CLINICAL VISION: NEW SCENARIOS BETWEEN ARTIFICIAL INTELLIGENCE AND THE NEED FOR AN "EMBODIED FIRST" CLINICAL APPROACH

LA VISIONE CLINICA: NUOVI SCENARI TRA INTELLIGENZA ARTIFICIALE E LA NECESSITÀ DI UN APPROCCIO CLINICO "EMBODIED FIRST"

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ABSTRACT
This work examines the integration of artificial intelligence (AI) in the healthcare field, highlighting the need for an "embodied first" clinical approach. In this sense, a hybrid human-machine model is proposed that leverages the computational power of AI while preserving the irreplaceable aspects of human judgment. Consistent with the aforementioned, the English healthcare model is analyzed, exploring the benefits derived from this integration, which can be attributed to greater efficiency while preserving privacy. Furthermore, the new frontiers of clinical training are being explored, emphasizing the need to prepare future doctors to collaborate with AI systems, prioritizing critical thinking and the ability to manage any potential hallucinations of these systems. It concludes by highlighting how the future of healthcare lies in the development of integrated approaches that combine technological and human capabilities to foster a post-pharmaceutical revolution.

Questo lavoro esamina l'integrazione dell'intelligenza artificiale (IA) in ambito sanitario, evidenziando la necessità di un approccio clinico "embodied first". In tal senso, si propone un modello ibrido uomo-macchina che sfrutti la potenza computazionale dell'IA preservando gli aspetti insostituibili del giudizio umano. Coerentemente con quanto asserito viene analizzato il modello sanitario inglese, esplorando i benefici derivanti da questa integrazione, i quali sono riconducibili a una maggiore efficienza preservando la privacy. Inoltre, si esplorano le nuove frontiere della formazione clinica, sottolineando la necessità di preparare i futuri medici a collaborare con i sistemi di IA, privilegiando il pensiero critico e la capacità di gestire le eventuali allucinazioni di questi sistemi. Si conclude evidenziando come il futuro dell'assistenza sanitaria risieda nello sviluppo di approcci integrati che combinino capacità tecnologiche e umane per favorire una rivoluzione post-farmaceutica.

KEYWORDS
Embodied theories; Artificial intelligence in healtcare; Advanced medical education; Human-machine hybrid model; Emotional dimension of care

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Introduction

Healthcare is facing significant challenges; it is estimated that around 2.6 million people lose their lives in hospitals each year due to preventable events (World Health Statistics, 2023). These incidents are often due, in addition to negligence (Bhattacharya & Makin, 2023), to a low problem-solving capacity among healthcare professionals and difficulties in processing the enormous amount of data available (Yalçın, 2024). To address these critical issues, innovation represents a turning point, capable of limiting damage and safeguarding patients' lives (Andriole, 2023; Kollars Jr, 2024). In this regard, artificial intelligence (AI), which after several decades of refinement has emerged as a transformative force generating profound changes in various sectors, such as business and education (Joshi et al., 2024; Singh et al., 2024), could provide valuable support (Kangra & Singh, 2024). However, for the implementation of AI to be effective in healthcare, it is essential that healthcare professionals receive adequate and specific training (Malerbi et al., 2023). Professional preparation should include both the technical aspects related to the functioning of such systems and the critical skills necessary to correctly interpret their outputs, recognize their limitations, and integrate this information with their clinical judgment (Domrös-Zoungrana et al., 2024). Inadequate or incomplete training could compromise the potential benefits of AI, transforming a support tool into an additional source of complexity (Reddy & Cooper, 2021). Through the adoption of this technology, it would be possible to reduce cases of negligence in hospitals, improve decision-making processes, diagnostic accuracy, and simplify patient management (Mensah, 2024). This improvement could be achieved through the deep learning algorithms used by AI, which, by triangulating millions of data points, would provide healthcare professionals with timely suggestions regarding different approaches for the correct healing of patients (Bhagat et al., 2024). Furthermore, these technologies could reduce analysis and problem-solving times through the information contained in databases (Yang, 2024), simplifying operations, optimizing the allocation of available resources, and assisting the decision-making process (Mittal, 2023). The systematic integration of these diagnostic resources could facilitate the formulation of accurate predictions and classifications of patients' potential future pathologies, thus facilitating personalized preventive and therapeutic interventions (Pallavi Patil & Kirankumari Patil, 2023). However, it should be noted that AI is in contrast with human cognition which, compatible with the principles of embodied cognition theory, implies that the learning of new notions occurs through the body and its perceptual system, by virtue of the interactions between them and the surrounding environment (Lakoff & Johnson, 1980; Tanton, 2023; Varela et al., 1991). The embodied approach is essential in care processes because, during this delicate phase, a holistic understanding of human experiences—one that encompasses the emotional, bodily, and existential dimensions of the patient—proves critical to healing (Ahmad, 2024; Lewis & Holm, 2023). Therefore, an interdisciplinary proposal is needed, which can favor human-machine hybridization, understood as an integrated approach between human capabilities and those of AI. Through this hybridization, one could aim for greater patient involvement, promoting a sense of trust and collaboration with healthcare professionals (Sisk et al., 2024). This connection would improve both the understanding of human cognition and the future design of AI (Hsiao, 2024), making both dimensions more adaptive, intuitive, and socially aware (Song et al., 2024).

1. Artificial Intelligence: Theoretical Foundations

AI is a difficult field to define (Rana et al., 2024), and this is due to the fact that the very concept of intelligence implies cognitive, emotional, social, and creative functions. Alan Turing and John von Neumann were among the first to hypothesize that human intelligence could be replicated by computers (K. Warwick & Shah, 2016); in this regard, in 1955, John McCarthy, Marvin Minsky, Nathaniel Rochester, and Claude Shannon drafted the "Dartmouth proposal," a 17-page document where the term artificial intelligence was first introduced (Klassner, 1996). Subsequently, in the summer of 1956 at Dartmouth College in Hanover, New Hampshire, they conducted a two-month study on the theory of automata involving ten participants, which led to the birth of modern computer science (McCarthy et al., 2006). Following the Dartmouth experiments, two main theories emerged: the symbolic and the sub-symbolic. In the symbolic field, researchers replicated the mechanism of human intelligence by trying to incorporate it into pre-structured codes (W. Warwick et al., 2009; Langley, 2024). Meanwhile, sub-symbolic scholars emulated the functions of neuroscience to develop unconscious learning mechanisms in computers, such as the ability to recognize images or identify sounds (Cybenko, 1996). Also in reference to the latter, some scholars have focused on the theory of positive and negative reinforcement that emerged after Skinner's neurological experience (Taylor, 2022), or as in the case of Rosenblatt (1958), who, through the perceptron, wanted to reproduce the structure of human brain neurons. From these pioneering studies began the evolution and use of artificial intelligence technologies, which have since progressed exponentially to the present day, with accessible tools that improve many sectors, including healthcare and education. This revolution implies that AI can replace human workers in some tasks, establishing itself as the most powerful driving force of our time, giving rise to what has been called the fourth industrial revolution (Guerschberg, 2025). However, in contrast to a replacement of the human figure, Rodney Brooks (1991), already in the 1980s, had conducted studies that focused on the development of intelligent systems through a bottom-up approach, emphasizing the importance of sensory and motor systems over traditional symbolic reasoning. This led him to claim the centrality of cognition over mere computational capacity, asserting that the advent of true AI would only occur if these systems acquired cognitive abilities. Therefore, while waiting for AI systems capable of definitively replacing the human figure, this integration between the two and cognition cannot disregard corporeality, suggesting the arrival of a transitional phase that can once again foresee the centrality of people over machines (MacLennan, 1996; Srinivasa et al., 2022).

2. Applications of AI in the Healthcare System: The Case of England

In 1970, potential applications of AI were introduced into the English National Health Service (NHS) to support clinical decisions (Miller & Brown, 2018; Reddy et al., 2019). Initially, these systems were structured as rule-based approaches, i.e., human-created rules for storing, ordering, and manipulating data. Despite initial perplexity, the first introduction of this technology proved to be an immediate success, as it had shown itself capable of providing valid support in interpreting ultrasounds and timely identifying diagnoses (Kundu et al., 2024). However, recent advances have made it possible to divide the algorithms supporting the NHS into two distinct categories, giving rise to the supervised algorithm: which collects a vast number of cases (input) and subsequently generates the diagnosis (output) (Xu et al., 2021). Meanwhile, the unsupervised algorithm identifies outliers in data through the analysis of complex interactions between variables, thus allowing the discovery of previously unrecognized patterns (Roberts et al., 2017). This evolution has brought about profound changes, as there has been a shift from the initial basic rule-based approach to more sophisticated and flexible systems capable of analyzing large amounts of data and identifying complex patterns. Indeed, the NHS has opted for a holistic approach, where supervised algorithms offer valuable support in diagnosis based on previous cases, while unsupervised ones open up new frontiers in the discovery of unprecedented correlations. Looking to the future, the integration of these technologies promises to further improve the efficiency and accuracy of healthcare services, limiting the mortality rate, but at the same time posing new ethical and organizational challenges to be addressed, with the aim of fully exploiting the potential of AI in patient care.

2.1 Recent applications and ethical considerations

Following the COVID-19 pandemic, the NHS had to make significant structural changes. As highlighted by researchers from various medical specialties, including cardiology and neurology, these changes have generated critical consequences (Owen et al., 2023). Currently, patients face waiting lists and prolonged hospital stays, problems exacerbated by the shortage of healthcare personnel and the persistent work-related stress weighing on the few professionals in service (Nabila & Ayuningtyas, 2024; Rachman et al., 2024). Consequently, costs for patients and the public service itself are rising rapidly (Williams & Gibbs, 2024). In this regard, a recent project at Harvard University, called Dr Penguin (https://doctorpenguin.com), is engaged in monitoring and reporting the latest uses of AI in the clinical setting. And following careful analysis, the research team found that the application of AI is progressing rapidly, reducing costs and maximizing efficiency (Rajpurkar et al., 2022). Similar results have been reported by other authors, highlighting how AI produces greater patient involvement, leading to better and faster recovery (Rathore et al., 2023), a massive reduction in administrative workload (Kumar, 2024), and more precise diagnoses and treatments (Ahmadi, 2024; Rakibul Hasan Chowdhury, 2024). Therefore, it is possible to conceive of AI as a solution to current problems related to costs and long waiting lists, while also increasing overall accuracy and results for patients. However, several critical points and concerns have also been raised regarding human-machine interaction (Herzog & Herzog, 2024). The lack of research (particularly randomized controlled trials) has been noted. For this reason, SPIRIT (www.spirit-statement.org) and CONSORT (www.equator-network.org) have updated their guidelines, integrating specific extensions for AI to standardize AI clinical trials, so that results can be shared among scholars in a systematic and rigorous manner (Sachdeva et al., 2023). Nevertheless, further ethical considerations have been raised regarding the use of AI in the NHS (Table 1).

Ethical Considerations	Description
Transparency of algorithms	AI algorithms must be developed in a way that can be understood and analyzed by experts in the field.
Lack of strict regulation	Currently, there is no comprehensive and stringent regulation for AI, raising concerns about its safe and ethical implementation.
Standardization of medical practices	Standardization of medical procedures using AI is necessary to ensure the safety and effectiveness of treatments.
Unclear responsibility	In case of AI malfunction, it is not always clear who should be held legally responsible. A legal framework of reference is needed.
Data privacy and security	The use of AI requires the management of large amounts of sensitive data. Infrastructures for more secure and privacy-respecting data sharing are needed.
Biased results towards marginalized groups	AI can generate discriminatory results. It is fundamental to mitigate biases present in data, from collection to implementation.
Environmental impact	The use of AI has an environmental impact. It is necessary to develop green computing strategies to make it more sustainable.

Table 1. Ethical Considerations in the Use of Artificial Intelligence in the NHS

However, to have a more in-depth view of the phenomenon related to artificial intelligence, it is necessary to report its numerous applications and innumerable benefits. For example, through the use of these systems, the discovery of new drugs has become possible, obtained thanks to the ability of this technology to increase their production process, with a high level of efficiency and automation in identifying target molecules (Narkhede, 2024). Similarly, these systems can be integrated with robotic medical systems, which have been introduced in recent years to assist doctors and patients (Selvakumar et al., 2025). A valid example is the case of the Da Vinci robot where the integration of artificial intelligence has increased the precision of surgical instruments, removing hand tremors and providing surgeons with greater accuracy (Lopez-Lopez et al., 2023). In conclusion, the uses of AI in healthcare are varied and the possibilities are numerous, with a potentially beneficial impact on both medical personnel and patients.

3. Artificial Intelligence and New Training Horizons for Medical Personnel

The demand for effective and efficient medical services is growing rapidly (Preda et al., 2024), and the integration of AI in the training and assistance of healthcare personnel represents a promising solution (Morenikeji I Yisa, 2024), as these systems function through advanced algorithms and are updated through machine learning. Therefore, these supports prove to be a fundamental resource capable of assisting healthcare professionals in their daily activities, simplifying workflows, and improving patient care. Furthermore, AI is capable of generating effective educational experiences and offering personalized learning paths and immediate feedback for the training of future doctors. Indeed, through AI, it is possible to perform clinical case simulations, allowing healthcare professionals to interact in realistic scenarios without harming patients (Gray et al., 2022). In this perspective, AI offers unlimited possibilities, through a virtual space where students can practice in metaphysical surgical scenarios (Popov et al., 2024). Furthermore, aspiring doctors could engage with realistic and dynamic clinical simulations, thanks to virtual scenarios, in order to improve communication skills through interaction with digital patients (Afzal et al., 2020). AI also plays a key role in the evaluation phase, as it could be used both to assign scores to tests and to provide reliable feedback on the ability to interpret medical images. This synergy, which combines technology and human skills, would strengthen a certain level of expertise related to the use of new technologies, facilitating collaboration between multidisciplinary teams to develop and validate AI algorithms tailored to specific hospital contexts. Furthermore, healthcare staff trained in these technologies can conduct training sessions for their colleagues, improving their understanding of AI applications (Couzin-Frankel, 2019), in line with the core values of patient care and safety, table 2.

Aspect	Description	Benefits
Context	Growing demand for effective and efficient medical services	Promising solution through AI integration
Simulation and Clinical	Creation of realistic clinical scenarios	Practical learning without risks for patients
Automated Evaluation	Scoring student responses	Reliable feedback on medical image interpretation
Relational Skills	Implementation of intelligent tutors with conversational interfaces	Improvement of doctor-patient interaction skills
Transfer of Skills	AI-trained doctors collaborating in multidisciplinary teams	Development and validation of customized algorithms for specific hospital contexts
Continuing Education	AI-expert doctors training colleagues	Improved understanding of AI applications in healthcare
Possible Outcomes	Efficient integration of AI in hospital contexts	More effective healthcare system with a focus on patient care and safet

Table 2. Training possibilities for health personnel

4. Discussions and Conclusions

AI in healthcare has disrupted the traditional way of thinking about medicine; through its use, significant progress has been made in diagnostics, treatment planning, and patient care. This integration has allowed for the timely and accurate identification of patient pathologies and the development of targeted and effective treatments. Furthermore, the implementation of predictive analytical models has made it possible to anticipate the onset of potential diseases through the integrated processing of multiple patient clinical parameters. Suffice it to say the significant developments generated through the integration of AI with robotic intervention systems, such as the Da Vinci robot, which has led to the implementation of imaging technologies (Ali & Cui, 2024). Through which AI-based 3D navigation and image processing systems are generated (Cheng & Dong, 2022). These innovations allow for a more detailed visualization of the surgical field, increase surgeons' precision, and minimize the risk of errors during complex interventions. Another valid example is provided by the algorithm developed by University College London Hospital, which predicted, with 90% accuracy (based on data from 22,000 appointments at two NHS hospitals), which patients booked for MRI scans would not keep their appointments. Despite the incorrect identification of some users, this system could generate significant savings for the English healthcare system (Iacobucci, 2019). However, several concerns remain regarding the lack of transparency of these generative algorithms, which hinders the understanding of the reasoning guiding decision-making processes. This opacity generates a lack of trust on the part of healthcare professionals, limiting the widespread adoption of AI in the clinical setting (Bortolini et al., 2024). Another danger concerns the biases present in the data used by the algorithm, which could generate discriminatory results. This problem emerges especially when the database used does not adequately reflect demographic diversity, thus risking amplifying existing health inequalities (Uygun İLiKhan et al., 2024). Although AI offers significant advantages, adequate and continuous training is essential, without which healthcare professionals would encounter difficulties in correctly interpreting the results obtained, which could lead to incorrect diagnoses and inadequate and potentially counterproductive treatment plans (Francis et al., 2023). In this sense, continuous professional development and interdisciplinary collaboration are fundamental in all uses, especially in the medical field, in order to bridge knowledge gaps and the lack of practical experience with AI. This combination would guarantee a high percentage of success in the prevention and healing process of patients (Soleas et al., 2025). The aforementioned training should include programs dedicated to the ethical use of artificial intelligence, with particular attention to the protection of personal data, the safeguarding of patient privacy, and the mitigation of algorithmic biases (Archana, 2024). The acquisition of these skills represents an indispensable requirement to guarantee the responsible and ethical application of AI in healthcare (Pargaien et al., 2024). Indeed, without rigorous and systematic programming, such technologies could generate erroneous decisions, with potential irreversible adverse clinical consequences (Golpayegani et al., 2022). In order to prevent such biases, it is essential to implement systems equipped with advanced monitoring and automatic protection mechanisms capable of intervening preventively (Muley et al., 2023). The final verification will rest with healthcare professionals who, through critical thinking skills acquired through training and field practice, will make the optimal decision for the patient's healing. This dual feedback would serve as a "safety check" capable of limiting both errors made by the aforementioned artificial systems and those decision-making errors adopted by medical personnel. In a future perspective, the balance between technological innovation and human clinical judgment is fundamental, in a view where AI serves as a support and comparison tool rather than a substitute for human capital (Rozillio-Mercado et al., 2024; Suazo Galdames, 2024).

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