diagnostics that have the potential to save countless lives. While there are numerous benefits there are also significant challenges, ranging from the tangible problems of data and infrastructure to the intangible problems of ethics. Some of the benefits and challenges are exacerbated by the unique context of the South African (SA) environment. This review outlines some of the key clinical applications and ethical considerations required for large-scale AI implementation in the SA health sector.

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*Yudarshan Pillay graduated with a BHSc in 2024 and is currently a third-year medical student. Current interests include the adaptation of artificial intelligence into everyday life. Interests specific to medicine include sports physiology and specifically the physiology behind endurance sports.*

Advances in AI and machine learning are changing the landscape of health services by enabling more personalised, predictive and data-driven care. High-income countries are investing heavily in AI applications such as medical imaging diagnostics, telemedicine, precision medicine and drug discovery.<sup>[1]</sup> In contrast, many low- and middle-income settings face constraints in data, infrastructure and expertise, raising concerns that AI may exacerbate existing global inequalities if the benefits are not universally accessible.<sup>[1,2]</sup> It must be noted that the challenges regarding data and infrastructure are universal, but exacerbated in low- and middle-income settings. South Africa (SA) offers a unique challenge as it has a dual health system (a well-resourced private sector and an under-resourced public sector) along with a high burden of disease (both communicable and non-communicable). These conditions make it an important setting to explore how AI can aid healthcare delivery, and what safeguards are needed to implement AI ethically and effectively.

SA's healthcare system struggles with limited resources and workforce shortages, which reduce its ability to meet the population's healthcare needs.<sup>[3]</sup> AI has the potential to alleviate some of the pressure placed upon the healthcare environment by automating tasks, enhancing clinical decision-making and optimising workflows.<sup>[3,4]</sup> For example, AI-powered tools can assist in diagnosing disease, analysing medical images and predicting patient risks, along with managing healthcare-generated data more efficiently than human personnel can in the status quo. However, experts warn that before the benefits become a reality, robust supporting frameworks such as universally accessible data systems, logically relevant algorithms and strong ethical oversight are required.<sup>[3]</sup>

This literature review will examine the application of AI in the SA healthcare environment with a two-pronged approach: (i) the practical and clinical applications of AI in SA with the explicit focus on AI application in clinical diagnosis and decision support; and (ii) the ethical considerations required for such an implementation.

## Applications of AI in SA healthcare

AI has considerable theoretical applications within healthcare, and several pilot projects and studies in SA have demonstrated its utility in diagnostics, predictive analysis and health systems management. Here we discuss a few of the key areas where AI has been applied or has potential to be applied.

### Clinical diagnosis and decision support

One of the most impactful uses of AI in healthcare is in diagnostic medical imaging, especially radiology. Modern AI algorithms such as deep convolutional neural networks (a type of artificial neural network particularly trained towards image recognition<sup>[5]</sup>) can analyse various medical images from different imaging modalities such as X-rays, magnetic resonance imaging scans and computed tomography scans with high accuracy and speed. In several tasks, such as the interpretation of various imaging modalities, AI performance has approached and/or exceeded expert human level.<sup>[6]</sup> A randomised controlled trial found that AI-based computer-aided detection (CAD) software improved the detection of actionable lung nodules compared with human standard practice (AI group v. non-AI group  $p=0.008$ ).<sup>[7]</sup> A review confirmed that AI can interpret various medical images from different imaging modalities as well as specialists are able to in many cases.<sup>[8]</sup> These capabilities have a particular significance in SA, where there is a shortage of radiologists. In 2022, it was reported by the Radiology Society of South Africa that 650 registered radiologists served a population of 59 million people, which equates to roughly 11 radiologists per million people,<sup>[9]</sup> compared with an average for Europe of 127 radiologists per million people.<sup>[10]</sup> This scarcity poses a risk in terms of patient care, as ‘delays, misdiagnoses and undesired outcomes’ occur when imaging analyses cannot be interpreted in a timely manner.<sup>[6]</sup> AI tools such as CAD offer a solution by ‘reading and interpreting images more effectively and faster than radiologists’.<sup>[6]</sup> Importantly, while in isolated circumstances the CAD software may be better than traditional radiologists, in the current SA environment the skills and decision-making capacity of human radiologists still triumph.<sup>[11]</sup>

In the realm of routine care, AI systems could assist in screening and triage. For example, SA has a high burden of infectious diseases, notably tuberculosis (TB). Chest X-rays are used as a modality for TB screening. Based on analysis of the diagnostic accuracy of CAD software for detecting pulmonary TB in people aged under 15 years, the World Health Organization made a recommendation for the use of CAD in this context.<sup>[12]</sup> In SA, the AI system qXR by Qure.ai was evaluated for detecting lung pathologies such as TB and lung cancer. The AI system was able to achieve a sensitivity and specificity of 90% and 79%, respectively, for pulmonary TB, and 84% and 91%, respectively, for lesions suggestive of lung cancer.<sup>[8]</sup> The results of this study indicate that this AI (CAD) can accurately flag chest X-rays with pathology, making earlier diagnosis and referrals possible in areas with a high burden of disease (the study was conducted at a hospital with a high burden of TB and lung cancer).

Beyond medical imaging, AI is being increasingly applied to a wide range of clinically relevant tasks. These include diagnosing disease using presenting symptoms and clinical data, predicting prognosis and outcomes, and personalising treatment. A 2023 review by Kumar *et al.*<sup>[13]</sup> found that AI techniques have been used for disease diagnosis across a number of conditions, most of which require imaging, often with improved diagnostic accuracy and efficiency.

### Public health surveillance and disease outbreak response

AI has shown promise in strengthening public health intelligence in Africa. Across the African continent, researchers are using machine learning to analyse epidemiological data or mobility data for early disease outbreak detection.<sup>[4]</sup> During the COVID-19 pandemic, AI-driven models were used to analyse mobility patterns and try to predict the emergence of infection waves in African cities in order to aid authorities to target interventions with their limited resources.<sup>[2]</sup> Beyond COVID-19, AI tools have been applied for malaria risk mapping and could similarly aid in predicting other disease outbreaks, which is increasingly valuable as Africa faces about 16 public health emergencies annually.<sup>[2]</sup>

### Healthcare operations and resource allocation

AI systems are being used to improve health systems efficiency in SA. One of the current applications is in human resources planning using machine learning models in SA’s public health sector to predict how long healthcare workers are likely to remain in their posts, allowing administrative personnel to work on retention strategies and workforce planning.<sup>[14]</sup> Similarly, AI has been piloted to optimise the scheduling of community healthcare workers in under-served communities.<sup>[14]</sup> These operational and administrative tools use algorithms to allocate the limited human resources more effectively across facilities and regions. A reported innovation is the use of AI models for supply chain and medication management. SA hospitals are exploring the use of predictive algorithms to foresee drug demand to try to prevent drug stockouts.<sup>[1]</sup> Collectively, these applications aim to address the systemic inefficiencies that exist in a resource-constrained health environment, with the objective of stretching the impact of every intervention.

### Chronic disease management

SA’s heavy burden of HIV/AIDS has spurred AI-driven solutions to improve chronic disease management. An example is the AI-powered analytics platform Vantage to support HIV treatment adherence. In Ugu District, KwaZulu-Natal Province, this system (the Vantage platform) helped achieve the UNAIDS 90-90-90 target by analysing clinic data to identify patients at risk of defaulting on treatment and enabling targeted interventions.<sup>[15]</sup> By monitoring patient data, the AI system could flag adherence issues in real time and suggest possible tailor-made follow-ups, contributing to viral suppression rates. During the COVID-19 pandemic, a mobile app enabled with an AI chatbot was introduced to Mpumalanga Province for community screening and triage, guiding users through symptom analysis and directing them to the appropriate course of action.<sup>[15]</sup> These are two examples of how AI can engage patients via mobile technologies, supporting remote screening, telemedicine consultations and personalised reminders for medication or follow-up appointments. In SA, where rural and under-served populations struggle with access to adequate care, AI-driven mobile health services can expand the reach and continuity of care,<sup>[1]</sup> possibly alleviating some of the strain on the healthcare infrastructure and services in these areas. These systems also generate data that can be utilised for continued improvement and training for machine learning.

In summary, the early implementation of AI in the SA healthcare setting demonstrates various benefits across multiple domains: faster and more accurate diagnosis, strengthened public surveillance, optimised use

of constrained resources, and enhanced delivery of care at the patient level. These cases are generally small-scale or pilot programmes, but their results demonstrate what is possible. It is noted that broader adoption of AI in SA healthcare could mitigate critical healthcare gaps, for example by compensating for the shortage of specialist doctors through AI decision support, or by improving service delivery in rural clinics via smart triage systems.<sup>[4]</sup>

## Ethical issues in AI-driven healthcare

### Privacy and data protection

Implementing AI in healthcare requires vast amounts of patient data, raising serious concerns about privacy and data security. SA's Protection of Personal Information Act (POPIA) provides a framework for data protection, but it was not designed with AI in mind and may not cover the novel challenges posed by AI in health contexts.<sup>[16]</sup> AI systems often rely on large data sets of personal and clinical data to train algorithms, and even if the data are de-identified, there remains a risk of re-identification of individuals through advanced computational methods, and this possibility threatens patient confidentiality. It therefore underscores a need for data governance measures.<sup>[16]</sup>

### Patient autonomy and informed consent

AI should be implemented in a way that respects patient autonomy and the principle of informed consent. The integration of AI into clinical decision-making can blur the lines of responsibility and understanding, potentially undermining a patient's ability to make informed choices about their care.<sup>[16]</sup> Ethically, patients have the right to know when AI is being used in their diagnosis or treatment and to understand the implications. However, obtaining truly informed consent for AI-driven systems is challenging. The complex and opaque nature of AI algorithms is often described as black box systems, making it difficult to explain to patients how AI arrived at the recommendation. Moreover, patients may mistrust or fear AI technologies, especially if misunderstandings exist.<sup>[16]</sup> To address this issue, healthcare providers in SA must develop strategies for commenting on the role of and risks that exist with AI-enabled technologies in patient-friendly language and allow patients to refuse the use of AI.<sup>[17]</sup>

### Algorithmic bias and health equity

One of the most pertinent ethical concerns with AI in healthcare is the potential for algorithmic bias, which can lead to unfair or unequal treatment outcomes. AI systems trained on data that are not representative of SA's diverse population may perform better for certain groups and worse for others. It is critical that machine learning and AI programs be trained on populations that most represent the populations that they are going to treat. For example, there is evidence that some medical AI devices such as pulse oximeters have significantly lower accuracy in patients with darker skin tones, because algorithms were developed on data sets predominantly composed of individuals of European ancestry.<sup>[16]</sup> Such biases can exacerbate existing health disparities by yielding less accurate diagnoses or suboptimal treatment recommendations for under-represented communities. Exploring this concept in SA, a country with a wide mix of ethnicities, many languages and a history of inequality, shows that the consequences of algorithmic bias are especially high.<sup>[15]</sup> From an ethical point of view it is critical that AI tools are fair and inclusive,

meaning that developers and healthcare institutions must actively seek to identify and mitigate biases in algorithms. Fairness is also linked to the principle of justice – an intervention should not disproportionately benefit one group at the expense of another.<sup>[16]</sup>

### Transparency, accountability and trust

The transparency concerns relating to AI stem from the opacity with which they operate.<sup>[16,18]</sup> Additionally, accountability is a key ethical concern: who is responsible if an AI-empowered system makes a mistake? SA legal precedent currently imparts ultimate responsibility on the human practitioners, as AI has no legal personhood.<sup>[15]</sup> Ethically, this aligns with the principle that technology should not undermine professional accountability. It follows that AI should be used to support, not replace, human clinicians, and clinicians must be empowered to overrule AI outputs when necessary. It is argued that human oversight is essential; qualified healthcare professionals should always interpret AI results in context and take responsibility for the final decisions.<sup>[19]</sup> Moreover, fully autonomous AI systems (especially opaque ones) are not appropriate for high-stakes medical decisions, because they do not allow for the assignment of responsibility in the case of an error.<sup>[16]</sup> In these circumstances, having trained individuals with decision-making capacity is therefore important.

### Impact on healthcare workforce and ethical implementation

The rise of AI in healthcare also brings up ethical considerations related to the healthcare workforce and the broader implementation process. AI technologies can perform or assist with tasks that were traditionally done by healthcare workers, which raises concerns about job displacement, role changes and the need for new skills. In SA, where healthcare resources and personnel are already strained, the introduction of AI should be managed in a way that supports healthcare workers rather than undermines them. Ethicists and policy-makers note that the impact of AI on the healthcare workforce is a significant issue that must be addressed proactively. A possible solution to aid in job retention in the age of AI programs is for healthcare workers to be trained on how to incorporate AI into their work.<sup>[20]</sup> This involves creating policies and strategies for up-skilling and reskilling clinicians so they can work effectively and synergistically with AI.<sup>[16]</sup> National frameworks such as SA's National Digital Health Strategy and forthcoming AI policies stress social equity and inclusion as core goals, seeking to leverage AI to reduce disparities in access to care.<sup>[16]</sup>

Each of the above considerations – from protecting privacy to ensuring fairness of access and distribution, transparency, and workforce integration – highlights that the successful implementation of AI in the SA healthcare setting must be guided by core ethical principles.

## Conclusion

AI holds incredible transformative potential for SA healthcare, but realising its potential requires the navigation of complex real-world integration and ethical concerns. This literature review supports the premise that AI could help address some of SA's most pressing health challenges, from improving diagnostic potential amid personnel shortages to enhancing public health surveillance for disease outbreaks, making healthcare delivery more efficient along with being more patient and person centred. Pilot studies and early deployments show encouraging

results, whether in AI systems aiding in districts achieving HIV targets or algorithms assisting in detecting communicable and non-communicable diseases.

However, beyond the clinical benefits it is equally important that the ethical principles of fairness, transparency, accountability and respect for patient autonomy should be embedded in all decisions regarding AI healthcare integration.

If SA can strike the right balance between embracing AI-driven innovation while instituting thoughtful regulation and ethical oversight, it stands to gain significantly. AI has the potential to be a substantial ally in extending the quality of care to remote and under-served populations, easing the burden on overtaxed facilities, and enabling greater health interventions tailored to this country's epidemiological profile.

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