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COMMENTARY

Navigating ethical dimensions in algorithmic radiology: A call for action to ensure representation of low-resource contexts

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Abstract

Artificial intelligence (AI) has revolutionised medicine, particularly radiology, transforming our ability to interpret complex imaging data. While traditional methods rely on subjective visual assessments, AI excels at recognising intricate patterns and providing quantitative and automated evaluations. In this commentary, I delve into the various ethical considerations in algorithmic radiology, beyond the conventional concerns. Focusing on utilitarianism, patient understanding, virtue ethics, and social contract theory, the paper contributes to a comprehensive understanding of the ethical landscape surrounding AI technologies. The challenges in the use of algorithmic AI in radiology underscore the significance of the ethics of care, responsiveness to context, and the role of human emotion, whether pertaining to the practitioner, the patient, or both. The social contract theory guides the responsibilities of healthcare professionals, urging action to address biases in AI algorithms and ensuring equitable representation of various ethnic and racial populations. Diversity in data must be prioritised to avoid disparities in administering healthcare and uphold patient rights in the adoption of AI. In terms of virtue ethics, professionalism and responsibility are crucial for radiologists adopting AI. Also, an absence of explicit guidelines on the use of AI in healthcare poses challenges, necessitating further discourse. Finally, a utilitarian perspective on public health mandates a fair distribution of imaging technologies to address prevalent health issues in a given population. In conclusion, this paper advocates for an ethical approach to AI integration, which aligns technology with human values and wellbeing, as we shape the future of healthcare.

Introduction

Artificial intelligence (AI) has emerged as a transformative force in the field of medicine, particularly in the domain of radiology, where the interpretation of complex imaging data plays a pivotal role in disease detection and management [1, 2]. The integration of deep learning — a subset of machine learning inspired by neural network structures — has empowered AI to autonomously pick out discriminating features within the available data, enabling it to approximate intricate non-linear relationships [3]. This has significantly impacted various healthcare applications, ranging from drug discovery to medical diagnostics and imaging, with radiology standing out as a notable beneficiary [4].

In radiology, the traditional process involves trained physicians visually assessing medical images to detect, characterise, and monitor diseases. However, this is a qualitative approach, and can be subjective, being dependent on the individual's education and experience [5]. AI, by contrast, excels at recognising complex patterns within the imaging data, and can provide a quantitative assessment automatically. Incorporating AI into clinical workflows as a supportive tool enables more accurate and reproducible assessments [6]. As the field of algorithmic radiology advances, we must critically examine the ethical implications and challenges that arise from the use of AI in healthcare, particularly in radiology. While issues such as informed consent, privacy, and data protection have been extensively discussed, this paper seeks to delve deeper into the philosophical dimensions of the ethical challenges and biases that affect algorithmic radiology [7–9]. Going beyond the conventional concerns such as data safety and informed consent, this review aims to explore the nuances of ethical considerations related to utilitarianism, patient understanding, virtue ethics, and social contract theory.

Philosophical foundations of algorithmic bias

To explore algorithmic bias in the context of radiology, we must delve into the philosophical foundations that underpin ethical theories. Recognising that bias can be multifaceted and that it has implications in algorithmic radiology, this section aims to examine the ethical theories that relate to algorithmic bias.

Fairness and justice

Fairness, as a philosophical concept, emphasises impartiality and just treatment to ensure that every individual has an equal opportunity to access benefits [10]. In the context of algorithmic radiology, achieving fairness involves addressing disparities in access to the advantages that AI offers. Research on algorithmic radiology reveals a notable economic divide, both across countries and within communities, that affects the implementation and utilisation of AI technologies [11]. Studies indicate that some regions and demographics may have been left behind, hindering widespread realisation of the potential benefits of AI technologies [12, 13].

Justice, a philosophical principle focusing on equitable distribution, calls for fair access to healthcare services in the context of algorithmic radiology [14]. While developed countries may have the resources to adopt AI technologies in their healthcare systems, there is a pressing need to ensure that developing and underdeveloped nations are not left behind. Studies underscore the strain on healthcare systems in these regions, yet they lack sufficient research on the integration and impact of AI in radiology in such contexts [15]. These issues may further exacerbate existing challenges in low-resource regions, where the healthcare system is burdened with a larger number of patients. To uphold justice in such contexts, there is a critical need for global initiatives that promote equal access to the benefits of AI in radiology.

Challenges in algorithmic AI and the ethics of care

In the context of medical ethics, the ethics of care is a perspective that places profound emphasis on relational and context-specific moral considerations [16]. Particularly in healthcare, this ethical framework acknowledges the significance of empathetic and compassionate relationships, challenging the abstraction of ethical principles often associated with traditional theories [17]. For clinicians and radiologists, grasping the ethics of care is crucial as it underscores the importance of understanding patient needs, vulnerabilities, and the contexts in which healthcare decisions unfold. Ensuring that the role of AI in healthcare decisions is advisory rather than determinative is essential in this respect.

On the practitioners' side, while AI holds immense potential to enhance diagnostic accuracy and efficiency in radiology, there is a growing concern regarding the de-skilling of future radiologists. As the technology becomes more prevalent in the field, there is a risk that reliance on algorithms may diminish the development of essential clinical skills among radiologists. We will need to strike a balance between leveraging the benefits of algorithmic AI while ensuring that it supplements rather than supplants human expertise and human touch. To ensure this, it is crucial to integrate AI training into radiology curricula, emphasising the importance of understanding algorithmic outputs within the broader context of patient care. Additionally, continued professional development programmes should focus on honing clinical skills to match technological advancements.

Relationship-centred ethics

With the advent and proliferation of algorithmic AI in medicine and diagnostics, there is a growing concern about maintaining relationship-centred ethics [18]. Moreover, the shift towards automation may inadvertently undermine the cultivation of empathetic and compassionate relationships between radiologists and patients, which are integral aspects of patient-centred care. The current capabilities of AI in healthcare do not, for example, adapt to the specific needs and circumstances of individuals [19].

Responsiveness to context

The dynamic and contextual nature of moral dilemmas, a central tenet of the ethics of care, are often overlooked in AI-enhanced technology. Responsiveness to unique circumstances and vulnerabilities of patients is not adequately integrated into current AI systems. In the era of algorithmic decision making, understanding individual contexts is essential to avoid overlooking critical factors that may impact patient outcomes [20].

Role of human emotion

While AI excels in processing vast amounts of data and making objective decisions, the human aspects of empathy and compassion are often sidelined. Human emotion, a critical component in patient care, is not entirely replaceable by AI. The emotional nuances involved in healthcare decisions, such as understanding a patient's fears or concerns, play a pivotal role that algorithmic AI may struggle to encompass fully [21].

Critique of abstract reasoning

The ethics of the care perspective challenges the prevailing trend of abstract reasoning in ethical theories. In contrast to deontological or utilitarian approaches, this ethical perspective recognises the complexity of real-life situations [22]. One of the principal challenges in using AI for healthcare lies in its risk of reducing ethical decisions to universal principles, without fully grasping the need for context-specific judgements.

In this context, a deontological approach might prioritise adherence to strict rules or protocols for interpreting images — focusing solely on predetermined criteria — without considering the unique circumstances of each patient. Similarly, a utilitarian approach might prioritise efficiency and maximising outcomes across a large population, potentially overlooking the needs and concerns of individual patients. However, the ethics of the care paradigm challenges these approaches by emphasising the importance of empathetic understanding and context-specific considerations.

When utilising AI algorithms in radiology, it is essential to recognise that each patient presents a unique set of circumstances, including their medical history, socio-economic background, and personal preferences. For example, consider a patient with a complex medical history who presents with vague symptoms. An AI algorithm may provide a straightforward diagnosis based on statistical probabilities and predetermined criteria. However, it may not be informed by the patient's individual context, including their past medical history, presenting symptoms, and demographic background, which could impact the patient's wellbeing.

Autonomy and informed consent

Autonomy, the right of individuals to make decisions about their own medical care, is a cornerstone of ethical healthcare practices [23]. In the context of AI in radiology, ensuring patient autonomy involves addressing various factors influencing the acceptability of AI technologies. User factors, including trust, system understanding, and AI literacy, play a crucial role [24]. Patients should be equipped with the necessary information and understanding to make informed choices regarding the integration of AI in their healthcare. The literature identifies factors affecting AI acceptability, but there is a notable gap in research on actively improving these aspects and address them to enhance public receptivity [25].

Informed consent in the context of AI in radiology is vital and requires the prioritising of equity of access and understanding. Language barriers pose a significant challenge here, especially since most AI-related literature is published in English [26]. This language bias can disproportionately affect individuals with lower health literacy, particularly in underserved areas. To truly uphold the principles of informed consent, we must make an effort to provide accessible and culturally sensitive information about the use of AI in radiology [27], through initiatives such as translated educational materials, AI literacy programmes, and actively involving patients in discussions about the integration of AI in radiology.

Social contract theory

Social contract theory posits that, in forming a society, individuals agree to a set of rules and principles for the common good. In the realm of medicine and radiology, this theory delineates the ethical responsibilities of healthcare professionals towards patients and society at large [28]. In medicine, the social contract implies that healthcare professionals — including radiologists — are entrusted by society to provide accurate diagnoses and contribute to patient wellbeing. This contract emphasises principles such as respect for autonomy, beneficence, and non-maleficence [29].

As AI and algorithmic approaches become integral to radiology, it is imperative to adhere to the principles of the social contract. Inherent biases in image acquisition and utilisation hold particular relevance for AI in radiology, demanding a renewed commitment to ethical responsibilities to ensure equitable and accurate outcomes [30]. It is imperative to address the inherent biases in AI algorithms — particularly in relation to racial and ethnic differences — which may affect diagnoses. There is an urgent need for equitable representation in the data used to train AI models and for consideration of diverse populations. Failing to account for these factors can perpetuate healthcare disparities. In the context of developing or underserved countries — with high demand and limited resources — there has been insufficient effort to ensure equitable representation and data collection [31].

Epistemic injustice

Epistemic injustice, as described by philosopher Miranda Fricker, is an important aspect of medical ethics. It encompasses situations where individuals are wronged in their capacity as knowledge contributors or recipients [32]. Two primary manifestations of epistemic injustice are testimonial injustice, where a person's credibility as a knowledge source is unfairly discredited due to prejudice, and hermeneutical injustice, where individuals lack the interpretive resources to make sense of their own experiences, often due to social exclusion. In algorithmic radiology, understanding and addressing epistemic injustice is paramount [33].

Inadequate data representation poses a risk of producing biased algorithms, hindering their effectiveness in addressing global healthcare concerns. Table 1 discusses the impact of testimonial injustice and hermeneutical injustice in the context of algorithmic radiology. Such limitations in the inclusivity of AI algorithms impedes their effectiveness across diverse populations. This inequitable representation, as previously discussed, created underrepresentation in datasets. Consequently, these biased algorithms may perpetuate healthcare inequalities, leading to disparities in diagnostic accuracy and patient outcomes [34]. The risk of algorithmic bias becomes pronounced when the knowledge-sharing practices and experiences of individuals from various backgrounds are inadequately considered. Inadequate data sharing exacerbates this challenge, potentially overlooking valuable insights specific to certain regions [35].

Overcoming epistemic injustice in algorithmic radiology necessitates a collaborative effort to bridge these gaps.

Patient rights

Algorithmic radiology can have a profound impact on privacy and healthcare needs, which is of paramount importance to patient rights. Patients exhibit diverse healthcare requirements, influenced by various factors such as socio-demographics, environments, socio-economic status, and geographical factors [36]. Among these rights, the right to privacy is crucial [37]. Biased algorithms can pose a serious risk to patient privacy by disproportionately affecting specific demographic groups [38].

Another essential patient right is that to informed consent. Patients have the fundamental right to be fully informed about any diagnostic procedures or treatments they undergo [39]. The interference by potentially biased algorithms hinders their ability to make well-informed decisions about their healthcare.

The right to non-discrimination is equally vital [40]. Patients are entitled to fair and equal treatment irrespective of their background, but biases in the algorithm may undermine this right. Additionally, the right to quality healthcare is jeopardised when biased algorithms lead to inaccurate diagnoses or inappropriate treatment recommendations. For instance, an algorithm trained primarily on imaging data from urban hospitals might not recognise tuberculosis presentations common in rural populations, leading to

Table 1. Testimonial vs Hermeneutical Injustice in Algorithmic AI

Aspect	Testimonial Injustice	Hermeneutical Injustice
Definition	Unfair discrediting of individual testimonies.	Lack of understanding or recognition of experiences.
Focus	Individual testimony.	Collective gaps in understanding.
Impact on AI	Affects the credibility of individual inputs.	Influences the overall interpretative capacity of AI.
Example in AI Radiology	Dismissing patient-reported symptoms erroneously.	Misinterpreting imaging characteristics broadly.
Data Representation	Biased interpretation of individual data points.	Incomplete understanding of conditions in certain populations.
Consequences	Impacts specific individuals.	Systemic misinterpretations or oversights.
Addressing Challenges	Emphasis on validating individual experiences.	Need for comprehensive understanding of conditions.
Call for Action	Ensure individual testimonies are treated fairly.	Advocate for a more inclusive understanding of diverse experiences.

missed diagnoses. When algorithms are trained on data that lack diversity or reflect historical biases, they may struggle to accurately interpret information for underrepresented groups.

Ensuring that algorithmic radiology adheres to ethical principles and supports patient rights is essential to maintain patients' trust in healthcare systems. Efforts to address biases, promote transparency, and actively involve patients in the development and validation of these technologies are crucial steps to protecting patient rights in the context of algorithmic radiology.

Ethical frameworks

As AI continues to make significant strides in the field of medicine, it is evident that we urgently need ethical frameworks tailored to address biases. Despite the accelerated progress, a noticeable void exists — a lack of established guidelines for AI implementation in radiology. This gap raises critical questions about the ethical implications, and therefore, it is crucial to lay down ethical foundations that uphold the principles of fairness, justice, and patient-centric care [41, 42]. Given these considerations, this paper proposes ethical frameworks tailored to algorithmic radiology, with comprehensive guidelines to guide the development, implementation, and evaluation of AI technologies in radiological practice.

Interestingly, Sqalli et al in their enlightening article highlight the intricate process of humanizing AI in medical training [43]. They argue for an interdisciplinary and collaborative approach that involves patients, medical practitioners, AI developers, policymakers, and other stakeholders. It is evident that establishing ethical guidelines is not just a scholarly pursuit but a collective responsibility that involves diverse stakeholders working towards the common goal of fostering fairness and transparency in algorithmic radiology. This collaborative effort is essential for the adoption of a human-centred approach to AI development, which entails careful consideration of the social, ethical, and legal implications of AI applications in medicine.

Applying virtue ethics

In the rapidly advancing field of algorithmic radiology, the concept of a virtuous radiologist becomes paramount to integrate virtue ethics into technological innovation and medical practice. The interplay of various ethical dynamics is crucial in shaping a responsible and accountable role for radiologists.

Professionalism and responsibility

Virtue ethics underscore the importance of professionalism, imbued with responsibility, accountability, and a commitment to continuous improvement [44]. Radiologists, as clinicians at the forefront of adopting AI technologies, bear the responsibility of ensuring that these innovations contribute to equitable healthcare. This involves not only embracing cutting-edge technologies, but also actively addressing disparities in access that may arise.

Determining liability in cases of diagnostic errors perpetuated by AI technologies becomes a critical concern as well. To begin with, while designers and coders play a crucial role in developing AI models, they may not necessarily bear the ultimate responsibility for diagnostic errors. Instead, legal frameworks often attribute responsibility to the healthcare professionals who make diagnostic decisions based on AI recommendations.

Hospitals and healthcare organisations also have a duty to ensure the safe and ethical use of AI tools, including proper training for clinicians, transparent communication with patients, and robust systems for monitoring and addressing errors.

In government-funded institutions, government agencies advocating for AI use may bear some responsibility for ensuring the appropriate implementation and oversight of AI technologies in healthcare settings. However, the ultimate responsibility often still lies with the healthcare professionals who make diagnostic decisions based on AI recommendations.

In terms of the accountability of individual coders, errors in AI algorithms may result from negligence or intentional misconduct. However, the source of training and testing data, which may contain inherent biases or flaws, also contributes to the performance of AI models.

Addressing legal issues related to wrong diagnoses in AI-assisted radiology, therefore, requires a comprehensive approach that considers the roles and responsibilities of all stakeholders involved.

Attention to detail

Attention to detail, as a part of virtue ethics, is of paramount importance in the development and implementation of novel technologies in algorithmic radiology [45]. Unlike standard ethical concerns, virtue ethics calls for the radiologist's commitment to actively scrutinize algorithmic outputs for subtle biases that could affect underrepresented groups. For example, a virtuous radiologist might routinely check AI recommendations against a diverse patient dataset to catch any disparities in diagnoses. This approach fosters a culture of proactive bias detection and correction, ensuring that innovative tools are held to high ethical standards and truly serve all patient demographics fairly.

Global equality

In resource-limited settings, where funding and training data may be scarce, virtue ethics guide radiologists to confront the dilemma of global healthcare equality. Virtuous radiologists should actively engage in initiatives that bridge the gap, advocating for research and development that considers the unique challenges of low-resource settings [46].

Furthermore, it is essential to highlight the importance of equitable distribution of training data and the inadequacies in data-sharing practices. The present lack of equitable access to training data not only hinders the development of AI technologies tailored to the needs of underserved populations, as mentioned earlier, but also perpetuates healthcare inequalities on a global scale. Addressing this issue requires a concerted effort to promote data-sharing initiatives which prioritise inclusivity and transparency, ensuring that AI algorithms are trained on representative datasets which reflect the diversity of patient populations worldwide.

The far-reaching implications of underrepresentation have been discussed later.

Utilitarian perspectives

Utilitarianism, a consequentialist ethical theory, anchors its moral framework in the principle of achieving the greatest overall happiness or wellbeing for the maximum number of individuals. Its role in the context of medicine and radiology — particularly within the context of algorithmic radiology — affects decision making, resource allocation, and ethical considerations.

Medical decision making

In medical decision making, the utilitarian approach seeks to maximise benefits across diverse patient cohorts. However, the current application of AI in radiology reveals significant underrepresentation in training data as well as access to AI-assisted healthcare, particularly of patients from underserved regions [47], as mentioned in the previous section. This imbalance introduces bias, exacerbating disparities in healthcare access. Funding and resource allocation must be strategically directed to rectify this underrepresentation and ensure equitable access to these innovative healthcare technologies.

Public health considerations

In the context of public health, a utilitarian perspective mandates a decision-making process that effectively allocates imaging technologies and AI-assisted diagnostic tools to address prevalent health issues. However, the challenge lies in reconciling potential benefits for the maximum number with the imperative for representation and accessibility. Recognising current social inequities, meticulous strategies must be formulated to align distribution with the goal of achieving maximal improvement in overall health and wellbeing of populations.

Balancing benefits and harms

Utilitarian considerations can be applied to balance the benefits and potential harms in the development and implementation of AI algorithms in radiology as well. They can steer efforts towards enhancing diagnostic accuracy, reducing radiologists' workloads, and ultimately improving patient care.

Underrepresentation

Despite its potential benefits, utilitarian perspectives in algorithmic radiology encounter ethical challenges. The underrepresentation of specific demographic groups introduces biases that may perpetuate healthcare disparities.

First, this can result in biased algorithms that disproportionately affect certain populations. For example, if a dataset primarily consists of images from individuals of a particular ethnicity or gender, the algorithm may not perform as accurately when applied to patients from underrepresented groups. This can lead to misdiagnoses or inadequate treatment recommendations for those patients, exacerbating existing healthcare disparities.

Secondly, the lack of diversity in training data can reinforce and perpetuate societal biases within healthcare systems. For instance, if historical biases exist in medical practices or diagnostic criteria, these biases may be inadvertently coded into AI algorithms trained on biased datasets. As a result, the algorithm may systematically disadvantage certain demographic groups.

Moreover, this also hinders the development of AI technologies that cater to the needs of a diverse patient population. This can limit the effectiveness and applicability of AI in addressing healthcare disparities on a broader scale.

Ethics meet innovation

The integration of AI in radiology necessitates a profound consideration of human values. Ethical frameworks — including principles of fairness, justice, and patient autonomy — must guide development and deployment of algorithmic systems. Ensuring that AI technologies align with these values is imperative to maintain the integrity of patient care and uphold the dignity of individuals impacted by these advancements [48].

Beyond adherence to ethical principles, however, this discussion extends to the broader concept of wellbeing. How does the integration of algorithmic technologies contribute to the overall wellbeing of patients and healthcare systems? This inquiry requires a critical examination of their impact on diagnostic accuracy, patient outcomes, and the efficiency of healthcare delivery.

In addition, it is crucial to address the concept of the "black box" phenomenon. The term "black box" refers to AI algorithms that produce outputs without providing insight into the underlying decision-making process. While these algorithms may yield accurate results, the lack of transparency raises ethical concerns. For radiologists, understanding the "black box" concept is essential, because it impacts their ability to trust and interpret AI-generated recommendations. Without visibility into how AI algorithms arrive at their conclusions, radiologists may struggle to assess the reliability and validity of the outputs.

This lack of transparency is particularly concerning in contexts where radiologists may have limited access to additional diagnostic tools or second opinions. In these settings, the reliance on AI algorithms as a key or sole diagnostic aid magnifies the importance of understanding how these algorithms work, and the potential limitations associated with their use.

Furthermore, the "black box" phenomenon can exacerbate disparities in healthcare access and outcomes, as radiologists in resource-limited contexts in the future may become disproportionately reliant on AI technologies without fully comprehending their inner workings.

It is also important to educate clinicians on the "black box" phenomenon to ensure that they are aware of the existing uncertainties within algorithmic AI.

Call to action and conclusion

As we delve into the philosophical dimensions of technology in algorithmic radiology, however, a call to action emerges. Future perspectives should emphasise interdisciplinary collaboration, transparency, and ongoing dialogue to address emerging ethical challenges. This involves developing guidelines, standards, and frameworks which not only align with current ethical principles but also anticipate and adapt to the evolving nature of technology.

The current landscape of AI in radiology lacks clear guidelines and regulatory frameworks to ensure the responsible and ethical development, deployment, and use of AI algorithms. Without adequate regulations, there is a risk of unchecked biases, privacy breaches, and disparities in healthcare delivery. To address this gap, policymakers must collaborate with experts in healthcare ethics, technology, and law to establish enforceable standards for AI in radiology. These standards should encompass issues such as data privacy, algorithmic transparency, fairness, and accountability. Additionally, regular audits and evaluations should be conducted to assess compliance with ethical guidelines and identify areas for improvement.

By fostering a global dialogue with key stakeholders — including researchers, developers, policymakers, and healthcare professionals — on AI-related ethics in radiology, we can work together to mitigate risks and promote the responsible use of technology for the benefit of patients and of society as a whole. In this context, the recent multi-society statement from the American College of Radiology (ACR), Canadian Association of Radiologists (CAR), European Society of Radiology (ESR), Royal Australian and New Zealand College of Radiologists (RANZCR), and Radiological Society of North America (RSNA) represents a significant step in the right direction — towards ensuring the carefully considered development and implementation of AI in radiology [49].

We need to take a conscientious approach to AI integration, one that respects human values, upholds dignity, and contributes meaningfully to the population's overall wellbeing. By embracing this ethos, we pave the way for a future where technology enhances healthcare ethically, aligning with our shared commitment to the betterment of human health and society.

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