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Ethical Challenges in AI-driven Healthcare Innovations

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Abstract:

Today, artificial intelligence (AI) is assuming an increasingly important role in shaping both how healthcare is delivered and healthcare decision-making. The ability of AI-driven technologies, from affordable technologies such as Fitbits and Apple Watches to more expensive MRI machines, to gather and analyze large datasets combined with the recent advances in AI technologies like deep learning is providing trillions of dollars in investment to numerous companies working in various areas of electronic health technologies in order to develop new innovative technologies so that AI interventions will become more unobtrusive and useful for treatment and disease management. This latest technological revolution makes it not only important to deliver AI-driven innovations wisely but also to understand the potential ethical challenges regarding uncertainties of the future. Studies in ethics and social science suggest that AI-driven healthcare solutions face four ethical challenges: a) Privacy challenges, as AI can decode encrypted data, making patients vulnerable to espionage. b) Medicolegal challenges arise from potential AI errors in surgeries or diagnoses, leading to legal accountability. c) Issues with transparency stem from AI's inadequate ability to explain decision-making processes simply. d) Challenges in obtaining informed consent occur as some AI applications may be too autonomous, complicating explanations to laypersons and potentially obfuscating breaches of consent. This adversarial dynamic between healthcare practitioners and patients' needs addressing. We discuss the necessity for ethical innovations in AI healthcare and propose strategies to mitigate negative impacts on patients and society. It is crucial to balance ethical innovation demands with the need for AI advancements in healthcare, ensuring equitable benefits for both patients and practitioners in this societal revolution.

INTRODUCTION

The development and expansion of artificial intelligence (AI) technologies in recent years have been rapid (Dwivedi *et al.,* 2023; Solanki *et al.,* 2023). In a healthcare context, AI-driven systems and software have been developed for a range of functions, from diagnostics and provision of care to administrative and logistical support (Elendu *et al.,* 2023; Bekbolatova *et al.,* 2024). It is widely acknowledged that such technologies have the potential to enhance the patient experience, improve care provision, and streamline healthcare processes (Karimian *et al.,* 2022; Siala and Wang, 2022; Reddy *et al.,* 2023; Yakhshiboyev and Ermetov, 2024). However, it is also essential that the deployment of such technologies is undergirded by a robust ethical framework that seeks to embed integrity and responsibility into AI-driven solutions (Ahmad *et al.,* 2024), in order to ensure that the key beneficiaries of any such innovation are the citizens we aim to serve (Salo-Pöntinen *et al.,* 2021; McLennan *et al.,* 2022).

One of the immediate challenges for these discussions is one that is, to a degree, inherent to AI technologies themselves: the question of what we mean by 'ethics', and who decides (Gerke *et al.,* 2020). These meetings will explore the genuine ethical challenges of AI-driven technologies in healthcare, to produce shared learning and understand key topics (Khanna *et al.,* 2020; Nassar and Kamal, 2021; Bommu, 2022; Patel, 2024). Each meeting will produce a follow-up report to be published and circulated to invite wider dialogue on the issues raised within it (Li *et al.,* 2024). AI's provision of healthcare solutions is a dual-edged sword of opportunity and challenge (Amann *et al.,* 2020). On the one hand, AI can improve the speed, accuracy, and nature of patient diagnosis, clinical decision-making, and care provision, and streamline administrative processes; on the other, the implementation of AI-driven medical technology may bisect clinical and professional responsibilities and create ethical problems at serious risk of dehumanization (Čartolovni *et al.,* 2022).

The Role of AI in Healthcare Innovations

AI in healthcare innovations extends across the spectrum of applications, from predictive analytics, image diagnostics, personalized medicine, prescription of treatment pathways, and drug discovery platforms, to practical applications such as robotic surgical interventions, automated services, and system automation within clinical environments (Nasr *et al.,* 2021; Amjad *et al.,* 2023; Kumar *et al.,* 2023a; Pinto-Coelho, 2023; Zahlan *et al.,* 2023). AI not only empowers us to analyze complex, multilayered data faster, more accurately, and efficiently than humans alone but also has disruptive potential by extending past human capabilities in certain areas (Dodda *et al.,* 2024; Khan *et al.,* 2024). For instance, the application of AI to radiology and imaging across many types of tumors has the potential to improve diagnostic capabilities and early intervention (Khan *et al.,* 2024). Technological applications are likely to develop even further (Haleem *et al.,* 2022). For instance, the availability of AI to predict the outcome of illness prior to symptoms being demonstrated places a further emphasis on the potential for such technologies to be used ethically (Alowais *et al.,* 2023).

The key critical aspect of these systems is to ensure accurate diagnosis, which can result in life-changing decision-making pathways and overall patient care (Dror, 2020). Human error in diagnostics can range up to 30% (Holland *et al.,* 2021). AI-based system errors are more likely to result from system errors (Hager *et al.,* 2024). The collection of big data improves AI systems due to an increase in dataset analysis (Mirbabaie *et al.,* 2021). Over time, the accuracy and prediction skills of AI systems are likely to improve substantially (Nifakos *et al.,* 2021). These systems can predict outcomes not just for an individual, but for large populations, and often by an invisible algorithmic process (Javaid *et al.,* 2022). By investing in AI to predict health, the AI industry landscape may transform itself in healthcare based not on interest in treating patients but in creating them. At present, it is difficult not to perceive the potential perils of AI becoming entangled in healthcare-related demographic control and prejudice (Lewis and

Sauro, 2021). We maintain that forward-thinking ought to be focused on the benefits of AI (Kapania *et al.,* 2022). We must also do so without neglecting the investment in addressing the consequences of such enhancement (Tariq *et al.,* 2024). Additionally, we must not forget the potential direct harm that might occur to a patient as a result of utilizing an AI system (Desai and Shah, 2021).

Ethical Principles in Healthcare

The ethical environment in clinical medicine is guided by four basic principles: autonomy, beneficence, nonmaleficence, and justice (Varkey, 2021). Autonomy is defined as respecting or promoting the rights of individuals to make discretionary decisions and act with intention (Masters, 2023). Beneficence involves promoting well-being and maximizing benefits to prevent or remove harm (Parsa-Parsi, 2022). Nonmaleficence has the converse meaning of preventing or avoiding harm and refraining from causing harm. Justice is concerned with ensuring access to healthcare services and the equitable distribution of individual rights (Boe-Lillegraven *et al.,* 2024). Autonomy functions in a pivotal role in the healthcare environment, stipulating that patients should be allowed to make choices regarding their personal health, lifestyle, and medical needs (Montemayor *et al.,* 2022). Furthermore, it has been emphasized that physicians have a moral obligation to help their patients make choices about what is most beneficial to them (Akdeniz *et al.,* 2021). Respecting a healthcare consumer's autonomy is a fundamental right, which is protected by various regulatory bodies, scholarly specialists, and the law (Gupta *et al.,* 2020; Burgess *et al.,* 2021; Karunarathna *et al.,* 2024).

Abstracting from the contemporary healthcare environment, it is requisite that every science be governed and guided by ethical statutes (Palkova, 2021). As science proceeds on the path of discovery, it introduces constraints and presents new moral dilemmas (WHO, 2021). Further, the requirement for ethical guidelines in the research and development practices concerning AI in healthcare can be seen as a dynamic representation of the evolving principles of healthcare ethics (Díaz-Rodríguez *et al.,* 2023). It is essential for businesses developing services or systems using AI to hold themselves to the same standards society expects of doctors and patients, even as technologies evolve (Naik *et al.,* 2022). Healthcare industry practices are bound to the principles of autonomy, beneficence, nonmaleficence, and justice, which stipulate that healthcare professionals provide processes and services that do not pose added uncertainty (McLennan *et al.,* 2022). The relevance of these principles can best be comprehended in light of the ethical challenges that resulted in the AI win against Mr. Lee Se-Dol (Murphy *et al.,* 2021). The combination of human intuition and the computational power of AI-enabled a quantum leap from human competition to AI-human collaboration (Gerke *et al.,* 2020). Perspective-taking and understanding enable the drafting of workable guidelines (Khan *et al.,* 2024). AI-driven ethical principles address some of the obstacles to effective and trustworthy AI use in healthcare (Siala and Wang, 2022). The ethical and moral codes of conduct for machines should not remain static because thinking about neural networks and having the ability to see through the adversarial mist is an ever-evolving process of professional and public engagement while upholding the highest level of scrutiny to protect an individual's rights (Amann *et al.,* 2020).

Ethical Challenges in AI-driven Healthcare Innovations

AI has the potential to contribute invaluable insights to healthcare. Several AI-driven innovations have been successfully developed and piloted in clinical medicine, biotechnology, digital health, and healthcare delivery and management (Mikalef *et al.,* 2022). However, many commentators are not convinced that AI is inherently ethically neutral; even if it were, it is unlikely to escape negative consequences if healthcare goals and ethical values are not built into AI from the very beginning (Bankins and Formosa, 2023). Moreover, the values and goals with which AI is designed and used are, in some sense, a collective or public matter because they shape the societal environment on which we rely and which is collectively under our control

(Cheng *et al.,* 2021; Huang *et al.,* 2022; Saisubramanian *et al.,* 2022; Floridi, 2023). Several reasons support the consideration of AI's ethical implications (Acemoglu, 2021; Han *et al.,* 2021; Williams and Yampolskiy, 2021; Han *et al.,* 2022).

AI-driven healthcare innovations raise several ethical and societal challenges, and main concerns relate to, but are not limited to (Li *et al.,* 2024):

Safety and risks

AI interventions, no matter how advanced, are tested and show excellent performance in simulation (Chien *et al.,* 2022). Thus, the fairness of machine learning-driven patient recruitment and pricing relies on the assumption that the data used to train the system are reliable and comprehensive (Chen *et al.,* 2023; Peña *et al.,* 2023; Anuyah *et al.,* 2024). In this regard, one should acknowledge that the scores are not built into the world; they are constructed by our local organization (Weissler *et al.,* 2021). In addition, predictions in healthcare are embedded in the normative values of society (Pessach and Shmueli, 2022). Therefore, choices about which data to collect, what type of models to use, and the cost-benefit analysis of adopting them construct and change the physiology that results from AI predictions (Azimi and Zaydman, 2023). The challenge, therefore, is to leverage the benefits of advanced prediction while managing the associated exposure to direct and indirect risks, such as interventions that can be detrimental to care or breaches of confidentiality (Rahman *et al.,* 2024; Vrudhula *et al.,* 2024).

Privacy and Data Security

Patients need to trust that their personal health information will be treated with the utmost confidentiality (Cherif *et al.,* 2021). However, in today's world, where the digitization of healthcare has brought about an explosion of medical data stored in or derived from lightning-fast computer systems and devices, a certain vulnerability has been introduced (Belfrage *et al.,* 2022). Given the increased dependency of AI-driven healthcare on vast amounts of personal data, it is important to closely examine the potential risks of unauthorized viewing of or tampering with individual or pooled datasets, if left insufficiently protected (Wu *et al.,* 2022). We associate these threats with unauthorized data breaches that are defined as the result of a security incident, which concerns the confirmed unauthorized disclosure to an unauthorized person of personal information about one or more individuals that is in the care and control of a relevant holder or where no such confirmation is possible, which could give rise to the risk of harm (Hutchings *et al.,* 2020). Additionally, a logical extension to any discussion about unauthorized or partially authorized data breaches is unauthorized access to protected data, where someone accesses the data with unauthorized or malicious intent (Goldstein *et al.,* 2020). Unauthorized data breaches initiated by outside attackers, as well as criminals or malicious actors, constitute a major concern in this context and must be taken seriously, particularly by responsible healthcare organizations (Carlson *et al.,* 2021). The negative effects of potential unauthorized data breaches on patient trust are a compounding factor when it comes to discussing their potential ethical implications for relevant healthcare institutions (Abbas *et al.,* 2024). In order to counter potential data breaches, organizations, where possible supported by policymakers, are responsible for implementing robust data protection measures (Tapuria *et al.,* 2021).

Navigating these risks entails finding a balanced approach when utilizing large datasets, both for the express purpose of validating AI-driven applications, as well as to train and perfect such applications. The question arises, then: how should healthcare organizations address the issue of large datasets while upholding patients' privacy? (Lastrucci *et al.,* 2024). Furthermore, how does this square with obtaining consent from patients to use their data for multiple specific AI-driven applications, applications that may very well not yet exist? (Gerke *et al.,* 2020). In other words, is it ethical for organizations to collect, use, and share medical data across different institutions for multiple yet unknown AI-driven healthcare innovations? (Verma *et al.,* 2020). We would argue, in sum, that tight data security considerations must be given priority in

AI-driven healthcare innovation while also respecting the individual privacy rights of those from whom medical data has been gleaned (Roy, 2022). Given the current and anticipated problems arising from unauthorized breaches of data protection and the impact that these may have on patient trust in healthcare and its associated institutions, we argue for stringent security and privacy measures, including privacy-centric policies, as an ethical imperative (Zeb *et al.,* 2024). At the same time, as AI-driven healthcare innovations can advance patient care, we must also consider perspectives that defend the use of data to drive further innovations (Esmaeilzadeh, 2024). It is clear that any emphasis on data security in our context must be seen as complementary to ethical discussions on the sharing of health data across databases (Marengo, 2024). Our position outlines the need for those utilizing medical data for AI-driven systems to champion high levels of data security while coupling this with the use of 'fair' AI-centric data-sharing principles. This discussion is mirrored in recommendations to design systems in such a way that privacy and user consent do not undermine each other (George, 2024).

Bias and Discrimination

The use of AI, contrary to human decisions, can lead to subtle unintentional biases and discrimination (Fountain, 2022). State-of-the-art AI algorithms are trained using available data, which, if historical, may contain biases reflecting societal attitudes (Belenguer, 2022). Thus, AI can expand, institutionalize, and automate the bias and discrimination of society (Varona and Suárez, 2022). These algorithms may lead to reinforcing systemic biases, which could result in a lack of efficacy for marginalized groups (Zajko, 2021; Omar and Burrell, 2024). This section provides a study on the exploration of the extent to which bias and discrimination arise in AI systems used in healthcare and whether and how they can be managed (Gavoor and Teperdjian, 2021; Packin, 2021; Selbst, 2021; Emma, 2024; Osasona *et al.,* 2024).

AI learns from data, which can be biased and does not provide the full picture (Montoya *et al.,* 2024). After using AI to target melanoma skin cancer, a company inadvertently excluded darker-skinned patients from its trial (Patel *et al.,* 2023). In the United States, a software-based healthcare provider was reported to treat white patients more favorably than sicker Black patients (Selbst, 2021). The company made new guidelines as it perpetuated systemic inequalities (Emma, 2024). In image recognition, breast cancer datasets for mammography AI analysis lack diversity (Rana, 2022). The consequences of ignoring gender disparities in AI have been devastating for Black women (Adamu *et al.,* 2024). Researchers emphasize a more varied dataset including broader skin tones to avoid portraying Black patients in a dehumanized manner in AI-driven treatment (İsmail Mendi *et al.,* 2024). For a sample to be recognized by AI, Black individuals had to be 25% sicker. Trained on predominantly light-skinned individuals, an AI algorithm identified skin cancer with lesser accuracy (Haggenmüller *et al.,* 2021). In the future, owing to a scarcity of data on racial and ethnic minorities, this could lead to critical ethical problems, such as exacerbating healthcare disparities (Bevan and Atapour-Abarghouei, 2022). Users buying AI do not claim that they prefer their outputs to be biased: biased AI developers, rather than end-users, will be considered to have done wrong (Zhang *et al.,* 2023). Despite all possible efforts, AI systems will have some inaccuracies; thus, there is a balance or measure between utility and accuracy (Hussain and Toscano, 2024). The necessity of identifying and accordingly mitigating biased AI is unavoidable (Zhang *et al.,* 2023). A suitable regime to ensure that decisions are met would be one with upper floors and lower limits for discrimination and biases in AI (Adamu *et al.,* 2024). Any bias and discrimination present in AI systems should be regarded (İsmail Mendi *et al.,* 2024). All the possibilities to make AI bias as simple to track and rectify as can be technically executed should be exploited. Ongoing refinement of AI and ethical pondering to guarantee that it is the best approach can contribute to diminishing biases and discrimination found in AI systems (Hussain and Toscano, 2024).

Transparency and Accountability

The increasing use of AI-driven solutions in healthcare settings raises various ethical questions about transparency and accountability (Morley *et al.,* 2020). An AI process is often opaque, for instance in the case of machine learning where the final model components can be difficult to interpret (Keshta, 2022). The capacity for explanation matters because certain choices are necessary for healthcare, as daunting as they may be (Healthcare, 2021). Ensuring that care is open, known, and consented to by the patient is an important part of the patient–patient relationship (Esmaeilzadeh, 2020). It is also a matter of communication between the practitioner and the patient (Chikhaoui *et al.,* 2022). For several reasons, it is an ethical need to ensure that the system is sufficiently transparent and that it is very important for practitioners to be able to recognize and hold accountable any adverse pitfalls (Klimova *et al.,* 2023).

These healthcare AI accidents raise questions of responsibility and accountability (Smith, 2021). For any faults that appear where no one is significantly at fault, several ethical systems firmly suggest that the doctor, patient, or perhaps the company's differences should be responsible (Lang *et al.,* 2023). The wrong practice is very important because it underscores the moral necessity of producing compliant operational procedures that can serve as a channel of apology or complaint (Verdicchio and Perin, 2022). This refers to these as regulatory systems and proposes to guarantee over and beyond the compliance of the usual level of safety and confidence (Bleher and Braun, 2022). This prevails in the review, and also due to the extent and gravity of the injury, there is deep public concern about AI market transactions (Griffin, 2021). In addition, a successful examination also revealed demands for regulation (Zhang *et al.,* 2023). A few opposed general avenues for introducing a general framework for detailed considerations that could be explored are also available since it is not the same spirit that motivates all those against it – any functions or subfunctions that it may promote, which are partially compatible with the broader digital and AI strategy, are no different from the principles that it might promote (Sujan *et al.,* 2022; Porter *et al.,* 2023; Yazdanpanah *et al.,* 2023).

Informed Consent and Autonomy

In order for informed consent to be obtained, patients need to have information regarding the process that they are about to undergo, that is, the kind of AI applications, methodologies, predictive algorithms, or others that were used for their individual care process (Fouad *et al.,* 2020). This kind of information is patient-specific and poses new challenges for the informed consent process in AI (Bohr and Memarzadeh, 2020). The involvement of AI in clinical decision-making can be delicate and complex because patients may discredit the professional knowledge of human doctors in favor of the neutral, unbiased AI, which can be seen as being cheaper and having more knowledge (Lee and Yoon, 2021). There is also the risk of many patients not being able to accurately understand their processes of care or to make genuine decisions regarding it (Park *et al.,* 2020). Even though people may say they no longer care about how an AI-driven outcome came about, this does not mean that their autonomy is respected in such a setting (Jayakumar *et al.,* 2021).

The concept of respect for patient autonomy refers to the fact that patients should have the right to decide what is best for their bodies and minds and that their choices about care should not be influenced by media, interest groups, politicians, friends, or family (Blease *et al.,* 2022). This idea reinforces the point that there is a right way for healthcare professionals to act; namely, by creating the right conditions for decision-making, not by making decisions on behalf of the patients (Goldberg *et al.,* 2024). They have the duty to allow patients who might not care about knowing what is behind their automatic translator the liberty to access that knowledge if they so choose (Timmermans, 2020). This key point is the crux of the matter because, in healthcare, especially when new technologies are involved, the idea is to allow for the availability of knowledge about a course of

action rather than constraining choice by denying knowledge (Lee *et al.,* 2023). In this regard, the general idea must be that patients should have access to knowledge about the course of action or the prediction (Guerra-Farfan *et al.,* 2023), thereby allowing themselves to be truly 'informed.' Technological innovation has thus made it ethically obligatory to ask what it would take for informed consent to actually take place in the digital age (Jin *et al.,* 2021).

Mitigating Ethical Challenges

Researchers and ethicists have suggested multiple ways to mitigate the ethical challenges associated with AI-driven healthcare innovations (Trocin *et al.,* 2023). These strategies advocate the inclusion of ethical principles in the development and deployment of AI-driven solutions in the health sector (Kumar *et al.,* 2023b). The ethical design, development, and implementation of AI systems for healthcare ultimately help to foster trust in these technologies (Leslie *et al.,* 2020). Strategies to operationalize the development and application of responsible AI in healthcare are beginning to take shape and explore potential standards, certifications, tools, and practices (Markus *et al.,* 2021). Over the past few years, discussions about AI's potential use in healthcare have also intersected with questions about the direction and development of policies and regulations as enablers of a 'good' or responsible use of AI (Alami *et al.,* 2020). As such, the framework has been employed to conceptualize four different rationalities – reflexive, consequential, communicative, and ethical (Lekadir *et al.,* 2023). In consultation with some stakeholders, including one dedicated specifically to discussing healthcare ethics, this research undertook capacity-building through participation in a form of 'deliberative priority setting,' which engaged participants in scenario planning, normative debate, and the development of detailed policy recommendations and an evaluation framework to ensure that stakeholders' contributions can be taken forward by policymakers and practitioners working with AI (Albahri *et al.,* 2023). Key themes arising from the specific healthcare ethics deliberations included 1) a call for effective collaboration between healthcare providers, technologists, industry, financial backers, policymakers, and regulators in the co-production of responsible AI to ensure that the cleansing of data in healthcare can stand up to public and patient scrutiny, that it is subject to the right governance and funding, and is driven by the ethical priorities of healthcare, not big tech; 2) a call for data 'hygiene' linked to the generation of ethical AI, as the need for cleaner data requires ongoing conversations about what constitutes ethical innovation and responsible data management; and 3) a need for reflection on whether the state has a role in funding and/or supporting innovation, and a further need to consider whether the NHS should invest in the development of bespoke systems rather than importing off-the-shelf solutions from big tech companies, or pay big tech for access to their innovation (Saraswat *et al.,* 2023). Further, focus group discussions allowed us to scope potential action points and policy options to advance AI in healthcare that were informed by a broad range of public opinion, and to help elucidate the evidence and documentation we needed to develop to enable the action points to be realized by relevant agencies and industry (de Bock *et al.,* 2024). We claim that healthcare has important implications for the development of AI in society, as it is a very civilized culture that has uniquely been able to discuss the 'ethos' of what we want to achieve with and through big data and AI on a systematic, ad-hoc, and national scale (Albahri *et al.,* 2023). Our consultation has allowed diverse stakeholders to map their views about the present state of AI in healthcare to a moral landscape, but we also stressed that further consultation is necessary if any policy work that proceeds upon these foundations is to be genuinely responsive to the voice and experience of the public (de Bock *et al.,* 2024).

Regulatory Frameworks

The rapid evolution of AI technologies has created significant regulatory challenges for healthcare systems. There is a consensus supporting the need for adaptive rather than static regulations because it enables and obliges actors in the field to find their path independently, therefore leaving room for

innovation (Taeihagh, 2021). However, those who defend this thesis must also identify certain criteria that allow avoiding possible negative externalities that could damage third parties, in addition to highlighting situations in which the presence of regulations is to be considered essential, including all cases in which there is a negative impact on the rights and freedoms of citizens (Ajiga *et al.,* 2024; Akintuyi, 2024). Regarding AI in healthcare, an adaptive approach implies constantly updating the rules in proportion to technological progress and associated risks (Alam, 2022). These rules must ensure that the healthcare system is transparent, attentive to the future without, however, neglecting the present, develops research projects based on the principles of innovation, with the aim of achieving effective and safe results (Arif *et al.,* 2024; Bello *et al.,* 2024).

The law and technology literature has offered various regulatory models, ranging from full regulatory approval for AI developments to a laissez-faire, post-market surveillance approach (de Almeida *et al.,* 2021). These regulatory models refer to a complex and uncertain chain of human behaviors and environmental conditions (WHO, 2023). Policymakers must engage with AI developers and healthcare practitioners to understand how best to regulate AI, in the interest of patient safety and economic value to public and private sponsors (Kiseleva *et al.,* 2022). Regulatory models embedded in stringent laws and regulations may result in conservative and restrictive AI in health innovation, with companies choosing not to invest in those fields (Guidance WHO, 2021). A laissez-faire approach may protect companies from disclosing potentially negative AI performance, which may be against public health, patient, and consumer best interests, leaving them with no possible remedies and not advancing healthcare (Amann *et al.,* 2020). An adaptive regulatory approach should be sought, reducing uncertainty and battery effect by ensuring that regulatory policies, scientific expertise, testing, and use are aligned (Karunarathna *et al.,* 2024).

CONCLUSION

Technological advancements have always posed numerous ethical challenges, and the alteration of societal values in response to technological innovations seems to be inevitable as well. AI-driven technologies are no exception, particularly in the domain of healthcare. Privacy, data security and ownership, bias, transparency, and explainability of algorithms, as well as informed consent have been identified as aspects of AI ethics that are currently discussed most prominently. Current ethical guidelines and regulatory measures emphasize these aspects as the main priorities of responsible AI technology development in healthcare. In general, there is consensus that the implementation of AI-driven technologies in healthcare should be made in close collaboration with various stakeholders and in close interaction with healthcare professionals who are affected by AI technologies for the use of individual patients. Even though there still is no agreement on clear-cut best strategies and concepts, stakeholders recommend as the principal means to foster AI in healthcare not only the development and implementation of ethical guidelines and regulatory frameworks but also continuous evaluation of these rules and, if necessary, refinement to keep pace with the rapid and disruptive character of this technological area.

CONFLICT OF INTEREST

Authors hereby declare that they have no conflict of interest.

REFERENCES

Abbas, A., Alroobaea, R., Krichen, M., Rubaiee, S., Vimal, S., Almansour, F.M., 2024. Blockchain-assisted secured data management framework for health information analysis based on Internet of Medical Things. Pers. Ubiquitous Comput., 28(1): 59-72.

Acemoglu, D., 2021. Harms of AI. No. w29247. National Bureau of Economic Research.

Adamu, S., Alhussian, H., Aziz, N., Abdulkadir, S.J., Alwadin, A., Abubakar Imam, A., Abdullahi, M., Garba, A., Saidu, Y., 2024. The future of skin cancer diagnosis: a comprehensive systematic literature review of machine learning and deep learning models. Cogent Eng., 11(1): 2395425.

Ahmad, A., Husnain, A., Shiwlani, A., Hussain, A., Gondal, M.N., Saeed, A., 2024. Ethical and clinical implications of AI integration in cardiovascular healthcare. World J. Adv. Res. Rev., 23(3): 2479-501.

Ajiga, D., Okeleke, P.A., Folorunsho, S.O., Ezeigweneme, C., 2024. Navigating ethical considerations in software development and deployment in technological giants. Int. J. Ethics Res. Util., 7(1).

Akdeniz, M., Yardımcı, B., Kavukcu, E., 2021. Ethical considerations at the end-of-life care. SAGE Open Med., 9:20503121211000918.

Akintuyi, O.B., 2024. Adaptive AI in precision agriculture: a review: investigating the use of self-learning algorithms in optimizing farm operations based on real-time data. Res. J. Multidis. Stud., 7(02): 016-30.

Alam, A., 2022. Employing adaptive learning and intelligent tutoring robots for virtual classrooms and smart campuses: reforming education in the age of artificial intelligence. InAdvanced computing and intelligent technologies: Proceedings of ICACIT, Aug 31 (pp. 395-406). Singapore: Springer Nature Singapore.

Alami, H., Rivard, L., Lehoux, P., Hoffman, S.J., Cadeddu, S.B., Savoldelli, M., Samri, M.A., Ag Ahmed, M.A., Fleet, R., Fortin, J.P., 2020. Artificial intelligence in health care: laying the Foundation for Responsible, sustainable, and inclusive innovation in low-and middle-income countries. Global. Health., 16: 1-6.

Albahri, A.S., Duhaim, A.M., Fadhel, M.A., Alnoor, A., Baqer, N.S., Alzubaidi, L., Albahri, O.S., Alamoodi, A.H., Bai, J., Salhi, A., Santamaría, J., 2023. A systematic review of trustworthy and explainable artificial intelligence in healthcare: Assessment of quality, bias risk, and data fusion. Inf. Fusion., 96: 156-91.

Alowais, S.A., Alghamdi, S.S., Alsuhebany, N., Alqahtani, T., Alshaya, A.I., Almohareb, S.N., Aldairem, A., Alrashed, M., Bin Saleh, K., Badreldin, H.A., Al Yami, M.S., 2023. Revolutionizing healthcare: the role of artificial intelligence in clinical practice. BMC Med. Educ., 23(1): 689.

Amann, J., Blasimme, A., Vayena, E., Frey, D., Madai, V.I., Precise4Q, Consortium., 2020. Explainability for artificial intelligence in healthcare: a multidisciplinary perspective. BMC Med. Inform. Decis. Mak., 20:1-9.

Amjad, A., Kordel, P., Fernandes, G., 2023. A review on innovation in healthcare sector (telehealth) through artificial intelligence. Sust., 15(8): 6655.

Anuyah, S., Singh, M.K., Nyavor, H., 2024. Advancing clinical trial outcomes using deep learning and predictive modelling: bridging precision medicine and patient-centered care. arXiv preprint arXiv., 2412.07050.

Arif, H., Kumar, A., Fahad, M., Hussain, H.K., 2024. Future Horizons: AI-Enhanced Threat Detection in Cloud Environments: Unveiling Opportunities for Research. Int. J. Multidis. Sci. Arts., 3(1): 242-51.

Azimi, V., Zaydman, M.A., 2023. Optimizing equity: working towards fair machine learning algorithms in laboratory medicine. J. Appl. Lab. Med., 8(1): 113-28.

Bankins, S., Formosa, P., 2023. The ethical implications of artificial intelligence (AI) for meaningful work. J. Busin. Ethics. 185(4): 725-740.

Bekbolatova, M., Mayer, J., Ong, C.W., Toma, M., 2024. Transformative potential of AI in Healthcare: definitions, applications, and navigating the ethical Landscape and Public perspectives. Healthcare., 12(2), p. 125.

Belenguer, L., 2022. AI bias: exploring discriminatory algorithmic decision-making models and the application of possible machine-centric solutions adapted from the pharmaceutical industry. A.I. Ethics., (4): 771-87.

Belfrage, S., Helgesson, G., Lynøe, N., 2022. Trust and digital privacy in healthcare: a cross-sectional descriptive study of trust and attitudes towards uses of electronic health data among the general public in Sweden. BMC Med. Ethics., 23(1): 19.

Bello, H.O., Ige, A.B., Ameyaw, M.N., 2024. Adaptive machine learning models: concepts for real-time financial fraud prevention in dynamic environments. World J. Adv. Eng. Technol. Sci., 12(02): 021-34.

Bevan, P.J., Atapour-Abarghouei, A., 2022. Detecting melanoma fairly: Skin tone detection and debiasing for skin lesion classification. InMICCAI Workshop on Domain Adaptation and Representation Transfer (pp. 1-11). Cham: Springer Nature Switzerland.

Blease, C., Salmi, L., Rexhepi, H., Hägglund, M., DesRoches, C.M., 2022. Patients, clinicians and open notes: information blocking as a case of epistemic injustice. J. Med. Ethics., 48(10):785-93.

Bleher, H., Braun, M., 2022. Diffused responsibility: attributions of responsibility in the use of AI-driven clinical decision support systems. A.I. Ethics. 2(4): 747-61.

Boe-Lillegraven, S., Georgallis, P., Kolk, A., 2024. Sea change? Sensemaking, firm reactions, and community resilience following climate disasters. J. Manage. Stud., 61(7): 3021-51.

Bohr, A., Memarzadeh, K., 2020. The rise of artificial intelligence in healthcare applications. InArtificial Intelligence in healthcare (pp. 25-60). Academic Press.

Bommu, R., 2022. Ethical Considerations in the Development and Deployment of AI-powered Medical Device Software: Balancing Innovation with Patient Welfare. J. Innov. Technol., 5(1): 1-7.

Burgess, A., Matar, E., Roberts, C., Haq, I., Wynter, L., Singer, J., Kalman, E., Bleasel, J., 2021. Scaffolding medical student knowledge and skills: team-based learning (TBL) and case-based learning (CBL). BMC Med. Educ., 21(1): 238.

Carlson, J., Goldstein, R., Hoover, K., Tyson, N., 2021. NASPAG/SAHM statement: the 21st Century Cures Act and adolescent confidentiality. J. Adolesc. Health., 68(2): 426-8.

Čartolovni, A., Tomičić, A., Mosler, E.L., 2022. Ethical, legal, and social considerations of AI-based medical decision-support tools: A scoping review. Int. J. Med. Inform., 161: 104738.

Chen, R.J., Wang, J.J., Williamson, D.F., Chen, T.Y., Lipkova, J., Lu, M.Y., Sahai, S., Mahmood, F., 2023. Algorithmic fairness in artificial intelligence for medicine and healthcare. Nat, Biomed, Engin., 7(6): 719-42.

Cheng, L., Varshney, K.R., Liu, H., 2021. Socially responsible ai algorithms: Issues, purposes, and challenges. J. Art. Intell. Res., 71: 1137-81.

Cherif, E., Bezaz, N., Mzoughi, M., 2021. Do personal health concerns and trust in healthcare providers mitigate privacy concerns? Effects on patients' intention to share personal health data on electronic health records. Soc. Sci. Med., 283: 114146.

Chien, I., Deliu, N., Turner, R., Weller, A., Villar, S., Kilbertus, N., 2022. Multi-disciplinary fairness considerations in machine learning for clinical trials. InProceedings of the 2022 ACM Conference on Fairness, Accountability, and Transparency. ACM FAccT., 906-924).

Chikhaoui, E., Alajmi, A., Larabi-Marie-Sainte, S., 2022. Artificial intelligence applications in healthcare sector: ethical and legal challenges. Em. Sci. J., 6(4): 717-38.

de Almeida, P.G., dos Santos, C.D., Farias, J.S., 2021. Artificial intelligence regulation: a framework for governance. Ethics. Inf. Technol., 23(3): 505-25.

de Bock, K.W., Coussement, K., de Caigny, A., Słowiński, R., Baesens, B., Boute, R.N., Choi, T.M., Delen, D., Kraus, M., Lessmann, S., Maldonado, S., 2024. Explainable AI for operational research: A defining framework, methods, applications, and a research agenda. Eur. J. Oper. Res., 317(2): 249-72.

Desai, M., Shah, M., 2021. An anatomization on breast cancer detection and diagnosis employing multi-layer perceptron neural network (MLP) and Convolutional neural network (CNN). Clin. eHealth., 4: 1-11.

Díaz-Rodríguez, N., Del Ser, J., Coeckelbergh, M., de Prado, M.L., Herrera-Viedma, E., Herrera, F., 2023. Connecting the dots in trustworthy Artificial Intelligence: From AI principles, ethics, and key requirements to responsible AI systems and regulation. Inf. Fusion., 99: 101896.

Dwivedi, Y.K., Sharma, A., Rana, N.P., Giannakis, M., Goel, P., Dutot, V., 2023. Evolution of artificial intelligence research in Technological Forecasting and Social Change: Research topics, trends, and future directions. Technol. Forecast. Soc. Change., 192: 122579.

Dodda, S., Chintala, S., Kanungo, S., Adedoja, T., Sharma, S., 2024. Exploring AI-driven Innovations in Image Communication Systems for Enhanced Medical Imaging Applications. J. Electr. Syst., 20(3s):949-59.

Dror, I.E., 2020. Cognitive and human factors in expert decision making: six fallacies and the eight sources of bias. Anal. Chem., 92(12): 7998-8004.

Elendu, C., Amaechi, D.C., Elendu, T.C., Jingwa, K.A., Okoye, O.K., Okah, M.J., Ladele, J.A., Farah, A.H., Alimi, H.A., 2023. Ethical implications of AI and robotics in healthcare: A review. Med., 102(50): e36671.

Emma, L., 2024. The Ethical Implications of Artificial Intelligence: A Deep Dive into Bias, Fairness, and Transparency.

Esmaeilzadeh, P., 2024. Challenges and strategies for wide-scale artificial intelligence (AI) deployment in healthcare practices: A perspective for healthcare organizations. Artif. Intell. Med., 151: 102861.

Esmaeilzadeh, P., 2020. Use of AI-based tools for healthcare purposes: a survey study from consumers' perspectives. BMC Med. Inform. Decis. Mak., 20: 1-19.

Floridi, L., 2023. The ethics of artificial intelligence: Principles, challenges, and opportunities.

Fouad, H., Hassanein, A.S., Soliman, A.M., Al-Feel, H., 2020. Analyzing patient health information based on IoT sensor with AI

for improving patient assistance in the future direction. Meas., 159: 107757.

Fountain, J.E., 2022. The moon, the ghetto and artificial intelligence: Reducing systemic racism in computational algorithms. Gov. Inf. Q., 39(2): 101645.

Gavoor, A.A., Teperdjian, R., 2021. A Structural Solution to Mitigating Artificial Intelligence Bias in Administrative Agencies. Geo. Wash. L. Rev. Arguendo., 89: 71.

George, A.S., 2024. Emerging Trends in AI-Driven Cybersecurity: An In-Depth Analysis. Partn. Univers. Int. Res. J., 2(4): 15-28.

Gerke, S., Minssen, T., Cohen, G., 2020. Ethical and legal challenges of artificial intelligence-driven healthcare. AI in Healthcare., 26:295–336.

Goldberg, C.B., Adams, L., Blumenthal, D., Brennan, P.F., Brown, N., Butte, A.J., Cheatham, M., DeBronkart, D., Dixon, J., Drazen, J., Evans, B.J., 2024. To do no harm—and the most good—with AI in health care. NEJM AI., 1(3): AIp2400036.

Goldstein, R.L., Anoshiravani, A., Svetaz, M.V., Carlson, J.L., 2020. Providers' perspectives on adolescent confidentiality and the electronic health record: a state of transition. J. Adolesc. Health., 66(3): 296-300.

Griffin, F., 2021. Artificial intelligence and liability in health care. Health Matr., 31: 65.

Guerra-Farfan, E., Garcia-Sanchez, Y., Jornet-Gibert, M., Nuñez, J.H., Balaguer-Castro, M., Madden, K., 2023. Clinical practice guidelines: The good, the bad, and the ugly. Injury., 54: S26-9.

Guidance WHO. 2021. Ethics and governance of artificial intelligence for health. World Health Organization.

Gupta, M.M., Jankie, S., Pancholi, S.S., Talukdar, D., Sahu, P.K., Sa, B., 2020. Asynchronous environment assessment: A pertinent option for medical and allied health profession education during the COVID-19 pandemic. Educ. Sci., 10(12): 352.

Hager, P., Jungmann, F., Holland, R., Bhagat, K., Hubrecht, I., Knauer, M., Vielhauer, J., Makowski, M., Braren, R., Kaissis, G., Rueckert, D., 2024. Evaluation and mitigation of the limitations of large language models in clinical decision-making. Nat. Med., 30(9): 2613-22.

Haggenmüller, S., Maron, R.C., Hekler, A., Utikal, J.S., Barata, C., Barnhill, R.L., Beltraminelli, H., Berking, C., Betz-Stablein, B., Blum, A., Braun, S.A., 2021. Skin cancer classification via convolutional neural networks: systematic review of studies involving human experts. Eur. J. Cancer., 156: 202-16.

Haleem, A., Javaid, M., Singh, R.P., Suman, R., 2022. Medical 4.0 technologies for healthcare: Features, capabilities, and applications. Internet. Things. Cyber-Phys. Syst., 2: 12-30.

Han, T.A., Lenaerts, T., Santos, F.C., Pereira, L.M., 2022. Voluntary safety commitments provide an escape from over-regulation in AI development. Technol. Soc., 68: 101843.

Han, T.A., Pereira, L.M., Lenaerts, T., Santos, F.C., 2021. Mediating artificial intelligence developments through negative and positive incentives. PLoS One., 16(1): e0244592.

WHO. 2021. World Health Organization. Ethics and governance of artificial intelligence for health: WHO guidance: executive summary.

WHO. 2023. World Health Organization. Regulatory considerations on artificial intelligence for health.

Healthcare, R.T.A.D., 2021. Bridging the gap: Overcoming data, technological, and human roadblocks to AI-driven healthcare transformation. J. Manag., 8(1): 7-14.

Holland, J., Kingston, L., McCarthy, C., Armstrong, E., O'Dwyer, P., Merz, F., McConnell, M., 2021. Service robots in the healthcare sector. Robot., 10(1): 47.

Huang, C., Zhang, Z., Mao, B., Yao, X., 2022. An overview of artificial intelligence ethics. IEEE Trans. Artif. Intell., 4(4):799-819.

Hussain, S.I., Toscano, E., 2024. An extensive investigation into the use of machine learning tools and deep neural networks for the recognition of skin cancer: challenges, future directions, and a comprehensive review. Symmetry., 16(3): 366.

Hutchings, E., Loomes, M., Butow, P., Boyle, F.M., 2020. A systematic literature review of health consumer attitudes towards secondary use and sharing of health administrative and clinical trial data: a focus on privacy, trust, and transparency. Syst. Rev., 9(1): 235.

İsmail Mendi, B., Kose, K., Fleshner, L., Adam, R., Safai, B., Farabi, B., Atak, M.F., 2024. Artificial Intelligence in the Non-Invasive Detection of Melanoma. Life., 14(12): 1602.

Javaid, M., Haleem, A., Singh, R.P., Suman, R., Rab, S., 2022. Significance of machine learning in healthcare: Features, pillars and applications. Int. J. Intell. Networks., 3: 58-73.

Jayakumar, P., Moore, M.G., Furlough, K.A., Uhler, L.M., Andrawis, J.P., Koenig, K.M., Aksan, N., Rathouz, P.J., Bozic, K.J., 2021. Comparison of an artificial intelligence–enabled patient decision aid vs educational material on decision quality, shared decision-making, patient experience, and functional outcomes in adults with knee osteoarthritis: a randomized clinical trial. JAMA Netw. Open., 4(2): e2037107.

Jin, D., Pan, E., Oufattole, N., Weng, W.H., Fang, H., Szolovits, P., 2021. What disease does this patient have? a large-scale open domain question answering dataset from medical exams. Appl. Sci., 11(14): 6421.

Kapania, S., Siy, O., Clapper, G., Sp, A.M., Sambasivan, N., 2022. Because AI is 100% right and safe: User attitudes and sources of AI authority in India. InProceedings of the 2022 CHI Conference on Human Factors in Computing Systems, 1-18.

Karimian, G., Petelos, E., Evers, S.M.A.A., 2022. The ethical issues of the application of artificial intelligence in healthcare: a systematic scoping review. AI. Ethics., 2: 539–551.

Karunarathna, I., Hapuarachchi, T., Ekanayake, U., Gunathilake, S., 2024. The ethics of genetic editing: Navigating the future of science.

Keshta, I., 2022. AI-driven IoT for smart health care: Security and privacy issues. Inform. Med. Unlocked., 30: 100903.

Khan, M., Shiwlani, A., Qayyum, M.U., Sherani, A.M., Hussain, H.K., 2024. AI-powered healthcare revolution: an extensive examination of innovative methods in cancer treatment. BULLET: Jurnal. Multidisiplin. Ilmu. 3(1): 87-98.

Khanna, S., Srivastava, S., Khanna, I., Pandey, V., 2020. Ethical Challenges Arising from the Integration of Artificial Intelligence (AI) in Oncological Management. Int. J. Resp. Artif. Intell., 10(8): 34-44.

Kiseleva, A., Kotzinos, D., De Hert, P., 2022. Transparency of AI in healthcare as a multilayered system of accountabilities: between legal requirements and technical limitations. Front. Artif. Intell., 5: 879603.

Klimova, B., Pikhart, M., Kacetl, J., 2023.Ethical issues of the use of AI-driven mobile apps for education. Front. Public. Health., 10: 1118116.

Kumar, P., Dwivedi, Y.K., Anand, A., 2023a. Responsible artificial intelligence (AI) for value formation and market performance in healthcare: The mediating role of patient's cognitive engagement. Inform. Syst. Front., 25(6): 2197-2220.

Kumar, P., Sharma, S.K., Dutot, V., 2023b. Artificial intelligence (AI)-enabled CRM capability in healthcare: The impact on service innovation. Int. J. Inform. Manage., 69:102598.

Lang, B.H., Nyholm, S., Blumenthal-Barby, J., 2023. Responsibility gaps and black box healthcare AI: shared responsibilization as a solution. Dig. Soc., 2(3): 52.

Lastrucci, A., Pirrera, A., Lepri, G., Giansanti, D., 2024. Algorethics in Healthcare: Balancing Innovation and Integrity in AI Development. Algo., 17(10):432.

Lee, D., Yoon, S.N., 2021. Application of artificial intelligence-based technologies in the healthcare industry: Opportunities and challenges. Int. J. Environ. Res. Public. Health., 18(1): 271.

Lee, P., Goldberg, C., Kohane, I., 2023. The AI revolution in medicine: GPT-4 and beyond. Pearson.

Lekadir, K., Feragen, A., Fofanah, A.J., Frangi, A.F., Buyx, A., Emelie, A., Lara, A., Porras, A.R., Chan, A.W., Navarro, A., Glocker, B., 2023. FUTURE-AI: International consensus guideline for trustworthy and deployable artificial intelligence in healthcare. arXiv preprint arXiv: 2309.12325.

Leslie, D., 2020. Tackling COVID-19 through responsible AI innovation: Five steps in the right direction. Harvard Data Sci. Rev., 10.

Lewis, J.R., Sauro, J., 2021. Usability and user experience: Design and evaluation. Handbook of human factors and ergonomics. 15: 972-1015.

Li, Y.H., Li, Y.L., Wei, M.Y., Li, G.Y., 2024. Innovation and challenges of artificial intelligence technology in personalized healthcare. Sci. Rep., 14(1): 18994.

Marengo, A., 2024. Navigating the nexus of AI and IoT: A comprehensive review of data analytics and privacy paradigms. Internet Things., 101318.

Markus, A.F., Kors, J.A., Rijnbeek, P.R. 2021. The role of explainability in creating trustworthy artificial intelligence for health care: a comprehensive survey of the terminology, design choices, and evaluation strategies. J. Biomed. Infor., 113: 103655.

Masters, K., 2023. Ethical use of artificial intelligence in health professions education: AMEE Guide No. 158. Med. Teach., 45(6): 574-584.

McLennan, S., Fiske, A., Tigard, D., Müller, R., Haddadin, S., Buyx, A., 2022. Embedded ethics: a proposal for integrating ethics into the development of medical AI. BMC Med. Ethics., 23(1): 6.

Mikalef, P., Conboy, K., Lundström, J.E., Popovič, A., 2022. Thinking responsibly about responsible AI and 'the dark side'of AI. Eur. J. Inf. Syst., 31(3): 257-68.

Mirbabaie, M., Stieglitz, S., Frick, N.R.J., 2021. Artificial intelligence in disease diagnostics: A critical review and classification on the current state of

research guiding future direction. Health. Technol., 11(4): 693-731.

Montemayor, C., Halpern, J., Fairweather, A., 2022. In principle obstacles for empathic AI: why we can't replace human empathy in healthcare. A.I. Soc., 37(4):1353-9.

Montoya, L.N., Roberts, J.S., Hidalgo, B.S., 2024. Towards Fairness in AI for Melanoma Detection: Systemic Review and Recommendations. arXiv preprint arXiv: 2411.12846.

Morley, J., Machado, C.C., Burr, C., Cowls, J., Joshi, I., Taddeo, M., Floridi, L., 2020. The ethics of AI in health care: a mapping review. Soc. Sci. Med., 260: 113172.

Murphy, K., Di Ruggiero, E., Upshur, R., Willison, D.J., Malhotra, N., Cai, J.C., Malhotra, N., Lui, V., Gibson, J., 2021. Artificial intelligence for good health: a scoping review of the ethics literature. BMC Med. Ethics., 22: 1-7.

Naik, N., Hameed, B.Z., Shetty, D.K., Swain, D., Shah, M., Paul, R., Aggarwal, K., Ibrahim, S., Patil, V., Smriti, K., Shetty, S., 2022. Legal and ethical consideration in artificial intelligence in healthcare: who takes responsibility?. Front. Surg., 9: 862322.

Nasr, M., Islam, M.M., Shehata, S., Karray, F., Quintana, Y., 2021. Smart healthcare in the age of AI: recent advances, challenges, and future prospects. IEEE Access., 9: 145248-70.

Nassar, A., Kamal, M., 2021. Ethical dilemmas in AI-powered decision-making: a deep dive into big data-driven ethical considerations. Int. J. Resp. Artif. Intell., 11(8):1-1.

Nifakos, S., Chandramouli, K., Nikolaou, C.K., Papachristou, P., Koch, S., Panaousis, E., Bonacina, S., 2021. Influence of human factors on cyber security within healthcare organisations: A systematic review. Sens., 21(15): 5119.

Omar, M., Burrell, D.N., 2024. Organizational Dynamics and Bias in Artificial Intelligence (AI) Recruitment Algorithms. InEvolution of Cross-Sector Cyber Intelligent Markets (pp. 269-290). IGI Global.

Osasona, F., Amoo, O.O., Atadoga, A., Abrahams, T.O., Farayola, O.A., Ayinla, B.S., 2024. Reviewing the ethical implications of AI in decision making processes. Int. J. Manag. Entrep. Res., 6(2): 322-35.

Packin, N.G., 2021. Disability discrimination using artificial intelligence systems and social scoring: Can we disable digital bias?. J. Int. Comp. L., 8: 487.

Palkova, K., 2021. Ethical guidelines for artificial intelligence in healthcare from the sustainable development perspective. Eur. J. Sust. Develop., 10(1): 90-90.

Park, C.W., Seo, S.W., Kang, N., Ko, B., Choi, B.W., Park, C.M., Chang, D.K., Kim, H., Kim, H., Lee, H., Jang, J., 2020. Artificial intelligence in health care: current applications and issues. J. Korean Med. Sci., 35(42).

Parsa-Parsi, R.W., 2022. The international code of medical ethics of the world medical association. JAMA., 328(20): 2018-21.

Patel, K., 2024. Ethical reflections on data-centric AI: balancing benefits and risks. Int. J. Artif. Intell. Res. Develop., 2(1): 1-7.

Patel, R.H., Foltz, E.A., Witkowski, A., Ludzik, J., 2023. Analysis of artificial intelligence-based approaches applied to non-invasive imaging for early detection of melanoma: a systematic review. Cancers., 15(19): 4694.

Peña, A., Serna, I., Morales, A., Fierrez, J., Ortega, A., Herrarte, A., Alcantara, M., Ortega-Garcia, J., 2023. Human-centric

multimodal machine learning: Recent advances and testbed on AI-based recruitment. SN Comput. Sci., 4(5): 434.

Pessach, D., Shmueli, E., 2022. A review on fairness in machine learning. ACM Comput. Surv., 55(3): 1-44.

Pinto-Coelho, L., 2023. How artificial intelligence is shaping medical imaging technology: A survey of innovations and applications. Bioeng., 10(12): 1435.

Porter, Z., Ryan, P., Morgan, P., Al-Qaddoumi, J., Twomey, B., McDermid, J., Habli, I., 2023. Unravelling Responsibility for AI. arXiv preprint arXiv: 2308.02608.

Rahman, A.U., Saqia, B., Alsenani, Y.S., Ullah, I., 2024. Data quality, bias, and strategic challenges in reinforcement learning for healthcare: A survey. Int. J. Data. Inf. Intell. Comput., 3(3): 24-42.

Rana, S., 2022. SkinCAN AI: A deep learning-based skin cancer classification and segmentation pipeline designed along with a generative model. Master's thesis, University of Windsor (Canada).

Reddy, S., Rogers, W., Makinen, V.P., Coiera, E., Brown, P., Wenzel, M., Weicken, E., Ansari, S., Mathur, P., Casey, A., Kelly, B., 2021. Evaluation framework to guide implementation of AI systems into healthcare settings. BMJ Health. Care. Inform., 28(1): e100444.

Roy, S., 2022. Privacy prevention of health care data using AI. J. Data. Acquis. Process., 37(3): 769.

Saisubramanian, S., Zilberstein, S., Kamar, E., 2022. Avoiding negative side effects due to incomplete knowledge of AI systems. AI Mag., 42(4): 62-71.

Salo-Pöntinen, H., 2021. AI Ethics : Critical Reflections on Embedding Ethical Frameworks in AI Technology. In M. Rauterberg (Ed.), Culture and Computing : Design Thinking and Cultural Computing. 9th International Conference, C&C 2021, Held as Part of the 23rd HCI International Conference, HCII 2021, Virtual Event, July 24–29, 2021, Proceedings, Part II (pp. 311-329). Springer. Lecture Notes in Computer Science, 12795.

Saraswat, D., Bhattacharya, P., Verma, A., Prasad, V.K., Tanwar, S., Sharma, G., Bokoro, P.N., Sharma, R., 2022. Explainable AI for healthcare 5.0: opportunities and challenges. IEEE Access., 10: 84486-517.

Selbst, A.D., 2021. An institutional view of algorithmic impact assessments. Harv. JL. Tech., 35: 117.

Siala, H., Wang, Y., 2022. SHIFTing artificial intelligence to be responsible in healthcare: A sysp-tematic review. Soc. Sci. Med., 296:114782.

Smith, H., 2021. Clinical AI: opacity, accountability, responsibility and liability. A.I. Soc., 36(2): 535-45.

Solanki, P., Grundy, J., Hussain, W., 2023. Operationalising ethics in artificial intelligence for healthcare: A framework for AI developers. AI Ethics., 3: 223–240.

Sujan, M.A., White, S., Habli, I., Reynolds, N., 2022. Stakeholder perceptions of the safety and assurance of artificial intelligence in healthcare. Saf. Sci., 155: 105870.

Taeihagh, A., 2021. Governance of artificial intelligence. Policy. Soc., 40(2): 137-157.

Tapuria, A., Porat, T., Kalra, D., Dsouza, G., Xiaohui, S., Curcin, V., 2021. Impact of patient access to their electronic health record: systematic review. Inform. Health. Soc. Care., 46(2): 194-206.

Tariq, M., Hayat, Y., Hussain, A., Tariq, A., Rasool, S., 2024. Principles and

Perspectives in Medical Diagnostic Systems Employing Artificial Intelligence (AI) Algorithms. Int. Res. J. Econ. Manage. Stud., 3(1).

Timmermans, S., 2020. The engaged patient: The relevance of patient–physician communication for twenty-first-century health. J. Health Soc. Behav., 61(3): 259-73.

Trocin, C., Mikalef, P., Papamitsiou, Z., Conboy, K., 2023. Responsible AI for digital health: a synthesis and a research agenda. Infor. Syst. Front., 25(6): 2139-57.

Varkey, B., 2021. Principles of clinical ethics and their application to practice. Med. Princ. Prac., 30(1): 17-28.

Varona, D., Suárez, J.L., 2022. Discrimination, bias, fairness, and trustworthy AI. Appl. Sci., 12(12): 5826.

Verdicchio, M., Perin, A., 2022. When doctors and AI interact: on human responsibility for artificial risks. Phil. Technol., 35(1): 11.

Verma, A., Rao, K., Eluri, V., Sharma, Y., 2020. Regulating AI in public health: systems challenges and perspectives. ORF Occasional Paper. 261.

Vrudhula, A., Kwan, A.C., Ouyang, D., Cheng, S., 2024. Machine Learning and Bias in Medical Imaging: Opportunities and Challenges. Circ. Cardiovasc. Imaging., 17(2): e015495.

Weissler, E.H., Naumann, T., Andersson, T., Ranganath, R., Elemento, O., Luo, Y., Freitag, D.F., Benoit, J., Hughes, M.C., Khan, F., Slater, P., 2021. The role of machine learning in clinical research: transforming the future of evidence generation. Trials. 22: 1-5.

Williams, R., Yampolskiy, R., 2021. Understanding and avoiding ai failures: A practical guide. Philos., 6(3): 53.

Wu, Z., Xuan, S., Xie, J., Lin, C. et al. 2022. How to ensure the confidentiality of electronic medical records on the cloud: A technical perspective. Comput. Biol. Med., 147: 105726.

Yakhshiboyev, R.E., Ermetov, E., 2024. Ethical considerations in the development and deployment of AI. Innov. Sci. Technol., 1(5): 26-42.

Yazdanpanah, V., Gerding, E.H., Stein, S., Dastani, M., Jonker, C.M., Norman, T.J., Ramchurn, S.D., 2023. Reasoning about responsibility in autonomous systems: challenges and opportunities. A.I. Soc., 38(4): 1453-64.

Zahlan, A., Ranjan, R.P., Hayes, D., 2023. Artificial intelligence innovation in healthcare: Literature review, exploratory analysis, and future research. Technol. Soc., 102321.

Zajko, M., 2021. Conservative AI and social inequality: conceptualizing alternatives to bias through social theory. A.I. Soc., 36(3): 1047-56.

Zeb, S., Nizamullah, F.N., Abbasi, N., Fahad, M., 2024. AI in healthcare: revolutionizing diagnosis and therapy. Int. J. Multidiscip. Sci. Arts., 3(3): 118-28.

Zhang, J., Zhong, F., He, K., Ji, M., Li, S., Li, C., 2023. Recent Advancements and Perspectives in the Diagnosis of Skin Diseases Using Machine Learning and Deep Learning: A Review. Diagnostics., 13(23): 3506.