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The performance of artificial intelligence in medical field

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Abstract. In modern society, there is an increasing prevalence of individuals who are able to avail themselves of medical facilities for the purpose of receiving healthcare services. With the rise in population, there has been a corresponding decrease in the availability of medical resources for some disorders, leading to challenges in accurately diagnosing patients by healthcare professionals. According to specialists, artificial intelligence (AI) is being considered as a potential solution for addressing medical challenges. This paper mainly focuses on discussing the impact of artificial intelligence in the medical field. Through methods of literature review and analysis, this study explores the fundamental idea of AI and its use in the medical field. Besides, the paper also introduces the potential flaws behind AI in the medical field, and how will artificial intelligence help us further in the medical field. The study reveals that artificial intelligence is extensively employed within the medical sector. Through extensive training, AI has the potential to attain a considerable level of accuracy when it comes to diagnosing various ailments. The level of precision exhibited is akin to that observed in medical practitioners' diagnoses. Nevertheless, artificial intelligence possesses certain limitations. For instance, in the context of privacy preservation, several patients exhibit a reluctance to divulge their symptoms. In the absence of adequate safeguards for information security, this situation might potentially lead to adverse consequences in the lives of these patients and their interpersonal interactions. Ultimately, AI continues to possess significant potential for advancement within the realm of medicine.

Keywords: Artificial Intelligence, Medical Field, Practical Use.

1. Introduction

In recent times, the field of artificial intelligence has witnessed significant progress and advancements, leading to notable achievements across various domains. The domain of medicine is considered a prominent focal point for the advancement of artificial intelligence. Presently, the integration of artificial intelligence in the field of medical healthcare has received widespread recognition. The field can be broadly classified into various sectors, including virtual assistants, medical imaging, pharmaceutical research, biotechnology, healthcare management, wearable devices, risk management, and other related domains [1]. The aforementioned capabilities can be succinctly described as the utilization of artificial intelligence to facilitate human recognition, cognition, analysis, and the execution of intricate tasks.

Regarding the completion of the aforementioned intricate task, a concrete illustration may be found in the form of a medical robot. Clinical medical robots encompass a range of advanced technological devices, such as intelligent prosthetics, surgical robots, auxiliary diagnosis and treatment robots, medical care robots, and guide robots. The present utilization of advanced medical robots encompasses the implementation of exoskeletons. The ReWalk series stands out as a highly accomplished exoskeleton rehabilitation robot on a global scale. The robot is largely composed of three fundamental components, namely a software control system, a mechanical support and power system, and a sensor system. Clinical medical robots include several types of advanced technology that are used in the field of medicine. These technologies include of intelligent prosthesis, surgical robots, tools that aid in diagnostic and therapeutic procedures, robots designed to provide medical care, and robots that assist in guiding medical processes. Exoskeletons are currently employed as advanced medical robots in contemporary practice. Among the several options available, the ReWalk series emerges as a prominent rehabilitation exoskeleton robot with a notable global success. The robot consists of three essential components: a control system based on software, a mechanical support and power mechanism, and a sensor arrangement [2]. In addition to the utilization of medical robots, artificial intelligence also assumes a significant role in the domain of medication research and development. By harnessing the capabilities of deep learning, artificial intelligence has made significant progress in multiple fields, such as cardiovascular medicine, anti-cancer treatments, and common infectious diseases [2].

Notwithstanding the notable impact of artificial intelligence, it is crucial to avoid underestimating its possible challenges. The widespread integration of human intelligence in the realm of human medicine gives rise to numerous societal and ethical dilemmas. The pace of regulatory and supervisory measures frequently fails to keep up with the rapid advancements in innovation [3]. In instances where artificial intelligence and medical professionals diverge in their diagnoses and treatment approaches, the establishment of a definitive standard for resolving medical disputes becomes a challenging endeavor.

This study presents a comprehensive examination of the difficulties and consequences associated with the integration of artificial intelligence (AI) into the medical domain, employing a systematic analysis of existing scholarly works. This article effectively demonstrates the capabilities and limitations of AI within the medical domain, offering a comprehensive comprehension of its current state and future prospects.

2. Fundamental Idea of AI

2.1. Artificial Intelligence Overview

AI pertains to the emulation of human-like behavior by computer systems. This interdisciplinary discipline integrates computer science, statistics, neuroscience, and social science, representing a frontier area of research. The objective of this endeavor is to comprehend the essence of intelligence and develop a novel form of artificial intelligence capable of emulating human cognitive abilities. To provide further clarification, the main areas of investigation in the field of artificial intelligence include knowledge representation, automated reasoning and search methodologies, machine learning and knowledge acquisition, knowledge processing systems, natural language comprehension, computer vision, intelligent robotics, automated programming, and expert systems [3].

Artificial intelligence can be categorized into three distinct levels: weak artificial intelligence, strong artificial intelligence, and super artificial intelligence. According to scholarly consensus, it is widely held that AI will predominantly remain at the level of weak AI for an extended period. Weak AI refers to AI systems that are limited to solving specific issues within a certain domain. Consequently, there is now no imperative to expend resources on concerns over future implications or the need to prepare for potential threats posed by machines [4]. Hence, given the existing state of artificial intelligence, it is imperative to prioritize the seamless and expeditious integration of artificial intelligence into healthcare systems, with the aim of enhancing human well-being and elevating societal standards of living.

2.2. Practical Use of Artificial Intelligence in the Medical Field

Medical artificial intelligence encompasses various applications, including but not limited to medical robotics, aided medicine, literature analysis, and health management. Robotic applications within the medical domain encompass many categories, such as surgical robots, gastrointestinal inspection and diagnostic robots, rehabilitation robots, and further treatment-oriented robotics [5]. Assisted medicine refers to the utilization of artificial intelligence technology to aid physicians in doing diverse quantitative analysis of medical images, conducting comparisons with previous images, and identifying potentially suspicious lesions. This facilitates the rapid and precise completion of diagnoses. In the realm of literature analysis, artificial intelligence employs machine learning and natural language processing techniques to autonomously extract clinical variables from medical records. It adeptly integrates diverse and disparate medical data from multiple sources, facilitating the creation of standardized databases for structured medical records and literature. Furthermore, it efficiently converts accumulated medical records into structured databases in a batch-wise manner [5]. Health management, in essence, is the utilization of artificial intelligence technology to evaluate various physiological indicators such as blood pressure, genetic information, and pulse rate. The primary objective of this analysis is to identify probable health abnormalities and afterwards provide appropriate solutions for improvement. Ultimately, the objective is to facilitate personalized health management for individuals.

3. Practical Accuracy of AI

In recent years, there has been a proliferation of scholarly articles examining the precision and pragmatic utility of artificial intelligence within the domain of healthcare, encompassing diverse areas such as cancer detection, skin diagnostics, and computed tomography (CT) imaging, among others. This study will primarily concentrate on the diagnosis of early-stage esophageal cancer, as it serves as a compelling illustration of the efficacy and precision of artificial intelligence. In the past twenty years, there has been a significant increase of 44% in the prevalence of esophageal cancer, and this rising trend continues. Esophageal cancer can be primarily classified into two histological types: esophageal squamous cell carcinoma, also referred to as squamous cell carcinoma, and esophageal adenocarcinoma. In the Chinese population, the prevalence of esophageal squamous cell carcinoma accounts for approximately 90% of all reported instances of esophageal cancer [6]. The survival rate for persons diagnosed with early-stage esophageal cancer has the potential to exceed 85% over a period of five years. However, it is important to note that a significant proportion of patients are typically diagnosed during later stages of the disease, resulting in a notable decrease in the five-year survival rate, which falls below 20% [7].

The rapid growth of artificial intelligence technology has made deep learning common in gastrointestinal endoscopic image interpretation. AI-assisted diagnostic systems collect many images, which are then divided into training and test datasets for model building and validation. AI-assisted diagnostic systems capture many images, which are categorised into training and test datasets to construct and test models. Endoscopy is increasingly using AI-assisted technologies to diagnose esophageal disorders. Numerous studies have shown that AI-assisted endoscopy accurately detects early-stage esophageal cancer [7]. However, the above investigations used different endoscopes and had varied levels of study rigor. This section analyzes the accuracy of AI help systems in detecting esophageal cancer early. To provide a medical foundation for therapeutic use.

As previously said, analysis is employed for the purpose of examining correctness, with a primary focus on statistical analysis. The statistical analysis was mostly performed using Stata 16 software, in addition to Meta-DISC 1.4 software and RevMan 5.4 software. The subsequent procedure entailed the use of a bivariate mixed-effects regression model subsequent to the implementation of a random effects model. The aforementioned model was utilized to assess critical indicators, including pooled sensitivity, specificity, positive likelihood ratio, negative likelihood ratio, diagnostic odds ratio (DOR), and area under the curve (AUC). In order to identify variability among the aggregated studies, an initial evaluation was conducted through visual examination of the integrated receiver operating characteristic curve (SROC curve). It is worth mentioning that the observation of an asymmetrical shape in the curve provided evidence of substantial heterogeneity [8]. The researchers utilized Spearman correlation analysis to examine whether there was heterogeneity resulting from the threshold effect. In order to assess the presence of heterogeneity resulting from non-threshold effects, we employed both Cochran's Q test and the I2 value. When the I2 value was less than 50%, it signified limited variability among the study outcomes, resulting in the utilization of a fixed-effect model for combining the results. Conversely,

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an I2 value of $\geq 50\%$ suggested considerable heterogeneity, prompting the utilization of a random effects model for synthesis [7]. To delve into the origins of heterogeneity, subgroup analysis, and meta-regression analysis were undertaken.

Deek's funnel plot was utilized to evaluate publication bias, with a P-value less than 0.1 indicating an asymmetric funnel plot. A significance level of $P \leq 0.05$ was adopted for statistical significance. Concurrently, Fagan's nomogram was employed to assess the role and clinical relevance of AI-assisted systems in esophageal cancer diagnosis. The analysis results involved the calculation of the Spearman correlation coefficient using Meta-Disc 1.4 software. The obtained phase connection was determined to be $p = -0.083$ (P = 0.751). This observation suggests the lack of a threshold effect. The AI-assisted method demonstrated a concurrent sensitivity of 0.94, together with a specificity of 0.85 and a positive probability ratio of 6.28, in the context of early esophageal cancer diagnosis. The negative likelihood ratio was reported as 0.07, indicating a low probability of a negative test result in relation to the presence of the condition being tested. The diagnostic odds ratio (DOR) was found to be 89, suggesting a strong association between the test result and the presence of the condition. Additionally, the area under the curve (AUC) was calculated to be 0.96, indicating a high level of accuracy in the test's ability to discriminate between positive and negative results. These findings were reported in a previous study [9].

The results of subgroup analysis revealed that the AI-assisted method exhibited greater diagnostic accuracy for early esophageal cancer in Western countries, as evidenced by a DOR of 96. In contrast, the DOR for Asia was 80. It is worth noting that the diagnostic accuracy of retrospective research, as shown by a DOR of 102 in the literature examined, was higher than that of prospective studies, which had a DOR of 67. The results of the meta-regression analysis indicated that there were statistically significant variations associated with sample size ($P = 0.02$) and endoscope type ($P = 0.001$), suggesting that these characteristics may be possible causes of heterogeneity.

Through a systematic process of excluding individual studies and performing combined analyses, it was determined that the results remained relatively consistent, suggesting that the included studies did not exert a substantial influence on the outcomes. Deek's quantitative funnel plot displayed a distribution of included studies on both sides of the regression line ($P = 0.11$), implying an absence of potential publication bias in this study. In the assessment of clinical applicability, Fagan's nomogram was employed. With a pre-test probability set at 50%, a positive likelihood ratio of 6 corresponded to a post-test probability of 86%. Conversely, for a pre-test probability of 50%, a negative likelihood ratio of 0.07 yielded a post-test probability of 7% [7]. These results underscore the significant clinical importance of applying AI-assisted systems in the early diagnosis of esophageal cancer.

The aforementioned data may not elicit an intuitive perception among individuals, thus necessitating more explanation. A research investigation was carried out in Cixian County, a region in China characterized by a notable prevalence of esophageal cancer. The patients exhibiting esophageal lesions were subjected to active treatment, which involved the utilization of gastrointestinal endoscopic screening. According to the findings, it was observed that after a period of ten years, there was a notable decrease of 29.47% in the occurrence rate of esophageal cancer among the population. Additionally, the fatality rate exhibited a decline of 33.56% [9]. However, variations in diagnostic proficiency and operational skill among endoscopists can have a substantial impact on the timely identification of esophageal cancer. The emergence of AI-assisted systems has the potential to effectively tackle this dilemma.

AI is ideal for medical image identification and complicated clinical data analysis because to its data processing capabilities. The integration of AI with digestive endoscopic imaging technologies allows the collection of a large dataset of endoscopic images for AI training and learning. This integration improves healthcare practitioners' diagnosis accuracy and precision. The AI-assisted approach for esophageal cancer diagnosis had 94% sensitivity and 85% specificity, according to this study. This means 6% of diagnoses were missed and 15% were misdiagnosed. These numbers demonstrate the AI-assisted system's outstanding ability to diagnose esophageal cancer. The Diagnostic Odds Ratio (DOR) shows how diagnostic test results affect disease presence. A higher DOR indicates more discrimination. In this study, the AI-assisted system's DOR of 89 shows its strong esophageal cancer discrimination.

The results of this study strongly show that AI-assisted endoscopic treatments may improve early cancer identification. Thus, patient long-term survival is expected to improve.

4. Flaws of AI in the Medical Field

As science advances, the theories and technologies behind artificial intelligence continue to mature. However, AI still falls short of replicating human-like thinking and reasoning, particularly considering the complexity of the human brain, meaning a structure composed of billions of nerve cells that remains incredibly challenging to fully simulate. Consequently, while the use of artificial intelligence in medicine is expanding, it is unlikely to completely replace all medical professionals.

To start with, artificial intelligence is dependent exclusively on the preexisting information held by humans and lacks the capability to process and analyze unfamiliar components. Therefore, the medical capabilities of artificial intelligence are inevitably constrained by the current pinnacle of medical knowledge and competence. Furthermore, it is important to note that AI systems presently lack the capability to develop unique information or devise innovative solutions. The fundamental underpinnings of machine learning are rooted in disciplines such as statistics, information theory, and cybernetics. This form of learning is predominantly dependent on “experience” and is grounded on intellect that is founded on logic. Nevertheless, human intelligence extends beyond the acquisition of knowledge from experience. It encompasses the potential to develop novel ideas, commonly known as inspiration, intuition, insight, and visual thinking [3]. In order to examine the matter in greater detail, it is important to note that there exist certain complex medical procedures and clinical operations that are beyond the capabilities of artificial intelligence systems to supplant physicians. The aforementioned operations exhibit a considerable degree of intricacy and fluctuation, hence requiring the presence of on-site analysis and discernment. In contrast to disciplines such as imaging and pathology, which frequently yield more conclusive outcomes, the domains of surgery and certain medical therapies lack set resolutions.

Furthermore, human cognitive processes and emotive feelings are absent from AI. The system uses large datasets and expert knowledge to diagnose and treat. Its advise may be objective and optimized. However, clinical practitioners regularly communicate with patients and their families. The doctors explain everything in detail and offer personalized therapy options for each patient. Artificial intelligence cannot engage patients at this level or give tailored treatment. AI in healthcare has numerous problems, but its future is bright. According to the survey, 72% of chief physicians, deputy chief physicians, and attending physicians would recommend using artificial intelligence robots or big data algorithms for patient diagnosis and treatment. This represents 68.4% of respondents. These findings demonstrate that highly qualified medical professionals endorse these technological approaches [10]. This acceptance indicates a significant rise in alignment and identification with these achievements.

5. Conclusion

Leveraging IT and the Internet, the significance of artificial intelligence in the realm of medicine is progressively becoming apparent. As artificial intelligence technology continues to advance, its potential for medical applications is set to expand even further. This trend is expected to lead to an increased range of scenarios where AI can play a pivotal role, from optimizing treatment plans through predictive analytics to enhancing surgical precision through robotic assistance. These developments hold the promise of substantial contributions to the fields of disease prevention, diagnosis, and treatment, revolutionizing the landscape of modern healthcare.

In contrast to the prolonged training period necessitated for traditional physicians, the swift implementation of medical artificial intelligence in local communities and hospitals at a reduced cost becomes feasible once it attains the capability to perform patient evaluations. This measure has the potential to mitigate the persistent scarcity of human medical personnel. Furthermore, owing to its remarkable ability to handle extensive quantities of data, artificial intelligence (AI) possesses the capability to augment the accuracy of healthcare provision. This has the potential to enhance the level of assistance offered to healthcare professionals in their diagnostic and therapeutic initiatives.

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In conclusion, AI is poised to be a pivotal direction and trend in the future of human medical care. While the complete replacement of doctors in the medical field remains uncertain, it's clear that artificial intelligence will undoubtedly serve as a valuable tool for healthcare professionals. It is expected to alleviate certain aspects of the medical burden, such as diagnostics and data analysis, enhance the quality of medical services through personalized treatments, and drive the ongoing advancement and evolution of the field of medicine. As AI continues to collaborate with medical experts, a promising synergy emerges that has the potential to revolutionize patient care and outcomes.

References

[1] Chen Mei, Lu Xiaojuan, Zhang Lin, Chen Ying, Opportunities and Challenges of AI-assisted Medical Care [J]. China Digital Medicine, 2018: 16-18.
[2] Liu Zhenfeng, Xu Ning, Tao Changjun. Application and Prospect of Artificial Intelligence in Medical field [J]. Network Security Technology and Application, 2018(08): 98-99.
[3] Wang Xishan. Future Medical era: Artificial Intelligence Diagnosis and Treatment [J]. Chinese Journal of Colorectal Diseases Electronic, 2017: 349-352.
[4] Jiang Luyi, Wang Xianji, Jin Chunlin, Application and Access of Artificial Intelligence in Medical Field [J], China Health Policy Research, 2018: 78-82.
[5] Yuan Ziteng, Tao Jting, Tan Ying, Application Status and Related Policies of Medical Artificial Intelligence at Home and Abroad [J], Journal of Medical Informatics, 2019: 2-9.
[6] Lin Y, Totsuka Y, Shan B, et al. Esophageal cancer in high-risk areas of China: Research progress and challenges. Ann Epidemiol, 2017: 215-221.
[7] Hong Ziqiang, Jin Dacheng, Li Hongchao et al. Systematic Review and Meta-analysis of the Accuracy of Endoscopy-based Artificial Intelligence Assisted Diagnosis System in Early Esophageal Cancer Diagnosis [J]. Chinese Journal of Cardiovascular Surgery Clinical Thoracic, 2023: 1-8.
[8] Bradley AP. The Use of The Area Under the ROC Curve in the Evaluation of Machine Learning Algorithms. Pat Recog, 1997: 1145-1159.
[9] Wei WQ, Chen ZF, He YT, et al. Long-term Follow-up of a Community Assignment, One-time Endoscopic Screening Study of Esophageal Cancer in China. J Clin Oncol, 2015: 1951-1957
[10] Zhao Yujuan. Survey on Chinese Doctors' Attitude towards Gene and Medical Big Data [J]. Chinese Hospital President, 2016: 40-41.