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THE USE OF ARTIFICIAL INTELLIGENCE IN HEART DISEASE: FROM PREVENTION TO TREATMENT

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INTRODUCTION

The concept of Artificial Intelligence (AI) was developed by Alan Turing in 1950 and consists of the idea of a digital mind capable of learning, adapting, reacting, and "thinking" in the same way as a human being, characterizing a concept called machine learning (ML) (OZSAHIN *et al.*, 2022). This entire process is carried out through supervised and unsupervised learning methods of the AI computational model (OZSAHIN *et al.*, 2022). In this way, this model receives data and "learns" how to create associations and differences between the information that has been entered, and as a result, performs tasks that classical computer programming is not capable of (OZSAHIN *et al.*, 2022).

The capacity for AI to act within the clinical and medical sphere shows promising effects in complementing human reasoning (TOLU-AKINNAWO *et al.*, 2025). AI can act as an additional tool that assists doctors' judgment, i.e., it helps improve the quality of medical care, being responsible for making early and non-invasive diagnoses in as many patients as possible, increasing the quality of health care, reducing hospital costs, and making medical assistance more accessible to all (OZSAHIN *et al.*, 2022). Its application covers multiple aspects, such as cardiology, including diagnostic imaging methods such as chest X-rays, echocardiography, and cardiac computed tomography; genetic evaluation; risk stratification processes based on the analysis of health system data, taking into account clinical history and tests performed; electrocardiographic records; and evaluation of cardiac auscultatory records from databases (OZSAHIN *et al.*, 2022).

Thus, the justification for its use is relevant in various contexts, such as heart disease, given the prevalence and mortality of these diseases today (OZSAHIN *et al.*, 2022). This is shown by the Centers for Disease Control and Prevention (CDC), which found that 20% of deaths in the US were caused by heart disease in 2020, equivalent to 696,962 people and characterizing the leading cause of death in the country (OZSAHIN *et al.*, 2022). In addition, population growth and increased life expectancy further increase the workload in health centers, which, as a result, increases the number of medical errors that could be preventable (OZSAHIN *et al.*, 2022).

Therefore, in many cases, the integration of artificial intelligence and clinical cardiology practice can contribute significantly to improving cardiology care (GANDHI *et al.*, 2018). Based on this analysis, it is important to note that even though rapid diagnosis can improve clinical decision-making and prevent serious cardiac complications, there are still many challenges, such as algorithm transparency and the need for continuous validation for their application (GANDHI *et al.*, 2018). Therefore, for AI algorithms to be widely implemented in clinical practice, they must have a result accuracy similar to or superior to that of human observers , reinforcing the importance of future studies that focus not only on developing new algorithms, but also on analyzing existing ones and verifying what can be done to implement them in the context of heart disease (OEVER *et al.*, 2020).

OBJECTIVE

This integrative literature review aims to describe the main applications of AI in the context of heart disease and to identify the main challenges associated with its use.

METHODOLOGY

To conduct this integrative literature review, the following databases were used to search for scientific articles: National Library of Medicine (PubMed), using the descriptors heart diseases, diagnostic imaging, and artificial intelligence, with the Boolean operator AND**.** The inclusion criteria were limited to articles that included research related to the use of AI in the diagnosis and presence of heart disease. In addition, studies that included correlations between the application of AI and changes in other systems were excluded. The following were selected: literature reviews, editorials, and original research articles available in digital format in English published in the last 10 years. Initially, 21 studies were selected. After reading the abstracts, 16 studies were chosen for full-text reading, and 9 of these were used to establish correlations.

DISCUSSION

The use of AI is part of improving care for heart patients, from early diagnosis to personalized and innovative treatments (OZSAHIN *et al.*, 2022).

In prevention

The study by Hernandez-Suarez *et al.* (2019) revealed that ML performed well compared to classical statistical methods for predicting outcomes in patients with heart failure, coronary artery disease, and congenital heart disease (RIBEIRO *et al.*, 2022). This study used the supervised ML model to estimate hospital mortality in patients who underwent transcatheter mitral valve repair, achieving greater accuracy than previous models used (RIBEIRO *et al.*, 2022) .

Valvular heart disease can have harmful outcomes, such as heart failure, requiring tests to prevent these late stages (LIN *et al.*, 2024). Thus, to perform low-cost screening capable of detecting these cardiac abnormalities at stages when the patient is asymptomatic, an artificial intelligence-enabled electrocardiogram (AI-ECG) can be used to identify subtle changes that exceed those perceived by human specialists, such as ventricular hypertrophy, atrial enlargement, aortic stenosis (LIN *et al.*, 2024).

Coronary artery disease (CAD) is one of the leading causes of death worldwide (OEVER *et al.*, 2020). Imaging aids in the early detection of CAD, contributing to the prevention of complications (OEVER *et al.*, 2020). Thus, there are AI algorithms that can identify early left ventricular ischemia caused by coronary stenosis, which may be invisible to the human eye, and classify the degree of this stenosis (OEVER *et al.*, 2020). It is also worth mentioning that AI algorithms are being developed to stratify the risk of the disease, contributing to therapeutic decision-making based on its prognosis (OEVER *et al.*, 2020).

In diagnosis

AI can detect subtle cardiac abnormalities that traditional imaging methods and human capabilities may overlook (TOLU-AKINNAWO *et al.*, 2025). Thus, technological advances in hardware and software in cardiac magnetic resonance imaging, coronary angiotomography, and coronary artery calcium scoring tomography are some examples that use AI to diagnose these heart diseases (TOLU-AKINNAWO *et al.*, 2025).

An AI model was created to classify changes obtained in chest X-ray imaging,

such as those found in valvular heart disease (UEDA *et al.*, 2023). This information could usually only be obtained from an echocardiogram, but the application of AI has made it possible to infer this data solely from the analysis of X-rays, expanding the diagnostic power of the method (UEDA *et al.*, 2023). However, its use is still limited, and it is currently applied as a complement to echocardiographic diagnosis (UEDA *et al.*, 2023).

The study by Playford *et al.* (2020) applied an AI algorithm developed based on echocardiograms, making it possible to diagnose severe aortic stenosis, overcoming the limitations related to measurements of the left ventricular outflow tract (RIBEIRO *et al.*, 2022). Thus, AI was able to predict the difference in survival between cases of severe and non-severe aortic stenosis (AS) when compared to conventional assessments, and diagnosed more severe AS than other traditional methods (RIBEIRO *et al.*, 2022).

In treatment

AI can be used to refine and combine different imaging exams used during transcatheter interventions in structural heart disease, given that fluoroscopy alone has difficulty distinguishing soft tissues, requiring the combination of other complementary exams, such as echocardiography or computed tomography (RIBEIRO *et al.*, 2022). With this, AI automates image segmentation and anatomical structure recognition, enabling the superimposition of images obtained by different examination methods and the identification of important areas for positioning valves and devices, such as in the direction of transapical access in complex interventions (RIBEIRO *et al.*, 2022).

In clinical decision-making

AI protocols capable of producing a score used in transthoracic echocardiography, based on the detection of thrombi in the left atrial appendage (PIESZKO *et al.*, 2023). Given these results, it is possible to select which patients will undergo transesophageal echocardiography before cardioversion or catheter ablation, allowing for a reduction in the number of these interventions in patients on chronic oral anticoagulation and, consequently, avoiding adverse outcomes (PIESZKO *et al.*, 2023).

Limitations

Even with its clinical advantages and high precision, AI still has major limitations and requires further in-depth scientific study (POTERUCHA *et al.*, 2025). Therefore, in clinical practice, it is difficult to assess whether an algorithm is good enough to be implemented, as there are variations in the metrics used to analyze them, such as: there are metrics used by computer engineers that are difficult for clinicians to interpret, and it is complicated to know whether a human observer would be able to perform that particular function performed by algorithms more efficiently (OEVER *et al.*, 2020). In addition, these algorithms may be biased, since large databases often contain irrelevant or inconsistent information (RIBEIRO *et al.*, 2022). Therefore, obtaining well-structured data is essential for the development of robust algorithms, but most of the evidence comes from single-center studies, which hinders the quality of these results (RIBEIRO *et al.*, 2022).

FINAL CONSIDERATIONS

In short, AI in the process of prevention, screening, diagnosis, prognosis, treatment, and future complications in the context of cardiac pathologies is capable of reducing delays, increasing the productivity of care, making access to information faster and more effective, avoiding complications, preventing inappropriate treatments, and above all, complementing the care already provided by human power. However, the use of this technology still needs to be evaluated, given its computational limitations and the boundaries between human assessment and reasoning and the use of advanced technologies. Given the above, the current evidence is still vulnerable, and new clinical trials, preferably multicenter studies, should be conducted to improve the evidence obtained.

Conflict of interest: The authors have no conflicts of interest to disclose.

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