ARTIGO DE REVISÃO

ADVANCES IN ARTIFICIAL INTELLIGENCE AND ITS APPLICATIONS IN MEDICAL DIAGNOSTICS PROMISING APPROACH

Avanços na inteligência artificial e suas aplicações em diagnóstico médico abordagem promissora

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ABSTRACT

Artificial intelligence (AI) technologies applied to the medical and biomedical fields are contemporary topics in rapid development, offering significant benefits, in addition to presenting challenges and promising future perspectives for advances in diagnostics. AI makes it possible to identify complex patterns in imaging exams, laboratory and genetic tests, which are often challenging for human analysis, enhancing the early detection of diseases such as cancer, cardiovascular diseases and infectious diseases. OBJECTIVE: Investigate through current literature the application of artificial intelligence (AI) in medical areas, with particular emphasis on the biomedical field. METHODOLOGY: Literature review using the main databases. CONCLUSIONS: This scientific work shows the relationship between new treatment technologies and the performance of biomedical professionals, who play a fundamental role in the detection, diagnosis and treatment of diseases. AI has been transforming medicine, bringing significant advances in diagnoses, treatments, and health care management. However, for these benefits to be fully realized, it is crucial to address challenges related to data security, ethics, professional qualification, and legal regulations.

Keywords: Artificial Intelligence (AI), diagnostics, medicine, biomedicine, diseases, health.

RESUMO

A Inteligência Artificial (IA) aplicadas às áreas médica e biomédica são temas contemporâneos em rápido desenvolvimento, oferecendo benefícios significativos, além de apresentar desafios e perspectivas futuras promissoras para avanços em diagnósticos. A IA possibilita identificar padrões complexos em exames de imagem, testes laboratoriais e genéticos, muitas vezes desafiadores para análise humana, potencializando a detecção precoce de doenças como câncer, doenças cardiovasculares e doenças infecciosas. OBJETIVO: Investigar por meio da literatura atual a aplicação da Inteligência Artificial (IA) em áreas médicas, com ênfase especial na área biomédica. METODOLOGIA: Revisão bibliográfica utilizando as principais bases de dados. CONCLUSÕES: Este trabalho científico mostra a relação entre novas tecnologias de tratamento e a atuação de profissionais biomédicos, que desempenham papel fundamental na detecção, diagnóstico e tratamento de doenças. A IA vem transformando a medicina, trazendo avanços significativos em diagnósticos, tratamentos e gestão da assistência à saúde. No entanto, para que esses benefícios sejam plenamente concretizados, é crucial abordar desafios relacionados à segurança de dados, ética, qualificação profissional e regulamentações legais.

Palavras-chave: Inteligência Artificial (IA), diagnóstico, medicina, biomedicina, doenças, saúde.

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INTRODUCTION

In contemporary times, Artificial Intelligence (AI) has made significant advances, gaining notable space in the health area. This tool has been used as an ally in various medical and diagnostic processes, aiming to improve the well-being of patients[1]. AI can analysis large volumes of data using algorithms, which can help improve diagnoses. This new tool has already been used in clinical decision support systems, particularly in situations where resources are low. Studies on literature review have shown that IA can provide more accurate diagnoses in a variety of fields, such as early detection of Alzheimer's and cancer [2].

Several studies explore concerns related to the interaction between doctors and artificial intelligence, highlighting the fear that health professionals could be replaced by automated systems[3]. The same authors emphasize that the artificial intelligence tools currently available act as an aid to health professionals and fail to incorporate the subjective aspect inherent to clinical practice. Thus, although the resistance of some professionals to the use of technologies with broad applicability in various areas of medicine is legitimate, it is essential that this opposition considers the potential benefits that such devices can offer to medical practice. One of the contexts in which artificial intelligence demonstrated its effectiveness occurred during the COVID-19 pandemic. Before the widespread spread of the disease, technological systems were able to detect the spread of the virus and predict its spread in several countries, issuing alerts to health organizations. The World Health Organization (WHO) recognizes the advancement of artificial intelligence in the health field as large companies [4].

While artificial intelligence has the potential to transform medical diagnostics, its implementation faces significant challenges. These include the generalization of diagnoses due to biases in data sets, as well as issues related to the privacy and security of medical data. Additionally, there is a risk of compromising clinical intuition and fostering an overreliance on automated systems. It is essential to question the applicability of artificial intelligence as a complementary tool to the skills of health professionals, aiming to promote a collaborative approach, rather than replacing them[2].

Although artificial intelligence has demonstrated numerous benefits and has received wide visibility in several areas in recent years, its use in medicine also presents significant challenges and concerns. One example involves trust and acceptance by doctors and patients, aspects that can generate doubts about its use and hinder the integration of this technology into clinical practice[5]. In relation to data privacy, according to the same authors, confidential information needs to be treated with the utmost care and security to avoid the violation of unauthorized access.

The integration of artificial intelligence (AI) into biomedical science has the potential to revolutionize many facets of healthcare, from diagnosis and treatment to drug research and

development[6]. This advancement is driven by the ability of artificial intelligence to process and analyze large volumes of data with high precision and speed, overcoming several limitations inherent to human performance. However, according to authors Franco et al.[5] it is crucial to address the technical and ethical challenges to maximize benefits and minimize risks. Future studies should focus on improving data quality, developing better algorithms, and ensuring the ethical and responsible implementation of these technologies.

This study aimed to investigate, through current literature, the application of Artificial Intelligence (AI) in medical areas, with specific emphasis on the biomedical field. Thus, it was evaluated how AI can improve the diagnosis, treatment and monitoring of diseases, in addition to raising the ethical and legal implications associated with the implementation of AI technologies in the medical environment, aiming to provide subsidies for future research on the use of AI in diagnosis and health.

2. Artificial Intelligence in Medicine

Kuwaiti et al.[7] demonstrated in his studies that Artificial Intelligence (AI) is the area of science and engineering that creates machines capable of imitating human abilities, such as learning and solving problems, through algorithms. These technologies are developed to simulate typical human intelligence processes, such as adaptation, learning, reasoning, interaction and sensory perception.

The history of Artificial Intelligence (AI) began in the 1950s, when researchers began exploring the idea of creating machines that could think like humans. The term "artificial intelligence" was first used at a conference at Dartmouth College in the United States in 1956. In the years that followed, there was much enthusiasm and investment in AI, but this was followed by a period of disappointment, called the "AI winter". In recent decades, however, advances in algorithms, computer power and large amounts of data have revived interest, generating major advances in the field[8].

Olawade et al.[9] explain that since the 2000s, advances in computer vision, natural language processing and machine learning have enabled the creation of increasingly complex AI systems, capable of evaluating large amounts of data and anticipating results. As a result, AI-based diagnostic systems have emerged, such as those that analyze medical images to help identify diseases such as cancer. Advances in text mining and natural language processing methods have also enabled AI to evaluate unstructured data, such as electronic health records, extracting valuable conclusions and contributing significantly to the work of healthcare professionals.

Artificial Intelligence is already used in radiological exams, such as mammograms and CT scans, helping doctors analyze images more accurately by comparing them with a large database of previous exams. In addition, devices such as smart watches and bracelets are used to

monitor health signals, including blood pressure, glucose levels and heart rate, becoming common in everyday life to monitor patients' health[10]. Companies like IBM are already using Artificial Intelligence in medicine, such as in the Watson Health platform. With EyePACs technology, Watson analyzed 35,000 retinal images, achieving 86% accuracy in diagnosing retinopathy. In the US, many healthcare institutions use Watson, which stores about 80% of medical information[11].

3. AI Applications in Medical Diagnostics

Tian et al.[12] conducted research to compare traditional radiological examination methods with a convolutional neural network. A convolutional neural network (CNN) is a type of network designed to process images by automatically recognizing complex patterns. In this research, CNNs were used to analyze medical images such as X-rays, CT scans, MRIs, and ultrasounds. When comparing performance with traditional methods, the CNN AI method proved to be more accurate. For example, when analyzing X-rays, CNN achieved an accuracy of 94%, higher than 88% for conventional methods. In MRIs, it achieved a sensitivity of 94%, better identifying pathological conditions. In ultrasound, it had a specificity of 93%, showing efficiency in avoiding incorrect diagnoses.

Borba et al.[13] brought reports that AI covers several areas of chronic diseases such as diabetes, hypertension and asthma. In this way, helping with early diagnoses that use AI to minimize errors in treatments, assisting in clinical decision-making, to make treatments more effective, AI adapts to different situations at the time of diagnosis and in surgeries that require greater precision.

Several studies have demonstrated several advantages in diagnosis, including the ability to help identify Alzheimer's in its early stages, differentiating between mild cognitive impairment and normal cognition through analysis of brain images. In addition, artificial intelligence has the potential to revolutionize the treatment of neoplasms, allowing intervention in the early stages of the disease. Costa et al.[2] claim that an accurate diagnosis can improve the quality of data on DL and provide earlier treatment for patients.

During the COVID-19 pandemic, Artificial Intelligence (AI) has played an essential role in several areas: detecting the disease through image analysis, predicting the spread of the virus, monitoring symptoms via chatbots, accelerating vaccine research, analyzing large volumes of data, as well as facilitating deliveries and disinfection by robots and monitoring social distancing. Institutions such as Mount Sinai Hospital (USA), Ghent University Hospital (Belgium), and Seoul National University Hospital (South Korea) have used AI to predict disease severity, disinfect areas, and conduct temperature screenings, demonstrating the effectiveness of AI in diagnosis and hospital safety during public health crises. Hospitals in China have employed AI to analysis medical images, while others have implemented AI

chatbots for symptom triage. These applications have demonstrated the potential of AI in areas such as diagnosis, resource management, and hospital safety during public health crises[8].

Coronary heart disease is a type of disease that results from blockages in the arteries of the heart, causing heart failure, heart attacks, and strokes. Artificial Intelligence, especially fuzzy logic, has been used to identify heart diseases efficiently. Studies have shown that neuro-fuzzy systems can accurately identify cardiac risks. An arrhythmia clustering system was developed using fuzzy classifiers to process ECG signals quickly while maintaining accuracy in detecting conditions such as angina and heart attack. This method has also excelled in accurately diagnosing Pulse Pressure Variability[14].

4. Advantages and Benefits of AI in Medical Diagnostics

The authors Moraes et al.[1] discuss in their study that Artificial Intelligence (AI) is revolutionizing medical diagnosis, making it more precise. With its ability to analyze large volumes of data and recognize complex patterns, AI helps healthcare professionals diagnose a wide variety of conditions. Additionally, AI can integrate clinical and historical data from patients, such as family history and previous test results, to identify inherited diseases, risk factors, and predict the development of certain conditions. This targeted approach improves diagnostic accuracy, enabling targeted treatments and prevention strategies.

However, AI can prevent errors from being made. This damage can be caused by the action or omission of those who can use it or by those who developed it. There is still the doubt about civil liability due to these errors that can be caused. One question that the author asks is who would be responsible for this error or the parameters for forming the duty to compensate for errors. The vulnerability of these programs is inevitable, as they are susceptible to external intrusions that can compromise diagnostics and collect data inappropriately. Such actions can be unpredictable and potentially harmful. The reliability of algorithms in relation to data privacy and excessive dependence on technology are concerns that require adequate care[1].

Soares et al.[10] explored in their work information about the great data processing capacity of artificial intelligence in medicine. This technology allows you to store and organize files digitally, facilitating access, security and the search for specific information. The authors Moraes et al.[1] explained in their study that AI has the unique ability to process large volumes of data in real time and perform complex analyses quickly and accurately, which results in a significant acceleration of medical diagnostic processes.

Scientific research shows that artificial intelligence in medicine can be used not only to aid in diagnosis, but also to increase the efficiency of treatments. The introduction of artificial intelligence (AI) in diagnostic medicine is creating a model of personalized healthcare, where diagnoses

are tailored to the unique characteristics of each patient. Personalized medicine is becoming a reality thanks to AI's ability to analyze large volumes of clinical, genetic and environmental data, enabling the identification of specific patterns and the provision of more effective treatments[1].

A successful example is Watson, a software created by IBM, which suggests the most appropriate treatment for each patient, including possible complications and side effects [10].

5. Challenges and Limitations of AI in Medical Diagnostics

For artificial intelligence (AI) to be effective in medical diagnosis, it is essential that it be trained on large, high-quality medical data sets. AI algorithms need to "learn" from existing diagnostic examples, such as scan images, test results, and medical records, to identify patterns and make informed decisions based on the available data. In this way, AI can understand the patterns associated with each dis-ease and, consequently, make diagnoses with greater accuracy[15].

However, there are significant challenges related to the quality and complete-ness of this data. Many medical records are incomplete or lack sufficient infor-mation, which may be due to the lack of a single standard in the collection of this data or the lack of details about some specific diseases. This makes it difficult for AI to learn, since the lack of complete data reduces the ability of algorithms to extract and "learn" from this information efficiently and comprehensively, compromising the accuracy of diagnoses[15].

Furthermore, according to authors Tariq et al.[14] , It is essential to standard-ize data, that is, to create standards that allow different medical AI systems to ex-change information easily and accurately. If all systems follow the same standards, it will be possible to better integrate data, allowing AIs to work together and use the same information to generate more reliable diagnoses.

In this context, Big Data Analytics becomes an indispensable tool, as it uses advanced data analysis techniques to process large volumes of health information, identifying patterns, trends and correlations that would be difficult to detect manually, given the quantity and complexity of the information. The use of Big Data Analytics, according to authors Al Kuwaiti et al.[7] enables AI to improve clinical data manage-ment, facilitating the discovery of new drugs and streamlining administrative pro-cesses. However, if the data used to train AI does not include rare cases or repre-sent specific populations, it may be difficult to provide accurate diagnoses for specif-ic groups.

Interpreting the results generated by Artificial Intelligence (AI) systems is es-sential for healthcare professionals. However, understanding how AI arrives at these results is challenging, as many algorithms operate as "black boxes". This means that while AI can produce diagnoses and predictions, the process by which these conclu-sions are reached is not always clear. This lack of transparency makes it difficult for healthcare professionals to trust the results, as they cannot see how the AI made its decisions[7].

To solve this problem, "explainable artificial intelligence" (XAI) was proposed. XAI aims to "open" the black box by providing clear explanations of how and why an AI reached a particular conclusion or recommendation. This helps healthcare pro-fessionals better understand the results, increasing their confidence and security when applying these diagnoses in clinical practice[15].

Furthermore, standardization and interoperability between different AI sys-tems are essential. It is important that all systems follow common standards that allow data exchange between different platforms and professionals. This standardi-zation makes it easier to integrate AI data with other tools and systems used by cli-nicians, allowing healthcare professionals to access the same data and diagnoses across different devices or software. This way, clinicians can work collaboratively and in an integrated manner, making AI more useful and reliable in supporting clini-cal decisions[14].

The authors Amaro et al.[6] discuss an important ethical aspect involving the responsibility for protecting patients' personal data and the results obtained by AI. When healthcare professionals use AI, they assume responsibility for the security of the data and for possible errors in diagnosis or treatment. However, the situation becomes more complex when patients use AI tools for self-diagnosis or treatment. The availability of healthcare AI programs to the public can compromise the relationship between professionals and patients, resulting in unintended consequences. In such cases, the attribution of responsibility becomes less clear, raising questions about civil liability in situations of harm or incorrect diagnosis. Thus, the democratization of medical AI programs can negatively impact the professional-patient relationship, presenting risks of misinformation like those found on internet search platforms.

A practical example of the use of AI in Brazil's public health system is the automation of medical records in the Unified Health System (SUS), managed by an online database that houses patients' medical information. However, the authors express concern about the security of patient data[3].

6. The role of the biomedical scientist in the use of AI for Medical Diagnostics

Biomedical professionals, when working on the use of AI in medical diagnostics, play crucial roles ranging from developing and testing models to clinically interpreting results. With the advancement of technologies such as Machine Learning (ML) and Deep Learning (DL), AI can process large volumes of medical data, detect patterns in high-resolution images, and improve diagnostic accuracy. This processing is especially useful in areas where image-based diagnostics are essential, such as oncology, neurology, and cardiology, where AI can help detect tumours, identify degenerative diseases, and predict the risk of heart disease with high accuracy[9].

The role of the biomedical scientist, according to Lucas et al.[4] is fundamental at the interface between health and technology, especially in the context of Artificial Intelligence (AI) in medicine. Biomedical scientists work on the front lines of AI-generated exams, continually striving to ensure the privacy of patient data. In this way, biomedical scientists contribute to technological

advancement, ensuring that its use brings positive benefits to health. The authors Santos et al.[16] state that the biomedical professional is highlighted as a key professional in the analysis and interpretation of medical images, using AI tools in radiography to improve diagnosis.

CONCLUSION

Artificial intelligence (AI) has demonstrated a significant impact on medicine, particularly in improving diagnostic accuracy and early detection of diseases. As discussed in this review, several authors highlight that AI technologies in medical practice offer more detailed and personalized diagnoses. The integration of these tools in medicine allows for more effective treatments and improves patient prognosis. However, the use of AI in medicine is not without challenges, as there are several ethical issues, such as data security and patient privacy, which are emerging concerns in the field of digital health. The implementation of AI also faces obstacles related to technological infrastructure, technical understanding, and the training of health professionals. The outlook for AI in medicine is promising and promises to further transform medical diagnosis and treatment.

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Observação: os/(as) autores/(as) declaram não existir conflitos de interesses de qualquer natureza.