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REVIEW ARTICLE

The Current Status of Artificial Intelligence in Modern Medical Applications

ABSTRACT

Artificial intelligence has significantly transformed modern medicine, reshaping diagnosis, treatment, and patient care across a broad spectrum. This article examines the current applications of artificial intelligence in medicine, the ethical challenges it presents, and its potential future developments. By addressing the use of artificial intelligence in healthcare, issues such as data security, privacy, and algorithmic bias are discussed. Additionally, the challenges in integrating artificial intelligence into healthcare services and its future roles are analyzed.

Keywords: Artificial intelligence, healthcare, future roles, ethics

Artificial intelligence has made significant progress in the field of medicine, as in many other areas, and has initiated innovative applications. Artificial intelligence methods such as machine learning, deep learning, and natural language processing have been implemented at every stage of disease diagnosis, examination, and treatment. In medicine, artificial intelligence aims to develop early diagnosis and treatment models by utilizing results obtained from demographic, clinical, laboratory, and radiological data collected from a large number of patients. For the training and application of artificial intelligence, patient records, genetic data, and patient monitoring data in the healthcare sector can be used. Manual, human-based evaluation of data, apart from artificial intelligence, can lead to errors and result in time loss. However, artificial intelligence-based systems analyze billions of medical images and are significantly superior to manual evaluation in the early detection of poor-prognosis and high-mortality diseases such as cancer (1,2).

The use of artificial intelligence in developing epidemiological models, alongside personalized treatment models in the healthcare sector, has gained increased importance, especially after the COVID-19 pandemic. With effective diagnostic methods and treatments at both patient and societal levels, the role of artificial intelligence in healthcare is becoming increasingly indispensable (3-6).

Artificial Intelligence facilitates the implementation of patient-centered, customized medical diagnoses and treatments by analyzing individual clinical and radiological data. Genetic and protein analysis can enable the development of personalized treatment plans. For example, artificial intelligence algorithms that evaluate the genetic profile of tumors in cancer patients assist clinicians in determining the most effective drugs. This not only improves patient outcomes but also reduces unnecessary treatment costs (7-9). Artificial intelligence has brought comprehensive and fundamental changes to diagnostic methods in the healthcare sector, enabling healthcare professionals to make more accurate diagnoses and provide treatment in a shorter time. As a result, the financial burden in the healthcare field is decreasing on a national scale, allowing for increased budgets allocated to technological advancements in the sector. This article aims to comprehensively discuss the applications of artificial intelligence in medicine. Additionally, the use of artificial intelligence will be examined within ethical and legal frameworks. The article will also evaluate how artificial intelligence can be utilized more effectively as a method in the healthcare sector.

Types of Artificial Intelligence Used in Healthcare Systems

- **Machine Learning (ML):** Advances in the field of informatics have expanded the range of applications for artificial intelligence types, such as machine learning and deep learning, in health information systems.

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• **Deep Learning (DL):** Deep learning utilizes multi-layered models, sometimes with as many as 1,000 layers, trained using artificial neural networks. These layers process data at different levels within the healthcare system, enabling the model to learn more complex and deeper relationships. Although deep learning is used in health-related artificial intelligence systems, such as computer vision and natural language processing, it has not been sufficiently integrated into clinical practice.

Natural Language Processing (NLP): It is a branch of artificial intelligence that enables information systems used in the healthcare sector to understand, analyze, and produce results from human language. NLP is a method developed through the combination of linguistics and computer science, and it can be used for examination, diagnosis, and treatment. It provides information on drug side effects, rare diseases, and patients' feelings and thoughts by scanning medical publications. Artificial intelligence applications in this category are utilized in various areas of medicine, ranging from patient care services to surgical operations. Today, robots used in surgical procedures are highly effective and efficient. In fields such as cardiovascular surgery, urology, and neurosurgery, these robots enhance the surgeon's dexterity and minimize the margin of error. However, the feasibility of using robotic surgery and other robotic programs in the healthcare sector is limited by cost, a skilled workforce, and the traditional mindset of people, making their use quite restricted in underdeveloped and developing countries around the world (10-12).

Artificial intelligence, particularly in the field of radiology, performs tasks that typically require human intelligence as learning, reasoning, problem-solving, and interpretation-by leveraging algorithms, data and computational power in computer systems. Despite the complexity of large data sets, artificial intelligence can provide insights for diagnosis and treatment through data-driven problem-solving and decision-making supported by advanced analytical methods.

Deep learning algorithms used in techniques such as computed tomography, magnetic resonance imaging, and ultrasonography enable the automatic detection of abnormalities in radiological images. For instance, algorithms used in the diagnosis of lung cancer can detect nodules at early stages.

In breast cancer screenings, artificial intelligence-based systems assist radiologists in classifying lesions and evaluating malignancy potential, thereby reducing error rates. Additionally, in digital pathology, artificial intelligence algorithms are utilized for tasks such as identifying tumor cells and classifying their subtypes. This is particularly advantageous for analyzing large datasets, providing significant time and resource savings (13-16).

In the era we live in, artificial intelligence is a highly integrated technology in laboratory medicine, striving towards achieving optimal efficiency. One of the indispensable applications of artificial intelligence in disease diagnosis is Clinical Decision Support Systems (CDSS). These systems analyze patient complaints, medical history, family history, laboratory results, and radiological findings to provide diagnostic recommendations to physicians.

In emergency departments, artificial intelligence-supported triage systems can optimize the classification of patients by prioritizing diagnosis and treatment according to their urgency.

Large datasets derived from laboratory tests, biochemical, microbiological, or genetic analyses are rapidly analyzed by artificial intelligence algorithms, enabling the swift detection of abnormalities (17-19).

Artificial Intelligence and Modern Medicine

Although movement-related artifacts may cause false-positive results, artificial intelligence has been used since 2014 when the FDA first approved AliveCor's KardiaMobile device for the early detection of atrial fibrillation. Apple's application for ECG monitoring and atrial fibrillation detection was also approved. artificial intelligence is utilized to predict the risks of cardiovascular diseases such as acute coronary syndrome, heart attack, and arrhythmias. artificial intelligence has also been effectively used in devices that measure and continuously monitor blood glucose levels, accurately indicating the rate and direction of changes (20,21).

Artificial intelligence applications are increasingly used in nephrology as well. For instance, artificial intelligence can predict the decline in glomerular filtration rates in patients with polycystic kidney disease and provide risk alerts for progressive IgA nephropathy. In gastroenterology, convolutional neural networks and deep learning models are widely used to process endoscopy and ultrasound images for detecting abnormalities. artificial intelligence also plays a role in the diagnosis and prognosis of diseases such as peptic ulcer, gastroesophageal reflux disease, atrophic gastritis, gastrointestinal bleeding, esophageal cancer, and ulcerative colitis (22).

In 2018, the FDA approved a wearable device called "Embrace," which detects epileptic seizures and provides information to physicians and caregivers. Additionally, wearable sensors have been developed for monitoring conditions such as Parkinson's disease, multiple sclerosis, and Huntington's disease (23,24). Artificial intelligence-based imaging analysis systems are particularly valuable in diagnosing skin cancer (25). These systems assess the malignancy potential of lesions, assisting dermatologists in improving diagnostic accuracy. Deep neural networks are used for the automatic evaluation of biomarkers in breast cancer. Moreover, models that analyze the connections between mammography and histology enhance the accuracy of disease detection (26).

Natural Language Processing in Modern Medicine

In modern medicine, NLP (Natural Language Processing) is a method used to interpret patient data and produce accurate and effective solutions in the diagnosis and treatment stages. It is employed in various areas, such as utilizing and recording patients' medical information more efficiently, highlighting critical data, extracting notes that guide diagnosis and treatment, conducting meta-analyses and literature reviews, selecting suitable patient profiles for clinical trials, creating and evaluating applications that respond to patient inquiries, scheduling appointments with virtual health professionals, and managing medication applications.

The unstoppable rise of artificial intelligence is opening new horizons in nearly every field. This rapid advancement is leading to significant changes, particularly in scientific research, and offering innovative approaches in complex areas such as evolutionary biology. Growing evidence suggests that artificial intelligence, by integrating healthcare solutions and genetics, positions modern medicine as an indispensable foundation of medical practice by providing the right medication at the right dose and at the right time for patients with various diseases. In light of recent advancements in artificial intelligence and machine learning techniques, numerous biomarkers and genetic loci associated with various diseases and their related treatments are being discovered through the use of imaging and multi-omics methods (27,28). Especially with the COVID-19 pandemic, the diagnostic value of artificial intelligence in infectious diseases has become increasingly evident. Artificial intelligence has been successfully applied to various tasks, including the analysis of chest X-rays and tomography, classification of PCR test results, and modeling disease spread. In the differential diagnosis of viral infections, artificial intelligence can provide rapid results. For viral and bacterial infections with similar clinical features, artificial intelligence can assist in differential diagnosis through symptom analysis and radiological image evaluations. Artificial intelligence can evaluate patients' genetic characteristics, medical histories, and family histories to develop personalized diagnosis and treatment plans.

This approach enhances treatment success while reducing complication rates. In hospitals, artificial intelligence contributes effectively to managing patient flow in interventional procedures, ensuring efficient utilization of both financial and human resources.

Ethical Issues in Artificial Intelligence Used in Modern Medicine

The use of artificial intelligence in modern medicine is employed in disease diagnosis, targeted treatments, and patient monitoring. Its broad application also brings significant ethical challenges and debates. These intelligent and modern technologies, capable of generating, interpreting, and making decisions through algorithms, are advancing at a pace that exceeds the natural development of human intelligence. Addressing ethical issues such as data security, privacy, fairness, bias, and accountability is of great importance in modern medicine. This section will comprehensively examine the ethical concerns related to artificial intelligence. Artificial intelligence applications in healthcare often rely on extensive datasets. This use of artificial intelligence raises concerns about ensuring security and privacy. Datasets that require meticulous handling carry the risk of security breaches and unauthorized access during collection and storage for artificial intelligence training. Informed consent must always be obtained from patients, and all examinations and treatments should be conducted transparently (29-31).

The evaluation of racial bias in medical machine learning (ML) applications is essential. If artificial intelligence systems used in healthcare are trained only with data from specific ages, genders, or ethnic groups, they may fail to provide accurate and fair results for other groups. Consequently, the use of these artificial intelligence applications in different ethnic groups could lead to misdiagnoses and inappropriate treatments. Furthermore, the limited accessibility of artificial intelligence systems to certain populations may further hinder access to healthcare services in resource-limited regions. Biased outcomes, such as increasing insurance premiums or restricting treatment options, could unfairly disadvantage individuals (32,33). Algorithmic fairness in clinical machine learning is a cornerstone of ethical usage. Proactively mitigating potential racial biases is crucial for preventing inequities in modern medicine. Algorithmic fairness in healthcare is still in its infancy. Emphasizing standardized reporting and data accessibility is recommended to enhance transparency and facilitate future research.

Who will be held responsible if artificial intelligence makes an incorrect diagnosis or if diagnosis and treatment planning are entirely non-human? Moreover, if this situation harms the patient or leads to complications, it will become even more complex. Currently, there are still no clear legal regulations in place. This is an area that requires thorough discussion and the establishment of clear legal frameworks by the healthcare sector, government authorities, and artificial intelligence developers.

The sharing, visibility, and use of individuals' clinical and radiological examinations and results within the healthcare system are only possible with explicit consent obtained from patients. However, the lack of a universal standard for consent procedures makes it difficult for patients to fully and accurately understand these processes. It remains a debated issue whether health data belongs exclusively to individuals, the healthcare sector, or even artificial intelligence developers. In this context, the scope and boundaries of ethical violations regarding the use of health data have not yet been clearly defined (34,35).

The inability to establish emotional connections or empathy between humans and machines in medical equipment raises new ethical questions. Ethically, it is essential to ensure that machines do not completely replace humans and that designs are developed to recognize the need for emotional interaction. The ethical suitability of artificial intelligence should be adjusted to balance human needs with the utilization of technological advancements. The use of artificial intelligence in modern medicine may inevitably lead to ethical violations. Its malicious use can jeopardize patient safety, result in privacy breaches, pose cybersecurity risks, diminish trust in the healthcare system, fail to uphold ethical responsibilities, spread misleading information, and increase the influence of commercial interests (1,10). Transparency, strict oversight, and adherence to ethical standards are extremely important in the use of artificial intelligence in modern medicine.

Artificial Intelligence and Future

Various plans must be implemented to meet the ethical requirements of artificial intelligence in modern medicine. Developing global decisions and practices for the use of artificial intelligence. Informing both healthcare professionals and patients about artificial intelligence in all its aspects. Utilizing data from different regions of the world and representing various demographic groups in diagnosis, follow-up, and treatment stages to develop fair and unbiased algorithms. Creating explainable artificial intelligence approaches to make the decision-making processes more transparent and understandable, fostering collaboration between healthcare professionals and patients.

Although artificial intelligence is increasingly becoming indispensable in modern medicine, ethical issues remain unresolved. Developing artificial intelligence fairly and transparently is essential to ensure that this technology provides maximum benefits to human health. Adhering to ethical values not only builds trust but also ensures the fair and successful delivery of healthcare services (1,36,37).

CONCLUSION

Artificial intelligence, has emerged as one of the most contemporary and beneficial resources in healthcare today, with its use increasingly expanding across all medical fields for disease diagnosis, treatment, and patient management. Artificial intelligence, offers highly successful advantages in areas such as radiological imaging, genetic analysis, diagnosis, follow-up, treatment, clinical decision support systems, and public health management, supported by statistical data analysis, machine learning, and deep learning techniques. Artificial intelligence ‘s success in early disease detection, personalized treatment planning, and public health efficiency is remarkably high. However, certain concerns still persist. Preserving ethical values, ensuring data security, and applying technology appropriately will enhance the effective use and success of artificial intelligence. While providing equal healthcare services to every individual worldwide is not yet feasible, improving this aspect and optimizing human-machine collaboration will undoubtedly make artificial intelligence an indispensable part of healthcare in the future.

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