Artificial Intelligence in healthcare: challenges, opportunities and threats with a specific focus on Italy

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Abstract: This positioning paper delves into the potential applications of Artificial Intelligence (AI) within the healthcare sector, with a particular focus on its implementation in the Italian National Health System. It outlines the key challenges faced by healthcare, emphasizing how AI can address inefficiencies in organizational models and manage the ever-growing volume of healthcare data.

By presenting various examples, the paper shows the broad range of applications AI offers in improving healthcare services. One of the primary benefits is AI's ability to enhance data management, enabling more efficient and informed decision-making for both doctors and patients. By automating routine and repetitive tasks, AI allows healthcare professionals to dedicate more time and attention to patient-centered care, ultimately improving the overall patient experience and quality of treatment.

However, despite the many advantages AI brings - such as better diagnostics, personalized care, and more efficient healthcare delivery - significant challenges remain. These include issues related to the accuracy and quality of healthcare data, problems with interoperability between systems, and serious ethical concerns such as data privacy, security, and accountability in AI-driven medical decisions.

For AI to be fully and successfully integrated into the Italian Healthcare System, technical and ethical hurdles must be addressed comprehensively. Achieving national standardization in healthcare practices, investing in essential digital infrastructure like the Electronic Health Record, and ensuring strict adherence to privacy regulations are vital steps toward maximizing AI's potential. By overcoming these barriers, AI can revolutionize healthcare delivery, offering a more efficient, accurate, and patient-centered system.

Keywords: artificial intelligence, healthcare, digitalization, Italy

1. Introduction

The purpose of this positioning paper is to analyze the potential fields of implementation of Artificial Intelligence (AI) in the healthcare sector, providing an overview of its applications and the challenges that arise, with a focus on the Italian National Health System.

There are multiple definitions of Artificial Intelligence, but the one that best captures its essence is provided by Kreutzer and Sirrenberg (2020): "*Artificial intelligence is the ability of a machine to perform cognitive tasks that we associate with the human mind*". From this definition, three elements emerge: when we talk about Artificial Intelligence, we refer to the functioning of a machine or an artificial system that includes a machine; it also involves cognitive tasks, meaning the processing of information necessary to produce knowledge; and finally, it is not a generic process, but one that resembles the operations of the human mind, to which it can therefore be associated. The computational techniques developed by these technologies replicate processes typical of the human mind, such as reasoning, involvement, deep learning, adaptation, and sensory perception.

Humans have been fascinated by the possibility of creating machines capable of simulating the functioning of the human brain since the 1st century B.C., but it was only in the 1950s, a period of great scientific excitement about the study of computers and their application to intelligent technologies, that the first traces of Artificial Intelligence as a scientific discipline can be found. As early as 1936, Alan Turing developed the Turing Machine, which was fundamental for transforming formal mathematical models into algorithms, evaluating their computability and complexity. In 1943, Warren McCulloch and Walter Pitts laid the groundwork for modern Artificial Intelligence by introducing a mathematical model that allowed the emulation of brain function, using the artificial neuron as a computational unit that was 'turned on' or 'off' by external stimulation to execute a calculation, with the result then being transmitted to neighboring artificial neurons. In 1956, at a conference held at Dartmouth College in New Hampshire, the term "Artificial Intelligence" was used for the first time by computer scientist and cognitive scientist John McCarthy. However, the enormous enthusiasm of the scientific community and the major computing companies of the time quickly faded due to the computational limitations of the computers of that era, initiating a first phase of decline that lasted until the early 1980s, when computers became mature enough to adopt Artificial Intelligence algorithms in industrial settings. The development of expert systems—programs capable of solving problems in an application domain by using rules derived from the knowledge of experts in that domain—led to a second wave of enthusiasm, but this too was destined to fade quickly: intelligent technologies were still not very accessible and reserved for the use of an elite. In 1996, IBM's Deep Blue managed to defeat chess champion Garry Kasparov: this event reignited the industrial world's enthusiasm for Artificial Intelligence, which thus ceased to be confined solely to the academic world. This was just the beginning of a period of exponential advancement in Artificial Intelligence, which year after year

continues to achieve exceptional results. The development of specializations within Artificial Intelligence, such as Machine Learning and Deep Learning, which train algorithms to learn from various environmental situations without needing to be explicitly programmed, subsequently enabled ever-wider application scenarios for these technologies. Today, Artificial Intelligence plays a central role in the increasing convergence between the physical, digital, and biological worlds, which leads it to be considered the protagonist of the Fourth Industrial Revolution.

2. An overview of AI in healthcare

Healthcare is one of the sectors most influenced by Artificial Intelligence, highlighting the importance of analyzing its application areas, as well as the benefits and risks associated with it.

Two trends have led to these computer systems gaining significant importance in healthcare. First, the presence of inefficient organizational models that require high investments but generate poor results. Second, the exponential increase of healthcare data, due to digital transformation on one hand and connectivity on the other, making it difficult for humans to collect and analyze this data. Artificial Intelligence offers a possible solution to these problems: it develops a way to use all the collected data meaningfully and reasonably and helps doctors, healthcare providers, and patients make quick, effective, and informed decisions.

The doctor-patient relationship has undergone profound changes with the advent of digital technologies, which is another trend in healthcare. "*Citizens expect to be treated as customers, with responsiveness and consideration. That is as much true at the social security office as it is at the supermarket*" (DiIulio Jr 1993). On one hand, Medicine 2.0 places the patient in a virtual world that allows them to know everything, or almost everything, about their health condition or illness, thereby increasing the awareness they have of their current state and future therapeutic possibilities. As a result, the citizen, a holder of civil, political, and social rights, does not want to be seen as passively managing a position that classifies them as a service user external to the decision-making process, but rather desires to establish a two-way relationship with the doctor in which they have direct influence, just like a customer. "*Imagine if a doctor can get all the information he needs about a patient in 2 minutes and then spend the next 13 minutes of a 15-minute office visit talking with the patient, instead of spending 13 minutes looking for information and 2 minutes talking with the patient*" (Simon, DiNardo et al. 2019). On the other hand, Artificial Intelligence allows doctors to be relieved of the more tedious and repetitive tasks and focus on high-value-added processes, increasing their engagement with patients. This creates a patient empowerment process, progressively placing the patient at the center of the healthcare system and necessitating the development of innovative organizational models through digital technologies that can offer personalized services.

Indeed, the technological revolution is at the foundation of 4P medicine (Prevention, Prediction, Personalization, Participation), which does not solely aim to cure disease

but broadly takes a holistic view of the patient and aims to manage overall well-being by improving care, extending it to a larger number of patients, reducing costs, and encouraging innovation and the creation of new activities.
The role of AI in healthcare has been a rapidly expanding field of research, with numerous studies exploring its potential benefits, challenges, and applications. The scientific literature on AI in healthcare is extensive, demonstrating the transformative potential of AI across various domains. While the benefits are substantial, particularly in improving diagnostics, personalized medicine, and healthcare management, there are also significant challenges that must be addressed, including ethical concerns and the need for appropriate regulation. The future of AI in healthcare looks promising, with ongoing research focusing on expanding its applications and addressing existing limitations. Below is an overview of the existing scientific literature, highlighting key themes and quotations from various studies.

2.1 AI in Medical Imaging and Diagnostics

AI has shown significant promise in the field of medical imaging, particularly in diagnostics. Various studies have documented AI's ability to analyze imaging data with high accuracy. Esteva, Kuprel et al. (2017) highlighted the potential of AI in dermatology, stating: "*Our algorithm's performance is on par with all tested experts, demonstrating an artificial intelligence capable of classifying skin cancer with a level of competence comparable to dermatologists*". Topol (2019) emphasized AI's impact on diagnostics noting that: "*AI tools have been shown to equal or exceed the diagnostic performance of clinicians, especially in fields like radiology and pathology, where pattern recognition is critical*".

2.2 AI in Drug Discovery and Development

AI is increasingly used in drug discovery and development, helping to accelerate the identification of potential drug candidates and optimize clinical trials. Mak and Pichika (2019) discussed the integration of AI in drug discovery: "*AI can rapidly analyze vast datasets, identify drug targets, and predict how different compounds will behave, significantly speeding up the drug discovery process*". Zhang, Tan et al. (2017) pointed out the efficiency of AI in predicting drug interactions: "*Machine learning algorithms can predict adverse drug reactions by analyzing patterns in large-scale patient data, potentially reducing the risk of harmful side effects*".

2.3 AI in Personalized Medicine

AI is transforming personalized medicine by enabling the customization of treatment plans based on individual patient data, including genetic information. Krittanawong, Zhang et al. (2017) highlighted AI's role in personalizing treatment: "*AI-driven models can predict patient outcomes based on genetic, clinical, and lifestyle data, allowing for more tailored and effective treatments*". Lavecchia (2019) elaborated on AI's role in genomics: "*AI algorithms can analyze genomic data to identify mutations associated with diseases, paving the way for personalized therapies*".

2.4 AI in Healthcare Operations and Management

AI is also being used to optimize healthcare operations, including hospital management, resource allocation, and patient flow. Rajkomar, Oren et al. (2018) described AI's impact on healthcare operations: "*AI can streamline hospital operations by predicting patient admissions, optimizing staff schedules, and improving resource allocation, thereby enhancing overall efficiency*". Davenport and Kalakota (2019) further noted: "*AI is reshaping healthcare management by providing insights from large datasets that can be used to improve decision-making processes at the organizational level*".

The future of AI in healthcare is seen as highly promising, with ongoing research focusing on expanding its applications and addressing existing challenges. Jiang, Jiang et al. (2017) discussed that: "*Emerging AI technologies hold the potential to revolutionize every aspect of healthcare, from diagnostics and treatment to patient monitoring and administrative tasks*". Shen, Chen et al. (2020) emphasized the need for continuous research: "*To fully realize the benefits of AI in healthcare, continued research is needed to improve algorithms, address ethical concerns, and integrate AI seamlessly into clinical workflows*".

3 AI's impacts on patient experience

The integration of AI in healthcare has had profound impacts on patients' experiences, influencing how they interact with healthcare systems, the quality of care they receive, and their overall satisfaction with healthcare services. Below are some key impacts of AI on patients' experience:

3.1 Enhanced Diagnostic Accuracy and Speed

AI-driven diagnostic tools, particularly in fields like radiology and pathology, can analyze medical images and data with high precision, leading to earlier and more accurate diagnoses. This improvement in diagnostic accuracy means patients can receive the correct treatment faster, which is crucial for conditions like cancer where early intervention is critical. Patients benefit from quicker diagnoses and reduced anxiety as they receive definitive answers sooner. For example, AI can rapidly analyze mammograms and reduce the need for follow-up tests, sparing patients from prolonged uncertainty.

3.2 Personalized Treatment Plans

AI enables the creation of personalized treatment plans by analyzing a patient's genetic data, medical history, and other relevant factors. This leads to treatments that are more closely aligned with the patient's unique needs, increasing the likelihood of successful outcomes. Patients experience more effective treatments with fewer side effects, as therapies are tailored to their specific conditions. This personalized approach can lead to higher satisfaction as patients feel their care is individualized rather than one-size-fits-all.

3.3 Improved Access to Care through Telemedicine

AI-powered telemedicine platforms allow patients to consult with healthcare providers from the comfort of their homes. AI can also monitor patients' vital signs in real-time, providing continuous care and timely interventions without the need for frequent in-person visits. The convenience of telemedicine enhances the patient experience by reducing travel time, lowering costs, and providing access to healthcare professionals, especially in remote or underserved areas. This is particularly beneficial for patients with chronic conditions who require regular monitoring.

3.4 Faster Drug Development and Access to New Treatments

AI is revolutionizing drug discovery by speeding up the identification of potential treatments. This rapid development is particularly evident in situations like the COVID-19 pandemic, where AI-assisted research led to quicker identification of therapeutic candidates. Patients benefit from faster access to new, potentially life-saving drugs and treatments. For those with rare or difficult-to-treat conditions, AI's role in drug discovery offers hope for new and effective therapies where few options previously existed.

3. 5 Enhanced Patient Engagement and Education

AI chatbots and virtual assistants can provide patients with information about their conditions, medications, and treatment options, helping them better understand their health and make informed decisions. Increased knowledge empowers patients to take a more active role in their care, leading to greater satisfaction and better adherence to treatment plans. Patients feel more supported and engaged, reducing feelings of helplessness or confusion.

3.6 Reduction of Medical Errors

AI systems can analyze large amounts of patient data to detect potential errors in prescriptions, diagnoses, or treatment plans. By cross-referencing data with established guidelines, AI can alert healthcare providers to discrepancies or potential risks. The reduction in medical errors enhances patient safety and trust in the healthcare system. Patients experience fewer complications and adverse events, leading to a smoother and more reassuring healthcare journey.

3.7 Shorter Waiting Times and Optimized Resource Allocation

AI can predict patient admissions, optimize scheduling, and manage resources more effectively, reducing wait times for appointments, procedures, and test results. Shorter waiting times lead to a more efficient and pleasant healthcare experience, as patients spend less time waiting for care and more time receiving it. This can significantly reduce the stress and frustration often associated with lengthy healthcare processes.

3.8 Emotional Support and Mental Health

AI-powered apps and platforms can provide mental health support by offering therapy, mood tracking, and interventions. For example, AI chatbots can engage with patients

to provide support during times of stress or anxiety. Patients have access to immediate support, which can be particularly beneficial for those in need of mental health care but who are unable or unwilling to seek in-person therapy. This can lead to improved mental well-being and a sense of constant support.

3.9 Cost Reduction and Financial Accessibility

By improving efficiency, reducing unnecessary tests, and enabling preventive care, AI can help lower overall healthcare costs for patients. Reduced healthcare costs make high-quality care more accessible, easing financial burdens and enhancing overall satisfaction with the healthcare system. Patients are less likely to delay or forgo treatment due to cost concerns.

4 Challenges

The implementation of Artificial Intelligence in healthcare results in several technical and ethical challenges that still need to be fully addressed.

As far as **technical issues** are concerned, the main problem is the presence of low-quality clinical data, i.e., data from unknown sources or non-representative individuals, upon which to build AI systems based on algorithms: this problem stems from the delayed digitization of the National Health System, which leads to errors in the accurate representation of real-world data, as well as in the correlation and causality of the data itself. Secondly, there is a lack of interoperability, meaning that data is not exchanged or recorded in a standardized way in electronic systems and, consequently, is not correctly interpreted by AI applications. For example, if two doctors from two different facilities use the same metrics to measure a specific patient parameter, the same metrics are not collected and interpreted uniformly across the two facilities. Currently, there is no collaborative approach or uniform method in the healthcare sector to collect, analyze, and enter patient data in the same way: each region or hospital creates its own AI software to use internally.

On the **ethical side**, while medicine has a great need for AI, AI has a great need for ethics. The World Health Organization (WHO) addressed this issue in its document "*Ethics and Governance of Artificial Intelligence for Health*" (World Health 2024) identifying six key points to promote the ethical use of AI in healthcare. The first point is to protect human autonomy, which should not be overridden by the autonomy of machines. On the one hand, medical decisions must be made by humans, as technological systems are meant solely to provide a more complete level of information and enable healthcare professionals to make informed choices. On the other hand, individual privacy must be protected with great sensitivity and care. The second point is to promote human well-being, safety, and the public interest: AI technologies must never harm people. This point relates to the first law of robotics coined by Russian writer Isaac Asimov, which states: "*A robot may not injure a human being, or, through inaction, allow a human being to come to harm*". The third point emphasizes the need to ensure transparency, clarity, and intelligibility: every project involving AI technology should be preceded by public consultation and debate to clarify its uses,

ensuring clear access to information as well as operational protocols and data ownership. The fourth point stresses the need to promote responsibility and accountability. If a doctor makes an error or fails to provide the appropriate level of care, they can be sued for medical negligence, but if the error is due to AI processing, who is responsible? In the case of malfunctions or mistakes, the responsibility must always be attributed to the people who misapplied the technology. The fifth point stresses the need to ensure inclusivity and fairness: barriers to access and biases related to gender, age, income, and other discriminatory factors must be eliminated. Additionally, training data should not contain sampling biases but rather be complete, accurate, and diverse. Finally, the sixth point highlights the importance of promoting AI that is both responsive, thus quick in solving problems, and sustainable. In a context where thousands of data centers worldwide generate energy consumption issues, the WHO establishes that AI systems must be designed from the outset to minimize energy consumption and increase efficiency.

Implementing AI in healthcare therefore requires adherence to best practices to ensure effectiveness, safety, and ethical integrity.

Despite the benefits, there are concerns about data privacy and the trustworthiness of AI systems. Patients may worry about the security of their personal health data and the transparency of AI-driven decisions. Addressing these concerns is crucial for maintaining patient trust. Clear communication about how AI systems work, how data is protected, and the involvement of healthcare professionals in decision-making processes can help alleviate these concerns and improve the overall patient experience.

- **Example: Google Health** focuses on creating explainable AI models in their projects, such as their AI-driven diagnostic tools. They ensure that the decision-making process of AI systems is understandable to healthcare providers, allowing them to explain AI-driven recommendations to patients, thereby improving trust and adoption.
- **Example: Zebra Medical Vision** develops AI tools for radiology with a focus on improving patient outcomes. They engage with patient advocacy groups and clinicians during the design process to ensure that their AI tools are user-friendly and enhance the patient care experience.

Yu, Beam et al. (2018) discussed the need for regulation: "*As AI becomes more integrated into clinical practice, robust regulatory frameworks will be essential to ensure patient safety and trust in AI-driven healthcare solutions*".

- **Example: Mayo Clinic** has implemented robust data governance frameworks to manage and standardize their clinical data. They use advanced tools for data cleaning and normalization to ensure that AI algorithms are trained on high-quality, accurate datasets. This practice helps in reducing biases and improving the reliability of AI predictions.
- **Example: Massachusetts General Hospital** has established a dedicated AI research center where data scientists, clinicians, and engineers work together. This interdisciplinary approach ensures that AI tools are clinically relevant, user-friendly, and address real-world healthcare challenges.
- **Example: FDA-cleared AI algorithms** like those developed by companies such as **Aidoc** and **Viz.ai** for medical imaging undergo extensive clinical trials and

validation processes to meet the FDA's stringent requirements. These practices ensure that the AI tools are safe, effective, and compliant with healthcare regulations.

- **Example: Cleveland Clinic** uses AI tools for predictive analytics in patient care. They have a system in place for continuous learning where AI models are periodically retrained with new patient data. This helps in adapting to changing patient demographics and medical practices, thereby maintaining the accuracy and effectiveness of AI-driven predictions.
- **Example: Johns Hopkins Medicine** employs advanced cybersecurity protocols to protect AI-driven systems and the patient data they utilize. This includes encryption, regular security audits, and real-time monitoring to prevent unauthorized access or breaches, ensuring patient data remains secure.

Furthermore, AI in healthcare presents significant challenges, including ethical issues related to data privacy, bias in algorithms, and the need for regulatory frameworks. Char, Shah et al. (2018) addressed ethical concerns: "*The deployment of AI in healthcare raises critical ethical issues, particularly around patient consent, data ownership, and the potential for bias in decision-making algorithms*".

- **Example: IBM Watson Health** adheres to strict ethical guidelines in the development of its AI tools. They conduct bias audits on their AI systems to detect and mitigate any biases related to race, gender, or socio-economic status. They also emphasize the importance of patient consent and data protection in their AI initiatives.

Continuously monitoring AI systems and evaluating their performance in real-world settings clearly becomes a priority.

- **Example: Partners HealthCare** in Boston monitors the performance of their AI tools in clinical settings. They have established a feedback loop where clinicians can report issues, and the AI team can make necessary adjustments, ensuring that AI systems remain effective and aligned with clinical needs.

Finally, developing AI solutions that can be easily scaled and integrated into existing healthcare systems represents a key success factor for AI implementation.

- **Example: Philips Healthcare** has developed AI solutions like IntelliSpace AI Workflow Suite, designed for seamless integration into existing hospital IT systems. Their AI tools are scalable, allowing them to be deployed across multiple departments and facilities, ensuring consistent and widespread adoption.

These examples highlight how healthcare organizations can effectively implement AI by adhering to best practices such as data quality management, ethical AI development, transparency, continuous learning, and robust security. By following these practices, healthcare organizations can maximize the benefits of AI while minimizing risks and ensuring that AI tools are safe, effective, and patient-centered.

5 A selection of Italian case studies

Italy has been actively exploring and implementing AI in healthcare, with several notable case studies that demonstrate the impact and potential of AI technologies. Below are some key Italian case studies:

5.1 AI in Radiology: University of Bologna

The University of Bologna, in collaboration with various hospitals in the Emilia-Romagna region, has implemented AI to enhance radiological diagnostics. AI algorithms were deployed to assist radiologists in detecting lung cancer through CT scans. The system was designed to identify and analyze nodules with high accuracy, reducing the time needed for diagnosis and increasing early detection rates. The AI system showed a significant improvement in the early detection of lung cancer, with a reported increase in diagnostic accuracy by approximately 20%. The use of AI also helped reduce the workload on radiologists, allowing them to focus on more complex cases (Faggioni and Coppola 2024).

5.2 AI in Personalized Medicine: Istituto Europeo di Oncologia (IEO), Milan

The Istituto Europeo di Oncologia (IEO) in Milan has been at the forefront of integrating AI into personalized cancer treatment. IEO has utilized AI to analyze large datasets of patient records, including genetic information, to create personalized treatment plans for cancer patients. This approach includes predicting how patients will respond to specific therapies based on their unique genetic profiles. The implementation of AI-driven personalized medicine has led to more effective treatment strategies, particularly for breast and lung cancer patients. Studies conducted at IEO showed improved survival rates and a reduction in adverse side effects, as treatments were better tailored to individual patient needs (Ciardiello, Arnold et al. 2014).

5.3. AI in Telemedicine: Lombardia Region

The Lombardia Region, one of Italy's hardest-hit areas during the COVID-19 pandemic, deployed AI-powered telemedicine solutions to manage and monitor patients remotely. AI was integrated into telemedicine platforms to monitor COVID-19 patients' vital signs remotely, predict the progression of symptoms, and determine the need for hospitalization. These systems used machine learning algorithms to analyze data from wearable devices and patient-reported symptoms. The use of AI in telemedicine during the pandemic significantly improved patient outcomes by enabling early intervention and reducing the burden on hospitals. The system allowed healthcare providers to triage patients effectively and allocate resources more efficiently (Foglia, Garagiola et al. 2024).

5.4 AI in Drug Discovery: Dompé Farmaceutici, Milan

Dompé Farmaceutici, a leading Italian pharmaceutical company based in Milan, has been leveraging AI for drug discovery and development. Dompé has developed an AI platform called Exscalate, which is used to accelerate the identification of potential drug candidates. The platform integrates AI with high-performance computing to analyze vast chemical libraries and predict the efficacy of compounds against specific targets. Exscalate has been instrumental in the rapid identification of promising drug candidates, including during the COVID-19 pandemic, where it was used to identify

potential treatments. The AI platform has shortened the drug discovery timeline significantly, allowing for faster development of new therapies (https://exscalate.com/).

5.5 AI in Predictive Analytics: San Giovanni Battista Hospital, Turin

San Giovanni Battista Hospital in Turin has implemented AI for predictive analytics in patient care, particularly in predicting patient deterioration. The hospital deployed an AI system that analyzes electronic health records (EHRs) to predict which patients are at risk of deterioration, such as developing sepsis or requiring intensive care. The system uses machine learning algorithms to detect patterns and provide early warnings to healthcare providers. The AI system has improved patient outcomes by enabling earlier interventions, reducing the incidence of severe complications. The hospital reported a decrease in mortality rates for patients at risk of deterioration and a more efficient use of ICU resources (De Filippo, Cammann et al. 2023).

These case studies from Italy illustrate how AI is being integrated into various aspects of healthcare, from diagnostics and personalized medicine to telemedicine and drug discovery. Italian healthcare institutions and companies are leveraging AI to improve patient outcomes, increase efficiency, and address some of the most pressing challenges in modern medicine. The success of these initiatives highlights the potential of AI to transform healthcare not just in Italy, but globally.

6 Conclusions: AI in the future in Italian National Health System

AI's impact on the patient experience in healthcare is largely positive, offering enhanced accuracy, personalized care, and greater accessibility. However, it also presents challenges, particularly regarding trust and data privacy. Overall, AI has the potential to significantly improve the quality of care and patient satisfaction when implemented thoughtfully and ethically.

The healthcare sector is of significant importance both locally and nationally, not only because maintaining good health is crucial for every individual but also due to the sector's impact on determining the economic performance and stability of each country, reducing social exclusion through employment, working conditions, and family incomes, and promoting sustainable development through procurement and purchasing functions. Despite its importance, inefficient business models are often consolidated in this sector, creating the need for innovative and improved solutions. Recent key trends in the healthcare sector include the exponential increase in healthcare data, the adoption of a more personalized care model for each patient, and the shift from a passive role for the patient to an active one, where they participate in and are involved in their treatments. When combined with advances in AI technologies, these trends have enormous potential in terms of economic growth and innovation.

AI in the Italian National Health System holds great promise. This is evidenced by the various benefits that these technologies offer: the optimization of work processes, increased efficiency in terms of costs and time, and improvements in the quality of care provided are among the most notable examples. Nevertheless, the process and implementation are slow due to numerous obstacles that need to be addressed, both technical, as they prevent access to complete, understandable, and reliable information,

and ethical, due to the stringent regulations regarding the handling and sharing of personal data, as well as the impact that AI has on replacing human roles in the job market. The process is further slowed by the uniqueness of each healthcare facility, which has its own way of treating patients and handling their data, leading to the need for internal, tailored solutions for specific needs.

Therefore, for the Italian healthcare sector to fully benefit from AI, an ideological and practical change must be adopted at the national political level. First, health must be repositioned at the top of the political agenda to ensure that the healthcare sector is not the first to face cuts when economic resources become scarce and to ensure that priority interventions and substantial funding are allocated to revive public healthcare. There is currently a dichotomy between the underfunding of the National Health System - which results in a shortage of doctors and nurses, the failure to define new essential services, and long waiting lists for patients - and the numerous financial resources that the European Union, through the Next Generation EU fund, allocates to the digital transformation of the healthcare sector. However, the two dimensions are complementary, and for satisfactory results to be achieved in the Italian public healthcare, the national level must first reorganize itself: it is clear that professional medical figures are indispensable, and in their absence, the very purpose of the digitalization process of healthcare is undermined.

Second, substantial funds must be allocated to make the Electronic Health Record accessible and available: in Italy, where its importance is accentuated by significant interregional mobility from South to North for specialist visits, only one in five people have activated it. This tool, containing the entire clinical history of the patient and channeling all related information flows, is crucial. To encourage its use, it would be strategic to promote training courses for the users most likely to use it, such as pregnant women, chronic patients, or full-time working parents who need support in managing their family's healthcare. Additionally, specific initiatives should be promoted to make users threatened by digital exclusion, such as the elderly and the less literate, aware and confident with these services, from which they could greatly benefit.

Third, national standardization in the functioning of various healthcare facilities must be planned to simplify and speed up the management of clinical situations and communication between different doctors treating the same patient throughout their life. These processes could be facilitated by the development of a single AI software that becomes, by law, mandatory for all hospitals. Lastly, and consistent with the idea that the patient's well-being during the entire treatment process must be prioritized, ensuring the correct protection of health data is one of the main issues that medical managers must currently address. Health data express the essence of the body's privacy and its irregularities, and thus can expose individuals to discrimination or social stigmatization, which is why they require the highest level of protection.

Currently, AI use in healthcare must be consistent with and adhere to the General Data Protection Regulation (GDPR), a European Union regulation requiring transparency, contestability of algorithmic processes, and precautionary measures by those handling data, aiming to protect both patient data and healthcare professionals' data. To avoid seeing privacy as an obstacle to the modernization of the healthcare sector, it would be desirable to develop privacy-by-design digital tools—technological devices in which

privacy and the various legal principles related to personal data processing are anticipated and considered from the early stages of design and implementation. This approach would ease the privacy obligations that those using the devices will have to follow.

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