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Bioethical challenges related to the use of artificial intelligence in hospitals

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Abstract

This paper explores advantages and possible bioethical challenges of using artificial intelligence in hospitals. By identifying challenges both in the development of artificial intelligence systems (pre-hospital phase), its adoption, and training of healthcare teams (hospital phase), it analyzes the role of the bioethical approach in addressing this situation, especially in hospital bioethics committees. Hence, by identifying individual – related to autonomy, consent and patient privacy –, and collective challenges – how society at large should behave before new technologies –, the paper examines the role of the state in protecting patient privacy in contexts where artificial intelligence is used. In conclusion, considering the human vulnerability before technology, regulation is a tool that, anchored in bioethical principles, aims to minimize the challenges concerning artificial intelligence in hospitals.

Keywords: Artificial intelligence. Hospitals. Bioethics.

Resumo

Desafios bioéticos do uso da inteligência artificial em hospitais

Este artigo explora vantagens e possíveis desafios bioéticos do uso da inteligência artificial em hospitais. A partir da identificação de desafios no desenvolvimento de sistemas dotados de inteligência artificial (fase pré-hospitalar) e na implementação e capacitação de equipes de saúde (fase hospitalar), analisa-se o papel da abordagem bioética no enfrentamento dessa situação, sobretudo dos comitês de bioética hospitalar. Desse modo, mediante a identificação de desafios de ordem individual – referentes à autonomia, consentimento e privacidade dos pacientes – e coletiva – como a sociedade em geral deve se portar diante das novas tecnologias –, observa-se o papel do Estado na proteção da privacidade do paciente no contexto de utilização da inteligência artificial. Em conclusão, considerando a vulnerabilidade humana perante a tecnologia, entende-se que a regulamentação é um instrumento que, junto com os princípios bioéticos, tenta minimizar os desafios do uso da inteligência artificial em hospitais.

Palavras-chave: Inteligência artificial. Hospitais. Bioética.

Resumen

Desafíos bioéticos del uso de la inteligencia artificial en los hospitales

Este artículo explora las ventajas y los posibles desafíos bioéticos que plantea el uso de la inteligencia artificial en los hospitales. Con base en la identificación de los desafíos en el desarrollo de sistemas dotados de inteligencia artificial (etapa prehospitalaria) y en la implementación y capacitación de los equipos de salud (etapa hospitalaria), se analiza el papel del enfoque bioético en el enfrentamiento de esta situación, especialmente de los comités de bioética hospitalaria. Por lo tanto, mediante la identificación de los desafíos individuales –relativos a la autonomía, al consentimiento y a la privacidad de los pacientes– y colectivos –cómo debe actuar la sociedad en general ante las nuevas tecnologías–, se observa el papel del Estado en la protección de la privacidad del paciente en el contexto del uso de la inteligencia artificial. En conclusión, teniendo en cuenta la vulnerabilidad humana ante la tecnología, se entiende que la regulación es un instrumento que, junto con los principios bioéticos, trata de minimizar los desafíos del uso de la inteligencia artificial en los hospitales.

Palabras clave: Inteligencia artificial. Hospitales. Bioética.

The authors declare no conflict of interest.

Research

Medical devices, genetic engineering, and telemedicine are some examples of new technologies employed in healthcare. Among these innovations, the development and improvement of artificial intelligence (AI) systems, which are already being used as a healthcare aid in several countries, stand out. Besides, the new coronavirus (SARS-CoV-2) pandemic, which began in 2020, increased the use of AI in the search for solutions that could contribute to provide services and combat the virus.

With the growing demand for AI, we must reflect not only on the possible benefits arising from its use in healthcare, but also on the challenges and risks it can pose to patient care. This is especially true in hospitals, considering their multidisciplinary character where several professionals are involved in decision-making. Hence, this exploratory literature review [1] reflects and fosters debates on possible bioethical challenges for the use of AI in hospitals.

By means of a literature analysis we present the definition and operation of AI in healthcare, especially in hospitals, as well as the advantages of its use, challenges regarding its implementation, and the importance of bioethics in pointing out the limits and purposes of technology's intervention on life, and the role of the state in this implementation.

Based on such analysis, we suggest approaches that can be adopted by society at large, as well as scientists, health professionals and governments, to elaborate (pre-hospital phase), use in hospitals (hospital phase), and regulate and supervise the AI, for the safe and correct use of this technology.

Artificial intelligence

Second brain

Artificial Intelligence can be defined as a human-like intelligence, but developed by software. According to Santos, *artificial intelligence is a branch of computer science research that, through computational symbols, seeks to build mechanisms and/or devices that simulate the human capacity to think, solve problems, that is, to be intelligent* [2].

By the so-called machine learning, computers are programmed to learn as humans do, and almost all machine learning is built on neural networks. These are (...) *computer systems with interconnected nodes that function like the neurons in the human brain. Using algorithms, they can recognize, group and classify hidden patterns and correlations in raw data and – over time – continuously learn and improve* [3].

Neural networks are fed by big data entered into the system and are trained to find a solution involving such data. In healthcare, this encompasses anything from early diagnosis of diseases to drug infusion [4].

According to Professor Hal Daumé III, *at a basic level, machine learning is about predicting the future based on the past. For instance, you might wish to predict how much a user Alice will like a movie that she hasn't seen, based on her ratings of movies that she has seen.* (...) *In general, this means making informed guesses about some unobserved property of some object, based on observed properties of that object.* (...) *Generalization is perhaps the most central concept in machine learning* [5].

Based on different studies, Gomez [6] highlighted that AI unfolded into four approaches: 1) systems that think like humans; 2) systems that think rationally; 3) systems that behave like humans; and 4) systems that behave rationally. Robots can be considered intelligent computer systems capable of performing tasks without direct input from humans [7].

In its many forms, AI is increasingly employed in healthcare as a second brain, a thinking being used to help diagnose diseases and in patient care. Consequently, such technology must be accompanied by human brains, so that technological progress does not result in harm to patients or professionals.

The healthcare 4.0 era

Chen and collaborators [8] highlight that the field of healthcare can be divided into four eras. In the 19th century, the 1.0 era adopted intelligent public health approaches, such as sanitation measures and vaccination research, to improve quality of life. The 2.0 era, in the early 20th century, was marked by the expansion of big pharma, aided by industrial technology, which made mass production of various antibiotics possible. Basic science education and clinical training was also expanded, with mass structure being the hallmark of this era.

The 3.0 era begins around the 1980s, characterized by information technology. As computer technology

advanced, better use was made of images in healthcare, allowing physicians to examine lesions with additional information and identify diseases more quickly. Also in this era, the advancement of the Internet has enabled wide access to the medical literature, accelerating the development of evidence-based medicine.

Currently, the world is living the healthcare 4.0 era, characterized by smart medicine. Following the new wave of technological revolution, this phase is largely dominated by AI, automation, big data, precision medicine, telemedicine, etc., establishing itself as the era in which medicine gained new brains and new hands [8]. Hence, news of AI use in healthcare is frequent, and its use for disease prevention, detection, and treatment is being widely researched.

IBM [9], a US-based computer company, created the Watson Health, an evidence-based technology that allows health professionals to share data, for example, thus providing information for hospital care and research. Watson's performance stands out in assisting cancer treatment and in researching new therapies in science, which, according to IBM [9], reduces the costs of care and improves the value of health and social services via precision medicine.

In 2014 Google acquired DeepMind [7-10], a company focused on AI development that created a memory enhanced neural network called differentiable neural computer (DNC), which learns from experience using a deep learning system. DNCs [11] learn to use memory and produce responses from scratch.

In partnership with British hospitals and universities, Deep Mind develops studies and applications to find faster ways to identify common eye diseases from routine examinations [10] and differentiate healthy tissue from cancer cells. Moreover, the company has created an application to analyze data from medical records, alerting patients when their clinical condition changes [7].

Artificial intelligence in hospital support

Lobo states that *AI in medicine is the use of computers that, by analyzing a large volume of data and following algorithms defined by experts in the field, can propose solutions to medical problems* [7].

Much studies research the use of AI in healthcare, such as prognosis of cancer patients' quality of life, aiding decision-making about the most appropriate clinical treatment [12] or using facial recognition to detect fever [13]. The present research, however, seeks to analyze the use of AI in hospitals based on cases published in national and international studies. Importantly, although this analysis refers to the hospital environment, many observations and conclusions can also be applied to AI use in healthcare outside hospitals.

A South Korean study has proven the use of deep learning-based AI as a tool to accurately predict the need of intensive care for patients in pre-hospital emergency medical services. This outperformed conventional triage tools and early warning scores, allowing us to conclude that (...) *the predictive performance of the AI model based on deep learning is superior to those of the conventional triage tools and scoring systems* [14].

In deep learning, therefore, the algorithm learns by itself which image features are important to make a classification, without needing to be told by humans. As a result, it can discover features that may have been missed by people, outperforming humans. Nevertheless, we fear that this type of AI system could be presented to society as superior to medical expertise, creating pressure for its premature implementation in health systems, leading to development without a rigorous evidence base [15].

To avoid such scenario, the research and design of the system must be ethical, diligent, and transparent. Besides, this process must be based on scientific evidence and follow all the necessary protocols and steps for its safe implementation in healthcare, and researchers cannot succumb to social pressures lest they compromise the AI development.

The same rigor must be applied to the sharing of results, striving for the patient's best interest, and not technological pioneering. Hence, one must weigh benefit and harm, risk assessment and risk management, as stated in Articles 4 and 20, respectively, of the *Universal Declaration on Bioethics and Human Rights* (UDBHR) [16].

During the covid-19 pandemic, the use of AI in healthcare has become even more frequent. A study published in March 2020 in the journal *Radiology* claims that deep learning AI could accurately detect covid-19 from chest computed tomography (CT) images and distinguish it from pneumonia and other diseases, lung or otherwise [17]. This would speed up the detection of the disease, since chest CT could be used as a fast and reliable approach for covid-19 screening.

Despite their satisfactory results, Li and collaborators [17] highlighted several study limitations: one *disadvantage of all deep learning methods is the lack of transparency and interpretability (e.g., it is impossible to determine what imaging features are being used to determine the output)* [17]. They also highlight that *no one method will be able to differentiate all lung diseases based simply on the imaging appearance on chest CT scans. A multidisciplinary approach for this is recommended* [17].

Other studies report on the use of robots for hospital environment disinfection [18] and remote temperature measurement [19], and the recent authorization of telemedicine [20] in Brazil. In this country, AI has been used as a pre-hospital triage tool via an online intelligence system that answers questions and guides patients, acting as a digital emergency service to reduce hospital overload.

In hospitals, the robot Laura, which uses the same AI system as the digital emergency room, helps (...) *to prevent damage and reduce costs through predictive analyses. Laura's AI provides patients on a risk trajectory with early identification, giving the care team more time to begin care management* [21].

Challenges of using artificial intelligence in a hospital environment

Faced with so many possibilities, we must also expose the challenges arising from AI use. Hence, the following issues should be closely dissected and discussed in a responsible and ethical manner for the correct and safe implementation of AI in health systems and its use in hospitals: civil liability of the health team due to the AI-supported decision; poor training of health teams to adequately manage this system; confidence of health professionals in this system; scientific integrity in the AI construction process; protection and sharing of sensitive data captured to feed the system.

As for AI as support for health decision-making, "know-what" and the "know-why" stand out. The system can thus assist the professional in this process by suggesting hypotheses about the problem and its probability of occurrence (know-what) but cannot explain their causes (know-why). Consequently, if used as a decision-making system, AI can lead to errors regarding the medical conduct to be followed, depending on the system's ability to identify problems affecting patients [7], which would eliminate one its advantages.

We need to invest in training health professionals to correctly operate the available AI systems. Likewise, we must offer adequate training to future healthcare professionals, ensuring a more prominent place for bioethics in their education to promote patient benefit to the patient, not the success rate of the system.

Hence, even if technology becomes an object of study for health professionals, it is expected that, in equal measure, the offer of an even more humanized and ethical teaching for managing this technology will be expanded. As such, Han and collaborators point out *that artificial intelligence will reduce the efforts required by physicians to interpret digital data and improve their ability to establish a diagnosis and prognosis. Therefore, the non-analytical, humanistic aspect of medicine will come to be more emphasized because it is hard to replace it with technology.* (...) *Future medical education should be restructured to align with such inexorable changes by considering learners who will be working in digitalized health care systems* (...). *There are some considerations of digital learning with advanced technology, although it has many technical advantages. We must give careful consideration to ethical and moral challenges because computer-based learning and artificial intelligence algorithms may be programmed to be biased against certain groups or skewed toward any interests. Most of all, a humanistic approach should be prioritized for future physicians to deal with biopsychosocial complexity of patients that are not easily accessible to machine* [22].

Another key point in the use of AI in hospital settings is the feeding of the system, since, on one hand, patient data must be properly included in the tool and, on the other, there is a high staff turnover. Developing a feeding flow that does not suffer from staff turnover is thus imperative to achieve satisfactory results. In a chaotic period such as the covid-19 pandemic, for example, for AI to work as an aid in the hospital environment, data processing must be guaranteed by designating a specific team or people to feed the system and ensure its efficiency.

Lobo highlights that *currently, the problem is to process a large volume of information, either through electronic medical records with patient data, test results, proposed diagnosis, prescription, and results of these medications, or by typing, considering that data may be unavailable or incomplete. One must also consider that information may still have to be typed due to the incompatibility of systems in which it is recorded. It must be considered, however, that such typing may eventually introduce a human error component* [7].

Importantly, errors made in this phase can compromise the opinion issued by the AI, exposing patients and healthcare staff who trusted the system. This puts the role of bioethics before the use of AI in hospitals into question.

Bioethical challenges of using artificial intelligence

Bioethics arose as a result of the atrocities perpetrated during World War II, to build the ethics of life, common to all beings and nations. Currently, bioethics aims to respond to the new ethical questions raised by health and life sciences, especially regarding the new technologies employed in this field [23].

Concern regarding the perversities committed in human research, which resulted in the Nüremberg Code, seems to suggest that human research ethics is the main scope of bioethics. But it is increasingly urgent to apply it to other spheres of relationships and research, crossing the bridge idealized by Van Rensselaer Potter in his well-known work *Bioethics: Bridge to the Future*. When it comes to new technologies, as important as worrying about the ethics of testing is to pay attention to the scientific integrity of the research, the veracity of data, the consent of the data subject, and especially the smoothness and scientific rigor of the research presented.

Gomes argues that three questions about AI must be answered: 1) For when?; 2) For whom?; and 3) For what? In his own words: (...) *for when* (...) *today and now, we should (and can) avoid becoming objects of Artificial Intelligence (AI) and question its purpose rather than accepting it as inevitability or fatality. Regarding the second question, for whom*, (...) *AI should be directed to the good of humanity, of the person, and each person should stop being just a spectator and become a decisive actor in the ethical assessment of the value and best interest of AI in each concrete case. Regarding the question for what, AI should be at the service of the person and not the person at the service of technology; we all have an ethical responsibility not to impede scientific progress, but we also have the ethical duty to ask about its purpose* [24].

As Silva and collaborators point out, *even though advances in technology are paramount in the world of medicine, from the moment* [in which] *one begins to interfere in another life it is necessary to establish not only a limit, but a social, economic, and biological control of the extent to which it is a beneficial intervention to the population* [25].

Ethics are required at all stages of AI development, and this process starts with a sense of accountability from those who program the machine [6]. They must preserve scientific integrity throughout the process, from data collection and processing to the disclosure of results to the scientific community. They must be impartial about the results obtained and possible harm to users, incorporating the bioethical principle of non-maleficence.

Besides the already established principles, one must consider other bioethical references, such as the "4P"-based analysis described by Garrafa and Azambuja [26]: prudence with the unknown; prevention of possible harm; precaution against indiscriminate use of new technologies; and protection of the socially excluded, the most fragile and vulnerable. For the authors, the incorporation of such references are necessary

for the exercise of a bioethical practice committed to the most vulnerable, to the res publica, *and to the environmental and planetary balance of the 21st century* [26].

Compliance with the "4Ps" in conjunction with the bioethical principle of non-maleficence, imposes to highlight that the protection and authorization of patient data use is of paramount importance when analyzing the use of AI, especially in the hospital environment. Consequently, the following questions must be analyzed and debated in a transparent and rational manner, considering their possible unfoldings and assuming possible refusal of care by the hospital institution if patients refuse to share their data:

- Is the patient informed about how the system of a given hospital works?
- Is informed consent for the use and sharing of the sensitive patient clinical data collected?
- What are the ethical implications of omitting this clarification?

According to a study published in March 2020 in the *British Medical Journal*, although AI research is promising, the literature lacks (...) *transparency, clear reporting to facilitate replicability, exploration for potential ethical concerns, and clear demonstrations of effectiveness* [27]. The paper also highlights that one reason for this (...) *is the current lack of best practice guidance specific to machine learning and artificial intelligence* [27]. As such, the study proposes 20 critical questions to help identify common pitfalls that may hinder machine learning-based or IA-based applications in healthcare. The questions cover issues of transparency, reproducibility, ethics, and effectiveness.

The training of new health professionals must also be reevaluated to keep up with technological developments within a bioethical perspective. A study published in February 2020 in the journal *Frontiers in Medicine* analyzed this issue, highlighting the need to validate modern tools with traditional clinical assays and discuss the educational update of the medical curriculum in light of digital medicine, considering the ethics of ongoing connected monitoring [28]. The study uses the term "augmented medicine" trying to encompass the novelties brought not only by AI, but by all digital apparatuses.

In investigating why the field of augmented medicine can encounter some resistance from healthcare professionals – especially physicians –, the study highlights four reasons: 1) unpreparedness regarding the potential of digital medicine, given the lack of basic and continuing education on this subject; 2) early digitalization of healthcare processes, which culminated in a sharp increase in administrative burden, mainly related to electronic health records – which has come to be known as a major component of physician burnout; 3) growing fear regarding the risk of AI replacing physicians; and 4) current lack of legal framework worldwide defining the concept of liability in case of adoption or rejection of algorithm recommendations [28].

Given this parameter, education for AI use in healthcare should focus not only on technology management, but mainly on how to address patients. When practicing humanized medicine, focused on the patient well-being – the determining factor for medical decision –, professionals will not be afraid of civil or criminal liabilities for having relied or not on AI in their diagnosis, since the guiding principles of their decisions were ethics and beneficence.

Technology-related ethics began to be studied at least 20 years ago. Besides the ethical principles that govern health research – respect for persons, beneficence, and justice – the new era has brought additional ethical conflicts, given the new stakeholders, such as technology companies, and the large volume of data generated. Consequently, we must recognize who is involved in this process and identify how each party can and should take responsibility for promoting ethical practices in this work [29].

This is a concern of the World Health Organization (WHO), which in January 2020 published a report with the greatest public health challenges of the next decade, expressing concern about insufficient government investment in the sector. Among the major WHO concerns is mastering the new health technologies, especially regarding the challenges of monitoring and regulation [30].

This is to prevent technologies that have been developed to help people from harming them in any way. Hence, we must (...) *review evidence and guidelines on more controversial issues, such as human genome editing and digital health, and request that countries regulate the development and use of these new technologies* [30].

Nebeker, Torous, and Bartlett Ellis emphasize that, at least in the United States, *not all persons who initiate research are regulated or professionally trained to design studies.* (...) *The ethics review is a peer review process to evaluate proposed research, and identify and reduce potential risks that research participants may experience. Having an objective peer review process is not a requirement for technology giants, startup companies or by those who identify with the citizen science community; however, we have a societal responsibility to get this right* [29].

The authors also highlight a framework of digital health decision-making domains developed to help researchers make good decisions when selecting digital technologies for use in health research. Such framework comprises five domains, presented as cross-relationships: 1) participant privacy; 2) risks and benefits; 3) access and usability; 4) data management; and 5) ethical principles [29].

Role of bioethics committees

Given this scenario, bioethics committees play a key role in implementing and supervising AI use in hospitals, as well as in assisting health professionals with AI-supported decision-making to prioritize patient benefit. Rocha and Rocha, however, point out that *many bioethical decisions end up being made by hospital authorities and/or legal professionals, unequipped with bioethical knowledge, presenting answers that seek to legally safeguard public and private juridical entities from possible lawsuits, instead of proposing ethical solutions that can comfort patients and their families* [31].

In Brazil, according to the Federal Council of Medicine Recommendation 8/2015 [32], hospital bioethics committees/commissions should be formed by a multi-professional, autonomous collegiate with consultative and educational competence. These bodies aim to assist in the reflection and solution of issues related to morals and bioethics that arise in patient care. Bioethics committees help to make more appropriate decisions for the benefit of the patient.

When discussing a computational-based decision-making model, Siqueira-Batista and collaborators highlighted that it must be clear that this is a decision support system and not a transfer of the decision-making process to a computer system. Thus, *the final word, obviously, will always be of the trained professional, who will not have to give up the exercise of their ethical conscience* [33].

As such, in the event of moral and ethical conflicts arising from medical care based on the use of AI and other technologies, the bioethics committee should be asked to assist the health team in decision making. But the committee has a prior role: to assist in the implementation of these technologies in hospital units, investigating their scientific integrity, effectiveness and feasibility in each unit, according to the training of their health professionals.

Moreover, the committee should advocate for the implementation of periodic training in the management of the AI system, focusing on bioethical guidelines, especially the principle of beneficence. By doing so, it seeks to mitigate risks to the integrity of both patients and health teams, as a result of their technology-based decision.

Francisconi highlights that *the advances in technology have fostered the emergence of progressively more developed equipment that, for the most part, has brought unequivocal benefits to patients. On the other hand, technological advances often bring ethical problems* [34]. For the author, when new techniques are offered for implementation in their work activity, professionals must ask themselves: 1) Is the new procedure safe?; 2) Is it effective?; 3) Does it represent a real improvement over the traditional one?; 4) What is its utility (cost-benefit ratio)?; and 5) Which is its social repercussion [34]?

While some of these challenges can be faced with the help of bioethics, it alone cannot solve them all. Consequently, AI regulation, spearheaded by state action, is essential.

Role of the State in the age of artificial intelligence

As the AI system uses personal data, the State must regulate the accountability, limits, and principles that should be established to handle this technology. Internationally, many regulations have been enacted to establish the contours of AI use, such as the *Recommendation on AI Ethics*, launched in late 2021 by the United Nations Educational, Scientific, and Cultural Organization, the first global normative instrument on AI ethics approved by its member states [35].

In 2021, the Brazilian Strategy for Artificial Intelligence, a public policy that aims to serve as a basis for state actions regarding the development and use of AI, was developed. Within this action, the health sector has the largest number of AI startups funded by government programs [36]. Brazil still lacks specific legislation to regulate the development and use of this technology, but Bill 21/2020 [37], which aims to create the Legal Framework for the Development and Use of Artificial Intelligence, is being discussed by the Chamber of Deputies.

But since it deals with personal data – information whose protection obtained the status of a fundamental right through Constitutional Amendment 115/2022 –, even if there is no specific legislation for AI, the provisions of the General Personal Data Protection Law [39] must be followed. This directive considers health-related information as sensitive personal data, stating that it can only be processed upon consent of the data subject. Even in cases of exception to consent, they must be used in a way that preserves the holder's rights.

Bill 3814/2020 [40], which foresees the creation of a digital platform under the responsibility of the Unified Health System (SUS), unifying patient health information from public and private establishments, is being discussed by the Chamber of Deputies. If approved, it will put to the test the challenge of ensuring respect for patients' privacy, autonomy, and consent.

Besides, ConecteSUS, *a government initiative to advance new technologies, specifically to implement artificial intelligence in Brazilian public health management* [41], is already a reality. Lemes and Lemos point out that this program makes up the National Health Data Network (RNDS), which aims to integrate data from SUS users, allowing health professionals to access patient medical data by means of an app [41].

There is an undeniable need to analyze the bioethical impacts of using big data as a predictive tool in healthcare. This leads to a more in-depth discussion about possible impacts that such use can generate on life in society, with emphasis on surveillance capitalism and its developments in the social field [42]. As for bioethics as an interdisciplinary field of study, within philosophy, which connects science, life, and morality, it presents well-founded ethical principles that can be observed in all areas of life [43].

We can thus infer that the data protection legislation corroborates the principles established in the UDBHR [16], highlighting: 1) that of consent, given that the treatment of personal data needs the prior and informed consent of the patient, and its exception must follow ethical and legal standards consistent with human rights; 2) that of privacy and confidentiality, since we must respect the privacy and confidentiality of personal information, avoiding the distortion of the purpose for which they were collected; 3) that of respect for vulnerability, since the individual is the most vulnerable party in the relationship with technology, requiring protection in the application of scientific advances on them.

It is clear that the State has been exercising its duty by regulating the use, establishing principles, and imposing limits on AI. However, patients must be provided with a guarantee that the regulatory norms will be complied with, to protect their privacy and consent, as they are the vulnerable party in the relationship and must be protected.

Final considerations

The literature has presented numerous possibilities for the use of AI in healthcare, highlighting its use in hospital support and weighing both its benefits and challenges. A pre-hospital phase is highlighted, which needs to be overseen not only by society, but also by the researchers involved in the creation of the technology. In this stage, the ethical principles of

research and scientific evidence must be respected to ensure its transparency.

Above all, we must ensure the scientific integrity of the system, so that its purpose is in fact patient benefit and not technological pioneering. Scientists who develop these studies must not succumb to social pressures to launch a technology without it having been rigorously tested and fulfilled all the stages of its creative process. The best interest of the patient must always prevail.

Once AI is implemented in hospitals, the monitoring of the bioethics committee becomes essential, guaranteeing the integrity of the technology, the research data that preceded it, and its management. The committee must also help in eventual moral and ethical dilemmas involving AI-based decision making, always guided by bioethical principles and the best interest of the patient.

The bioethics committee can collaborate in the continuing education of health professionals able to handle the technology used in the hospital unit. Such action should always strive for the humanization of care and the patient's best interest, by means of a bioethical approach in decision making. By doing so, the health team will feel secure in its decisions, without having as a first concern a possible accountability for having adopted or not the suggestion of AI.

Beyond the hospital walls, the education of health teams must be urgently reviewed to include the management of AI and new technologies into their curriculum. In the same rate, we must bolster the humanization of care and the bioethical approach to care.

In our understanding, the State plays a key role in regulating AI and ensuring compliance with its legislation. Added to the application of bioethics in facing the challenges discussed, this will allow respect for the patients' consent and autonomy and the privacy of their data, despite their vulnerability to new technologies.

Finally, as a society, everyone should strive to promote social control of new technologies and their limits for the preservation and promotion of human dignity. Moreover, we must effectively regulate them, so that technology is at the service of humanity, not the other way around.

References

1. Gil AC. Como elaborar projetos de pesquisa. 4ª ed. São Paulo: Atlas; 2002.
2. Santos MAS. Inteligência artificial. Brasil Escola [Internet]. [2008] [acesso 18 nov 2021]. Disponível: https://bit.ly/3IjcQn3
3. Redes neurais: o que são e qual sua importância? Statistical Analysis System [Internet]. [s.d.] [acesso 18 nov 2021]. Disponível: https://bit.ly/3sgog5c
4. Gambus P, Shafer SL. Artificial intelligence for everyone. Anesthesiology [Internet]. 2018 [acesso 18 nov 2021];128(3):431-3. DOI: 10.1097/ALN.0000000000001984
5. Daumé H 3rd. A course in machine learning [Internet]. [Local desconhecido]: Hal Daumé III; 2012 [acesso 18 nov 2021]. p. 8-9. Tradução livre. Disponível: http://ciml.info/
6. Gomez JAV. Problemas bioéticos emergentes de la inteligencia artificial. Diversitas Perspect Psicol [Internet]. 2016 [acesso 2 abr 2020];12(1):137-47. DOI: 10.15332/s1794-9998.2016.0001.10
7. Lobo LC. Inteligência artificial e medicina. Rev Bras Educ Méd [Internet]. 2017 [acesso 18 nov 2021];41(2):185-93. DOI: 10.1590/1981-52712015v41n2esp
8. Chen C, Loh E, Kuo KN, Tam KW. The times they are a-changin': healthcare 4.0 is coming! J Med Syst [Internet]. 2020 [acesso 18 nov 2021];44(2):40. DOI: 10.1007/s10916-019-1513-0
9. IBM. IBM Watson Health [Internet]. [s.d.] [acesso 18 nov 2021]. Disponível: https://ibm.co/3Le5UbY
10. Deep Mind. Impact [Internet]. [s.d.] [acesso 18 nov 2021]. Disponível: https://bit.ly/35a218q
11. Wayne G, Graves A. Differentiable neural computers. DeepMind [blog] [Internet]. 2016 [acesso 18 nov 2021]. Disponível: https://bit.ly/3papHk0

12. Santos HG, Zampieri FG, Normilio-Silva K, Silva GT, Lima ACP, Cavalcanti AB, Chiavegatto Filho ADP. Machine learning to predict 30-day quality-adjusted survival in critically ill patients with cancer. J Crit Care [Internet]. 2020 [acesso 18 nov 2021];55:73-8. DOI: 10.1016/j.jcrc.2019.10.015
13. Council J. Hospitals tap AI to help manage coronavirus outbreak: health-care providers are enlisting the technology to monitor patients, screen visitors. Wall Street Journal [Internet]. Artificial intelligence; 20 mar 2020 [acesso 18 nov 2021]. Disponível: https://on.wsj.com/3BSZc7v
14. Kang DY, Cho KJ, Kwon O, Kwon JM, Jeon KH, Park H *et al*. Artificial intelligence algorithm to predict the need for critical care in prehospital emergency medical services. Scand J Trauma Resusc Emerg Med [Internet]. 2020 [acesso 18 nov 2021];28(1):17. p. 4-5. Tradução livre. DOI: 10.1186/s13049-020-0713-4
15. Nagendran M, Chen Y, Lovejoy CA, Gordon AC, Komorowski M, Harvey H *et al*. Artificial intelligence versus clinicians: systematic review of design, reporting standards, and claims of deep learning studies. BMJ [Internet]. 2020 [acesso 18 nov 2021];368:m689 DOI: 10.1136/bmj.m689
16. Organização das Nações Unidas para a Educação, a Ciência e a Cultura. Declaração universal sobre bioética e direitos humanos [Internet]. Brasília: Unesco; 2005 [acesso 18 nov 2021]. Disponível: https://bit.ly/3qPrixg
17. Li L, Qin L, Xu Z, Yin Y, Wang X, Kong B *et al*. Artificial intelligence distinguishes COVID-19 from community acquired pneumonia on chest CT. Radiology [Internet]. 2020 [acesso 18 nov 2021];296(2):e65-71. p. e69. Tradução livre. DOI: 10.1148/radiol.2020200905
18. Murray A. Coronavírus: os robôs usados para eliminar vírus em hospitais. BBC News Brasil [Internet]. 2020 [acesso 18 nov 2021]. Disponível: https://bbc.in/35sLg85
19. Alisson E. Startups brasileiras desenvolvem sistema que detecta febre a distância. Agência Fapesp [Internet]. 2020 [acesso 18 nov 2021]. Disponível: https://bit.ly/3Hoc074
20. Brasil. Lei nº 13.989, de 15 de abril de 2020. Dispõe sobre o uso da telemedicina durante a crise causada pelo coronavírus (SARS-CoV-2). Diário Oficial de União [Internet]. Brasília, 15 abr 2020 [acesso 26 abr 2020]. Disponível: https://bit.ly/3JP1uaw
21. Robô Laura [Internet]. [s.d.] [acesso 18 nov 2021]. Disponível: https://www.laura-br.com/
22. Han ER, Yeo S, Kim MJ, Lee YH, Park KH, Roh H. Medical education trends for future physicians in the era of advanced technology and artificial intelligence: an integrative review. BMC Med Educ [Internet]. 2019 [acesso 18 nov 2021];19(1):460. p. 13. Tradução livre. DOI: 10.1186/s12909-019-1891-5
23. Motta LCS, Vidal SV, Siqueira-Batista R. Bioética: afinal, o que é isto? Rev Bras Clin Med [Internet]. 2012 [acesso 18 nov 2021];10(5):431-9. Disponível: https://bit.ly/3LbszWg
24. Investigador do IB fala em 3 desafios éticos para a inteligência artificial. Universidade Católica Portuguesa [Internet]. 2019 [acesso 30 mar 2020]. Disponível: https://bit.ly/35phJwc
25. Silva ALAGMC, Sousa KCPC, Pereira GS, Araujo ACSS, Ribeiro LMN, Andrade IG, Vieira TLV. Os limites da tecnologia na prática médica segundo os princípios da bioética e da ética médica. Rev Bras Bioét [Internet]. 2018 [acesso 18 nov 2021];14(supl):81. Disponível: https://bit.ly/3LZ3NK5
26. Garrafa V, Azambuja LEO. Epistemología de la bioética: enfoque latino-americano. Rev Colomb Bioét [Internet]. 2009 [acesso 18 nov 2021];4(1):73-92. p. 82. Tradução livre. Disponível: https://bit.ly/3JXioUq
27. Vollmer S, Mateen BA, Bohner G, Király FJ, Ghani R, Jonsson P *et al*. Machine learning and artificial intelligence research for patient benefit: 20 critical questions on transparency, replicability, ethics, and effectiveness. BMJ [Internet]. 2020 [acesso 18 nov 2021];368:l6927. Tradução livre. DOI: 10.1136/bmj.l6927
28. Briganti G, Le Moine O. Artificial intelligence in medicine: today and tomorrow. Front Med [Internet]. 2020 [acesso 18 nov 2021];7:27. DOI: 10.3389/fmed.2020.00027
29. Nebeker C, Torous J, Bartlett Ellis RJ. Building the case for actionable ethics in digital health research supported by artificial intelligence. BMC Med [Internet]. 2019 [acesso 18 nov 2021];17(1):137. Tradução livre. DOI: 10.1186/s12916-019-1377-7
30. Saiba quais são os principais desafios de saúde da próxima década. Veja [Internet]. 2020 [acesso 18 nov 2021]. Disponível: https://bit.ly/3hneNml

31. Rocha MS, Rocha AS. Resolução de conflitos bioéticos no cenário hospitalar brasileiro: uma revisão sistemática da literatura. Rev Bras Bioét [Internet]. 2019 [acesso 18 nov 2021];15(e7):1-12. p. 10-1. Disponível: https://bit.ly/36Ipmyz

32. Conselho Federal de Medicina. Recomendação CFM nº 8, de 12 de março de 2015. Recomenda a criação, o funcionamento e a participação dos médicos nos Comitês de Bioética [Internet]. Brasília: CFM; 2015 [acesso 18 nov 2021]. Disponível: https://bit.ly/3BPsXpX

33. Siqueira-Batista R, Gomes AP, Maia PM, Costa IT, Paiva AO, Cerqueira FR. Modelos de tomada de decisão em bioética clínica: apontamentos para a abordagem computacional. Rev. bioét. (Impr.) [Internet]. 2014 [acesso 18 nov 2021];22(3):456-61. p. 460. DOI: 10.1590/1983-80422014223028

34. Francisconi FC. Aspectos éticos da tecnologia médica. Jornal do CFM [Internet]. 1997 [acesso 18 nov 2021]. Disponível: https://bit.ly/3JRiH3i

35. Organização das Nações Unidas para a Educação, a Ciência e a Cultura. Estados-membros da Unesco aprovam o primeiro acordo mundial sobre ética da inteligência artificial. Unesco [Internet]. 2021 [acesso 16 fev 2022]. Disponível: https://bit.ly/3t5fA12

36. Brasil. Estratégia Brasileira de Inteligência Artificial: Ebia [Internet]. Brasília: Ministério da Ciência, Tecnologia e Informação; 2021 [acesso 11 fev 2022]. Disponível: https://bit.ly/3HjRp3V

37. Brasil. Projeto de Lei nº 21/2020. Estabelece fundamentos, princípios e diretrizes para o desenvolvimento e a aplicação da inteligência artificial no Brasil e dá outras providências [Internet]. Brasília: Câmara dos Deputados; 2020 [acesso 11 fev 2022]. Disponível: https://bit.ly/3hy9UY5

38. Brasil. Emenda Constitucional nº 115, de 10 de fevereiro de 2022. Altera a Constituição Federal para incluir a proteção de dados pessoais entre os direitos e garantias fundamentais e para fixar a competência privativa da União para legislar sobre proteção e tratamento de dados pessoais. Diário Oficial da União [Internet]. Brasília, 10 fev 2022 [acesso 11 fev 2022]. Disponível: https://bit.ly/3IkWLNr

39. Brasil. Lei nº 13.709, de 14 de agosto de 2018. Lei Geral de Proteção de Dados Pessoais (LGPD). Diário Oficial da União [Internet]. Brasília, 8 jul 2019 [acesso 11 fev 2022]. Disponível: https://bit.ly/3IkWLNr

40. Brasil. Projeto de Lei nº 3.814/2020. Altera a Lei nº 8.080, de 19 de setembro de 1990 (Lei Orgânica da Saúde), e a Lei nº 13.787, de 27 de dezembro de 2018, que dispõe sobre a digitalização e a utilização de sistemas informatizados para a guarda, o armazenamento e o manuseio de prontuário de paciente, para obrigar o Sistema Único de Saúde a manter plataforma digital única com informações de saúde dos pacientes [Internet]. Brasília: Senado Federal; 2020 [acesso 11 fev 2022]. Disponível: https://bit.ly/3JXBdH4

41. Lemes MM, Lemos ANLE. O uso da inteligência artificial na saúde pela Administração Pública brasileira. Cad Ibero Am Direito Sanit [Internet]. 2020 [acesso 9 fev 2022];9(3):166-82. p. 172. Disponível: https://bit.ly/3HrRHG8

42. Harayama RM. Reflexões sobre o uso do big data em modelos preditivos de vigilância epidemiológica no Brasil. Cad Ibero Am Direito Sanit [Internet]. 2020 [acesso 9 fev 2022];9(3):153-65. DOI: 10.17566/ciads.v9i3.702

43. Fuentes MA. Princípios fundamentais de bioética. Vitória: Editora Centro Anchieta; 2021.

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