RCMOS – Revista Científica Multidisciplinar O
Saber. ISSN: 2675-9128. São Paulo - SP.
Ano VII, v.1 2026 | submissão: 15/08/2026 | aceito: 18/08/2026 | publicação: 21/08/2026

Artificial Intelligence Applied to Medical Devices: Challenges for Technological Innovation and Intellectual Property Protection

Inteligência Artificial aplicada a Equipamentos Médicos: desafios para a inovação tecnológica e a proteção da propriedade intelectual

Inteligencia Artificial aplicada a Equipos Médicos: desafíos para la innovación tecnológica y la protección de la propiedad intelectual

Sabrina da Silva Nogueira-https://lattes.cnpq.br/4382731922252565
Rayane Teles de Freitas-http://lattes.cnpq.br/7966194743709484

Abstract: The incorporation of Artificial Intelligence (AI) into medical equipment, such as diagnostic imaging systems, electrocardiography devices, and ultrasound systems, has promoted significant advances in diagnostic accuracy and clinical efficiency. Through deep learning algorithms, these devices are capable of identifying complex patterns, automating processes, and providing clinical decision support, assisting in the early detection of diseases and reducing variability among operators. However, it is important to emphasize that AI should act as a complementary tool to medical judgment.

Beyond its impact on healthcare assistance, AI functions as a powerful driver of technological innovation and industrial competitiveness by integrating areas such as electronics, embedded systems, and data science. This rapid evolution imposes complex challenges for intellectual property protection, particularly regarding the distinction between software protection through copyright and patent protection, which requires the demonstration of a technical effect and industrial applicability according to Brazilian legislation.

The strategic management of these assets, supported by Technology Innovation Centers (TICs), is essential to ensure legal security, encourage investments in research and development (R&D), and facilitate technology transfer from academia to the market. Finally, it is essential to balance economic protection with public interest in order to promote the development of accessible and efficient medical solutions.

Keywords: Artificial Intelligence; Medical Equipment; Intellectual Property; Technological Innovation; Medical Imaging.

Resumo: A incorporação da Inteligência Artificial (IA) em equipamentos médicos, como sistemas de diagnóstico por imagem, eletrocardiogramas e ultrassonografia, tem promovido avanços significativos na precisão diagnóstica e na eficiência clínica. Através de algoritmos de aprendizado profundo (deep learning), esses dispositivos são capazes de identificar padrões complexos, automatizar processos e oferecer suporte à decisão clínica, auxiliando na detecção precoce de doenças e na redução da variabilidade entre operadores. Ressalta-se, contudo, que a IA deve atuar como ferramenta complementar ao julgamento médico.

Além do impacto assistencial, a IA funciona como um potente motor de inovação tecnológica e competitividade industrial, integrando áreas como eletrônica, sistemas embarcados e ciência de dados. Essa rápida evolução impõe desafios complexos à propriedade intelectual, especialmente na distinção entre a proteção de softwares (direitos autorais) e patentes, que exigem a demonstração de um efeito técnico e aplicação industrial conforme a legislação brasileira.

A gestão estratégica desses ativos, mediada por Núcleos de Inovação Tecnológica (NITs), é fundamental para garantir a segurança jurídica, incentivar investimentos em pesquisa e desenvolvimento (P&D) e facilitar a transferência de tecnologia da academia para o mercado. Por fim, é essencial equilibrar a proteção econômica com o interesse público para fomentar o desenvolvimento de soluções médicas acessíveis e eficientes.

Palavras-chave: Inteligência Artificial; Equipamentos Médicos; Propriedade Intelectual; Inovação Tecnológica; Diagnóstico por Imagem.

Resumen: La incorporación de la Inteligencia Artificial (IA) en equipos médicos, como sistemas de diagnóstico por imagen, electrocardiogramas y ultrasonografía, ha promovido avances significativos en la precisión diagnóstica y en la eficiencia clínica. A través de algoritmos de aprendizaje profundo (deep learning), estos dispositivos son capaces de identificar patrones complejos, automatizar procesos y ofrecer soporte a la decisión clínica, auxiliando en la detección precoz de enfermedades y en la reducción de la variabilidad entre operadores. Se destaca, sin embargo, que la IA debe actuar como herramienta complementaria al juicio médico.
Además del impacto asistencial, la IA funciona como un potente motor de innovación tecnológica y competitividad industrial, integrando áreas como electrónica, sistemas embarcados y ciencia de datos. Esta rápida evolución impone desafíos complejos a la propiedad intelectual, especialmente en la distinción entre la protección de softwares (derechos de autor) y patentes, que exigen la demostración de un efecto técnico y aplicación industrial conforme a la legislación brasileña.
La gestión estratégica de estos activos, mediada por Núcleos de Innovación Tecnológica (NITs), es fundamental para garantizar la seguridad jurídica, fomentar inversiones en investigación y desarrollo (P&D) y facilitar la transferencia de tecnología de la academia al mercado. Por último, es esencial equilibrar la protección económica con el interés público para fomentar el desarrollo de soluciones médicas accesibles y eficientes.

Palabras clave: Inteligencia Artificial; Equipos Médicos; Propiedad Intelectual; Innovación Tecnológica; Diagnóstico por Imagen.

1. Introduction

The incorporation of Artificial Intelligence (IA) into medical equipment represents one of the most profound technological transformations in the area of health in recent decades. Unlike conventional devices with pre-programmed functions, AI-enabled equipment has the ability to analyze large volumes of data, recognize complex patterns and generate information that assist health professionals in grounded clinical decisions. This innovation is not restricted to the creation of new products, but promotes an incremental evolution in technologies already consolidated, such as radiography systems, computed tomography, magnetic resonance imaging and electrocardiography.

From a technical point of view, this advance is the result of convergence between various areas of knowledge, including electronics, embedded systems, digital signal processing and data science. In the care practice, the application of AI in imaging diagnoses, intelligent ECGs and ultrasound has shown efficacy in increasing diagnostic accuracy, early detection of pathologies and reduction of variability between operators. In addition, clinical decision support

systems integrate multiple data to provide recommendations that increase patient safety and efficiency in care.

However, this rapid technological evolution imposes complex challenges to the field of intellectual property. The protection of embedded software and machine learning algorithms requires a clear distinction between copyright (Software Law) and patents (Industrial Property Law), which require proof of technical effect and industrial application. The interdisciplinary nature and speed of AI innovation cycles hinder the delimitation of the scope of protection, requiring integrated management strategies to avoid technological obsolescence.

In this scenario, the protection of innovation becomes a strategic instrument to ensure legal certainty and encourage investments in research and development (R&D). The role of the Technological Innovation Centers (NITs) is fundamental to mediate technology transfer between the academy and the productive sector, transforming research results into market solutions. Finally, it is essential that the intellectual property system balances economic protection with the public interest, ensuring that technological development results in more efficient, accessible and safe medical solutions for society.

2. Artificial intelligence applicable to medical equipment

2.1 Artificial intelligence in medical equipment

The built-in Artificial Intelligence (IA) consists of the execution of machine learning algorithms directly on the medical equipment hardware, in many cases dispensing continuous processing on external servers or cloud computing. This approach, known as Edge AI, uses embedded systems composed of microprocessors, microcontrollers and specialized circuits capable of processing data in real time, reducing latency and increasing the reliability of information obtained by medical devices (LEE; SESHIA, 2017; WIPO, 2019). In medical equipment, the embedded AI integrates biomedical sensors, signal acquisition modules and digital processing techniques to continuously analyze physiological parameters of the patient, allowing rapid responses and greater operational autonomy. Examples of this technology include multiparametric monitors, smart infusion pumps, lung fans, digital electrocardiographs, and portable ultrasound equipment, which incorporate algorithms capable of detecting abnormalities, optimizing operating parameters, and providing support to health professionals (TOPOL, 2019). In addition to improving clinical performance, local processing contributes to data security and privacy, reducing the need to transmit sensitive information over the internet and meeting the growing requirements related to data protection in the health area. Thus, the

embedded AI represents an important technological advance, bringing together hardware, software and intelligent processing in increasingly accurate, efficient and connected medical devices (LITJENS et al., 2017).

2.2 Diagnosis by image

Artificial Intelligence (IA) has promoted significant advances in imaging diagnostic equipment, especially in radiography, computed tomography (CT) and magnetic resonance imaging (MRI) systems. Through machine learning and deep learning algorithms, these equipments are able to identify complex patterns in medical images, helping in early detection of diseases and reducing variability among different observers (LITJENS et al., 2017). On radiography, AI has been used to identify pulmonary alterations, fractures and other abnormalities with high sensitivity, working as a tool to support the specialist (TOPOL, 2019). In tomography and magnetic resonance imaging, the algorithms contribute to the automatic segmentation of anatomical structures, lesion detection and optimization of image reconstruction, reducing processing time and increasing diagnostic quality (PESAPANE; CODARI; SCOMAZZONI, 2018). Thus, the incorporation of AI into medical equipment increases diagnostic accuracy, reduces interpretation errors and favors faster and more well-founded clinical decisions. However, its use should complement the experience of the health professional, not replacing clinical evaluation and medical judgment (TOPOL, 2019).

2.3 Intelligent ekg

The incorporation of Artificial Intelligence (AI) to electrocardiography equipment (ECG) has increased the capacity for early detection of cardiac changes, especially through the automatic identification of arrhythmias. Using deep learning algorithms, trained with large electrocardiogram databases, these systems are able to recognize patterns associated with atrial fibrillation, tachycardia and other changes in heart rhythm with high sensitivity and specificity, assisting the physician in the interpretation of the exams (HANNUN et al., 2019). In addition to automatic analysis, the integration of intelligent ECG with wearable devices and telemedicine platforms enables the remote and continuous monitoring of patients, allowing the identification of cardiac events that could go unnoticed in conventional examinations performed for a short period (TOPOL, 2019). This approach favors early diagnosis, reduces the time for clinical intervention and contributes to a more personalized follow-up. However, the reliability

of the algorithms depends on the quality of the data used in the training and clinical validation of the systems before their application in the care practice (ATTIA et al., 2019).

2.4 Ultrasom with artificial intelligence

The application of Artificial Intelligence (IA) in ultrasound equipment has contributed to increase the quality of the exams and reduce dependence on the operator's experience. Through deep learning algorithms, systems are able to automatically optimize image acquisition, adjusting parameters such as gain, focus and depth, and guiding the proper positioning of the transducer to obtain images with higher diagnostic quality (NOBLE; BOUKERROUI, 2006; LITJENS et al., 2017). In the interpretation stage, AI helps in the identification and segmentation of anatomical structures, automatic measurement of organs and tissues, as well as in the detection of changes suggestive of pathologies, reducing the variability between operators and increasing the reproducibility of the tests (TOPOL, 2019). These features make ultrasound more efficient, especially in emergency and primary care environments, where the speed in obtaining information can directly influence clinical management. However, the adoption of these resources requires continuous clinical validation and supervision of health professionals, ensuring that diagnostic decisions remain based on medical evaluation (TOPOL, 2019).

2.5 Support of clinical decision

The application of Artificial Intelligence (IA) in clinical decision support systems has transformed the way information from medical equipment is used during the diagnostic and therapeutic process. These systems combine machine learning algorithms, processing large volumes of clinical data and information obtained by medical devices to provide recommendations that assist health professionals in the identification of diseases, risk assessment and definition of the most appropriate conducts (TOPOL, 2019). In modern equipment, AI is able to integrate data from imaging tests, electrocardiograms, vital signs and laboratory results, identifying patterns that could not be easily perceived during conventional analysis (LITJENS et al., 2017).

Diagnostic support systems are not intended to replace clinical judgment, but to provide additional information that increases the reliability of medical decisions. Studies have shown that these systems can contribute to the early detection of cardiovascular diseases, neoplasms and other clinical conditions, reducing diagnostic errors and promoting greater patient safety

(JIANG et al., 2017). In addition, the use of AI favors standardization of the interpretation of exams, reducing variability among professionals and providing greater efficiency in care, especially in environments with high care demand (TOPOL, 2019). However, its implementation should be accompanied by rigorous processes of clinical validation, transparency of algorithms and human supervision, ensuring that the recommendations generated are used as a support tool, preserving the responsibility and autonomy of the health professional (TOPOL, 2019).

3. Innovation and intellectual property

3.1 Artificial intelligence as a environment for innovation in medical equipment

The incorporation of Artificial Intelligence (IA) to medical equipment is one of the most relevant technological transformations in the health area in recent decades. Unlike conventional devices, which perform previously programmed functions, AI-enabled equipment is able to analyze large volumes of data, recognize complex patterns and generate information that helps health professionals to make clinical decisions. This capacity significantly increases the innovation potential of medical devices, allowing the development of more accurate, efficient and adaptable solutions to patients' needs (TOPOL, 2019; WORLD INTELLECTUAL PROPERTY ORGANIZATION, 2019).

The innovation provided by the AI is not restricted to the creation of new equipment, but also to the evolution of already consolidated technologies. Radiography, computed tomography, magnetic resonance imaging, ultrasonography, and electrocardiography systems began to incorporate algorithms capable of optimizing image acquisition, automating measurements, identifying clinical changes, and providing diagnostic support with greater speed and reliability (LITJENS et al., 2017). Thus, embedded intelligence adds new functionalities to existing equipment, characterizing a continuous process of incremental innovation, which is fundamental to increase the quality of health care and increase the efficiency of medical services (OECD; EUROSTAT, 2018).

From the perspective of engineering, innovation in medical equipment results from integration between different areas of knowledge, such as electronics, embedded systems, digital signal processing, data science and machine learning. This technological convergence enables the development of increasingly autonomous devices, connected and capable of learning from data obtained during their operation. As a result, intelligent medical equipment

is emerging that provides greater diagnostic accuracy, reduction of operational failures and optimization of workflows in hospitals and clinics (TOPOL, 2019).

In addition to the assistance benefits, AI drives the competitiveness of the medical equipment industry by stimulating research and development investments (R&D), favoring the emergence of new products and services with higher added value. In this context, innovation becomes an important strategic differential for companies and research institutions, reinforcing the need for mechanisms capable of protecting the technological knowledge generated and encouraging its transformation into solutions available to society (WORLD INTELLECTUAL PROPERTY ORGANIZATION, 2019).

3.2 Challenges of the intellectual property involving software on ship, somebody and artificial intelligence

The growing incorporation of embedded software, Artificial Intelligence (IA) algorithms, and machine learning techniques into medical equipment has expanded the challenges related to the protection of intellectual property. Unlike conventional medical devices, in which innovation was predominantly associated with mechanical or electronic components, smart equipment concentrates a significant part of its technological value in the software responsible for data processing, pattern recognition and support for clinical decision-making (WORLD INTELLECTUAL PROPERTY ORGANIZATION, 2019).

In this context, it is essential to distinguish the different protection mechanisms available. In Brazil, computer programs are protected by Law no. 9.609/1998 (Software Law), which gives them protection equivalent to copyright. However, the simple implementation of an algorithm or software does not in itself characterize a patentable invention. In order for a technology to be protected by patent, it must meet the requirements of novelty, inventive activity and industrial application laid down in Law No. 9.279/1996 (Industrial Property Law), in addition to producing a technical effect that goes beyond the abstract processing of information (BRASIL, 1996; BRASIL, 1998).

In AI-based medical equipment, this distinction is not always evident. In many cases, innovation results from the interaction between hardware, sensors, embedded systems and algorithms capable of continuously learning from the data collected during its use. This characteristic hinders the definition of the effectively protected object, since the evolution of the algorithm can modify the performance of the equipment over time, creating challenges for

the definition of the scope of intellectual protection and for the evaluation of patentability requirements (WIPO, 2019).

Another relevant aspect concerns the speed of technological developments. The development cycles of AI algorithms are significantly shorter than traditional patent granting processes, which requires efficient strategies to manage intellectual property to avoid obsolescence of technologies even before obtaining legal protection (OECD, 2021). In addition, the growth of AI-based innovations demands constant updating of intellectual property offices and patent examiners, who need to evaluate inventions characterized by high technical complexity and strong interdisciplinarity between engineering, computing and health sciences (WIPO, 2019).

Thus, the protection of intellectual property in intelligent medical equipment requires an integrated approach, capable of reconciling the incentive to innovation with the legal certainty of inventors, research institutions and companies. This balance is essential to stimulate technological development without compromising the dissemination of knowledge and the access of society to new solutions for the health area (TOPOL, 2019).

3.3 Protection of innovation as an instrument for research, development and transfer of technology

The protection of innovation through intellectual property mechanisms plays a fundamental role in stimulating research, technological development and the transfer of knowledge to society. In the medical equipment sector, characterized by high investments in research, development and clinical validation, intellectual property is a strategic tool to ensure legal certainty for inventors, research institutions and companies, allowing innovative technologies to be transformed into commercially viable products (WORLD INTELLECTUAL PROPERTY ORGANIZATION, 2019).

The development of medical equipment based on Artificial Intelligence involves a complex chain of innovation, which integrates universities, research centers, technology companies and health institutions. In this process, the protection of intellectual assets, such as patents, computer programs and technological knowledge, favors the creation of safer environments for research and development investments (R&D), since it reduces the risks associated with improper appropriation of the results obtained (OECD; EUROSTAT, 2018). Thus, intellectual property acts as an economic incentive mechanism, allowing organizations

to recover the resources applied in technological development and continue to invest in new solutions.

In the academic and institutional context, intellectual protection also plays a relevant role in technology transfer. Universities and Scientific, Technological and Innovation Institutions (ICTs) often develop technologies with industrial application potential, but rely on appropriate mechanisms to transform research results into products and services available on the market. In this scenario, the Technological Innovation Centers (NITs) play a strategic role in managing intellectual assets, establishing partnerships with companies and promoting the transfer of technologies developed in the academic environment (BRASIL, 2004; BRASIL, 2016).

In the specific case of medical equipment with AI, the protection of innovation can favor the approximation between researchers, manufacturers and health professionals, accelerating the incorporation of new technologies into care systems. Patents and other intellectual property instruments can facilitate licensing agreements, strategic partnership formation and the creation of new business models based on advanced medical technologies (WIPO, 2019).

However, the protection of innovation should be balanced with the public interest, especially in the area of health. The challenge is to promote an environment that encourages technological development without creating excessive barriers to access to essential technologies. Thus, intellectual property should be understood not only as an economic protection mechanism, but as a public policy tool capable of stimulating innovation, strengthening national technological capacity and contributing to the development of more efficient and affordable medical solutions (OECD, 2021).

4. Conclusion

The integration of Artificial Intelligence (IA) into medical equipment was consolidated as a determining factor for the evolution of contemporary medicine, promoting significant advances in diagnostic accuracy and treatment efficiency. Technologies such as imaging diagnosis, intelligent ECG and assisted ultrasonography demonstrate that deep learning algorithms are able to identify complex patterns and reduce variability between operators, allowing early detection and more well-founded clinical decisions. However, the sources emphasize that AI should act as a complementary tool, always preserving the autonomy and clinical judgment of the health professional.

In the field of intellectual property, the transition from predominantly mechanical innovations to software-centered systems imposes complex legal challenges. The distinction between copyright protection (Software Law) and patent protection (Industrial Property Law) requires inventors to demonstrate a clear technical effect and industrial application, overcoming the abstraction of algorithms. In addition, the speed of the AI innovation cycles, often higher than the deadlines for granting patents, requires agile management strategies to avoid technological obsolescence.

The work of the Technological Innovation Centers (NITs) is strategic to mediate the transfer of technology from academia to the productive sector, ensuring that the knowledge generated in research becomes market solutions. This management of intellectual assets is fundamental to attract research and development investments (R&D) and ensure industrial competitiveness.

Ultimately, the success of AI implementation in health depends on an intellectual property system that balances economic incentive with the public interest. Strengthening this ecosystem is essential to ensure that technological progress results in more efficient, safe and, above all, accessible medical devices for the whole of society.

5. References

ATTIA, Z. I. et al. An artificial intelligence-enabled ECG algorithm for the identification of patients with atrial fibrillation during sinus rhythm: a retrospective analysis of outcome prediction. The Lancet, v. 394, n. 10201, p. 861-867, 2019.

BRASIL. Lei nº 9.279, de 14 de maio de 1996. Regula direitos e obrigações relativos à propriedade industrial. Diário Oficial da União: Brasília, DF, 15 maio 1996.

BRASIL. Lei nº 9.609, de 19 de fevereiro de 1998. Dispõe sobre a proteção da propriedade intelectual de programa de computador. Diário Oficial da União: Brasília, DF, 20 fev. 1998.

BRASIL. Lei nº 10.973, de 2 de dezembro de 2004. Dispõe sobre incentivos à inovação e à pesquisa científica e tecnológica no ambiente produtivo. Diário Oficial da União: Brasília, DF, 3 dez. 2004.

BRASIL. Lei nº 13.243, de 11 de janeiro de 2016. Dispõe sobre estímulos ao desenvolvimento científico, à pesquisa, à capacitação científica e tecnológica e à inovação. Diário Oficial da União: Brasília, DF, 12 jan. 2016.

HANNUN, A. Y. et al. Cardiologist-level arrhythmia detection and classification in ambulatory electrocardiograms using a deep neural network. Nature Medicine, v. 25, p. 65-69, 2019.

JIANG, F. et al. Artificial intelligence in healthcare: past, present and future. Stroke and Vascular Neurology, v. 2, n. 4, p. 230-243, 2017.

LEE, E. A.; SESHIA, S. A. Introduction to Embedded Systems: A Cyber-Physical Systems Approach. 2. ed. Cambridge: MIT Press, 2017.

LITJENS, G. et al. A survey on deep learning in medical image analysis. Medical Image Analysis, v. 42, p. 60-88, 2017.

NOBLE, J. A.; BOUKERROUI, D. Ultrasound image segmentation: a survey. IEEE Transactions on Medical Imaging, v. 25, n. 8, p. 987-1010, 2006.

OECD. Artificial Intelligence, Machine Learning and the Economy. Paris: OECD Publishing, 2021.

OECD; EUROSTAT. Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation. 4. ed. Paris: OECD Publishing, 2018.

PESAPANE, F.; CODARI, M.; SCOMAZZONI, F. Artificial intelligence in medical imaging: threat or opportunity? Radiologists again at the forefront of innovation in medicine. European Radiology Experimental, v. 2, n. 35, 2018.

TOPOL, E. High-performance medicine: the convergence of human and artificial intelligence. Nature Medicine, v. 25, p. 44-56, 2019.

WORLD INTELLECTUAL PROPERTY ORGANIZATION (WIPO). WIPO Technology Trends 2019: Artificial Intelligence. Geneva: WIPO, 2019.