Revista Bioética
Print version ISSN 1983-8042 | On-line version ISSN 1983-8034

Rev. Bioét. vol.34 Brasília 2026

Pros and cons of artificial intelligence in clinical decision-making

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Abstract

Science has been experiencing technological breakthroughs that contribute to the advancement of medical practice; however, there is a fine line between incorporating these technologies and preserving the human dimension of the profession, especially regarding the development of clinical reasoning. Artificial intelligence represents a branch of computer science that mimics human thought and learning capacity. Questions are debated concerning the doctor-patient relationship and the clinical physical examination that leads to diagnosis, while acknowledging the overwhelming importance of technology in supporting public health. Artificial intelligence is being increasingly refined, with algorithms polished for greater clinical applicability and the improvement of disease diagnosis, treatment, and prognosis. However, its widespread application presents challenges and ethical dilemmas that must be discussed. To this end, there is an extremely fruitful territory with multiple possibilities. Nevertheless, to what extent can technology compete with the human mind?

Keyword: Technological development. Artificial intelligence. Clinical. Evidence-based medicine. Clinical medicine. Clinical decision-making.

Resumo

Prós e contras da inteligência artificial na decisão clínica

A ciência vem experimentando avanços tecnológicos que contribuem para o avanço da prática médica, porém há uma linha tênue entre a incorporação dessas tecnologias e a preservação da dimensão humana da profissão, especialmente no que tange ao desenvolvimento do raciocínio clínico. A inteligência artificial representa uma vertente da ciência da computação que imita o pensamento humano e a capacidade de aprendizagem. Discutem-se questões sobre a relação médico-paciente e exame físico clínico, que resulta no diagnóstico, e reconhece-se a importância avassaladora que a tecnologia tem no apoio à saúde pública. A inteligência artificial está sendo cada vez mais aperfeiçoada com algoritmos lapidados para maior aplicabilidade clínica e aprimoramento do diagnóstico, tratamento e prognóstico de doenças. Entretanto, sua aplicação difundida apresenta desafios e dilemas éticos que precisam ser discutidos. Para tanto, existe um território extremamente frutífero com múltiplas possibilidades. Contudo, até onde a tecnologia pode disputar com a mente humana?

Palavras-chave: Desenvolvimento tecnológico. Inteligência artificial. Medicina baseada em evidências. Medicina clínica. Tomada de decisão clínica.

Resumen

Pros y contras de la inteligencia artificial en la decisión clínica

La ciencia viene experimentando avances tecnológicos que contribuyen al progreso de la práctica médica; sin embargo, existe una línea delgada entre la incorporación de estas tecnologías y la preservación de la dimensión humana de la profesión, especialmente en lo que respecta al desarrollo del razonamiento clínico. La inteligencia artificial representa una vertiente de la ciencia de la computación que imita el pensamiento humano y la capacidad de aprendizaje. Se discuten cuestiones sobre la relación médico-paciente y el examen físico clínico que resulta en el diagnóstico, reconociendo la importancia abrumadora que la tecnología tiene en el apoyo a la salud pública. La inteligencia artificial está siendo cada vez más perfeccionada, con algoritmos pulidos para una mayor aplicabilidad clínica y la mejora del diagnóstico, tratamiento y pronóstico de enfermedades. No obstante, su aplicación difundida presenta desafíos y dilemas éticos que necesitan ser discutidos. Para ello, existe un territorio extremadamente fructífero con múltiples posibilidades. Sin embargo, ¿hasta qué punto puede la tecnología competir con la mente humana?

Palabras clave: Desarrollo tecnológico. Inteligencia artificial. Medicina basada en la evidencia. Medicina clínica. Toma de decisiones clínicas.

The authors declare no conflict of interest.

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Clinical decision-making is the choice of one or more actions among several possible ones for a given case. It is based on the collection of patient data and diagnostic hypotheses developed by the physician to assess the possible need for complementary tests and, thus, optimize the chances of success of the clinical decision and reduce uncertainties. There are several elements necessary in clinical decision-making, such as the professional's experience in the medical field, the body of knowledge, the data obtained from the patient's anamnesis, the formulation of clinical questions formed by the acronym PICO (patient/population, intervention, comparison, and outcome), among other factors. All this aims to arrive at a precise diagnostic hypothesis [1].

To assist clinical decision-making, artificial intelligence (AI) has been integrated into medicine. AI is a field of computer science that develops systems to simulate human intelligence by solving problems, identifying components of human reasoning, and proposing solutions to specific issues. Thus, AI can be understood as the practice of creating intelligent computing systems capable of performing tasks without direct human instruction. To propose an action, for example, implementing algorithms and decision-making strategies is required, as well as having a large amount of training data. Computers can store and retrieve large amounts of data to assist physicians in clinical practice, such as images from different exams, and generate diagnostic probabilities based on decision algorithms that can self-modify based on the results obtained [1].

However, the entry of AI into medicine has raised ethical debates, as ethics permeates the entire clinical decision-making process, regulating the conduct and practice of the medical profession in accordance with the moral principles that govern society. In this sense, despite the potential to bring numerous benefits to society, the application of AI to assist in medical diagnoses raises ethical questions that need to be discussed and analyzed to ensure that its use does not harm the social body. Among these issues, privacy and security, trust in proposed diagnoses, and responsibility for diagnoses stand out [2].

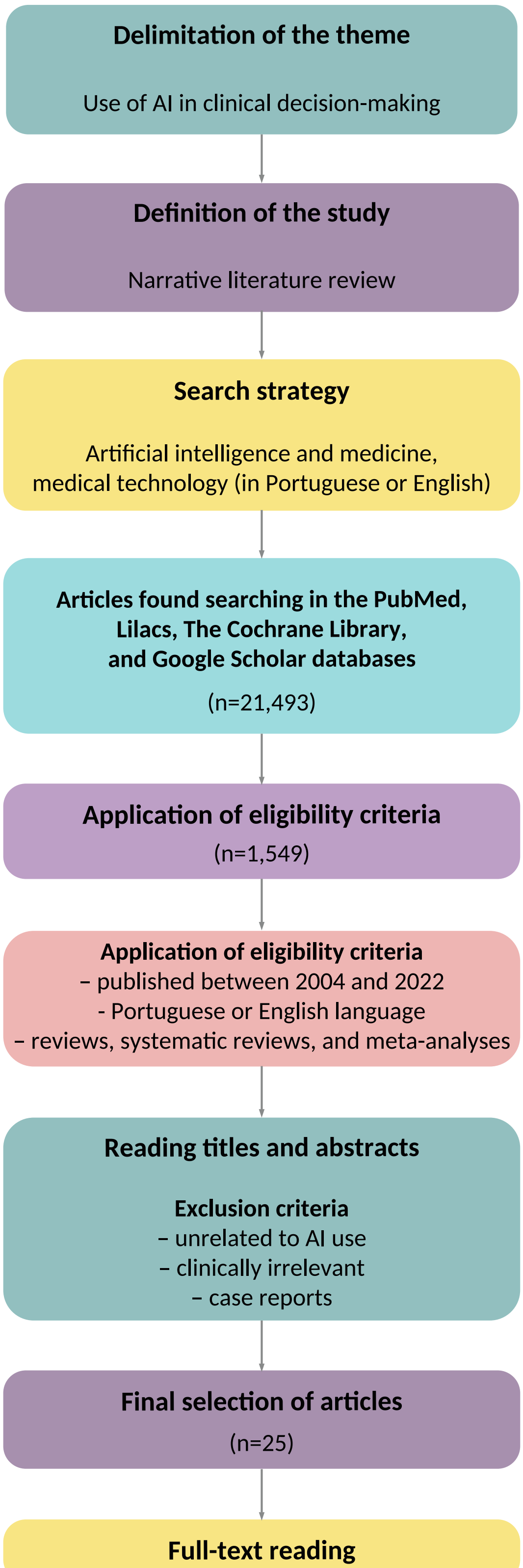
Method

This study is a narrative literature review that examines the relevance of the "artificial intelligence"- "medicine" interface in clinical decision-making. The search for articles was carried out in the PubMed/Medline (NCBI), Lilacs, The Cochrane Library, and Google Scholar databases, using the following descriptors: "inteligência artificial" and "medicina," "tecnologia médica," or their English equivalents on international platforms. For this study, articles published between 2004 and 2022, in English or Portuguese, were eligible.

The inclusion criteria were articles relevant to the foundation of the AI theme in medicine, including meta-analyses, systematic reviews, and literature reviews. Articles that did not correlate AI and medicine and its multifaceted perspective, as well as those without clinical relevance, were excluded. Case reports and articles published outside the period 2004-2022, or not written in Portuguese or English, were also excluded.

After a thorough reading of the eligible works, 25 articles were selected for analysis and discussion, with a critical interpretation of the data based on the theme "use of AI in decision-making during medical practice," as shown in Figure 1.

Figure 1. Flowchart of the selection for the study



Results and discussion

Clinical decision-making

The main tools available to a physician for diagnosing a patient are medical history and clinical examination. A study of 80 outpatients in England showed that medical history alone accounted for 82.5% of diagnoses; clinical examination and complementary tests, for 8.75% each [3]. The interpretation of this information is considered important for the clinical investigation process, requiring beginning the analysis with medical history, followed by clinical examination, and then complementary tests. These procedures provide the physician with essential information for clinical decision-making, while also allowing the exclusion of certain diagnostic hypotheses and the identification of patients in the early stages of terminal illnesses.

From this perspective, the data provided by medical history, physical examinations, and complementary tests may vary, as they depend on professional experience in recognizing patterns and criteria for developing hypotheses aimed at correct diagnoses, as well as on the possible variables in constructing the patient's medical history. Therefore, during decision-making, the professional's experience in the medical field is fundamental for analyzing complaints and the eventual process of constructing hypotheses, with a view to solving the problems presented by the patient. Diagnostic hypotheses are formulated through association with similar cases or by identifying similar situations in the literature. Consequently, physicians can obtain confirmation by searching for new data and, if there is a need to review the clinical picture, more information or test results will be required, or even research in databases, in order to find more data on the condition in the literature, favoring the success of the clinical decision [1].

Factors that influence the moment of decision include information acquired during the anamnesis and physical and complementary examinations, as well as the physician's and the patient's intrinsic conditions. In addition to academic and practical training, the physician's mental state, self-confidence, physical wear and tear, and personal issues can interfere with the interpretation of information. It is still necessary to consider patient-related factors, such as the ability to express symptoms, especially during the anamnesis, and understanding and adherence to treatment, variables that also influence the data collected. Therefore, despite being subjective and fluid, this data is indispensable for making a diagnostic decision [4].

The clinical decision-making process also involves identifying ethical conflicts and understanding moral values [5]. In contrast, technical aspects permeate the formulation of hypotheses, since available resources, such as individual data obtained through anamnesis and physical examination, must be grouped syndromically, topographically, and etiologically to justify the clinical manifestations and medical conduct [4].

Establishing the first step in the search for medical literature requires formulating clinical questions based on the questions raised and the data obtained previously, to seek appropriate answers to the hypothesis. Regarding the analysis of the question construction, PICO was used, an acronym that means: P – patient or population; I – intervention, information, or exposure; C – comparison (with alternatives); and O – clinical outcome, the expected result for the hypothesis. In the background, defining keywords that characterize each PICO element enables more focused, effective research results by avoiding information gaps or an increased number of references unrelated to the area of interest [6].

Despite this, there are uncertainties regarding interpretation and evaluation based on professionals' experience, opinions, and intuition, since diagnostic results lack complete reliability due to interpretative variability [7]. Therefore, the clinician must use mechanisms to reduce these doubts [4].

Artificial intelligence and its application in the medical field

In the context of medicine, AI systems can use advanced algorithms to "learn" from health data, assisting clinical practice and being programmed to perform self-correction based on feedback. Its use in the medical field facilitates the search for up-to-date information across various media, which can reduce diagnostic and therapeutic errors and facilitate the collection of data from large patient populations, supporting clinical practice [8].

In this sense, data collected from clinical activities were used to "train" AI systems before being implemented in medical practice. Based on this information, AI models learn to identify patterns, group similar cases, and recognize associations between characteristics within a given domain and the outcomes of interest. AI devices fall into two main categories: the first includes machine learning techniques that analyze structured data, such as images, genetic, and electrophysiological data, to group patient characteristics or infer the probability of disease outcomes. This process, in turn, can be subdivided into two categories of algorithms: unsupervised learning and supervised learning. The second category includes natural language processing methods that extract unstructured data, such as clinical notes and medical journal publications, and transform it into structured data, i.e., machine-readable text [9].

Regarding clinical decision-making, an important example of AI is Watson, IBM's supercomputer, which stores a wealth of health information and trains neural networks for data processing in fields such as oncology. Watson assimilates medical books, articles from PubMed and Medline, and patient records from Sloan Kettering Memorial Cancer Hospital, and, based on probabilistic analysis of this clinical data, proposes potentially appropriate diagnoses and medical care to assist professionals in clinical decision-making [1,8]. While this technology achieved 90% accuracy in the proposed diagnoses, in some cases, there was disagreement between the software and the physicians, so only 63% of these professionals chose to follow the AI's diagnosis [10].

Another relevant application of AI is in radiology, a specialty that has benefited considerably from this technology, as it assists with image recognition through computer vision and image processing techniques. These resources favor both obtaining the diagnosis more quickly and clearer visualization of the pathology, as well as issuing alerts in the event of potential emergencies. These benefits are highly relevant to medical decision-making [11].

It is worth highlighting the echocardiography software developed by researchers at the University of Oxford, which proposes diagnosing coronary heart disease with an accuracy rate of approximately 90%, compared with the 80% achieved by healthcare professionals, thus underscoring the advantage of using AI for diagnostic accuracy [12]. In conclusion, AI has wide application in medicine, and advances are being observed across its most diverse areas, as shown in Table 1.

Table 1. Medical specialties with the highest number of research studies in artificial intelligence, in 2020

Specialties with the highest number of AI research studies		
Total	**2,381**	**100%**
Radiology	783	33%
Psychiatry	406	17%
Neurology	287	12%
Pediatrics	239	10%
Cardiology	166	7%
Oncology	162	7%
Ophthalmology	155	7%
Other areas	183	7%

Source: the authors

It is not surprising that radiology is in first place; this specialty makes extensive use of AI in imaging exams, which generate a great deal of data for itself and for various other specialties [13]. In psychiatry, AI is being used as a kind of "social robot" for patients with dementia and autism spectrum disorder, conducting virtual psychotherapies through artificially intelligent agents for high-level therapeutic interventions, which used to be offered exclusively by qualified professionals [14]. In third place is neurology, a specialty closely linked to radiology in AI use. Several possibilities are observed, such as using AI to incorporate diverse data into a unified algorithm and combining non-invasive images with clinical and laboratory metrics for outcome prediction [15].

Pediatrics, which came in fourth place, reports uses of AI for AI-assisted auscultation, automated image-based bilirubin, and electronic health record systems [16]. In cardiology, support vector machines have been used to predict the deterioration of ventricular function in patients with tetralogy of Fallot. In addition, genetic algorithms have been employed in the development of a wearable device capable of detecting arrhythmias from single-lead electrocardiogram recordings [10].

Current regulations

Given the intense and growing use of AI across a wide variety of areas, the Organisation for Economic Co-operation and Development (OECD) pioneered the regulation of this technology, serving as a basis for several other countries, including Brazil, which is a signatory to this document [17]. Thus, in Brazil, federal deputy Eduardo Bismarck (PDT-CE) developed Bill 21/2020, based on OECD strategies, one of the first to present principles, rights, duties, and governance instruments for the use of AI in the country [18]. Despite its approval in the Chamber of Deputies, the bill was shelved, but served as a basis for subsequent regulatory proposals [19]. Despite this, it is worth noting that several experts criticize the bill, considering it too generic, especially for failing to provide objective guidelines on the use of AI, which may leave room for various interpretations, fostering, for example, legal uncertainty and conflict [20].

Regarding the perspective of responsibility, the bill presents the development and operation agents. AI systems are considered responsible for this technology. Despite this, there is no specific analysis of its use in medicine; it is relevant to establish criteria to define civil liability in the context of AI use [12,21]. In this context, given the lack of specific legal regulations, the attribution of civil liability to the physician, in the face of diagnostic error, is based on the subjective regime, determined by Article 927 of the Civil Code, which is based on the general clause of the unlawful act (Article 186 of the same Code) [22]. This clause is based on proof of normative fault, analyzing the agent's intentional or negligent conduct, the damage, and the causal relationship between the conduct and the damage. The attribution of fault will occur upon proof that the medical professional's conduct, in the face of AI information, constitutes errors [12,21]. As for holding those responsible for software errors accountable, the objective regime (Articles 12 and 14 of the Consumer Protection Code) must be analyzed, in which the civil liability of the AI manufacturers in question will be judged [23].

Thus, the need to accelerate the bureaucratic analysis so that AI advances can be implemented in the health field becomes evident. It is also worth mentioning the resistance of some people to accept that AI will provide a service of the

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same quality as a person, given that the models that prevail in clinics were built face-to-face. Furthermore, the patient's difficulty in accessing and using technology limits the expansion of AI use in the medical field, since, in the case of telemedicine, the patient would need to have access to the internet and mobile devices, as well as know how to use them for the consultation to work [24].

Among the negative aspects of AI, one can mention data protection and user privacy on online health platforms, as it cannot always be guaranteed that patient information will be protected and used only with their authorization. In addition, this data can be used without effective verification of its veracity, which compromises the results of reports developed based on the information collected [25].

Ethical aspects of artificial intelligence

As AI is increasingly being used in medicine, it is necessary to pay attention to the challenges and risks of this tool, as well as its ethical aspect [26]. From the moment a technology begins to interfere in a life, imposing a limit and questioning the extent to which this intervention will be beneficial for a given situation is required [21].

Furthermore, these technological advances prompt a robust ethical debate about the use of users' personal information, as there is a risk of data exposure that affects both privacy and the secure, anonymous use. Not far from the issue presented, the danger of data leaks is also present when hospitals share patients' clinical information with artificial systems that use it to improve their algorithms and, consequently, their diagnostic responses [2].

Another important issue is the reliability of diagnoses provided by AI, since diagnosis involves a subjective, multidimensional analysis of individuals and, therefore, the reliability of the clinical outcome indicated by AI depends on the diversity of the data sample used to train and improve this system. If sampling is restrictive and does not capture information on ethnic, racial, ancestral, socioeconomic, and diagnostic diversity, clinical results may exhibit bias, with a greater likelihood in groups underrepresented in this data [2,26].

Given this, there will be an unequal application of AI, which violates the ethical principle, as medical information is mostly collected from the ethnically white and European population; i.e., the diagnoses suggested by AI will be accurate and effective only for this population. Other groups will not be able to benefit from this technology satisfactorily, since they may be harmed by it. Thus, it is evident that the lack of diversity in the sampling undermines justice and the principle of non-maleficence, as its use can harm underrepresented groups. Therefore, a more inclusive collection of information, encompassing the most diverse social groups, becomes fundamental, so that its use in AI allows the entire population to be served, without being biased by prejudices and inequalities already existing in society and in the health field [2,26].

Another point to be highlighted in the ethical issue in AI in medicine is accountability for decision-making, since if an AI system using an algorithm makes a wrong decision, it would be difficult to assign responsibility for that decision. Legally, it is not possible to assign the responsibility that belongs to a human to an AI system, especially when there is a lack of transparency about that system. However, to avoid this situation, most of the solutions proposed by AI currently are clinical support tools rather than clinical decision-making tools, ensuring that this decision-making responsibility remains with the responsible physician [27,28].

Final considerations

The application of AI in medicine offers numerous advantages, including assisting with clinical decision-making, treatments, and medical procedures, such as devices for remote monitoring of health indicators and systems for analyzing imaging exams. Despite the benefits, the use of AI also brings with it negative aspects and ethical dilemmas, such as the misuse of personal and institutional information, the power to interfere in patients' lives, and the reliability of clinical results—which must be evaluated and resolved so that its use can be expanded, to favor and facilitate the work of healthcare professionals and fostering more accurate diagnoses of clinical cases. In this context, it is necessary to reduce bureaucracy and accelerate regulatory review to ensure greater adoption of AI in healthcare.

Regarding the ethical parameter, the regulation of AI use is fundamental to ensuring the safety and reliability of results, expanding data sampling to serve the most diverse social groups, avoiding segregation, and enabling universal use of this technology in the healthcare field. Furthermore, it is necessary to ensure that AI is used only as a tool to assist the healthcare team, especially during clinical decision-making, without seeking to replace medical professionals, but rather to support them, so that the responsibility for diagnosis remains with the physician. With continued development and improvement, AI use in the medical field can grow significantly, including supporting clinical research and generating diagnostic results.

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Giovana Lúcia Silva Diniz participated in the conceptualization, method, and writing (original draft). Samuel Sotero Lourenço participated in the methodology, writing (revision and editing), visualization, and project administration. Giovanna de Oliveira Melo Fiuza Lima participated in the conceptualization, method, writing (original draft), and visualization. Maria Carolina Bezerra Di Medeiros Leal participated in the supervision, and writing (revision and editing).

Data availability: All data used or generated in this study are described and presented in full in the body of the article.

Editor in charge: Dilza Teresinha Ambrós Ribeiro

Received: 2.24.2025
Revised: 8.7.2025
Approved: 11.27.2025