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Role of Artificial Intelligence in Health care System

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Abstract: The Indian healthcare scenario presents a spectrum of contrasting landscapes. In all, 400 million individuals had no access to any form of basic healthcare while two billion people do not have access to required medications. Therefore, more than one-fourth of the world population has unmet health needs. This leaves the global community with the challenge of how to support a significant number of the world's populace still lacking in access to basic healthcare facilities. AI has been a disruptive healthcare innovation. With its sophisticated algorithms and several applications, AI has assisted doctors and medical professionals in the domains of health information systems, geocoding health data, epidemic and syndromic surveillance, predictive modelling and decision support, and medical imaging. Artificial intelligence (AI) rapidly dominates the health service system. It removes the manual health system into automatic, in which humans conduct the routine works/tasks in medical practice to the management of patients and medical resources. Drug development is a famously costly procedure. Machine Learning can improve the efficiency of many of the analytical techniques used in drug development. In terms of practical implications, this paper aims to create a fruitful discussion with healthcare professionals and administrative staff and the role of artificial intelligence in healthcare system. Furthermore, this investigation offers a broad comprehension of bibliometric variables of AI techniques in healthcare.

1. Introduction

Healthcare challenges are arguably the most significant barriers to sustainable global development and are magnified by various socioeconomic problems and resource

inadequacies. Limited access to healthcare creates a major barrier to enduring social and economic development across the globe.¹ In all, 400 million individuals had no access to any form of basic healthcare² while two billion people do not have

access to required medications. Therefore, more than one-fourth of the world population has unmet health needs. This leaves the global community with the challenge of how to support a significant number of the world's populace still lacking in access to basic healthcare facilities.² The Indian healthcare scenario presents a spectrum of contrasting landscapes. At one end of the spectrum are the glitzy steel and glass structures delivering high tech medicare to the well-heeled, mostly urban Indian. At the other end are the ramshackle outposts in the remote reaches of the “other India” trying desperately to live up to their identity as health subcenters, waiting to be transformed to shrines of health and wellness, a story which we will wait to see unfold. With the rapid pace of change currently being witnessed, this spectrum is likely to widen further, presenting even more complexity in the future.

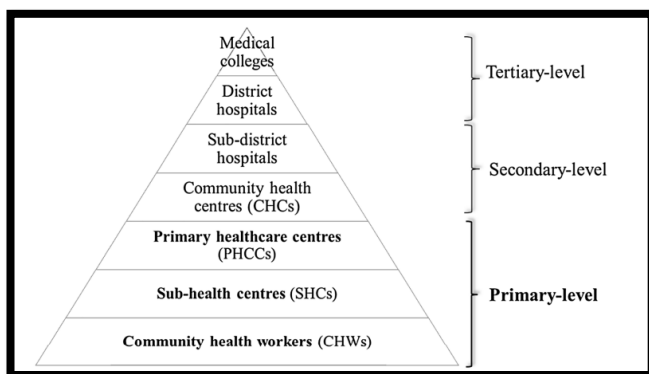


Figure 1: The health system structure in India

1.1 Challenges faced in Healthcare System

What are the challenges in delivering healthcare to the “everyone” which must include the socially disadvantaged, the economically challenged, and the systemically marginalized.³

There are many challenges, I present five “A’s” for our consideration:

i. Awareness or the lack of it: How aware is the Indian population about important issues regarding their health? Studies on awareness are many and diverse, but

lacunae in awareness appear to cut across the lifespan in our country. Adequate knowledge regarding breastfeeding practice was found in only one-third of the antenatal mothers in two studies.^{4,5}

ii. Access or the lack of it: Access (to healthcare) is defined by the Oxford Dictionary as “The right or opportunity to use or benefit from (healthcare).⁶ Again, when we look beyond the somewhat well-connected urban populations to the urban underprivileged, and to their rural counterparts, the question “What is the level of access of our population to healthcare of good quality?” is an extremely relevant one. A 2002 paper speaks of access being a complex concept and speaks of aspects of availability, supply, and utilization of healthcare services as being factors in determining access. Barriers to access in the financial, organizational, social, and cultural domains can limit the utilization of services, even in places where they are “available”.⁶

iii. Absence or the human power crisis in healthcare: Any discussion on healthcare delivery should include arguably the most central of the characters involved – the human workforce.⁷

iv. Affordability or the cost of healthcare: Quite simply, how costly is healthcare in India, and more importantly, how many can afford the cost of healthcare? It is common knowledge that the private sector is the dominant player in the healthcare arena in India. Almost 75% of healthcare expenditure comes from the pockets of households, and catastrophic healthcare cost is an important cause of impoverishment.⁸

v. Accountability or the lack of it: Being accountable has been defined as the procedures and processes by which one

party justifies and takes responsibility for its activities.⁹

The five as presented above present challenges to the health of the public in our glorious country. As we get ready to face a future which is full of possibility and uncertainty in equal measure, let us recognize these and other challenges and prepare to meet them, remembering that the fight against ill health is the fight against all that is harmful to humanity.³

1.3 Issues in healthcare:

AI has been a disruptive innovation in healthcare.¹⁰ With its sophisticated algorithms and several applications, AI has assisted doctors and medical professionals in the domains of health information systems, geocoding health data, epidemic and syndromic surveillance, predictive modelling and decision support, and medical imaging.¹¹

- i. **Health services management:** One of the notable aspects of AI techniques is potential support for comprehensive health services management. These applications can support doctors, nurses and administrators in their work. For instance, an AI system can provide health professionals with constant, possibly real-time medical information updates from various sources, including journals, textbooks, and clinical practices.¹² These applications' strength is becoming even more critical in the COVID-19 period, during which information exchange is continually needed to properly manage the pandemic worldwide.¹³ Other applications involve coordinating information tools for patients and enabling appropriate inferences for health risk alerts and health outcome prediction.¹⁴
- ii. **Predictive medicine:** Another relevant topic is AI applications for disease prediction and diagnosis treatment, outcome prediction and prognosis evaluation.¹⁵ Because AI can identify meaningful relationships in raw data, it can support diagnostic, treatment and

prediction outcomes in many medical situations.¹⁶ It allows medical professionals to embrace the proactive management of disease onset.

- iii. **Clinical decision-making:** One of the keyword analysis main topics is that AI applications could support doctors and medical researchers in the clinical decision-making process. According to Jiang et al.,¹⁶ AI can help physicians make better clinical decisions or even replace human judgement in healthcare-specific functional areas. According to Bennett and Hauser, algorithms can benefit clinical decisions by accelerating the process and the amount of care provided, positively impacting the cost of health services. Therefore, AI technologies can support medical professionals in their activities and simplify their jobs.¹⁷
- iv. **Patient data and diagnostics:** AI technology can recreate a 3D mapping solution of a patient's body. In terms of data, interesting research perspectives are emerging. For instance, we observed the emergence of a stream of research on patient data management and protection related to AI applications.¹⁸ For diagnostics, AI techniques can make a difference in rehabilitation therapy and surgery. Numerous robots have been designed to support and manage such tasks. Rehabilitation robots physically support and guide, for example, a patient's limb during motor therapy.¹⁹

2. AI in the Healthcare System

The term "artificial intelligence" was coined by John McCarthy at the Dartmouth Conference in 1956 to describe "the science and engineering of making intelligent machines".²⁰ McCarthy's original description still holds true today, albeit with some fleshing-out of the specifics. As a multidisciplinary field, AI involves integrating insights from diverse disciplines such as computer science, mathematics, psychology, linguistics, philosophy, neuroscience, artificial

insufficiently supportive of diagnostic procedures³¹. The promise of artificial intelligence (AI) in health care offers substantial opportunities to improve patient and clinical team outcomes, reduce costs, and influence population health. Current data generation greatly exceeds human cognitive capacity to effectively manage information, and AI is likely to have an important and complementary role to human cognition to support delivery of personalized health care.³²

Artificial intelligence (AI) rapidly dominates the health service system. It removes the manual health system into automatic, in which humans conduct the routine works/tasks in medical practice to the management of patients and medical resources. The technical challenges of digitizing health services pose new problems when developers create artificial intelligence systems to carry out tasks.³³ AI offers the potential for a huge improvement in patient care and a reduction in health care costs. The increasing population is expected to be able to encourage the demand for health services. The health service sector needs innovative solutions to find out how to be more effective and efficient without excessive expenditure.³⁴

2.1 History of AI

Artificial intelligence (AI) was first described in 1950; however, several limitations in early models prevented widespread acceptance and application to medicine. In the early 2000s, many of these limitations were overcome by the advent of deep learning. Now that AI systems are capable of analyzing complex algorithms and self-learning, we enter a new age in medicine where AI can be applied to clinical practice through risk assessment models, improving diagnostic accuracy and workflow efficiency.³⁵ AI has evolved dramatically over the past 5 decades. Since the advent of ML and DL, applications of AI have expanded, creating opportunities for personalized medicine rather than algorithm-only based medicine. Predictive models can be used for

diagnosis of diseases, predication of therapeutic response and potentially preventative medicine in the future. AI may improve diagnostic accuracy, improve efficiency in provider workflow and clinical operations, facilitate better disease and therapeutic monitoring, improve procedure accuracy and overall patient outcomes. The progressive growth and development of the AI platform in medicine is chronicled below and organized by specific time periods of seminal transformation.³⁶ In the mid-1930s, Alan Turing introduced the idea of what is today referred to as the “universal Turing machine”, which could simulate any possible computer. To some extent in march-step with the advances of the computer hardware, the history of AI has been one of fits and starts, of boom and bust (Figure 2).³⁷

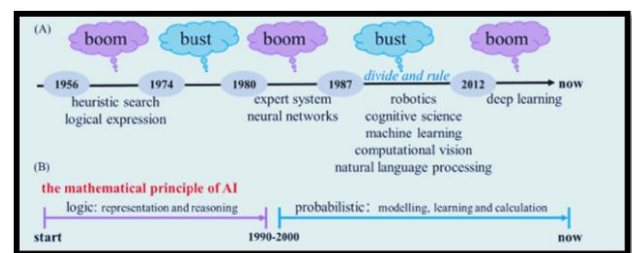


Figure 3: A brief history of AI

2.3 Applications of AI in Healthcare System

Unlike the typical technologies that deal with physical realms, AI technology is breaking new ground, as it has implications in more psychological realms such as experience, intelligence, and judgment of the experts. In particular, since the drastic improvement in the performance of machine learning algorithms for pattern recognition with the introduction of deep learning technology, the ability of AI technology in analyzing data patterns has become similar to that of an average human ability for specific tasks.^{38,39}

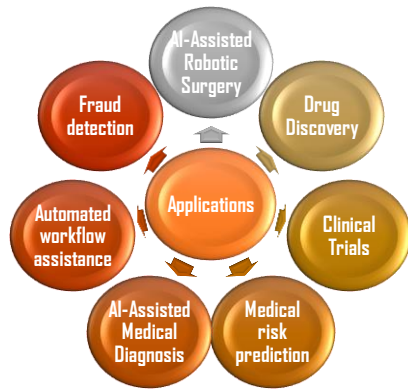


Figure 4: Applications of AI in Healthcare Systems

- i. **AI-Assisted Robotic Surgery:** Robotics usage has increased in healthcare across the globe. The main reason robots are preferred in surgery rooms is because they support non-invasive technology. In other areas, robotic surgeries are minimally invasive because of their high accuracy rates, unlike human surgery, which compels doctors to make huge incisions that take long to heal and are painful. Robots also use miniaturized surgical instruments, unlike human doctors. A robot-assisted surgery could reduce the patient's post-operational stay by 21% because they are more accurate and heal faster than human-made incisions. A surgeon from a computer console controls these machines.⁴⁰
- ii. **AI-Assisted Medical Diagnosis:** Artificial intelligence in medical diagnosis and healthcare provides overworked medical practitioners and facilities with reliable support, helping to minimize workload pressure while maximizing practitioner efficiency. Artificial intelligence in medical diagnosis helps with medical decision-making, management, automation, admin, and workflows.

- iii. **Drug Discovery:** AI has previously proven to be effective in all four stages of drug development:
 - ✓ Stage 1: Identifying intervention targets
 - ✓ Stage 2: Identifying pharmacological possibilities
 - ✓ Stage 3: Increasing the speed of clinical studies
 - ✓ Stage 4: Identifying biomarkers for illness diagnosis

Drug development is a famously costly procedure. Machine Learning can improve the efficiency of many of the analytical techniques used in drug development. This might save years of labor and hundreds of millions of dollars in investments.⁴¹

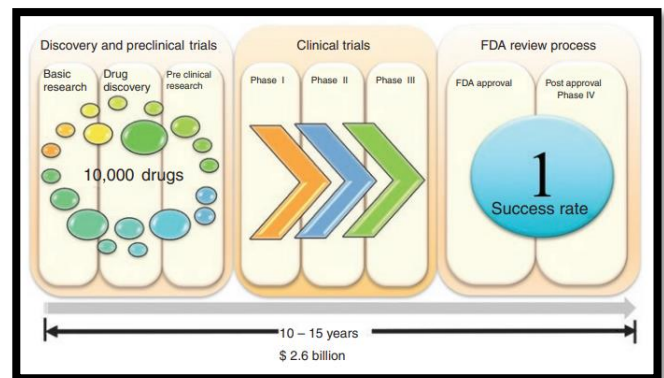


Figure 5: Drug discovery and development processes

- i. **Automated workflow assistance:** Machine learning has become a “General Purpose Technology”, in that it is pervasive, can be improved over time and has the potential to spawn complementary innovations.⁴² The implementation of such technologies tends to result in “widespread economic disruption, with concomitant winners and losers”.⁴³ Economists Acemoglu and Restrepo, who studied the historical effects of automation – the process of substitution of mechanization for human labour – argue that automation exerts a displacement effect where human labour is displaced by

machines in areas where machines have differential advantage.⁴⁴ However, countervailing forces that increase demand for labour offset this displacement effect: a productivity effect, as operations become more efficient and less costly. This in turn allows savings to be invested on existing non-automatable tasks and on the creation of new non-automatable tasks, some of which involve directly working on the automating technology.⁴⁵

ii. Medical risk prediction: In healthcare, risk prediction models are used to predict the likelihood of a patient developing a certain condition or disease. These models can be used to improve disease management programs, reduce costs and prevent unnecessary tests. Using this model is more accurate than traditional statistical methods.⁴⁶

iii. Fraud detection: There are many reasons why companies should use AI for fraud management and detection. AI can help companies to automate detection processes, which can save time and money. AI can also help companies to identify patterns in data that may be indicative of fraud. Additionally, AI can help companies to monitor customer behaviour and transactions in real-time, which can help to prevent fraudulent activities before they occur. The use of AI can also help companies to investigate fraud after it has occurred by providing insights that may not be readily apparent.⁴⁷

iv. Clinical Trials: Over the past few years, biopharma companies have been able to access increasing amounts of scientific and research data from a variety of sources, known collectively as real-world data (RWD). However, they have often lacked the skills and technologies to enable them to utilize this data effectively.

Unlocking RWD using predictive AI models and analytics tools can accelerate the understanding of diseases, identify suitable patients and key investigators to inform site selection, and support novel clinical study designs. AI algorithms, combined with an effective digital infrastructure, could enable the continuous stream of clinical trial data to be cleaned, aggregated, coded, stored and managed. In addition, improved electronic data capture (EDC) should can also reduce the impact of human error in data collection and facilitate seamless integration with other databases (figure 6).⁴⁸

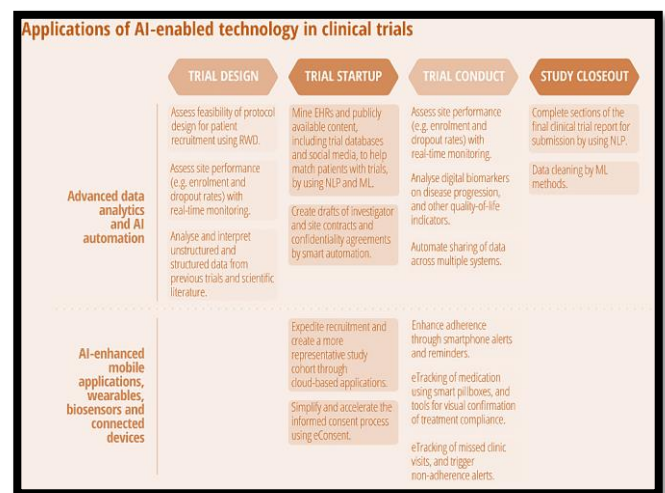


Figure 6: AI in Clinical trials

2.4 Clinical Applications of AI

It is expected that the clinical applications of AI will improve the diagnostic accuracy and workflow in echocardiography. The clinical application of medical AI algorithms and devices, it is important to understand the approval processes and regulations of the US FDA, the Japan Pharmaceuticals and Medical Devices Agency, and the responsible institutions of other countries.⁴⁹

i. Disease Prediction and Diagnosis: Despite the increasing application of AI in health care, the research mainly concentrates around

cancer, nervous system, and cardiovascular diseases because they are the leading causes of disability and mortality. However, infectious and chronic diseases (e.g., type 2 diabetes⁵⁰ inflammatory bowel disease⁵¹, Clostridium difficile infection⁵²) have also been getting considerable attention. Early diagnosis can now be achieved for many conditions by improving the extraction of clinical insight and feeding such insight into a well-trained and validated system.⁵³ For instance, the US Food and Drug Administration (FDA) permitted applying of diagnosis software designed to detect wrist fractures in adult patients.⁵⁴

- ii. **Treatment effectiveness and outcome prediction:** These are also important areas with the potential clinical implication in disease-management strategies and personalized care plans. A decade ago, only molecular and clinical information was exploited to predict cancer outcomes. With the development of high-throughput technologies, including genomic, proteomic, and imaging technologies, new types of input parameters have been collected and used for prediction. With a large sample size and integrated multimodal data types, including histological or pathological assessments⁵⁵, these methods could considerably (15%-25%) improve the accuracy of cancer susceptibility, outcome prediction, and prognosis.⁵⁶
- iii. **Drug Discovery and Repurposing:** About 25% of all discovered drugs were the result of a chance when different domains were brought together accidentally.⁵⁷ Targeted drug discovery is preferred in pharmaceuticals because of the explicit mechanism, higher success rate, and lower cost when compared to traditional blind screening. Machine learning is now used in the process of drug discovery due to high costs of drug development, increasing availability of 3-dimensional structural information that can guide the characterization of drug targets, and

extremely low success rates in clinical trials.⁵⁸ Machine learning can be used as a bridge to achieve cross-domain linkage. It can identify a newly approved drug by recognizing contextual clues like a discussion of its indication or side effects.⁵⁹

- iv. **Biomarker:** Another tool that uses Artificial Intelligence is biomarker testing. Biomarker testing that can also be referred to as molecular study involves the performance of a group of tests to identify molecular signs of health so that clinicians can provide the best treatment available to the patients.⁶⁰ Machine learning aided biomarker discovery is on-trend these years.⁶¹ Machine learning algorithms test various unbiased hypotheses based on the input features we train the model. These algorithms can be classified as classification algorithms and some based on feature selection. Many of these algorithms are applied to gene expression data derived from RNA sequencing data of human cells.⁴⁰

2.5 Impact of AI in Healthcare

- i. **Expands Access to Healthcare:** The human body requires to be handled by a professional to prevent someone from getting worse or even succumb due to misdiagnosis, mishandling, or unfair treatment. Unfortunately, developing nations and underdeveloped nations have no enough physicians. For instance, most such countries lack enough physicians and radiologists. AI impacts such countries by having machines that can be used for diagnostics. An example of such devices is the AI imaging tools used to conduct chest x-rays to diagnose tuberculosis. Hence, it allows people without access to enough healthcare providers to get even better services.
- ii. **Improves Record Keeping:** Most hospitals use electronic health records (EHR) because it is easier and more reliable than the traditional way of manually writing and storing data. Thus, EHRs play a significant role in the

process of digitalization. However, the increased burden of documentation and user burnout. AI technologies such as voice recognition and dictation have been very useful in improving the documentation process, thus reducing user burnout. Also, EHR developers are using AI to automate the entire process, therefore record keeping.

- iii. **Advances Immunotherapy:** AI plays a vital role in improving Immunotherapy for treating cancer. Over the years, cancer incidence has continued to increase and a lot of patients die. Scientists have not yet found the cure for cancer, but Immunotherapy is a promising way of treatment. It uses the body's immune system to attack the disease. However, the method does not help all patients. In addition, oncologists have no particular reliable way to identify the type of patents that benefit from the technique.⁶² AI is a better technology and machine learning algorithm that can use the complex data available to identify the patients.
- iv. **Improves Quality of Services:** Using AI helps in saving time. Machines that some healthcare facilities use are faster than human beings; thus, they hold on time. Also, there are these used in diagnosis and treatment; hence the chances of misdiagnosis are reduced. Additionally, records kept can be easily retrieved using the new technology. All this helps in saving on time and improving the quality of services offered. Also, they hold on to costs used in hiring a large labor force and subsequently reducing treatment costs.

2.6 Implications

Our analysis also has multiple theoretical and practical implications. In terms of theoretical contribution, this paper extends the previous results of Connelly et al., dos Santos et al, Hao et al., Huang et al., Liao et al. and Tran et al.^{63–66} in considering AI in terms of clinical decision making and data management quality. In terms of practical implications, this paper aims to create a

fruitful discussion with healthcare professionals and administrative staff on how AI can be at their service to increase work quality. Furthermore, this investigation offers a broad comprehension of bibliometric variables of AI techniques in healthcare. It can contribute to advancing scientific research in this field.

3. Patents for AI in Healthcare System

3.1 EP0850016 (*Appeal ref. T0598/07*), for a heart monitoring apparatus, was revoked in opposition in 2007 but reinstated following an appeal in 2010 and maintained in amended form. Analysis of an electrocardiograph using a neural network is used to monitor changes in the patient's heart function. In response to the opponent objecting that the claims were directed to a method of diagnosis of the human or animal body and thus excluded from patentability, the claims were considered to be directed to a computer performing the steps rather than the steps being performed on the body. Furthermore, the result of the claimed steps was considered to provide information, which is not only useful for diagnosis, but is "immediately indicative of the clinical picture which constitutes the diagnosis" – the result of the specific steps of the independent claims characterise, with sufficient precision, a specific heart condition. Thus, in line with G1/04, setting out a narrow interpretation of what a "diagnostic method" is, the claims were not considered to be excluded.

3.2 EP3187201 is directed to a portable medical device, including using sensor technology for monitoring integrity and for improving operational reliability of such devices. A classification algorithm operating on sensor data sets characterised the claimed invention, which includes a support vector machine (SVM) as known in the art. Following grant in 2019, it was opposed but maintained in amended form. During opposition, the opponent argued that the use

of SVM was known in the art and would be obvious. The proprietor counter argued that it was not known to use two data sets, to categorise an effect on a device as critical or not critical as claimed, and that the use of SVM was not trivial. Thus in this case it appears the detailed and specific disclosure of a particular implementation of machine learning, using SVM with two datasets, was important in supporting an inventive step over the art.

3.3 EP3537452 was directed to a system of a robotic surgical device and a machine learning engine aiming to recommend actions to take during surgery. It was refused because, while “recommendations” were provided by the system, these were considered to be options for a surgeon to consider rather than any technical credible parameter or physiological disclosure being obtained. The Examiner even considered that the whole disclosure “builds on the generic use of AI-buzz-words” rather than specifically disclosing technical features providing a technical effect. It was also considered that abstract algorithmic structures were claimed without tying them to specific technical features such as controlling a machine or guiding a surgeon, and were thus considered to be non-technical. While the purpose of improving robot surgery was considered technical, the claim features providing this result were not sufficiently technical.

3.4 EP3422356 was directed to predicting patient health issues using transduction – learning from unlabelled test data for patients with incomplete medical histories. The Examiner considered the claims to relate to an abstract mathematical method without functionally limiting the claims to any specific, sufficiently disclosed, technical purpose. In particular the claims were considered not to link any features of the claims to a specific technical problem. The claims were considered to be so potentially broad,

covering any sensed entity, that the skilled person could not know how to implement the invention over the whole scope of the claim.

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4. Conclusion

In conclusion, AI has been applied for a wide range of purposes, especially in the field of healthcare. With the rapid development of technology, AI has the opportunity to help raise important health problems to light but might be restricted by the unavailability of health data, and/or by the inability of AI to have some human characteristics, such as compassion. The role of AI raises some ethical and social issues. AI has been a disruptive innovation in healthcare. These findings inform a reconceptualization of compassion as a human-AI system of intelligent caring comprising several applications. Future research and development into the association between AI technologies and compassion could enrich education, learning, and clinical practice; extend healing spaces; and enhance healing relationships in new and novel ways, made possible by artificial intelligence.

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