Education Reform and Development, 2025, Volume 7, Issue 6
https://ojs.bbwpublisher.com/index.php/ERD
Online ISSN: 2652-5372
Print ISSN: 2652-5364

The Application Value of Artificial Intelligence in Standardized Training of General Medicine Resident Physicians

Wei Zhao, Yan Shang*, Yi Zhang, Zhiying Tong, Yiping Han

Department of General Practice, Changhai Hospital, Naval Medical University, Shanghai, China

**Author to whom correspondence should be addressed.*

Abstract: In the realm of medical education, the advancement of artificial intelligence (AI) technology has opened new opportunities for the standardized training of general medicine residents. This article focuses on the application of AI in this training, analyzing the current status and challenges of the training process. It explores the significance of AI in theoretical instruction, clinical practice, and assessment, while also considering the challenges and issues that arise from its use. The article proposes optimization strategies to enhance the quality of standardized training for general medicine residents, aiming to provide innovative insights and practical references.

Keywords: Artificial intelligence; General practice; Resident physician; Standardized training; Application value

Online publication: July 7, 2025

1. Introduction

With the rapid advancement of medical technology and the ongoing reform of healthcare systems, the critical role of general medicine in primary healthcare services has become increasingly prominent. The standardized training of general medicine residents is crucial for cultivating qualified general practitioners, and the quality of this training is directly linked to improving primary healthcare services. Currently, the standardized training of general medicine residents faces challenges such as a shortage of faculty, a lack of diverse clinical cases, and insufficient standardization. Artificial intelligence (AI) technology, with its advanced data processing, pattern recognition, and intelligent decision-making capabilities, offers new opportunities to address these issues. Discussing the application of AI in the standardized training of general medicine residents is of significant practical importance for innovating training models and enhancing training quality.

2. The status quo and problems of standardized training of general medicine resident physicians

2.1. The connotation and requirements of standardized training for general medicine resident physicians

The standardized training program for general medicine resident physicians is designed for those who have completed their basic medical education. It aims to advance systematic clinical practice and theoretical learning, ensuring that they master the fundamental theories, knowledge, and skills in general medicine. This training equips them with the ability to address common health issues and enhance community health services independently. The training requirements include mastering core general medicine knowledge, developing excellent clinical thinking skills, and acquiring community health service skills.

2.2. Current training status

Currently, the standardized training for general medicine residents primarily focuses on clinical rotations, with theoretical learning as a supplementary component. Training bases arrange for residents to rotate through various clinical departments, exposing them to diagnosing and treating common and frequent diseases. Additionally, theoretical learning is conducted through specialized lectures and case studies. However, in practice, this traditional training model faces numerous challenges, as detailed in **Table 1**.

Table 1. Challenges of the traditional training model

Training sessions	Traditional model approach	Face the challenge
Clinical rotations	Resident physicians are assigned to rotate in different clinical departments	Due to the limitation of scale and medical resources, some bases have insufficient types and numbers of cases, and scarce resources for rare and difficult diseases
Theoretical study	Special lectures and case exchanges will be conducted	Learning resources are not systematically integrated, which is difficult to meet the needs of personalized learning

2.3. Main problems existing in training

Currently, the shortage of qualified teachers is a significant challenge. With the rapid development of general medicine, there is a lack of qualified teachers, particularly in primary training bases where there is a shortage of general practitioners with both rich clinical experience and teaching skills, making it difficult to meet the training requirements. The diversity of clinical cases is limited, and some bases, constrained by their size and medical resources, have insufficient case exposure for resident physicians in terms of both variety and quantity. Resources related to rare and complex diseases are scarce, hindering the normal development of clinical thinking. The standardization of training is inadequate, with varying quality across different bases and no unified standards for content and assessment, leading to significant differences in training outcomes. Personalized guidance is insufficient, as the traditional training model fails to align with the learning progress and ability characteristics of each resident physician, making it difficult to provide targeted guidance.

3. Application value of artificial intelligence in standardized training of general medicine resident physicians

3.1. Application value in theoretical teaching

3.1.1. Construction of intelligent teaching resources

AI can integrate a wide range of medical literature, clinical guidelines, and case studies to create an

intelligent teaching resource collection. By using natural language processing technology, these resources are categorized, integrated, and annotated, providing resident physicians with ample and precise learning materials. The intelligent medical knowledge database developed through AI technology can automatically filter and recommend relevant theoretical knowledge and learning resources based on the specific needs of resident physicians.

3.1.2. Personalized learning support

AI can analyze the learning behaviors and progress of resident physicians, designing personalized learning plans. By using machine learning algorithms to analyze various data, including test scores and study time, AI can identify knowledge gaps and provide targeted learning content and questions, thus completing personalized learning support.

3.1.3. Virtual simulation teaching

By utilizing artificial intelligence technology, virtual clinical scenarios can be created to provide resident physicians with immersive learning experiences. Using virtual reality (VR) and augmented reality (AR) technologies, various clinical cases and treatment scenarios can be simulated, enabling resident physicians to conduct practical activities in a virtual environment. This enhances their ability to apply theoretical knowledge to practice.

3.2. Application value in clinical practice

3.2.1. Intelligent auxiliary diagnosis

By learning and analyzing vast amounts of clinical data, artificial intelligence can generate practical models for intelligent diagnosis, offering resident physicians auxiliary diagnostic suggestions. Medical imaging diagnostic systems, which rely on deep learning technology, can analyze X-ray, CT, and other imaging data, helping resident physicians identify signs of lesions and enhancing the accuracy and efficiency of diagnoses.

3.2.2. Clinical decision support

During the clinical diagnosis and treatment process, artificial intelligence can provide personalized treatment recommendations to resident physicians based on the patient's medical history, symptoms, and examination results. The intelligent clinical decision support system takes into account factors such as the patient's condition, drug allergy history, and economic status to select appropriate treatments and plans, assisting resident physicians in making more reasonable clinical decisions [1].

3.2.3. Remote clinical guidance

For resident physicians at primary training bases, artificial intelligence leverages remote communication technology to connect with experts from higher-level hospitals, providing them with remote clinical guidance. By using video conferencing and remote consultation technologies, these experts can participate in real-time case discussions and diagnostic processes, addressing the shortage of experienced faculty at the grassroots level.

3.3. Application value in assessment and evaluation

3.3.1. Objective assessment

AI can design objective and standardized assessment questions and methods to reduce the negative effects of

human factors on the assessment results. CAT technology is adopted to automatically change the difficulty of questions according to the answering situation of resident doctors, so as to more accurately measure their knowledge level and ability.

3.3.2. Multi-dimensional evaluation

By collecting and analyzing a variety of data from the training process of resident physicians, such as the progress of learning, clinical operation records, and the outcomes of case analyses, artificial intelligence can conduct multi-dimensional evaluations of resident physicians. Using big data analysis techniques, it measures the clinical thinking, communication, collaboration, and teamwork skills of resident physicians, providing a more comprehensive reference for evaluating training effectiveness, as shown in **Table 2**.

Table 2. Evaluative dimension and content

Evaluative dimension	Data sources	Evaluation content
Know-how	Test results, learning resource browsing history	Knowledge of theoretical knowledge
Clinical operation	Clinical operation records	Operational norms, degree of proficiency
Case analysis	Case analysis report	Diagnosis thinking, the rationality of the treatment plan
Communication and collaboration	Team collaboration record	Ability to communicate, teamwork ability

3.3.3. Real-time feedback and improvement

After the assessment, the AI can quickly provide comprehensive feedback to resident physicians, highlighting their issues and areas for improvement, along with actionable suggestions for enhancement. The intelligent assessment system automatically evaluates and comments on the case analysis reports of resident physicians, encouraging them to promptly identify and address these issues.

3.4. Application value in training management

3.4.1. Training process monitoring

By leveraging artificial intelligence, the training progress and learning status of resident physicians can be monitored in real time. This enables the immediate identification of any potential issues during the training process. Data such as attendance records, study duration, and test scores are analyzed to assess the residents' learning attitudes and effectiveness. Any resident physicians with problems are promptly reminded and interventions are implemented [2].

3.4.2. Optimal allocation of resources

Artificial intelligence technology can be used to reasonably optimize the allocation of training resources, improve the utilization efficiency of resources, and appropriately arrange clinical rotation plans according to the training needs of resident doctors and the situation of teachers in various departments, so as to ensure that every resident doctor can get sufficient training opportunities.

3.4.3. Training quality evaluation

Artificial intelligence can use data from analyzing the training process and results to comprehensively evaluate the quality level of training, provide evidence for the adjustment and optimization of training bases, analyze

the training effect data of different training bases, identify common problems and differences, and provide reference for formulating unified training standards and improving training methods.

4. Challenges faced by the application of artificial intelligence in the standardized training of general medicine resident physicians

4.1. Technical challenges

The application of artificial intelligence in medical training faces challenges including data quality and privacy protection, algorithmic explainability, and technological updates. The complexity and professionalism of medical data reduce its standardization, affecting the effectiveness of AI model training. Balancing patient privacy protection with data utilization is an urgent issue that needs to be addressed. The black-box nature of technologies like deep learning makes decision-making processes hard to interpret, hindering resident physicians' understanding of the AI decision-making basis. From a technological update perspective, AI algorithms and models evolve rapidly, and due to limited resources, training facilities struggle to quickly update their system platforms, impacting the practical outcomes of training applications [3].

4.2. Management challenges

The application of AI is driving a shift in training models from teacher-centered to resident physician-centered, prompting training bases to adjust their organizational structures and management systems to better meet diverse learning needs. However, the shortage of interdisciplinary faculty is now evident, with a lack of teachers who are knowledgeable in both medicine and AI technology. Additionally, the high costs associated with developing and deploying AI systems make it difficult for training bases in economically underdeveloped regions to afford these investments, hindering the widespread adoption of AI in general medical training.

4.3. Ethical and legal challenges

The dual challenges of ethics and law in AI medical training require vigilance against the potential risks of AI decision-making, fairness and over-reliance by resident physicians. For instance, diagnostic biases can mislead clinical judgments, necessitating the establishment of ethical guidelines to guide application practices. If AI-assisted diagnosis leads to medical disputes, there is currently no clear legislation defining the responsibilities of developers, training centers, and resident physicians. There is an urgent need to improve the legal framework to clearly define the rights and responsibilities of all parties [4].

5. Optimization strategies of the application of artificial intelligence in standardized training of general medicine resident physicians

5.1. Optimization strategies at the technical level

Efforts should be coordinated in three areas: data, algorithms, and technology updates. First, enhance medical data governance by healthcare institutions collaborating with training bases to establish standardized data management systems, thereby improving data quality. Additionally, use encryption and anonymization technologies to protect patient privacy. Second, accelerate the development of explainable AI by increasing research and development efforts on rule-based algorithms, enhancing model transparency. For example, develop rule-based AI systems that clearly outline decision-making processes, supporting resident physicians

in understanding and applying these systems. Third, establish a technology upgrade mechanism by forming alliances between training bases, universities, and research institutions to stay abreast of the latest advancements in AI technology and drive innovation through applied research.

5.2. Optimization strategies at the management level

Innovations in the focus model, faculty, and funding: Innovate training models by exploring new approaches such as 'AI-assisted clinical rotations' and 'virtual simulation training,' achieving diverse and personalized presentations. Simultaneously, improve management systems to standardize application processes. Strengthen the faculty team by offering AI knowledge and skills courses for current faculty members, attracting talents with both medical and AI backgrounds, and increasing teaching support. Establish a multi-channel funding model by expanding government investment, encouraging social capital participation, and supporting AI application projects through service procurement and the establishment of special funds.

5.3. Optimization strategies at the ethical and legal levels

Establish a dual safeguard system for review and regulation: Implement an ethical review model to conduct ethical assessments on the development, deployment, and application of AI systems, ensuring fair decision-making and protecting privacy; Enrich the legal framework for AI in healthcare by defining the responsibilities of AI developers regarding algorithm accuracy and security, as well as the obligations of training bases in managing applications, thus establishing a legal barrier for AI medical training applications [5].

6. Case analysis of the application of artificial intelligence in standardized training of general medicine resident physicians

6.1. Application of intelligent diagnosis training system

A training base at a top-tier hospital has introduced an intelligent diagnostic training system based on deep learning. This system integrates a vast amount of clinical cases and imaging data, simulating the diagnostic process for various common diseases. Resident physicians can input patients 'medical histories, symptoms, and examination results into the system, which then provides corresponding diagnostic recommendations and differential diagnosis ideas. Through the system's connectivity, resident physicians can learn the key points and mental shortcuts for diagnosing different diseases, thereby enhancing their diagnostic skills. Resident physicians trained through this intelligent diagnostic training system have shown significant improvements in the accuracy and efficiency of their clinical diagnoses [6].

6.2. Application of virtual simulation training platform

A training base of a medical school has developed a virtual simulation platform for general medicine. This platform uses virtual reality technology to create virtual scenarios of family doctor clinics and community health service centers. Resident physicians can perform tasks such as receiving patients, conducting consultations, performing physical examinations, and formulating treatment plans in this virtual environment. The system provides real-time evaluation and feedback based on the residents' actions and outcomes. Through virtual simulation training, resident physicians can repeatedly practice various clinical skills in a safe setting, enhancing their practical skills and ability to handle emergencies. Additionally, the platform can simulate a wide range of complex clinical scenarios, including home emergency response and chronic disease

management, thereby improving the clinical experience of resident physicians.

6.3. Application of an intelligent assessment and evaluation system

A provincial general medicine training center has implemented an intelligent assessment and evaluation system. This system utilizes computer adaptive testing and big data analysis to comprehensively evaluate the theoretical knowledge and clinical skills of resident physicians. For theoretical assessments, the system automatically adjusts the difficulty of questions based on the residents' answers, providing a more scientific evaluation of their knowledge levels. In terms of clinical skills, the system collects data such as clinical operation records and case analysis reports, using machine learning algorithms to assess multiple dimensions, including clinical thinking and communication skills. The adoption of this intelligent assessment and evaluation system enhances the objectivity and fairness of the evaluations, providing more scientifically reliable evidence for assessing training outcomes [7].

7. Conclusion

The application of artificial intelligence (AI) in the standardized training of general medicine residents is highly valuable. It can effectively address issues such as a shortage of instructors, a lack of diverse cases, and low standardization in training. AI applications also face challenges in technology, management, ethics, and law. It requires collaboration among multiple stakeholders, including the government, training bases, medical institutions, and research institutions, to enhance technological innovation and application, improve management regulations, and address ethical and legal concerns. This will enable AI to play a deeper role in the standardized training of general medicine residents, contributing to the development of high-quality general medicine professionals. As AI technology continues to evolve and improve, it is believed that its application in this field will become more widespread and profound, significantly boosting the development of China's healthcare sector.

Fundings

Chang-Feng Talent Fund of The First Affiliated Hospital of Naval Medical University (Second Military Medical University); 2024 Shanghai Oriental Talent Program Outstanding Project (Project No.: BJWS202428); Key Project on Teaching Research and Reform of the Naval Medical University (Project No.: JYG2024A40)

Disclosure statement

The authors declare no conflict of interest.

References

[1] Liu Z, Zhao J, Xi J, 2019, Experiences of Standardized Training for General Practitioners in Inner Mongolia. Continuing Medical Education, 33(8): 68–69.

[2] Zhang Q, Zhong Y, Meng P, 2019, Problems and Thoughts on Standardized Training of General Practitioners in China. Chinese Post-Graduate Medical Education, 3(4): 369–379.

[3] Wang Y, Zhao X, Yin A, 2019, Application and Evaluation of the Joint Stratified Teaching Method under the Mentor

System in the Standardized Training of General Practitioners. Chinese Community Physicians, 35(33): 184–186.

[4] Wang Y, Ding Z, Min H, et al., 2019, A Practical Exploration of the 'Whole-Process Dual-Mentor System' in the Standardized Training of General Practitioners. Clinical and Educational Practice of General Medicine, 34(12): 126–127.

[5] Zhang Y, 2021, The Value of the 'Internet+' Model in the Management of Details of Standardized Training for Resident Physicians. Smart Health, 7(14): 182–184.

[6] Li H, Wang X, 2020, Prospects and Challenges of the Application of Artificial Intelligence in Medical Education. Medical Education Management, 6(3): 201–205.

[7] Zhang W, Chen J, 2021, Design and Application of an AI-Based Medical Simulation Teaching System. Chinese Digital Medicine, 16(5): 112–115.